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5 services of Drones for increased airports and waterways safety and security

D2.1 Synthesis of the Regulatory Framework and Concept of Operations V1

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Executive Summary

This document presents the initial concept of operation for the 5D-AeroSafe H2020 project. Based on the review of existing ConOps, and the ongoing effort to define the use cases that will be trialled in the project, we identify the reference frameworks: the CORUS ConOps related to U-space and the SORA UAS Annex A initiating a risk assessment for drone operations in the UE specific category.

The second section gives an overview of the rulemaking and standardization activities that are relevant for the project: existing drone regulation and standards, and the upcoming draft U-space regulation. Some related research and development projects are described.

The third section lists the draft use cases that have been developed so far. As this is an ongoing work, we give a description of ten missions that are part of three scenarios: at a major airport (Heathrow), at a waterport (Corfu), and at another airport (Rhodes).

The fourth section highlights the required elements for the ConOps and describes the overall 5D-AeroSafe operational concept: overview of the location of the operations, focus on aerodrome specifics and UAS geographical zone, roles and responsibilities, types of drone operations, technologies, U-space services, communication and safety management.

We conclude with our assumptions with regard to the type of operations we will perform, and the coverage of the ConOps so far, in order to fuel the iterative process leading to the next revision of this document.

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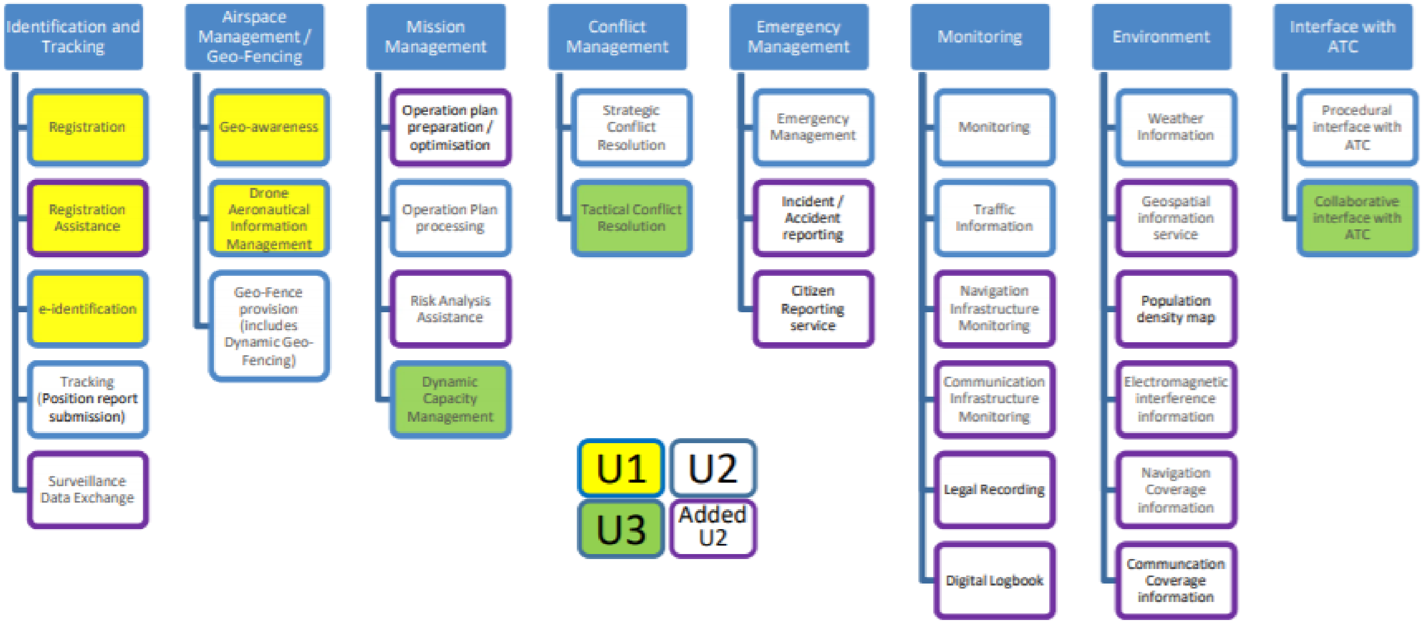

Figure 5 U-space services

Glossary of terms and abbreviations used

Abbreviation / Term	Description
AIP	Aeronautical Information Publication
AMSL	Above Mean Sea Level
ANSP	Air Navigation Service Provider
ARC	Air Risk Class
ARP	Airport Reference Point
ATC	Air Traffic Control
ATM	Air Traffic Management
ATSEP	Air Traffic Safety Electronics Personnel)
ATZ	Airport Traffic Zone
BVLOS	Beyond-visual-line-of-sight
CIS	Common Information Provider
CNS	Communication, Navigation and Surveillance
DAA	Detect and Avoid
DME	Distance Measuring Equipment
EASA	European Aviation Safety Agency
FAA	Federal Aviation Administration
FIMS	Flight Information Management System
FIMS	Flight Information Management Service
GRC	Ground Risk Class
GUTMA	Global UTM Association
IAS	Indicated Air Speed
ICAO	International Civil Aviation Organisation
IFR	Instrumental Flight Rules
NAA	National Aviation Authority
NASA	National Aeronautics and Space Administration
NOTAM	Notice to Airman
OLS	Obstacle Limitation Surface
OSO	Operational Safety Objectives
RID	Remote Identification
RPAS	Remotely Piloted Aircraft Systems
RPIC	Remote Pilot in Command
SAIL	Specific Assurance and Integrity Level
SESAR	Single European Sky ATM Research
SORA	Specific Operations Risk Assessment
UAS	Unmanned Aircraft Systems
USS	U-Space Service
UTM	Unmanned Traffic Management
VFR	Visual Flight Rules
VHF	Very High Frequency
VLOS	Visual-line-of-sight
VOR	VHF Omnidirectional Range

1 Introduction

Drones represent a rapidly growing sector of aviation in Europe and worldwide – potentially offering a myriad of services to businesses and citizens but placing new demands on the airspace around us. Estimates vary on the volume and value of the drone industry in the future. However, the European drones outlook study estimates that as many as 400 000 drones will be providing services in the airspace by 2050, and that the total market value will be more than EUR 10 billion annually by 2035. Recognising the huge potential available, the European Commission launched U-space in 2016 – an initiative aimed at ensuring the safe and secure integration of drones into the airspace.

Within the Work Package 2 (WP2) of the 5D-AeroSafe project, there are efforts to define use-cases, user requirements, tracking the evolutions of the regulatory framework for drone operations in the context of a U-space enabled environment. This document presents the initial version of our concept of operations, that aims to define the environment within which the operations of the project will take place. The definition, planning and execution of the operations will be based on the provisions of applicable framework documents (regulations, ConOps, etc). Possible gaps are addressed with educated and justified assumptions. This project's ConOps is the definition of the operations, the sum of the relevant framework documents and the necessary justified assumptions.

As the building process of use cases is an ongoing work until the delivery of D2.2, this first CONOPS in D2.1.1 is just a preliminary version, that will be updated in D2.1.2. The rulemaking and standardization activities in E.U. are also a moving target, especially in the field of U-space and related technologies and organizations. Likewise, many research and development activities are still going on, under the tutelage of SESAR2020 or other H2020 research frameworks. As mentioned in many documents describing CONOPS, this is an iterative work allowing further tasks: architecture, technology development, safety analysis, and ultimately filing a permit to fly for actual operations.

Since the rise of drone-related activities, many documents are mentioning drone ConOps, UTM and U-space ConOps. We will first give an overview of the related material.

1.1 Overview of existing CONOPS

The CONOPS notion stems in the systems engineering discipline. Over the years, different CONOPS have been published describing the characteristics of the systems to make information available to different stakeholders. A definition can be found in the **ISO/IEC/IEEE 29148:2018 Systems and software engineering — Life cycle processes — Requirements engineering** norm (ISO, ISO/IEC/IEEE 29148:2018, 2018): "verbal and graphic statement, in broad outline, of an organization's assumptions or intent in regard to an operation or series of operations". It aims at providing a **conceptual view of the system**, including preliminary diagrams describing the **architecture** and functional blocks, and illustrations of top-level activities in a predefined operation. It should also set some qualitative and quantitative **performance requirements**. From our project point of view, the ConOps will gather the rationale from **end-user's** perspective (users, organizations, supporters, trainers), and cover the **operating space**, **systems capabilities**, human and technological resources, and **organization** to achieve the operations, which will be described in **an operational scenario** (ISO, ISO/IEC/IEEE 15288:2015, 2015)**.**

Drone operations has led to the description of operations from a safety perspective. EASA has published different materials, including the **Concept of Operations for Drones – A risk-based approach to regulation of unmanned aircraft** (EASA, Concept of Operations for Drones – A risk based approach to regulation of unmanned aircraft , s.d.) which has paved the way to the 2019 E.U. regulations. JARUS has developed the SORA methodology, whose many steps start from the analysis of a proposed ConOps developed in step #1, stating: "The Annex **A of Guidelines on SORA** from JARUS (JARUS, JARUS guidelines on SORA - Annex A - Guidelines on collecting and presenting system and operation information for a specific UAS operation, 2017) provides detailed framework for data collection and presentation. The ConOps description is the foundation for all other activities and should be as accurate and detailed as possible. The ConOps should not only describe the operation, but also provide insight into the operator's operational safety culture. It should also include how and when to interact with ANSP (refer to Annex J). Therefore, when defining the ConOps the operator should give due consideration to all steps, mitigations and operational safety objectives". Here again, the ConOps development is meant to be iterative, and end up in a document describing the envisioned operations in an accurate fashion. The analysis of this ConOps will lead to the Air Risk Class and Ground Risk Class, and provide insight on the Operational Safety Objectives (OSOs), Specific Assurance and Integrity Levels (SAILs), etc. This SORA methodology has been accepted as one of the Acceptable Means of Compliance (AMC) for the European regulation, see section 2.3. The Annex A provides an overview of the SORA UAS Annex A. Another AMC lies in the use of standards scenarios, such as the STS-01 (JARUS, JARUS STS 01, 2019) and the STS-02 (JARUS, JARUS STS 02, 2019), which are quite comprehensive ConOps examples that we will be using in the project.

Other ConOps can be used for reference but are related to bigger drones (RPAS) in IFR environment, such as the ConOps defined by the ICAO in **Annex 2 Appendix 4 – Remotely Piloted Aircraft Systems** (ICAO, 2017), describing the vehicle (RPA), its ground control station (RPS), the C2link, operational safety systems, system interfaces, special considerations including human factors, and airworthiness. We can also mention the more global ICAO ATM operational concept, or an attempt to merge UAS and ATM in the **UAS ATM Integration Operational Concept** released by EUROCONTROL (EUROCONTROL, 2018), proposing solutions to harmonize the two worlds to address the emerging risks, describing different organisations based on the requirements of each airspace classification, and defining two new sets of flight rule-based operations: Low level Flight Rules and High level Flight Rules (LFR, HFR).

Both EASA ConOps and SORA ConOps emphasize a risk-based approach focusing on the drone operation in isolation, according to the different member states policies, and promotes a segregated operation. The advent of the UTM, U-space and other UAS traffic management initiatives has opened the door to other approaches: many countries and organizations have initiated R&D, rulemaking, and standardization work on the UAS traffic management. We can mention the conceptual framework developed in the USA since 2013, leading to the **FAA UTM ConOps v2.0** (FAA, UTM Concept of Operations v2.0, 2020), and the European U-space initiative, described in section 4.6, leading to the CORUS ConOps (SESAR project CORUS, 2019) as part of R&D efforts, and to the rulemaking and standardization process presented in section 2.4. More than just a conceptual or rulemaking process, UTM and U-space are now a reality, with industrial products deployed in many environments, including airports. This has led international organizations, such as the ACI, to promote their **Drones Policy Paper** (ConOps for drones in airport environment) (ACI, Drone Policy Paper, 2018), that shows how to include drone operation ConOps, U-space ConOps, and their benefits for safety assessment for UAS flights in the premises of a busy airport.

1.2 Take away for the 5D-AeroSafe CONOPS

From our project's perspective, building our own ConOps from scratch is outside of the scope of the project. Indeed, the project has to identify the environment (applicable rules, regulations, foreseen supporting services etc) it will operate in, as described in the various ConOps and other documents. It has to be stated that the purpose of this document is to bring together the applicable parts of the various regulatory and ConOps documents that help define the operations of the project. As the rulemaking process in E.U. seems to track the CORUS ConOps R&D efforts with regards to U-space, we have chosen to reuse some of its key findings (the different U-space services, the trade-off services/air space in X Y Zu Za), they are described in section 4.6. However, the project will hold live trials in airport environments, and will require us to apply for a permit to fly. As we want to showcase the technological research level of the 5D technologies and the maturity of our solution, we aim at using a standard application, which will be either STS or SORA based. It requires that the final version of this document (upcoming D2.1.2) contains all the elements required for the first step of the SORA methodology.

For the current version D2.1.1, we focus on the information we can gather from end user requirements and draft use cases, such as they have been described so far:

- Areas of operations
- Stakeholders
- Draft operational concept
- Technologies available or bound to be developed and interconnected during the 5D project

In order to identify the updates and list the required information, it is paramount to take into account the regulatory framework and its foreseen evolutions. Therefore, section 2 will present the different fields related to regulations, standards and R&D projects that are of interest for the 5D-AeroSafe project. Then, because regulations and standards depend on the nature and parameters of the operation, an overview of the use cases identified in the scope of the project will be provided in section 3. Then, using the definition of these use cases, a more precise definition of the operational concept is provided in section 4.

2 Regulation synthesis

2.1 Introduction – Overview of the relevant fields of regulation

This section aims at giving an overview of the different regulations, standards and guidelines that apply to the missions of the 5D-AeroSafe project.

First, manned aviation regulations must be considered. Indeed, the 5D-AeroSafe project aims at providing services for increased safety of manned aviation operations. Therefore, the knowledge of these regulations will allow us to clearly define the objective of the missions of this project. Furthermore, as manned aviation regulations also apply to UAS, and as UAS may have to be integrated in manned airspace for some missions of the 5D-AeroSafe project, these regulations must be known and respected for the operations defined in the project.

On a worldwide scale, general aviation regulations come from ICAO's Standards and Recommended Practices (SARPs) and its Annexes. ICAO Annex 2 (Rules of the Air) and parts of ICAO Annex 3 (Meteorology), Annex 10 (Communication Procedures), Annex 11 (Air Traffic Services) and Doc 4444 (PANS-ATM) have been translated by EASA into the Standardized European Rules of the Air (SERA) for the European context. The SERA is defined in the Commission Implementing Regulation (EU) 2012/932 and Commission Implementing Regulation (EU) 2016/1185 amending 923. However, even though European states are required to respect these regulations, they are still the ones responsible for the definition of their airspace, the issuance of special authorizations or limitations like NOTAMs, and security related matters.

Amongst the regulations applying to all type of aircrafts (manned and unmanned), regulations and standards specific to UAS also exist. On the European level, a distinction must be made between two type of regulations:

- Hard/binding laws like Commission Delegated Regulations (DR) or Commission Implementing Regulations (IR)
- Soft/non-binding laws like Acceptable Means of Compliance (AMC) or Guidance Material (GM)

It must be mentioned that since the withdrawal of the UK from the European Unions, a new regulatory situation has emerged. According to the CAA website (https://www.caa.co.uk/Our-work/About-us/UK-EU-transition/), during the transition, EASA regulation will still be the norm. However, after the transition, the CAA will have the authority on rulemaking. They aim at keeping regulations similar to European's ones, in order to facilitate collaboration with European member states.

Standards are also being developed for UAS and U-space by Standards Developing Organizations (SDOs).

Finally, U-space regulations and the problematic of UAS integration in ATM must be considered. Indeed, the 5D-AeroSafe project will rely on U-space services. The missions of the project, as they will take place in airport and waterport environments, will also raise the problematic of the integration of UAS in manned airspace. These fields are still emerging, and mainly develop as research projects. However, these projects provide a good overview of the challenges of these fields and allow the concept of U-space to evolve towards more standards and regulations.

In the above-mentioned fields, regulations of different nature coexist binding rules, non-binding rules, standards, and research projects. We will discuss more in detail these different regulations and standards.

2.2 Binding rules

Binding rules are regulations that must be followed by all states for which they have been defined. Amongst these binding rules are ICAO's SARPs & Europe's SERA that apply to all aircrafts, including UAS. A specific appendix in **ICAO Annex 2 "Rules of the air" (Appendix 4. Remotely Piloted Aircraft Systems)** (ICAO, 2017) is about the use of UAS.

The European Commission (EC) defines the regulations that members states implement through laws, using Implementing Regulations (IR) and Delegated Regulations (DR). These regulations are binding laws. Amongst these regulations is the **EU 2018/1139 on High Uniform Level of Civil Aviation Safety** (THE EUROPEAN PARLIAMENT AND THE COUNCIL, 2018), of which Section VII is about unmanned aircrafts. It defines essential requirements for the UAS and their components.

Two other regulatory documents are now the cornerstone of the new European UAS regulation: The **Commission Delegated Regulation 2019/945 on Unmanned Aircraft Systems and on Third-Country Operators of Unmanned Aircraft Systems** (EUROPEAN COMMISSION, Commission Delegated Regulation (EU) 2019/945, 2019) and the **Commission Implementing Regulation 2019/947 of on the Rules and Procedures for the Operation of Unmanned Aircraft** (EUROPEAN COMMISSION, Commission Implementing Regulation (EU) 2019/947, 2019).

The IR 2019/947 defines 3 drone operation categories:

- Open category:

The open category is a category of UAS operation that, considering the risks involved, does not require a prior authorization by the competent authority nor a declaration by the UAS operator before the operation takes place.

- Specific category:

The specific category is a category that, considering the risks involved, requires an authorization by the competent authority before the operation takes place, considering the mitigation measures identified in an operational risk assessment, except for certain standard scenarios where a declaration by the operator is sufficient or when the operator holds a Light UAS operator Certificate (LUC) with the appropriate privileges.

- Certified category:

The certified category is a category that, considering the risks involved, requires a certification of the UAS, a licensed remote pilot and an operator approved by the competent authority, in order to ensure an appropriate level of safety.

The LUC is a license delivered by the National Aviation Authority (NAA). The LUC requirements are described in **the subpart C of the Draft Annex (Part-UAS) to Draft Commission Regulation (EU) …/… "Laying Down Rules and Procedures for the Operation of Unmanned Aircraft"** (EUROPEAN COMMISSION, Draft Annex (Part-UAS) to Draft Commission Regulation (EU) …/… "Laying Down Rules and Procedures for the Operation of Unmanned Aircraft", 2020).

Some laws are not about UAS themselves but rather about the U-space or UTM concept.

Amongst these are the UTM Guidance from ICAO: **UTM - A Common Framework with Core Boundaries for Global Harmonization - Edition 3** (ICAO, 2020). This document is intended to provide States that are considering the implementation of a UTM system, with a framework and core capabilities of a "typical" UTM system.

"The aim of UTM is the safe, economical, and efficient management of UAS operations through the provision of facilities and a seamless set of services in collaboration with all parties and involving airborne and ground-based functions. Like ATM, a UTM system would provide the collaborative integration of humans, information, technology, facilities, and services, supported by air, ground and/or space-based communications, navigation, and surveillance.

UTM systems are therefore envisaged to be interoperable and consistent with existing ATM systems in order to facilitate safe, efficient and scalable operations. Although system-level requirements for UTM systems have not yet been *developed, core principles can be established that will guide their development. There are also numerous principles that exist in the current ATM structure that are applicable to UTM services."* (ICAO, 2020)

On the European side, EASA has also produced such a document: **Opinion 01/2020 - High-level regulatory framework for the U-space** (EASA, 2020). The objective of this Opinion is to create and harmonise the necessary conditions for manned and unmanned aircraft to operate safely in the U-space airspace, to prevent collisions between aircraft and to mitigate the air and ground risks. Therefore, the U-space regulatory framework, supported by clear and simple rules, should permit safe aircraft operations in all areas and for all types of unmanned operations. As such, this document is not yet binding but it paves the way for a Commission Regulation.

The European project CORUS developed a **ConOps for European UTM systems** (SESAR project CORUS, 2019). This ConOps was assumed by EASA. The SERA will evolve in 2021 with the integration of new regulations on U-space according to the conclusions of CORUS.

2.3 Non-binding rules

Adding to the above-mentioned binding rules, several non-binding rules exist for UAS. These non-binding rules are mainly Acceptable Means of Compliance (AMCs) or Guidance Material (GMs) issued by the EASA.

The **AMC and GM to Part-UAS - UAS operations in the 'open' and 'specific' categories – Issue 1** (EASA, AMC and GM to Part-UAS - UAS operations in the 'open' and 'specific' categories – Issue 1 , 2019) defines the different limitations and regulations for the operations in the "open" and "specific" categories, as well as the Light UAS operator Certificate (LUC).

For UAS operations in the specific category, AMCs and GMs exist to allow the operator to show that his operation can be carried out in a safe manner. These AMCs are defined in the Article 11 of the IR 2019/947 (EUROPEAN COMMISSION, Commission Implementing Regulation (EU) 2019/947, 2019) and described in the **AMC and GM to Commission Implementing Regulation (EU) 2019/947 – Issue 1** (EASA, AMC and GM to Commission Implementing Regulation (EU) 2019/947 – Issue 1, 2019). They are as follows:

- Being in the scope of standard scenarios ((UE Commission, 2020) (EASA, Opinion 05/2019, 2019)). Existing scenarios have been defined by JARUS according to SORA:
  - STS 01: VLOS, height<120m (JARUS, JARUS STS 01, 2019)
  - STS 02: BVLOS, distance<2km, height<120m (JARUS, JARUS STS 02, 2019)
- Being in the scope of a Predefined Risk Assessment (PDRA) and showing compliance with its requirements
- Carrying out a SORA analysis and showing compliance with its requirements

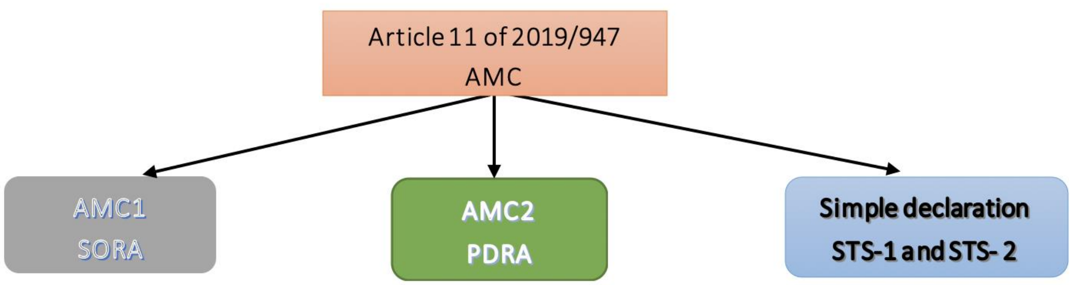

Figure 1 - AMCs related to the Article 11 of 2019/947

The EASA has also issued in 2020 a **Notice of Proposed Amendment (NPA 2020-07)** (EASA, Notice of Proposed Amendment 2020-07 , 2020) to clarify the conditions under which UAS in BVLOS operations over a populated area or an assembly of people can be authorised in the 'specific' category. This NPA proposes to amend the AMC and GM to Commission Implementing Regulation (EU) 2019/947. The AMC and GM to Article 11 'Rules for conducting an operational risk assessment' of said Regulation are proposed to be amended to define the intrinsic UAS ground risk classes (GRCs) for the following operational scenarios:

- BVLOS operations over a populated area; and
- BVLOS operations over an assembly of people.

The proposed amendments are expected to increase safety, improve harmonisation among EASA Member States, and facilitate societal acceptance of UAS BVLOS operations in the 'specific' category.

The EASA has issued a **Policy Statement on the Airworthiness Certification of Unmanned Aircraft Systems** (EASA, Policy Statement on Airworthiness Certification of Unmanned Aircraft Systems - E.Y013.01, 2009). This policy establishes general principles for type certification (including environmental protection) of an Unmanned Aircraft System.

Until today, the certification standards of UAS have been either derived from manned aircraft Certification Specifications (CS) or defined with Special Conditions (SC) based on documentation developed and published by JARUS. Therefore, EASA decided to develop a dedicated **Special Condition for Light UAS** (EASA, Proposed Special Condition Light UAS, 2020). It defines standards for the conception of light UAS depending on the operations they will carry out. EASA had produced in 2015 another SC, which applies to all RPAS's equipment, systems, and installations: the **SC-RPAS.1309-01** (EASA, Proposed Special Condition SC-RPAS.1309-01, 2015).

2.4 Standards

Standards define conception or implementation rules in order to create a common and unique framework for diverse stakeholders. They are defined by Standards Defining Organizations (SDOs).

Standards exist for the conception and use of UAS. The following paragraph provides an overview of the relevant standards for UAS.

On the American side, the American National Standards Institute (ANSI) Unmanned Aircraft Systems Standardization Collaborative (UASSC) produced a document on **Standardization Roadmap for Unmanned Aircraft Systems** (UNMANNED AIRCRAFT SYSTEMS STANDARDIZATION COL., 2020). It identifies existing standards, assesses gaps, and makes recommendations where there is a need for additional standardization. Its fields of study are airworthiness, flight operations, and personnel training, qualifications, and certifications.

The European UAS Standards Coordination Group (EUSCG) produced a document, the **EUSCG 108 version 50 RDP 2020**, summarizing the work achieved or still in progress to define standards for the conception and use of UAS and its services. It provides an overview of the ongoing projects of the Standards Developing Organizations (SDO), such as EUROCAE, ASTM, ISO, IEEE.

EUROCAE has produced a document on **Safe Design Standards for UAS in Specific Operations Category** (EUROCAE, 2020). It contains guidelines for a UAS operator or manufacturer to obtain evidence that the UAS is designed considering system safety and reliability. It also allows to perform the safety analyses to fulfil part of OSO#5 requirement ("*The equipment, systems, and installations are designed to minimise hazards in the event of a probable malfunction or failure of the UAS")* for its different levels of robustness as part of the SORA risk assessment, which is required for an operation in the specific category. EUROCAE also dedicated a working group to standards development for UAS: the **WG 105 / Unmanned Aircraft Systems (UAS): "***WG-105 is tasked to develop standards and guidance documents that will allow the safe operation of UAS in all types of airspace, at all times and for all types of operations*". WG-105 works in coordination with **RTCA SC-228 for Unmanned Aircraft Systems** (RTCA, s.d.).

Other standards also exist for the definition and implementation of U-space services. These standards are made available by the **AW-Drones project**, a H2020 project, on their platform: https://standards.aw-drones.eu/. Amongst these standards are the **ISO TR 23629 - UAS Traffic Management (UTM)**, the **EUROCAE WG105 SG 31**, and various others.

2.5 Research projects

To pave the way for more regulations and standards, many projects on UAS integration and U-space exist. They provide an overview of the challenges of these fields, as well as solutions for these challenges.

The SESAR Joint Undertaking has recently published a report on the results of European research projects on U-space: **SUPPORTING SAFE AND SECURE DRONE OPERATIONS IN EUROPE - Consolidated report on SESAR U-space research and innovation results** (SESAR Joint Undertaking, 2020). It provides an overview of the current coverage and maturity of U-space, as well as the future research and development needs.

The SESAR projects on U-space addressed various field of research, such as the development of a Concept of Operations for U-space (CORUS), or more specific U-space services like geofencing or strategic conflict resolution. The key findings presented in this document are shown on Figure 2.

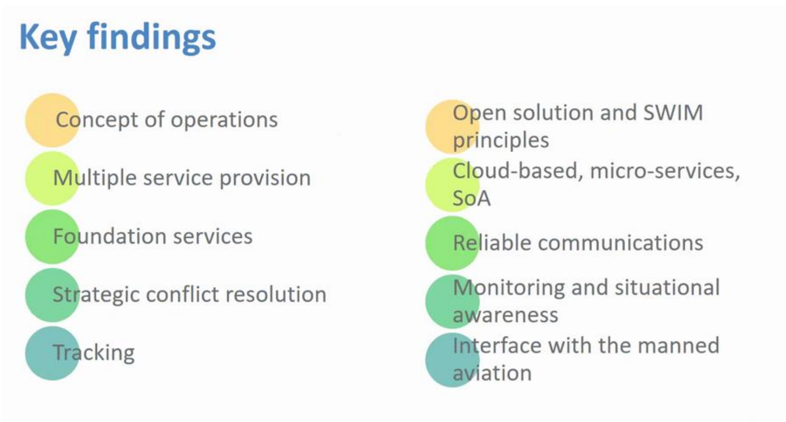

Figure 2 - Key findings of the Consolidated Report on SESAR U-space Research and Innovation Results (SESAR Joint Undertaking, 2020)

The different SESAR projects mentioned in this document allowed to identify the following U-space services (Figure 3).

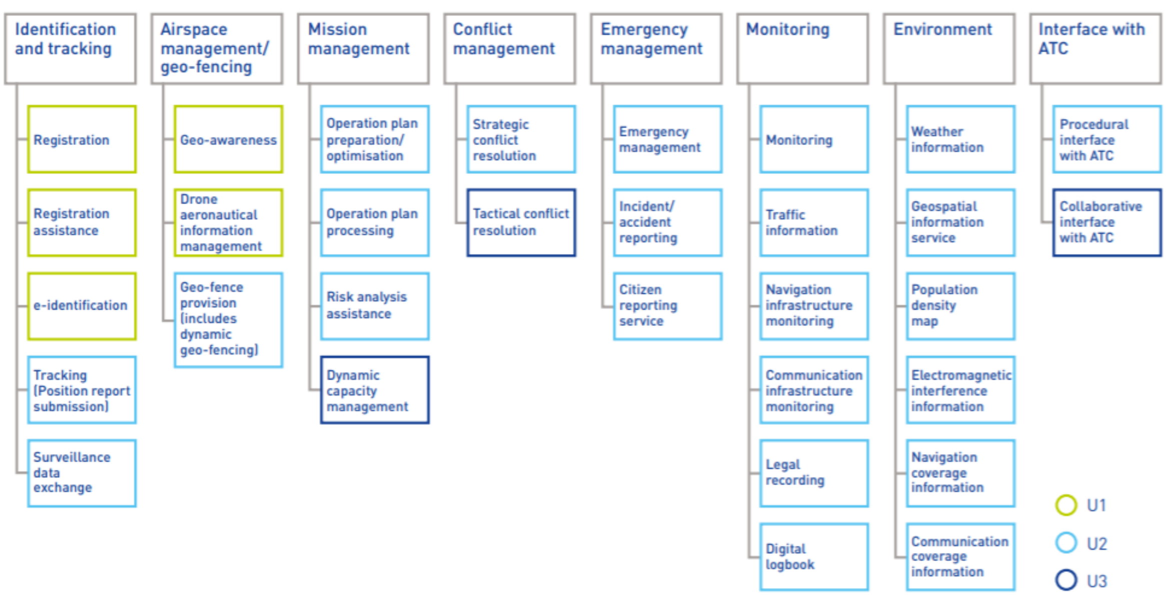

Figure 3 - List of U-space services (SESAR project CORUS, 2019)

The identification of the U-space services and the determination of different levels of maturity for the U-space (U1 to U4) allowed to determine the coverage for each level. This shows the current state of knowledge and technologies for U-space services, as well as the future need for R&D. This information allows the 5D-AeroSafe project to better understand

U-space ConOps and which services it can use for its operations, as well as how it can contribute to the development of the demonstration of U-space services.

On the American side, several research projects also exist. Among them is a project on **UAS Integration at Airports** led by the FAA (FAA, UAS Integration at Airports: 5 Core Applications, s.d.). It proposes Five Core Applications for UAS use in Airports environment: obstruction analysis, airfield pavement inspections, wildlife hazard management: mitigation and detection/monitoring, perimeter security, aircraft rescue and firefighting.

2.6 Conclusion

This section provided an overview of the general regulations, standards and research projects that are relevant for the 5D-AeroSafe project. However, all these regulations, standards, and research projects depend on the operational parameters of the mission. Therefore, we need to define these missions in order to understand which regulations apply to them.

On top of existing and upcoming drone regulations, as seen in section 2.1, U-space is under a rulemaking and standardization process, with the next step in Q1 2021. We expect propositions with regards to SERA and AMCs mentioning standards identified in section 2.4. For the 5D project, we will try to identify which are the relevant regulations for the trials and foreseen operations using our technologies, both from drone and U-space perspectives.

In the following section, an overview of the different missions is provided in section 3. Although all the parameters of these missions are not defined yet, it allows us to understand the operational concept of these missions. This operational concept is detailed in section 4.

3 Operational Scenarios

The use cases presented in this section focus on different aspects of U-space operations within 5D-AeroSafe. The use cases present examples of processes, technologies, and techniques for accomplishing different operational needs. The following table provides an overview of the different missions. They are further detailed in the following sections.

Some technical terms mentioned in this section will be explained further in section 4.

As mentioned in the introduction, these use cases are not completely determined yet. This explains why some operational parameters are not defined yet.

Use case	Type of operation	Area of operation	Flight plan	Type of drone	Payload	Category of operation (expected)
Scenario 1 – Airport infrastructure						
5D UC1 -M1: Level 1 inspection of the runway	EVLOS or BVLOS	Airport environment – runway (CTR/Za)	Route along the runway (≃4km)	AtraxM or fixed wing depending on the speed required	Visual camera	Specific (STS 2)
5D UC1 – M2: Stands, taxiway and runway level 2 inspection (surface & lighting)	VLOS	Airport environment – taxiways (CTR/Za)	Route along the taxiway 3m AGL	AtraxM	Visual camera	Specific (STS 1)
5D UC1 – M3: Runway FOD inspection	EVLOS or BVLOS	Airport environment – runway (CTR/Za)	Route along the runway (≃4km)	Quadrotor or fixed wing depending on the speed required	Visual camera	Specific (STS 2)
5D UC1 – M4: Rooftop inspection for engineering work	VLOS or EVLOS	Airport environment – Building (CTR/Za)	Route along the rooftop	AtraxM	Visual camera and thermal camera	Specific (STS 1)
5D UC1 – M5: Perimeter control	BVLOS	Airport environment – Perimeter (CTR/Za)	Route avoiding flight areas and getting to the incident area	AtraxM or fixed wing	Visual camera or thermal camera	Specific (STS 2)
5D UC2: Corfu waterdrome						
5D UC2 - M1: Waterdrome visual inspection	VLOS	Waterdrome environment – facilities and waterways Inside Corfu's airport CTR(CTR/Za)		AtraxM	Visual camera	Specific (STS 1)

5D UC3: Rhodes airport						
5 UC3 – M1: Extended ground test of a VOR	Extended ground test of a VOR	Airport environment – close to the runway (CTR/Za)	Area/ stationary inspection	AtraxM	CNS Transceiver	Specific (STS 1)
5 UC3 – M2: Short range flight test	VLOS	Airport environment – over the runway (CTR/Za)	Route along the runway and the VOR half orbit	AtraxM	CNS Transceiver	Specific (STS 1)
5 UC3 – M3: DME/DME coverage evaluation	EVLOS or BVLOS	Around the airport – Rhodes airport CTR (CTR/Za)	Route	Fixed wing	CNS Transceiver	Specific (too extended for STS 2)

3.1 Use Case 1: Inspections at airports

The missions of the first scenario take place at potentially Heathrow airport. These missions are about inspection of the facilities and equipment of different areas of the airport: stands, taxiways and runways. Such missions are carried out by the Airside Safety Department (ASD). Inspection procedures at airports follow a three-tier methodology. This methodology is specific to Heathrow Airport, but all airports have to conduct regular airfield inspections.

- **Level 1 – L1**: A routine **daily** inspection of the movement area and airfield ground lighting by the staff of the Airside Safety Department (ASD). This inspection is generally carried out from a vehicle, and covers all the movement areas (Runways, Taxiways, Stands and Roads) and includes a horizon scan of the surrounding area looking for objects with the potential to infringe the OLS. Any equipment faults or defects found are reported to the Engineering Help Centre for passing to the respective engineering teams for rectification
- **Level 2 – L2:** A more detailed inspection of a specific area is carried out by ASD under the 'Taxiway and Stands Monitoring System' (TMS & SMS). The taxiways associated lighting and stands are each divided into 32 areas (see detail below), with **one area of each being inspected per day**. Runways are inspected at a frequency of half a runway each week. This inspection is either carried out from a vehicle, or on foot. Lighting inspections are carried out at night, with taxiway and stand surface inspections during daylight hours. Any equipment faults or defects found are reported to the Engineering Help Centre for passing to the respective engineering teams for rectification
- **Level 3 – L3:** An audit/inspection carried out by members of the airside management team on a **bi-weekly basis**. The airfield is split into 6 inspection zones. One zone is inspected every 2 weeks, which results in each zone being inspected around 3.5 times per year. This inspection checks L1 and L2 performance and allows the management team to gain a perspective of the operational condition of the airfield. A walking inspection of the runways is carried out twice a year by the airside management team and will include representatives from wider departments, including engineering.

The following sections present each identified mission during discussions with end-users in a more detailed way.

3.1.1 Mission 1: Level 1 inspection of the runway

The Airside Safety Department carries out four level 1 inspections of runways daily. These are:

- Pre-operations (before the first arriving aircraft)

- Mid-morning (usually between 0900z and 1030z)
- Mid-afternoon (usually between 1400z and 1500z)
- Dusk

The pre-operations and dusk inspections are carried out by a single ASD vehicle. The mid-morning and mid-afternoon inspections are carried out using two vehicles. All vehicles are in active radio contact with ATC at all times. In order to carry out these operations, one or multiple drones take off from one end of the runway and fly to the other end of the runway. Each are equipped with visual cameras. In order to be competitive with current inspections (around 10 minutes), the operation needs to be carried out at high speed, so it is expected that a further analysis will determine that the best option shall be to use fixed wind drones.

Type of operation	Area of operation	Flight plan	Type of drone	Payload	Category of operation
EVLOS or BVLOS	Airport environment – runway (CTR/Za)	Route along the runway (≃4km)	AtraxM or fixed wing depending on the speed required	Visual camera	Specific (STS 2)

This mission is carried out either in EVLOS or BVLOS. It cannot be done in VLOS due to the size of the runway. The drones fly all along the runway to capture images of its state. The drone used will by a quadrotor or a fixed wing drone depending on the speed required for the runway inspection. The operation takes place in an airport environment. As the operation is requested by ATC and takes place in a sensitive area, the DMO is in constant link with ATC through VHF. The Task Order is created by the ATC and sent to the DMO through U-space. For these inspections, the collision avoidance with aircrafts is ensured by the temporary closure of the runway. This operation is scheduled and takes place in one of the time slots mentioned above. An interesting approach would also be to perform a parallel to the runway high-speed flight using buffer times between aircraft in normal operation. The drone should be able to gather the images while flying following the previous aircraft and process them/send them to processing looking for surface faults. These use case has two positive impacts: safety (keeping people out of airside) and economic (potential increase of capacity, freeing one slot).

3.1.2 Mission 2: taxiway level 2 inspection (surface & lighting)

Level 2 inspection is carried out each day under the 'Taxiway Monitoring System'. This involves a slow speed driving or walking inspection of a particular area of taxiway. The whole taxiway system is inspected to a Level 2 standard over a 32-day period. Inspectors will raise maintenance requests via the Engineering Help Centre or flag areas for monitoring. Results from these inspections are used to inform preventative or minor maintenance requirements and wider decisions on capital asset replacement programmes

As part of a level 2 inspection of an area, the ASD deploy drones equipped with visual cameras to carry out the inspection. Area 23 (see figure) is taken as example for this mission. The pavement inspection takes place during daytime, and the lighting inspection takes place during night-time.

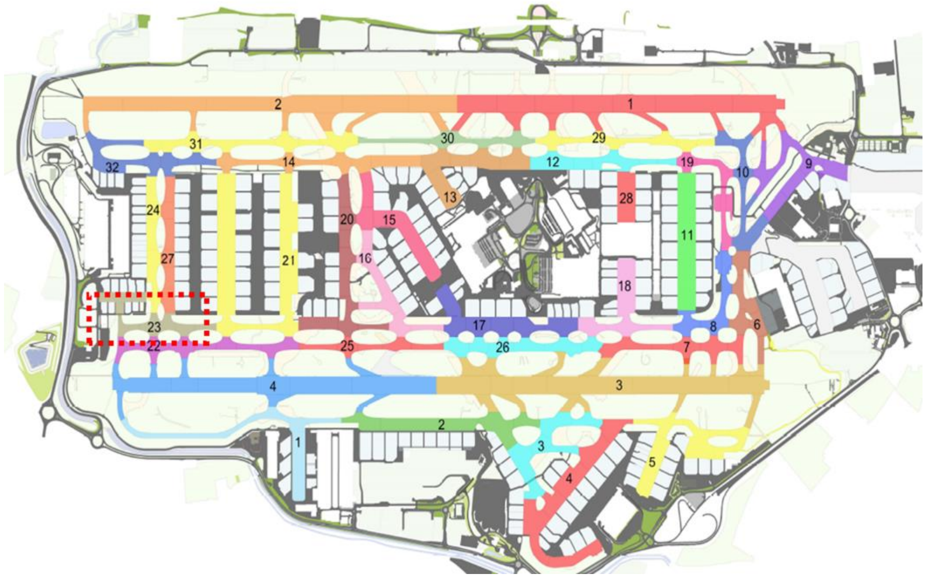

Figure 4 - Taxiway area inspection division

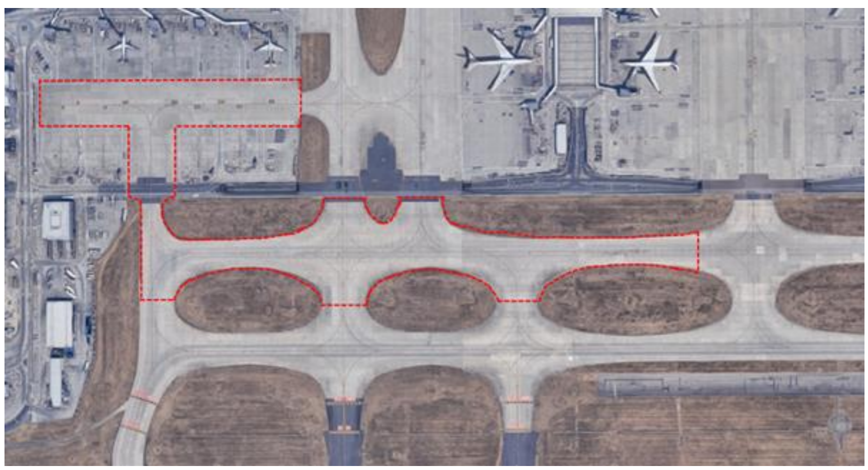

Figure 5 - Example of a 1/32 of the airport airfield

Type of operation	Area of operation	Flight plan	Type of drone	Payload	Category of operation
VLOS	Airport environment – taxiways (CTR/Za)	Route along the taxiway 3m AGL	AtraxM	Visual camera	Specific (STS 1)

The mission is carried out in VLOS and the drone is equipped with a camera for the inspection. In this mission, the drone used is a quadrotor drone. Furthermore, the mission is carried out at a height of 3m, which is ideal for visual analytics. This inspection requires coordination with the ATC and the other stakeholders of the airport. The flight plan for the mission is made available to the ATCO through U-space services, and the DMO is in constant link with ATM through VHF.

For this inspection, the collision avoidance with aircrafts is ensured by the closure of the area to inspect. These operations are scheduled operations. The pavement inspection operation takes place during daylight, at around 8 am. The lighting inspection takes place during night-time, either before 5 am or after 6 pm.

3.1.3 Mission 3: Runway FOD inspection

Warnings about the possible presence of Foreign Object Debris (FODs) on the runway can be issued by the ATC. After request of the ATC, the Airside Safety Department conducts a FOD runway inspection. One or multiple drones equipped with a visual camera take off from the end of the runway and fly to the other end, providing visual data for the detection of the FOD. Even though Heathrow Airport is equipped with Automatic Runway FOD detectors that perform this operation in around 2 minutes (full single runway scan), this operation can serve as a proof of concept for airports unequipped with such systems, like regional ones.

Type of operation	Area of operation	Flight plan	Type of drone	Payload	Category of operation
EVLOS or BVLOS	Airport environment – runway (CTR/Za)	Route along the runway (≃4km)	AtraxM or fixed wing depending on the speed required	Visual camera	Specific (STS 2)

The mission is carried out either in EVLOS or BVLOS, due to the size of the runway. For this inspection, the drone is equipped with a camera for the inspection. The drone used will be a quadrotor or a fixed wing drone depending on the speed required for the runway inspection. The operation takes place in an airport environment. As the operation is requested by ATC and takes place in a sensitive area, the DMO is in constant link with ATC through VHF. Task orderThis operation is not scheduled and is carried out upon request of the ATC. In this mission, the collision avoidance with aircrafts is ensured by the temporary closure of the runway.

3.1.4 Mission 4: Rooftop inspection for engineering work

Terminal buildings are inspected on a regular basis by the engineering team to determine its condition. An important aspect is the rooftop condition, that requires inspectors to climb to singular zones as the wave-formed Terminal 2.

Two main aspects are inspected, general and thermal enclosure condition.

Type of operation	Area of operation	Flight plan	Type of drone	Payload	Category of operation
VLOS or EVLOS	Airport environment – Building (CTR/Za)	Route along the rooftop	AtraxM	Visual camera and thermal camera	Specific (STS 1)

The mission is carried out either in VLOS or EVLOS due to the height of the building. For this inspection, the drone is either equipped with a camera for the visual inspection (RGB) and then with a thermal (FLIR) or uses a dual gimbal to just fly once. The drone used will be a quadrotor as precision is a key aspect and speed is not highly relevant. The operation takes place in an airport environment. As the operation takes place in a sensitive area (terminal buildings are close to the runways), the DMO is in constant link with ATC through VHF. Ideally, no runway/taxiway closure is needed, although some stands may present temporary restrictions.

3.1.5 Mission 5: Perimeter control

The primary vulnerabilities of most airport perimeters include the large geographic extent of the perimeter and, in some cases, periodically isolated areas along the perimeter with limited human traffic. A potential application of 5D-AeroSafe Technology may be linked with detection (awareness of the occurrence of an intrusion into the airfield) and response (providing situational awareness to Security teams) in order to ensure the safety of the airfield. The northern perimeter fence of the airport has a complicated road access and using drones for its surveillance is a good application of the technology.

Figure 6 - Nothern perimeter fence location

Figure 7 - Fence detail

Type of operation	Area of operation	Flight plan	Type of drone	Payload	Category of operation
BVLOS	Airport environment – Perimeter (CTR/Za)	Route avoiding flight areas and getting to the incident area	AtraxM or fixed wing	Visual camera or thermal camera	Specific (STS 2)

The mission in this case would be the fast deployment of a drone to provide situational awareness to Security reponse teams around a potential incursion or threat to the airport safety.

The mission is carried out in BVLOS as the drone will get to the incident area in advance of Safety response teams. The drone is equipped with a visual camera initially although for low light conditions it could also be equipped with a thermal camera to identify people. A multirotor or fixed wing drone may serve this purpose. The operation takes places under request, so coordination with ATC is key, but airport operations should not be disrupted.

3.2 Use Case 2: Water aerodrome visual inspection

This use case takes place at Corfu's water aerodrome. The water drome is located near Corfu's airport and harbour.

The missions aim at conducting regular and/or periodic visual flight inspections in order to ensure the safe and secure operation of seaplanes in the whole facility, during all stages of their movement. These inspections include:

- Internal and external areas
- Infrastructure and equipment
- Waterways

This use case consists of a single mission. Drones equipped with visual cameras take off from the water drome and carry out these inspections.

Type of operation	Area of operation	Flight plan	Type of drone	Payload	Category of operation
VLOS	Waterdrome environment – facilities and waterways Inside Corfu's airport CTR (CTR/Za)	?	AtraxM	Visual camera	Specific? (STS 1?)

The mission is carried out in VLOS. The drone is equipped with a camera for the inspection. The operation takes place in a water aerodrome environment. Collision avoidance with aircrafts or ships is ensured by the temporary closure of the area, with consultation with the relevant stakeholders of the water aerodrome and of nearby installations (harbour or airport traffic controllers). This operation can be scheduled or not. Some inspections must be carried out regularly, and other must be carried out on demand of stakeholders of the water aerodrome.

3.3 Use Case 3: Navaids inspection

The missions of this third use case take place in and around Rhodes airport.

Most of these missions are about navaids (VOR or DME) signal inspection. Two VOR/DMEs are in the vicinity of Rhodes airport: one at the end of the runway, and one in the mountains south of the airport.

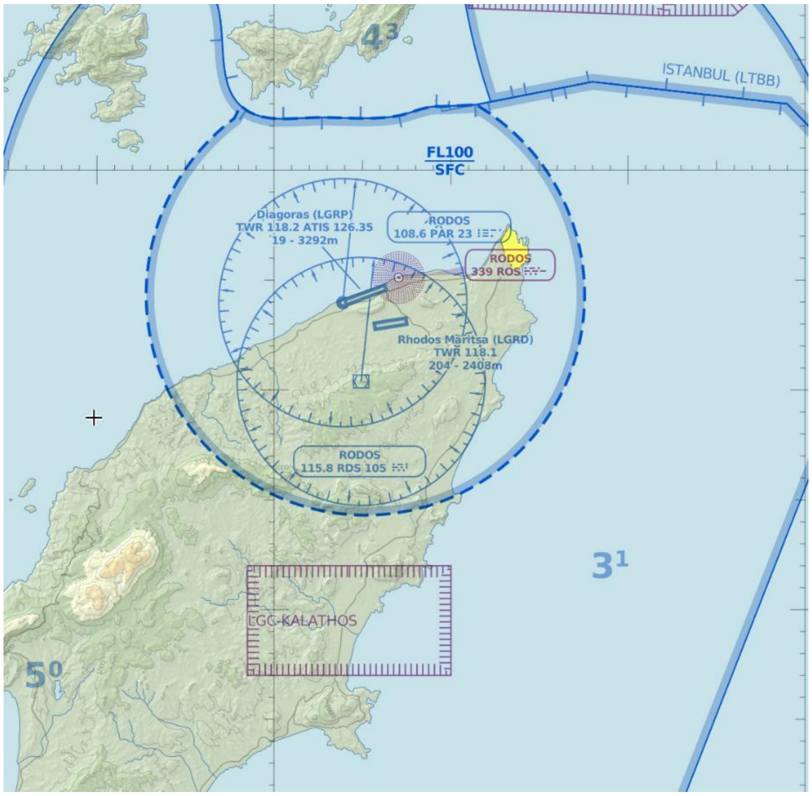

Figure 8 - Rodhes airport

3.3.1 Mission 1: Extended ground test of a VOR

ATSEPs (Air Traffic Safety Electronics Personnel) of an ANSP following a scheduled preventive maintenance on a VOR and a typical periodic ground test, decide to further inspect short range performance of the navigation aid (Terminal VOR). For this inspection, they deploy drones with measurement equipment close to the VOR.

Figure 9 - VOR inspection during an extended ground test

Type of operation	Area of operation	Flight plan	Type of drone	Payload	Category of operation
VLOS	Airport environment – close to the runway (CTR/Za)	Area/stationary inspection	AtraxM	CNS Transceiver	Specific (STS 1)

The mission is carried out in VLOS by the drone mission operator. The drone is equipped with a CNS Transceiver. The drone is a multicopter with VTOL capabilities (i.e., AtraxM). Its maximum speed is 5.6m/s. The operation takes place in an airport environment. Therefore, it requires coordination with the ATM and the other stakeholders of the airport. The flight plan for the mission is made available to the ATCO through UTM services, and the DMO is in constant link with ATM through VHF. The operation is scheduled to last between 15 and 30 min. Collision avoidance with aircrafts is ensured by the closure of the area by a NOTAM.

3.3.2 Mission 2: Short range flight test

This operation takes place in the vicinity of Rhodes airport. The ANSP needs to test terminal navaids, as part of the typical flight inspection routine, during days of heavy traffic. For this inspection, they deploy drones with measurement equipment close to the VOR.

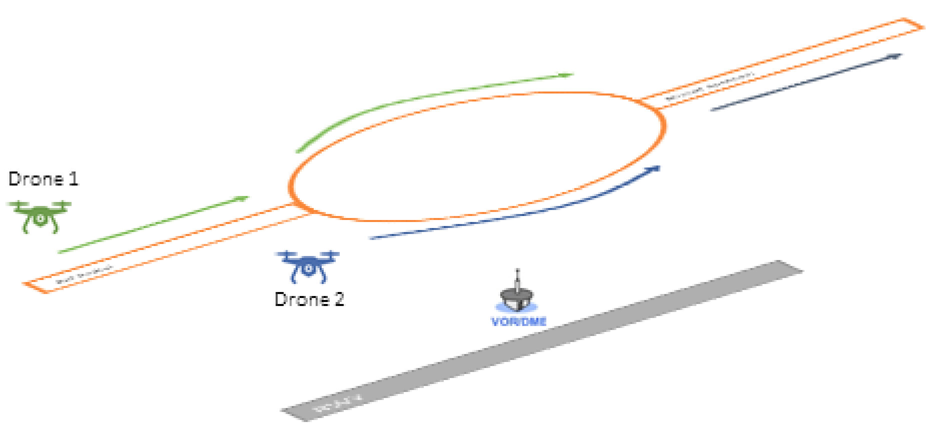

Figure 10 - Multi-drone deployment for short range flight test

Type of operation	Area of operation	Flight plan	Type of drone	Payload	Category of operation
VLOS	Airport environment – over the runway (CTR/Za)	Route along the runway and the VOR half orbit	AtraxM	CNS Transceiver	Specific (STS 1)

The mission is carried out in VLOS by the drone mission operator. The drones are equipped with a CNS Transceiver. The drones are multicopters with VTOL capabilities (i.e., AtraxM). Their maximum speed is 5.6m/s. The operation takes place in an airport environment. Therefore, it requires coordination with the ATM and the other stakeholders of the airport.

The flight plan for the mission is made available to the ATCO through UTM services, and the DMO is in constant link with ATM through VHF. The operation is scheduled to last between 15 and 30 minutes. Collision avoidance with aircrafts is ensured by the closure of the area by a NOTAM.

3.3.3 Mission 3: DME/DME coverage evaluation

The operation takes place in the vicinity of Rhodes airport. It aims at evaluating the DME/DME coverage provided by two VOR stations near the airport. For this operation, a fixed wing drone is deployed to take measurements of the coverage in two areas.

Figure 11 DME coverage around Rhodes airport

Type of operation	Area of operation	Flight plan	Type of drone	Payload	Category of operation
EVLOS or BVLOS	Around the airport – Rhodes airport CTR (CTR/Za)	Route	Fixed wing	CNS Transceiver	Specific (too extended for STS 2)

Since the area of operation is greater than for the other missions, observers may be deployed in the area to keep visual contact with the drone, in order to fall under the EVLOS category. The drone is equipped with a CNS Transceiver. The drone used is a fixed wing drone. The operation takes place in the Rhodes airport CTR. Therefore, it requires coordination with the ATM and the other stakeholders of the airport. The flight plan for the mission is made available to the ATCO through UTM services, and the DMO is in constant link with ATM through VHF. The operation is scheduled to last around 2 hours (one hour for each area). Collision avoidance with aircrafts is ensured by the closure of the area by a NOTAM.

4 Operational Concept of the 5D-AeroSafe Missions

As discussed in section 3, we are facing various scenarios with different operational parameters. This section provides a summary of the operational concept of the above-mentioned scenarios.

4.1 The operational environment: Airport & Waterport

This first section describes the environment of operation for the different use cases identified in the 5D-AeroSafe project. These environments vary depending on the location of the use cases. Three different environments, with their own specificities have been identified.

4.1.1 Overview of the three areas of operation

4.1.1.1 Heathrow airport

As described in section 3, several operations are expected to be conducted at Heathrow airport, near London (UK). Until 2019, it was the second busiest airport in the world by international passenger traffic, and the busiest in Europe. It is operated by Heathrow Airport Limited (HAL). The airport covers an area of 12.27 square kilometres with 2 parallel runways (27/09 R and L), 4 active terminals and 3 satellite buildings, and 185 stands with their connecting taxiways.. The airport has 4 main villages around, the urban area around it impacts the operational scenarios: the area around the airport must be considered as densely populated.

Figure 12 - Heathrow Airfield Map

4.1.1.2 Corfu waterdrome

Some of the use cases identified in the project take place in Corfu waterdrome (Greece). A Waterdrome (or water airport) is defined as the facility which serves operations of seaplanes and floatplanes. Corfu's waterdrome is divided in two main areas; the land side area that extends to an area of no more than 250 – 350 m2 and the water area.

The land area includes:

- the terminal building for passengers' services, ticketing, waiting area, admin office,
- the outer fenced area leading to seaplane,
- the docking area
- the windsock point (when is not in the vicinity of the facility) and
- in some cases, maintenance hangar and fuel supplier.

Figure 13 - Example of a PAX terminal

The water area includes:

- the floating platform (in cases that the quay is too high for docking),
- the waterway (a strip on the water surface where the seaplanes are accelerating or decelerate during arrivals or departures – the runway), where in some waterdromes are more than one.

Figure 14 - Seaplane docking points

Corfu's waterdrome is situated at Corfu's harbour near Corfu's international airport (LGKR). Therefore, coordination between these two other actors is key in order to ensure safe operations. Furthermore, the nature of the waterways makes them more subject to foreign floating objects that are a threat to landing or taking off aircrafts.

4.1.1.3 Rhodes airport

Finally, some use cases have been identified in Rhodes international airport (Greece). It is a civil airport located on Rhodes island. It is composed of one runway, stands and taxiways. The airport is located between the sea and a mountain. These elements impact the operational scenarios due to their nature (e.g., a drone cannot proceed to an emergency landing above water). Two VOR/DMEs are located near the airport. One stands at the end of the runway, and the other stands in the mountains about 5 km south of the airport.

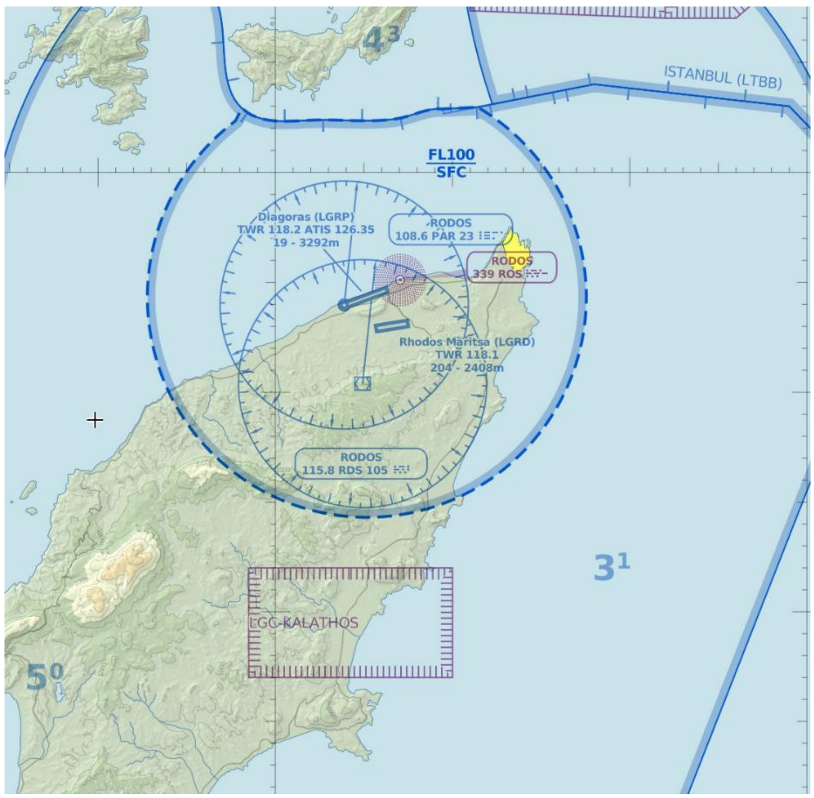

Figure 15 - Rhodes airport and the relative positions of the navaids

4.1.2 Aerodromes environments and their specificities

As mentioned before, the operations will take place in different airports and waterdromes. While each of these environments have different particularities, they share the fact that they all are aerodromes, and therefore share common specificities.

An aerodrome is a location from which flight operations take place such as large commercial airports, small general aviation airfields and military air bases.

The term airport may imply a certain structure (having satisfied certain certification criteria or regulatory requirements) that an aerodrome may not have. Therefore, whilst all airports are aerodromes, not all aerodromes are airports.

For the purpose of this document, only 'protected aerodromes' will be considered and can be one of the following:

- An EASA certified aerodrome ('airport')
- A government aerodrome (i.e., military airfield)
- A waterway
- A national licensed aerodrome (i.e., smaller 'general aviation' airfields)

In most cases a 'protected aerodrome' can be readily identified as an aerodrome that has an Aerodrome Traffic Zone (ATZ) established around it.

An **Aerodrome Traffic Zone (ATZ)** is defined as an airspace of defined dimensions established around an aerodrome for the protection of aerodrome traffic.

The ATZ is intended to protect the traffic such as the one on the manoeuvring area and in the immediate vicinity of an aerodrome. This includes, but is not limited to, the aircraft in the aerodrome traffic circuit. There are no worldwide accepted definitions about the size of ATZs in terms of lateral or vertical limits. Generally, the ATZ is considered to be a "small-volume" airspace, usually a cylinder extending from the surface up to a few thousand feet with a radius of a few nautical miles (NMs). The centre of the ATZ may be the aerodrome reference point (ARP), the centre of the longest runway, or another suitable point.

The airspace within the ATZ may be either controlled (serve by Control Tower) or uncontrolled (Aerodrome Flight Information Service offered). The precise from and dimensions of the ATZ may vary from country to country, and this information can be found in the appropriate national Aeronautical Information Publication (AIP) published by the Aviation Authority of each ICAO Member State.

Apart from ATZ, there is a NOTAM system for noticing blocks of airspace where particular limitations are place on the flight of all aircraft (manned or unmanned). Such areas are typically either Prohibited Areas, Restricted Areas or Danger Areas. Other airspace may have temporary restrictions imposed at specific times, either as a result of a longer term pre-planned event, or in reaction to a short notice occurrence, such as an emergency incident. It is important to note that these restricted areas apply to all aircraft, including drones, regardless of weight or height of operation.

4.1.3 UAS geographical zone

For most use cases of the 5D-AeroSafe project, it is expected that the UAS will fly in the UAS geographical zone of an airport. A "UAS geographical zone" is defined as follows:

"'UAS geographical zone' means a portion of airspace established by the competent authority that facilitates, restricts or excludes UAS operations in order to address risks pertaining to safety, privacy, protection of personal data, security or the environment, arising from UAS operations." (EUROPEAN COMMISSION, Commission Implementing Regulation (EU) 2019/947, 2019)

According to the ACI: *"Flights of drones around airfields or airports that are highly restricted. It is illegal to fly drones of any size within the UAS Geographical Zone of a protected aerodrome without appropriate prior permission from air trac control at the airport, and/or from the airport operator."* (ACI, Drones in the Airport Environment: Concept of Operations and Industry Guidance, 2019)

About the definition by member states of a "UAS geographical zone", the Article 15 of the EU 2019/947 states that:

"1. When defining UAS geographical zones for safety, security, privacy or environmental reasons, Member States may:

(a) prohibit certain or all UAS operations, request particular conditions for certain or all UAS operations or request a prior operational authorisation for certain or all UAS operations.

(b) subject UAS operations to specified environmental standards.

(c) allow access to certain UAS classes only.

(d) allow access only to UAS equipped with certain technical features, in particular remote identification systems or geo awareness systems.

2. On the basis of a risk assessment carried out by the competent authority, Member States may designate certain geographical zones in which UAS operations are exempt from one or more of the 'open' category requirements.

3. When pursuant to paragraphs 1 or 2 Member States define UAS geographical zones, for geo awareness purposes they shall ensure that the information on the UAS geographical zones, including their period of validity, is made publicly available in a common unique digital format."

In the majority of cases, the UAS geographical zone should primarily consist of two zones:

- The ATZ at the aerodrome
- The runway protection zones

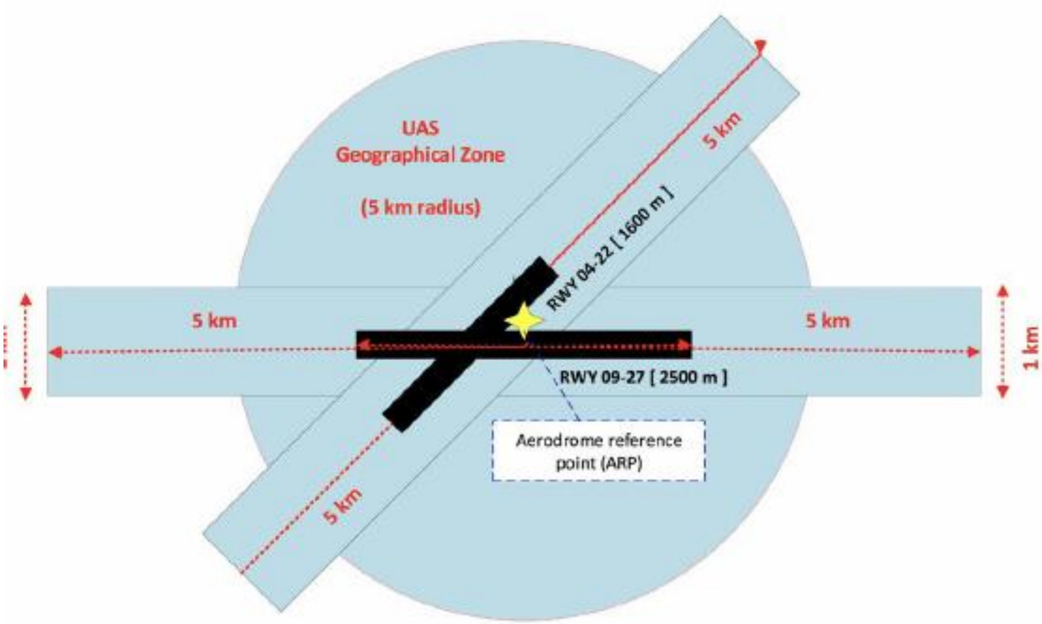

Figure 16 – UAS geographical zone (ACI, Drones in the Airport Environment: Concept of Operations and Industry Guidance, 2019)

The exact shape and dimensions of the UAS area of operation may vary depending on the specific aerodrome that it protects, based on the operational characteristics (complexity, type, and volume of traffic, etc). This should be assessed locally, resulting in an optimal configuration.

According to the Airports Council International (ACI), the different areas of operations for UAS in an airport are defined as follows (ACI, Drones in the Airport Environment: Concept of Operations and Industry Guidance, 2019):

No Fly Zone Red Zone	**Apply to Fly Zone** Orange Zone	**Advise and Fly Zone** Green Zone
		
An area of operation where **drone operations are not compatible with other airspace users.** ATC must perform an assessment to determine if the operation can be facilitated. The assessment is complex and approval is not likely. If approval is given, it will carry significant conditions or restrictions.	An area of operation where **drone operations may be compatible with other airspace users.** ATC must perform an assessment to determine if the operation can be facilitated. While approval is likely, it might carry some conditions or restrictions.	An operational area where **drone operations are compatible with other airspace users.** ATC is advised by an drone operator prior to and following an operation but explicit ATC approval may not be required.

Figure 17 - Areas of operation for UAS in an airport environment: the Drone FLy Zones (DFZ) (ACI, Drones in the Airport Environment: Concept of Operations and Industry Guidance, 2019)

Each airport can be composed of different DFZs according to how compatible drone operations are with other airspace users in these zones. The concept of the three fly zones within controlled airspace is designed to provide two primary operational advantages:

- Guidance to drone operators on when approval is required from a Competent Authority for an operation and the likelihood of that operation being approved
- Guidance to ATC when assessing or advising on airspace access applications.

4.2 Roles & Responsibilities

The missions identified for the 5D-AeroSafe project involve several stakeholders. Some of them are directly involved in the missions, either because they carry it out, asked for it, or because the results of these missions are of interest for their work. Some other stakeholders are indirectly involved in the missions because they are responsible of the safety or security of the environment or because the missions take place in an area that impact their work.

Due to the diverse natures of the missions identified, many stakeholders have to be taken into account. The following table gives an overview of the relevant stakeholders with their role or responsibilities in the missions.

Table 1 - Stakeholders and their role and responsibilities

Actor	Roles/Responsibilities
Principal stakeholders	
Drone Mission Operator	- Executes the operational aspect of the mission

(DMO)	
Drone Safety Operator (DSO)	- Responsible for the safety of the drone flight
Drone Pilot	- Designated by the drone operator or is the drone owner, as being in command and charged with the safe conduct of the drone flight.
Air Traffic Safety Electronic Personnel (ATSEP)	- Responsible for the maintenance of the navaids - Are the principal actors of the "navaid inspections" missions
Waterdrome Safety & Security Supervisor (WSP)	- Responsible for the safety of the waterport - Is the principal actor of the "waterport inspection" missions
Airside Safety Department	- Responsible for the maintenance of the airfield (stands, runways and taxiways and their equipment like lighting) - Is the principal actor for the "Heathrow inspection" missions
Indirect stakeholders	
National Aviation Authorities (NAA)	- Responsible for the delivery of special authorizations (e.g., NOTAMs) - Responsible for the definition of the airspace - Responsible for the authorization of UAS missions in restricted airspace
Air Traffic Management (ATM)	- Uses the services of the ANSP to provide guidance and ensure safety in controlled airspace - Is directly impacted by UAS missions in controlled airspace
Air Navigation Service Provider (ANSP)	- Responsible for the delivery of air navigation services - Can ask ATSPEs for navaid inspection
U-space Service Provider (USSP)	- Responsible for the delivery of U-space services
Airport Operator	- Responsible for the operations that take place inside the airport environment - Is directly impacted by UAS missions inside an airport environment
Airfield Duty Manager (AfDM)	- Manages the work of the ASD - Is responsible for the work conducted on the airfield
Port Authority (port near Corfu waterdrome)	- Responsible for the port operations - Their activity can impact or be impacted by the drone operations
Law enforcement bodies (police, military, coastguards)	- Responsible with security - Must monitor UAS operations to ensure general safety

As pointed out by this table, stakeholders are numerous in the different missions of the 5D-AeroSafe project. Some of them are directly involved in the mission, but many other have a role in the delivery of the authorization for the missions or have a need to be aware of or to monitor the missions in order to adapt their activities accordingly. This poses a serious challenge for the good coordination and communication between them.

An overview of the communication and coordination strategy will be provided in section 4.7.

4.3 Type of Operation, Drone & Payload

The diverse nature of the missions of the 5D-AeroSafe project imply different operational parameters for the missions. This section presents the different type of operations, type of drones and payload that can be used in the different missions.

Three type of UAS operations exist:

- Visual Line of Sight (VLOS): the UAS remains at all time visible by the remote pilot
- Beyond Visual Line of Sight (BVLOS): the UAS evolves in an area not visible by the remote pilot
- Extended Visual Line of Sight (EVLOS): the UAS is visible to an observer in direct link with the remote pilot

Most of the missions of the project should be VLOS operations. However, because in some cases the UAS will have to cover a great distance, some missions will be EVLOS or BVLOS operations (e.g., the DME/DME coverage inspection covers an area of several square kilometres and will take place above hostile environments like the sea or the mountain which can complicate the access for observers).

The type of drone used will also vary depending on the mission. For most missions, multicopters will be used, because they can travel at low speed allowing time for the inspection, and at low altitudes to ensure precision of the inspection of ground elements. Furthermore, they can fly stationery if needed to allow more time for signal inspection. These multicopters will be AtraxM multicopters, and the full description of this type of drone is available in Appendix D. However, for missions where the UAS must be able to fly faster or cover more ground (e.g., DME/DME coverage inspection; runway fast inspection), fixed wing drones can be used. The exact model of drone is not yet known, but this information will influence greatly the potential SORA analysis, with parameters such as the size, weight and maximum speed of the UAS.

The equipment that the UAS will carry also depends on the mission. For visual inspection missions, they will carry a visual camera, linked to either human observers or algorithms. For the navaid signal inspection missions, they will carry a CNS transceiver. These systems and technologies will also be further described in section 0.

This section provides us with an overview of the operational parameters of the different missions. Once the models of drones that will be used is better defined and their characteristics like maximum speed or weight are well known, most of the information required for the ConOps section of a SORA analysis will be available to us.

4.4 Prerequisites

So far, the information we have on the operational environment for the missions allows us to determine prerequisites for operations conducted in the UAS geographical zone of an airport environment. This section presents these prerequisites.

Before any drone operations can be authorised within an airport environment, arrangements need to be made considering the following aspects (EUROPEAN COMMISSION, Commission Implementing Regulation (EU) 2019/947, 2019):

- Operator/drone pilot known and registered
- Operator/drone pilot licenced and trained
- Acceptable equipment
- Confirmation of adherence to all applicable EASA and national/local regulatory requirements

- Equipment meeting conspicuity requirements (E.g., by mode-S transponder (used by manned aircraft), or different methods to broadcast the drone's position at close range by Bluetooth or Wi-Fi transmitters, or via a cellular communications network. The options may change as technology evolves. Alternative arrangements are possible, to the satisfaction of airport operator/ANSP)
- Appropriate third-party liability insurance arranged for commercial operators
- Operational Manual available and maintained
- Drone Pilots must give priority to all manned aircraft and stay well clear of the flight path.
- Drones must be flown at a safe distance from people and buildings
- Detailed scenario/flight plan
- VLOS, daylight only (Daylight restriction could be lifted if risks associated with night operations can be mitigated properly and risk assessment guarantees safe and secure operations.)
- Safety assessment for the specified operation (SORA completed by operator and ANSP analysis)
- Airport manager (written permission)
- Civil Aviation Authority permission
- Coordination and communication protocol with ATC (approach, tower) and airport operator (single point of contact if possible)
- Go/No-Go decision protocol arranged.

This list should be considered as a baseline. Regardless of the form of the arrangement between the drone operator and ATC/Airport Manager, the roles and responsibilities of drone operators should be unambiguously set out.

4.5 Technologies and systems

As mentioned in previous sections, several technologies and systems will be used in order to carry out the missions defined in the project. Some of these technologies already exist in their final state, while some others will be developed for the 5D-AeroSafe project. Therefore, as they are not in their final state yet, all the information about these technologies is not available to us yet.

Technology	Purpose
Already existing technologies	
Differential GNSS (DGNSS)	- Provides GNSS information corrected according to a ground station reference
C3 Link	- Command and Control link (C2 link) enriched with payload communication
Technologies developed during the project	
CNS Transceiver	- Inspection of the signal of a navaid - 5D-AeroSafe activities will include the miniaturisation of CNS transceivers incorporating GNSS over 1090 MHz, UNB L- Band, ADS-B and 4G networks
Generic Ground Control Station (GGCS)	- User interface through which the DMO and DSO operate the drone - Modular system solution for connecting RPAS, which includes embedded artificial intelligence to make RPAS more autonomous and agile for operations - Integrates two modules: o Mission module: prepare the missions for the RPAS from the task orders received o Exploitation module: integrates all the applications needed to exploit the RPAS sensor data - For 5D-AeroSafe, the GGCS will be adapted so it can pilot all the RPAS directly
FINoT Platform	- Platform for the management of sensors, actuators, and data streams from heterogeneous sources - Treatment and processing of the data acquired during the mission
UTM Center	- Open platform in which any UAS, pilot, or airspace stakeholder can exchange safety-critical information and services in real-time
5D API	- Makes the link between the abovementioned technologies (see Figure 18)

The link between the different technologies mentioned above and the U-space services is shown on Figure 18.

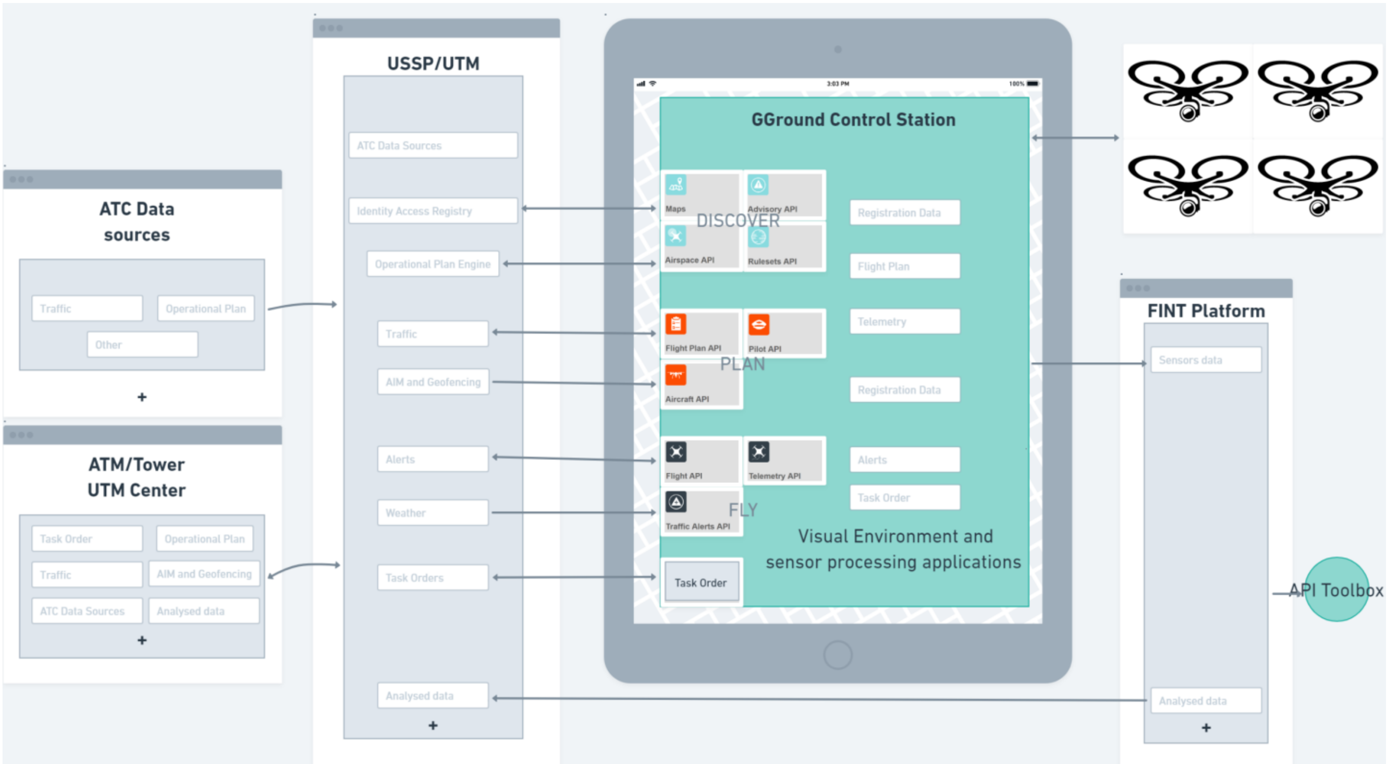

Figure 18 - General architecture of the technologies for the 5D missions (Airmap)

The UTM Center technology has the architecture presented on Figure 19. The focus of the 5D-Aerosafe project for this technology will be to integrate this UTM center with the UAS GGCS (represented by the bottom right arrow on the figure). It is accompanied by APIs, available here: https://developers.airmap.com/.

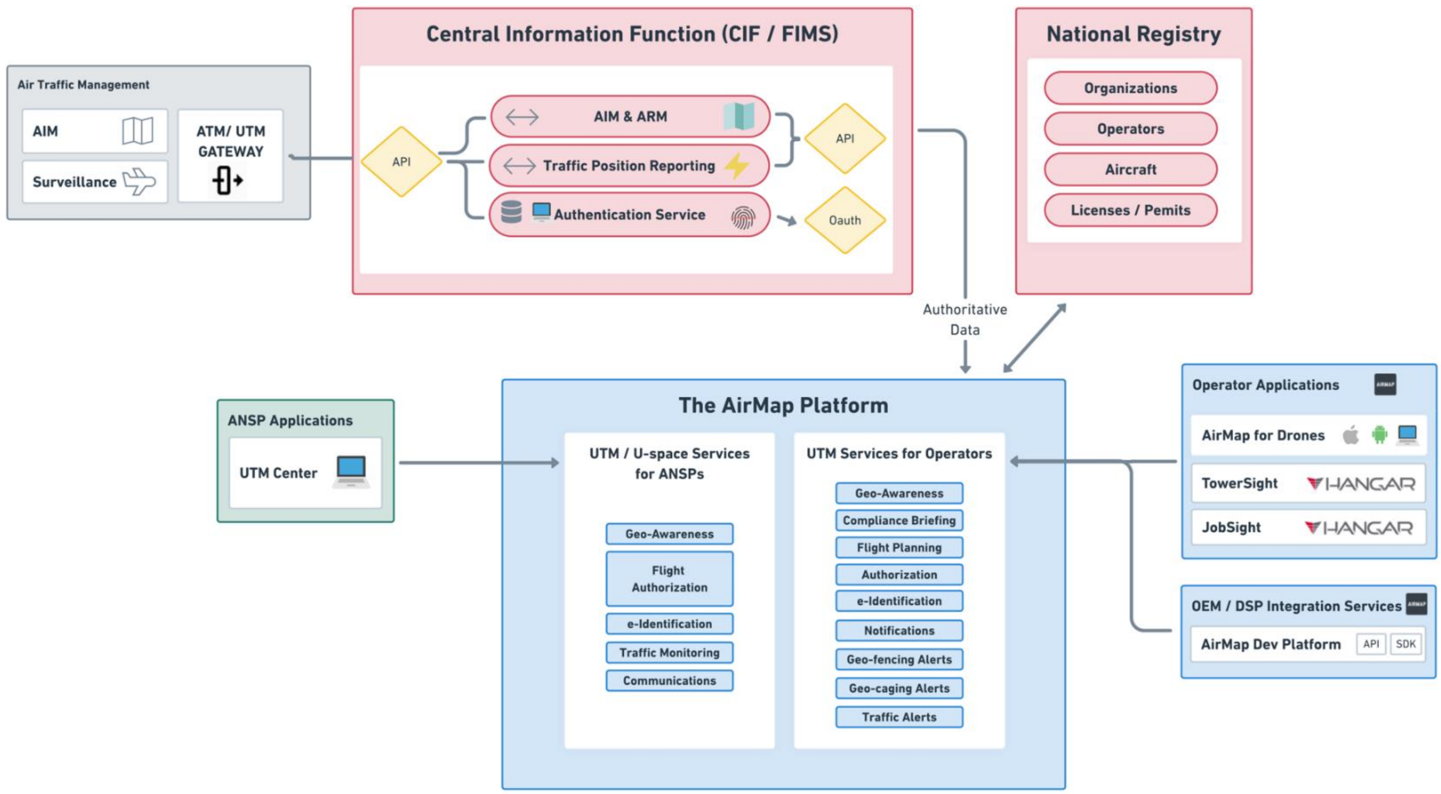

Figure 19 - Architecture of the UTM Center (Airmap)

4.6 U-space ConOps & services

The 5D-AeroSafe project falls under the scope of the UTM/U-space concept. U-space services will be used to carry out the mission and to show that there is a synergy between the project's missions and U-space services. Therefore, the U-space operational concept must be considered. The U-space operational concept is defined by CORUS (SESAR project CORUS, 2019).

CORUS ConOps addresses the VLL airspace. The VLL airspace is defined as the airspace below the airspace used by VFR, as defined by ICAO's Annex 2 and SERA. Inside this VLL area, CORUS defines new spaces: X, Y and Z (Za or Zu) airspace volumes (Figure 20).

Figure 20 - Airspace volumes defined in CORUS (SESAR project CORUS, 2019)

Most operations of the 5D-AeroSafe project will take place at low altitudes, in VLL (except for DME/DME coverage inspection). Furthermore, these operations will take place in an airport environment. Therefore, it can be determined that these operations will be conducted in a Za type of airspace.

This being said, CORUS defines a number of services that are optional or mandated depending on the airspace. These services are shown on Figure 21.

Service	X	Y	Z
Registration	Mandated	Mandated	Mandated
e-identification	Mandated	Mandated	Mandated
Geo-awareness	Mandated	Mandated	Mandated
Drone Aeronautical Information Publication	Mandated	Mandated	Mandated
Geo-fencing provision	Mandated	Mandated*	Mandated
Incident / accident reporting	Mandated	Mandated	Mandated
Weather information	Mandated	Mandated	Mandated
Position report submission sub-service	Recommended	Mandated*	Mandated
Tracking	Optional	Mandated*	Mandated
Drone operation plan processing	Optional	Mandated	Mandated
Emergency management	Optional*	Mandated*	Mandated
Monitoring	Optional	Mandated*	Mandated
Procedural interface with ATC	Optional+	Mandated+	Mandated
Strategic conflict resolution	No	Mandated	Mandated
Legal recording	Optional+	Mandated*	Mandated
Digital logbook	Optional+	Mandated*	Mandated
Traffic information	Optional	Mandated	Offered
Geospatial information service	Optional	Optional	Mandated*
Population density map	Optional	Optional	Mandated*
Electromagnetic interference information	Optional	Optional	Mandated*
Navigation coverage information	Optional	Optional	Mandated*
Communication coverage information	Optional	Optional	Mandated*
Collaborative interface with ATC	Optional+	Mandated+	Mandated
Dynamic capacity management	No	Mandated*	Mandated
Tactical conflict resolution	No	No	Mandated
U-space Phase	U1	U2	U3

\+ when needed * where available

Figure 21 - U-space services according to the airspace volume (SESAR project CORUS, 2019)

According to the results presented in the Consolidated Results on SESAR U-space Research and Innovation Results (SESAR Joint Undertaking, 2020), all services of U-space are not and probably will not be available by the end of the project. Indeed, as the document adresses the maturit of the different U-space levels (U1, U2, U3), it shows that U1 services are almost fully supported, but that U2 and U3 services are not yet completely covered.

4.7 Communication & Coordination

As mentioned above, the 5D missions involve a large variety of stakeholders. The communication and coordination between these stakeholders are key in order to ensure a global awareness and an acceptable level of safety. Communication will be mostly ensured by the UTM center.

In the nominal case, the drone operation passes through the following states.

1. Task Order Creation: The ASD/ATSEPs/WSS has the responsibility of creating the task orders (also referred to as operation requests) for the pre-scheduled and ad-hoc missions on the UTM platform. Task orders may be created days in advance except ad-hoc missions, which may be created before the commencement of the mission based on the duration an average consultation process takes (i.e., under an hour). Multiple task orders may be created successively, and each may intersect in the time and space as long as operators can ensure safe separation under VLOS/EVLOS/BVLOS conditions. The ASD/ATSEPs/WSS inputs the following information when creating a task order:
    a. Waypoints or radius
    b. Altitude
    c. Start time and duration
    d. Pilot and drone selection
2. Operation Plan Submission: Once the ASD/ATSEPs/WSS creates task order(s), UTM submits the operation requests. This step uses the Operation plan preparation service (U2). This map is then shared with ATC and other key stakeholders.
3. Review: Since the area of operation is within CTR, the ASD/ATSEPs/WSS consults with relevant stakeholders comprising appropriate companies and requiring their approval through the UTM system (and any other necessary documentation by means external to UTM). This step and the following steps #4 and #5 use the Operation plan processing service (U2).
4. Approval: If all the stakeholders of the review process approve the operation plan, the operation is approved, and a notification is sent to the ASD, DMO/DSO, and other participants of the UTM platform.
5. Rejection: If one of the stakeholders of the review process reject the operation plan, the rejection notification is sent to the ASD, DMO/DSO, and other participants of the UTM platform. The ASD/ATSEPs/WSS may start again with step #1.
6. Pre-flight: The Strategic phase ends at RTTA. At RTTA the operation enters its Tactical phase. The first Tactical state is known as Pre-flight. This state exists for a short time and includes such tasks as loading the plan into the drone, allowing the drone nav system to acquire satellites, logging on to U-space to establish:
    a. the flow of position reports to the Tracking (U2) service
    b. commence Monitoring (U2)
    c. start the Traffic Information (U2) service
    d. notify the ATC Supervisor of the activation of the operation through a Procedural interface with ATC (U2) and further coordinate with the ATC Supervisor if necessary (through external means to the UTM Center), complying with any instructions.
7. Take-off: The DSO will get the drone(s) to a position from which they can begin the useful part of their operation.
8. In-flight: The DMO will supervise the drone(s) during the pre-programmed part of the flight which is assumed to be BVLOS.
9. Final Approach: It is assumed that at the end of the BVLOS sequence, the drone(s) will be brought back to the location of the DSO within VLOS conditions.
10. Landing: Once the drone lands, the drone may take off again without closing the operation formally on the UTM system as the operation request may have been made for multiple successive flights.

11. Termination: The operation is closed by the DMO/DSO. Its associated characteristics are logged onto the UTM Center to be viewed and evaluated when needed through the Digital Logbook Service (U2). U-space stops providing services such as Tracking, Monitoring, Traffic Information, and Procedural interface with ATC.
12. The operational logs have a link to the analysed results from the FINT platform. FINoT stores the relevant data to the operation results and can be accessed from the UTM Center which will be displayed to the ASD/ATSEPs/WSS alongside the operational log of each mission.

The workflow may involve additional steps in-between the ones identified above during non-nominal or contingency states. The following outlines such alternative flows from the perspective of the UTM system:

- At any point in the process the ASD/AfDM/ATSEPs/WSS may cancel and/or update the task order, notifying the DMO/DSO and/or the ATC Supervisor. The ASD/AfDM/ATSEPs/WSS has overriding authorities with respect to the DMO/DSO at all times.
- At any point in the process the DMO/DSO may cancel the operation request, notifying the ASD/ATSEPs/WSS and/or the ATC Supervisor
- At any point the process the ATC Supervisor may rescind the operation request, notifying the UTM platform.
- If a cancellation (by the ASD/AfDM/ATSEPs/WSS or DMO/DSO) is requested after the operation is active i.e., take off, the DMO/DSO is required to hover the drone in position until further approval for an alternate operation request is received from the ATC Supervisor.
- If the cancellation is related to an emergency condition, the DMO/DSO takes the necessary action to safely land the drone whilst the ATC Supervisor is alerted.
- If a rescission (by the ATC Supervisor) is requested after the operation is active i.e., take off, the DMO/DSO is required to comply with ATC instructions. The ATC Supervisor may communicate the rescission by changing the state of the operation to “Rejected”.

Figure 22 shows the communication workflow between stakeholders for the Corfu waterdrome use case. Since the workflows for other use cases are very similar, they are only provided in Appendix C.

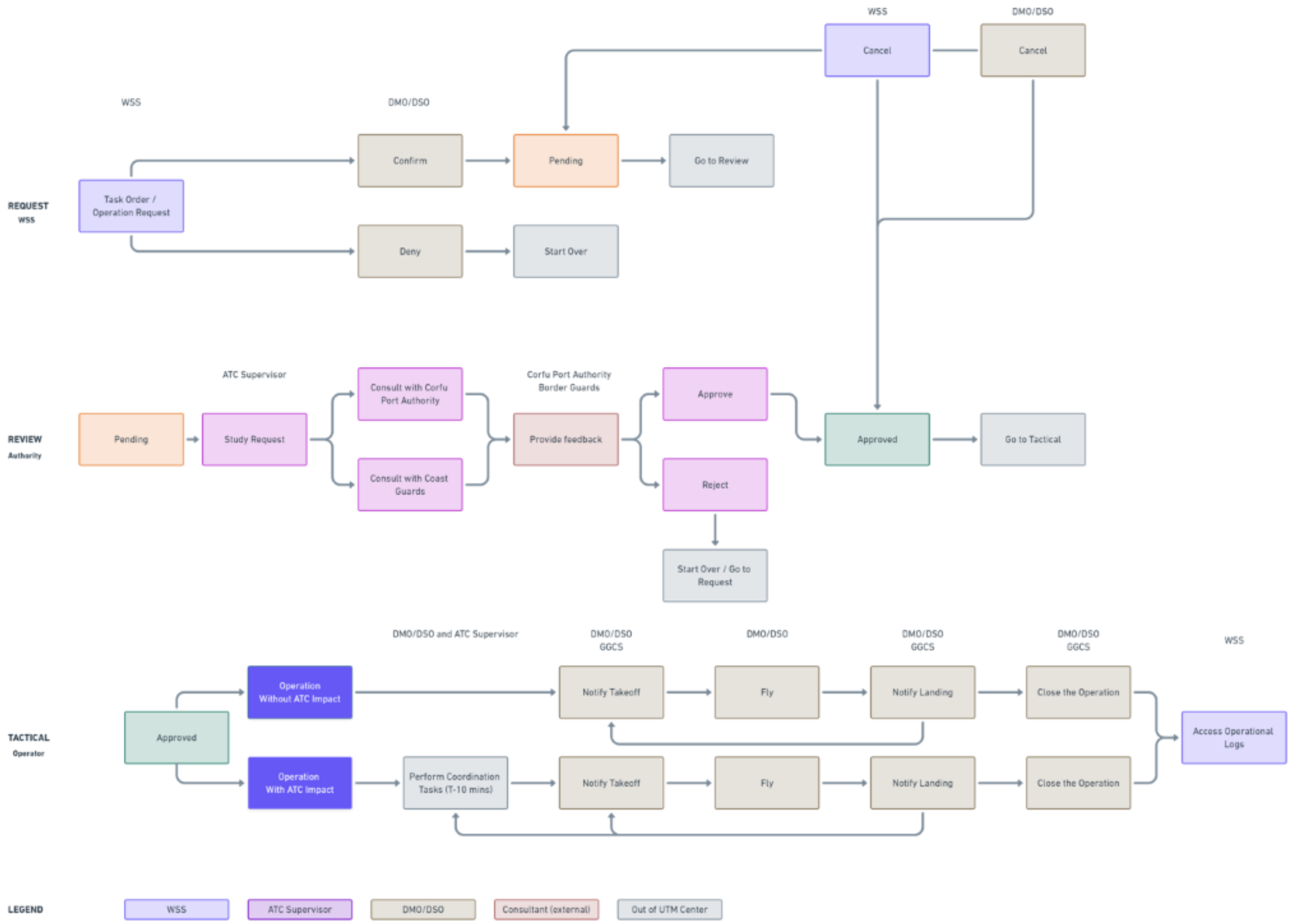

Figure 22 – Communication and coordination between actors and stakeholders

4.8 Safety Management - SORA

Safety for the operations of the 5D-AeroSafe project is ensured using a risk-based approach: The Specific Operation Risk Assessment (SORA). It is a methodology that allows a drone operator to evaluate the risks linked with a specific operation. Using information about the general concept of operations, the ground category, and the airspace of operation, it will give the operation a ground risk class and an air risk class, with requirements depending on these classes. It also uses these risk classes to compute a SAIL (Specific Assurance and Integrity Level), which determines the final requirements to implement: The Operational Safety Objectives (OSOs).

However, SORA does not currently address the risk created by multiple drones operating in the same airspace. Indeed, the air risk is computed only according to the probability of an encounter with a manned aircraft. This is why solely relying on SORA is not enough in the scope of our project: The U-space ConOps (CORUS) must also be taken into account in order to have a global ConOps covering all aspects of the operation.

5 Conclusion

After an introduction on the definition of a Concept of Operation, the exploration of different existing ConOps and their specificities, and finally the presentation of the objectives of this ConOps, the present document provides an overview of the relevant regulations, standards and research projects that will influence the 5D-AeroSafe project. Then, it gives a summary of the missions defined so far in the project, and finally details the operational context of these missions.

As mentioned in the introduction, this document had several objectives. These objectives and their results are presented in the following table.

Table 1 - Objectives and results of the document

Provide material for a SORA analysis	- Flight conditions (VLOS, EVLOS or BVLOS) (see section 4.3) - Maximum envisaged altitude (TBD) - UAS main features (TBD) - Country of operation (United Kingdom and Greece, see section 4.1)
Identify CORUS ConOps scope	- Operations carried out in Za (see section 4.6) - U1, U2 and U3 services (see section 4.6)
Provide ConOps material	- Area of operations (see section 4.1) - Stakeholders (see section 4.2) - Draft operational concept (see section 4.3) - Technologies (TBD, see section 0)
Regulation identification and observatory for regulatory updates	- Regulations, standards, and R&D projects (see section 2)

It must be reminded that this document is produced at an early stage of the project, and that all the parameters of the different missions have not been determined yet. Therefore, it must be acknowledged that this document does not provide the final version of the ConOps of the project, the Concept of Operation deliverable D2.1.2 by the end of the project, but that it rather aims at giving information about the operational context of the missions of the project. This will guide other participants of the project in their task by allowing them to have a global overview of the operational context.

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Appendix A: list of CORUS U1 U2 U3 service

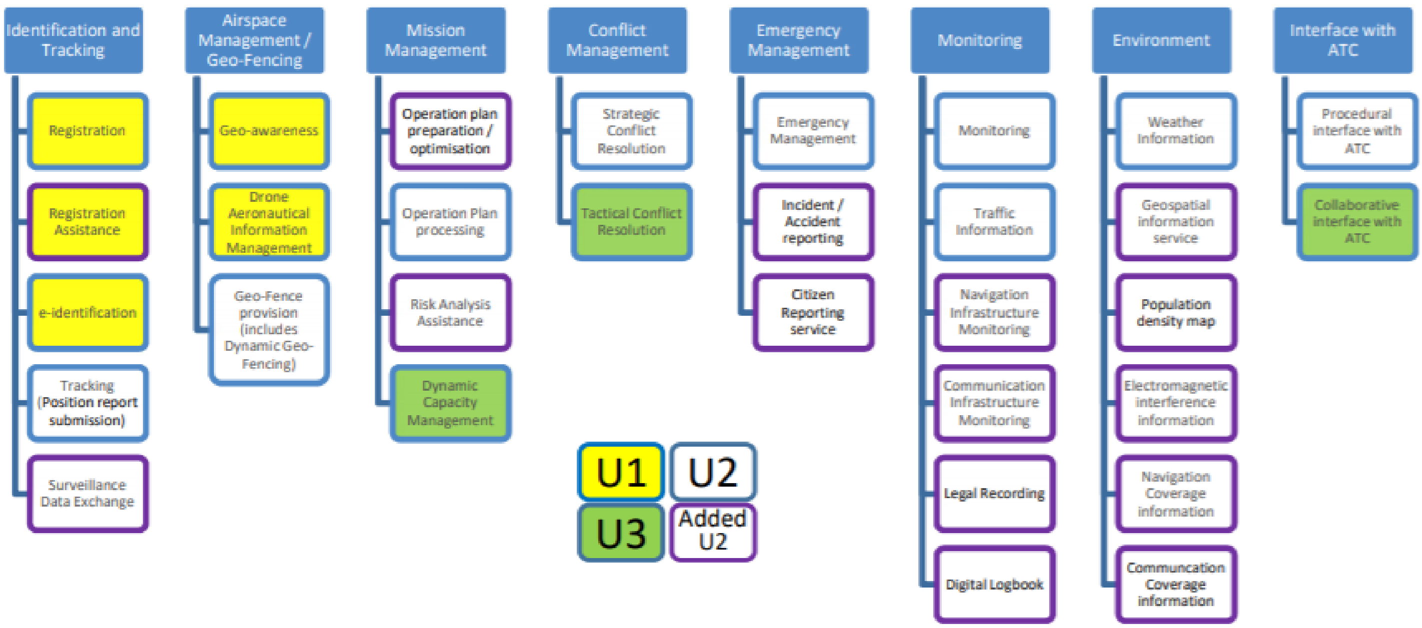


Figure 5 U-space services

Figure 23 - List of CORUS U-space services (SESAR project CORUS, 2019)

Appendix B: SORA UAS annex A

Guidance for collection and presentation of operation relevant information.

A.1.1 Definitions

Please refer to Annex I "Glossary of Terms".

A.1.2 Organisation overview

(a) This section describes how your organisation is defined, to support safe operations. Include:

a. Structure of organization and management

b. Responsibilities and duties of the UAS operator

A.1.2.1 Safety

(a) The specific category covers operations where the operational risks are higher and therefore the management of safety is particularly important. Describe how safety is integrated in the organization. What Safety Management System is in place?

(b) Any other safety related information?

A.1.2.2 Design and Production

(a) If the organization is responsible for the design and/or production of the UAS, describe the design and/or the production organization

A.1.2.3 Training of staff involved in operations

(a) Describe the training organization to qualify all staff involved in operations.

A.1.2.4 Maintenance

(a) Describe the maintenance organisation.

(b) Describe the general maintenance philosophy of the UAS

(c) Describe the maintenance procedures for the UAS

A.1.2.5 Crew

(a) Describe the responsibilities and duties of personnel. Describe all positions and people involved, for functions such as:

a. remote pilot (including flight team composition according to nature of operation, complexity, type of UAS…)

b. support personnel (like observers, launch crew, recovery crew, etc.)

(b) Operation of different types of UAS: details of any limitations to the types of UAS that a pilot may operate if appropriate

(c) Crew medical qualification requirements: details of the required medical qualifications necessary for the pilot or support crew, according to the types of UAS and roles employed by the operator

A.1.2.6 UAS Configuration Management

(a) Describe how the organization manages changes to the UAS design.

A.1.2.7 Other position(s) and other information

(a) Describe here any other position defined in the organization, or any other relevant information.

A.1.3 Operations

A.1.3.1 Type of operations

(a) Detailed description of the CONOPS: describe what types of normal operations the operator intends to carry out (cf. guidance [1] and [2]). The detailed description should contain all information to get a detailed understanding of how, where and under which limitations or conditions the operations shall be performed. Relevant charts and any other information helpful to visualize and understand the intended operation should be included in this section.

(b) Provide specific details on the type of operations (e.g., VLOS, BLOS), the population density to be overflown (e.g., away from people, sparsely populated, crowds) and the airspace requirements (e.g., segregated area, fully integrated, etc.

(c) Describe the level of involvement of the crew and automated or autonomous systems during each phase of the flight.

A.1.3.2 Standard Operating Procedures

(a) Describe the standard operating procedures (SOP) applicable to all operations for which an approval is requested. A reference to the applicable operations manual (OM) is acceptable.

Note: Checklists and SOP templates may be provided by the local competent authority or the Qualified Entity.

A.1.3.3 Normal Operation Strategy

(a) The Normal Operation Strategy should contain all the safety measures, such as technical or procedural measures, crew training etc., that are put in place to ensure that the UAS can fulfil the operation within the approved limitations, and so that the operation remains in control.

(b) Within this section, it should be assumed that all systems are working normally and as intended.

(c) The intent of this chapter is to get a clear understanding of how the operation takes place within the approved technical, environmental, procedural limitations.

A.1.3.4 Abnormal operation and emergency operation

(a) Describe the contingency procedures in place for any malfunction or abnormal operation, as well as emergency.

A.1.3.5 Accidents, incidents and mishaps

(a) UAS, like all aircraft, are subject to accident investigations and occurrence reporting schemes.

Mandatory or voluntary reporting should be carried out using the reporting processes provided by the competent bodies. As a minimum, the SOP should contain:

a. Reporting procedures in case of:

- Damage to properties
- Collision with other aircraft
- Serious or fatal injury (third party and own personnel)

b. Documentation and data logging procedures: describe how records and information is stored and made available, if required, to Accident Investigation Body, competent Aviation Authority, and other government entities (e.g. police)

A.1.4 Training

A.1.4.1 General information

(a) Brief description of the processes and procedures that the operator uses to develop and maintain the necessary competence for all staff involved in operations.

A.1.4.2 Initial training and qualification

(a) Description of the processes and procedures that the operator uses to recruit and qualify all staff involved in operations. In particular, it should be described which are the licensing and rating requirements for remote operators (if any) or, if license is not required, how their qualification is carried out.

A.1.4.3 Procedures for maintenance of currency

(a) Describe which processes and procedures the operator uses to ensure that the remote operators (if any) or other operational staff acquire and maintain the required currency to execute the various types of duties. Some elements may be required by the applicable regulations, some elements could be specific to the individual operator and the particular type of mission.

A.1.4.4 Flight Simulation Training Devices (FSTD)

(a) Is the operator using FSTD for acquiring and maintaining the practical skills?

(b) What are the opportunities and restrictions in connection with such training?

A.1.4.5 Training program

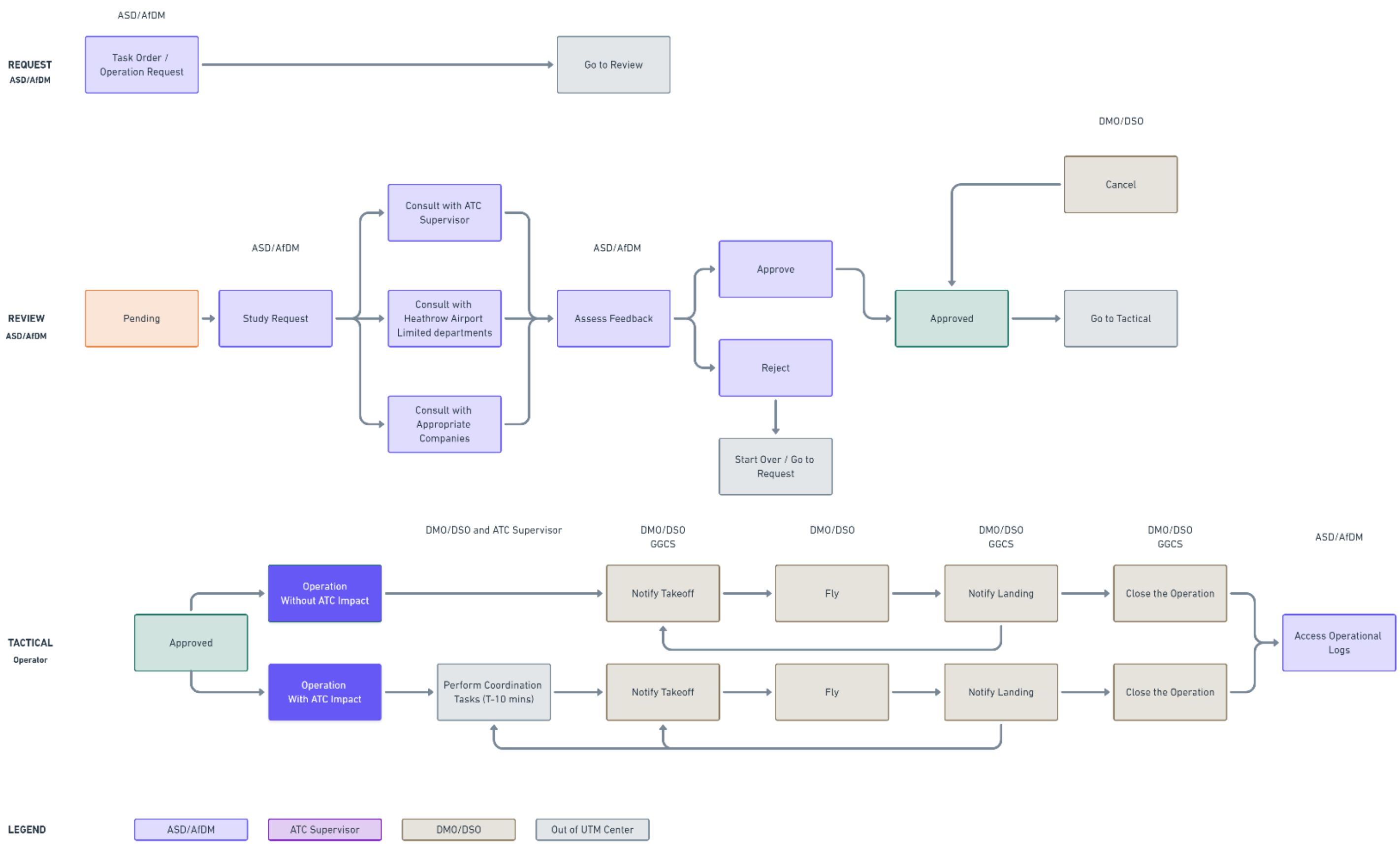
(a) Provide a reference to the applicable training program(s) for all staff involved in operations. This might simply be a reference to the program as required by regulation or, if the operator has developed a specific program, a reference to the operator's training program.

A.1.5 References

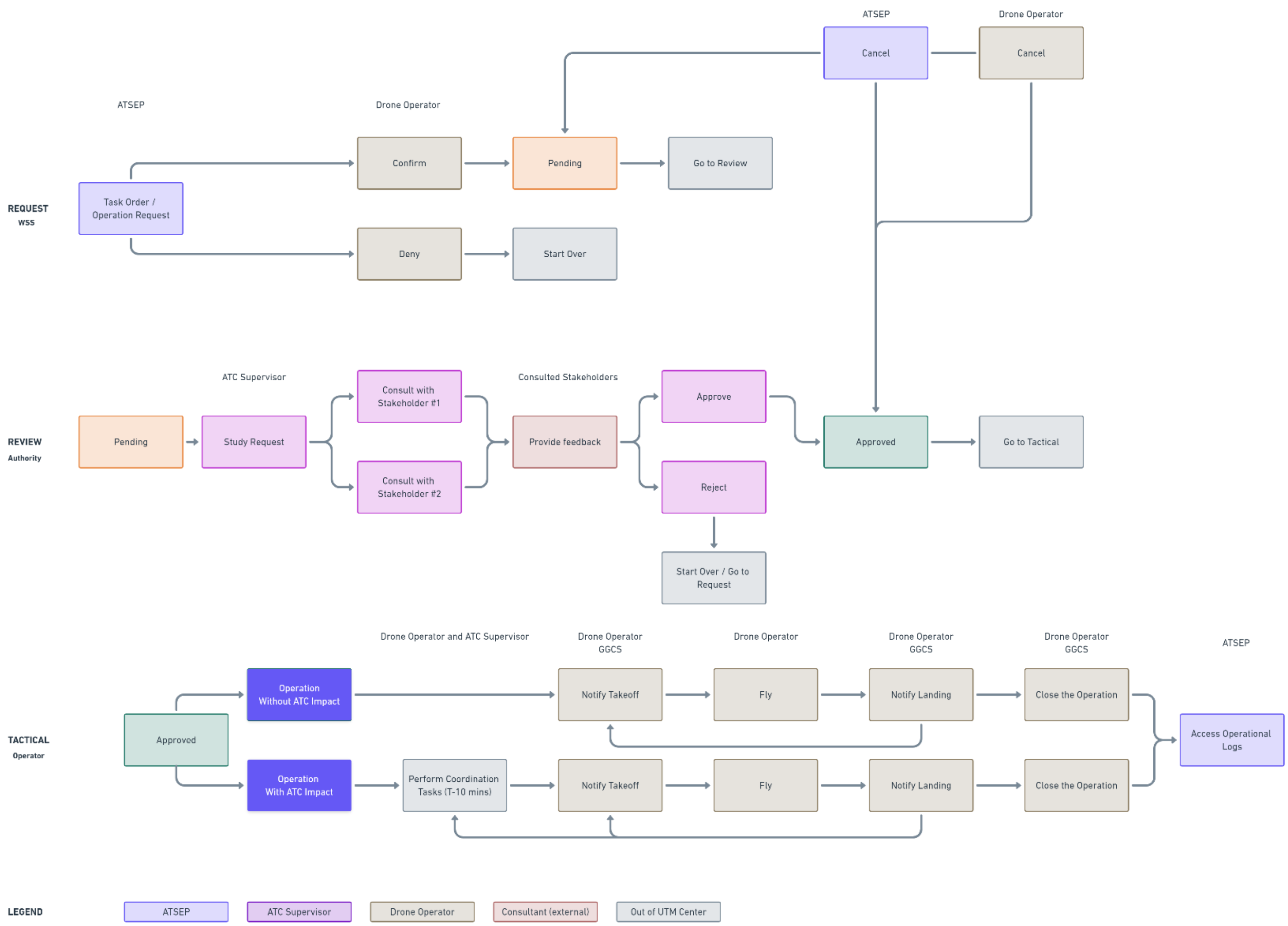
(a) Please list here all references (documents, URL, manuals, appendices) mentioned in this document.

Appendix C: UTM center workflows for each use case

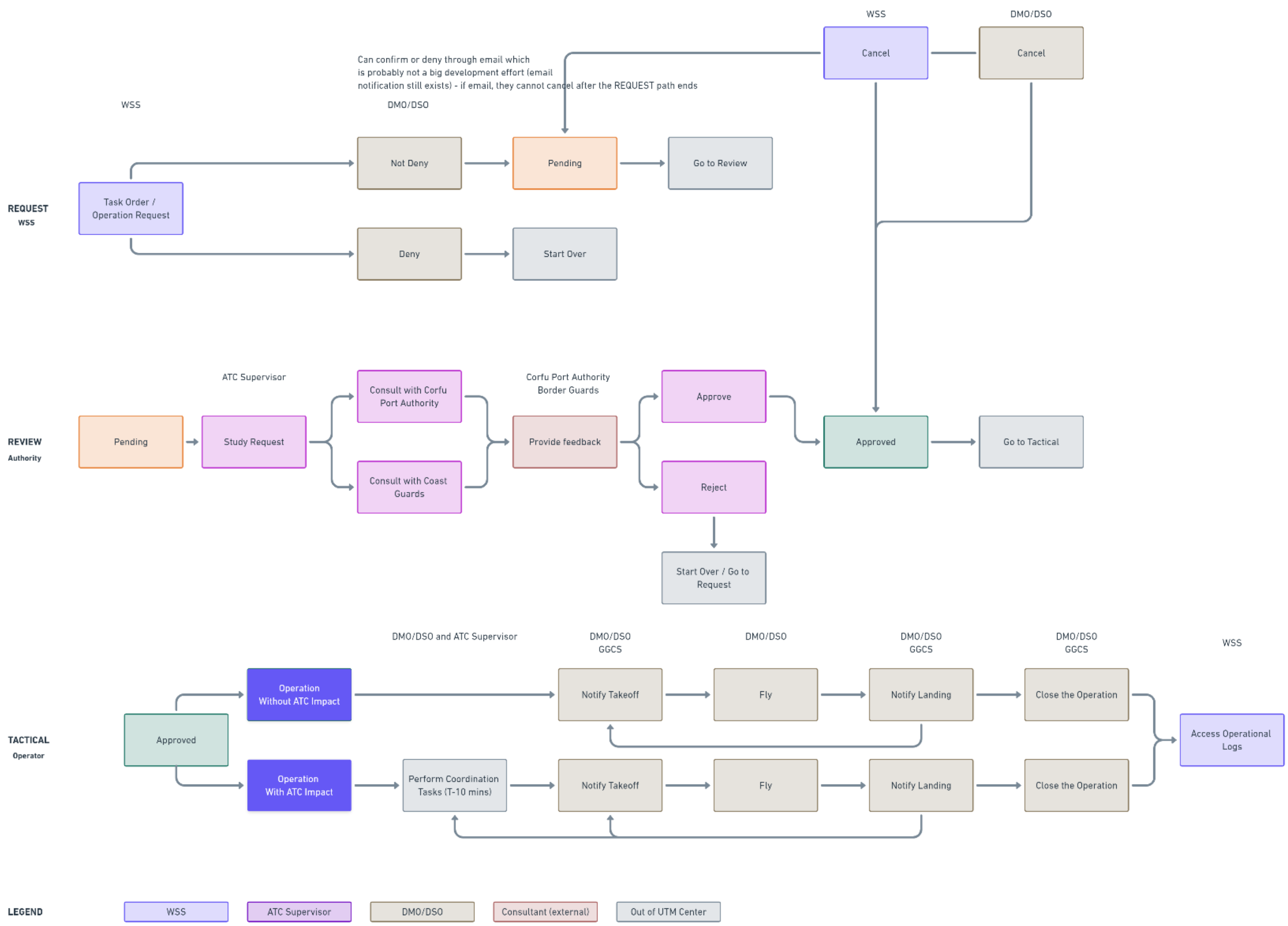
Heathrow Airport use case workflow



Rhodes airport use case workflow



Corfu Waterdrome use case workflow



Appendix D: the AtraxM multicopter

AtraxM reconnaissance system

The AtraxM Unmanned Aerial Vehicle System (UAV) is a system designed to perform observation, reconnaissance and surveillance missions. With special containers it is possible to perform combat flights.

The system can be used for the following purposes:

- intelligence and observation tasks within the operating radius of the system,
- area specific surveillance and monitoring,
- target observation,
- combat flights with explosives (armed version),
- flights with SAR (Restube) containers.
-

The AtraxM System includes:

- AtraxM UAV with and optoelectronic turret
- Ground Control Station,
- Transport box.

System technical data:

Lp.	Parameter	Unit	Value
1.	Take-off weight	kg	4,9 – 6,7
2.	The span between the propeller tips	m	1,2
3.	Height	m	0,20
4.	Maximum speed	km/h	80
5.	Optimum speed	km/h	20
6.	Maximum climb speed	m/s	16
7.	Maximum AGL ceiling	m	1500
8.	Optimal flight altitude	m	5-350
9.	Flight duration *	min	~ 35* (50**)
10.	Allowable wind	m/s	8
11.	The radius of action in an urbanized area	km	2

12.	Operating radius in the open area	km	5
13.	Ground Control Station weight	kg	4,5
14.	Transport box dimensions	m	0,7x0,4x0,4

* Flight time depends on weather conditions and operations

** Depending on the battery set used

Characteristic features of the AtraxM system:

- a completely Polish product,
- replaceable optical modules,
- economical and modern drive,
- mission radius up to 3km,
- flight duration ~ 35 min (up to 50 min with an additional battery),
- modular carbon fiber construction,
- high reliability,
- mobility,
- possibility of taking off from various ground without using the runway,
- resistance to weather conditions,
- low acoustic signature due to the electric drive,
- adapted to be operated by one operator,
- simple use,
- easy to maintain and operate,
- possibility of equipping with various types of containers (combat, medical, chemical reconnaissance, SAR, LIDAR).

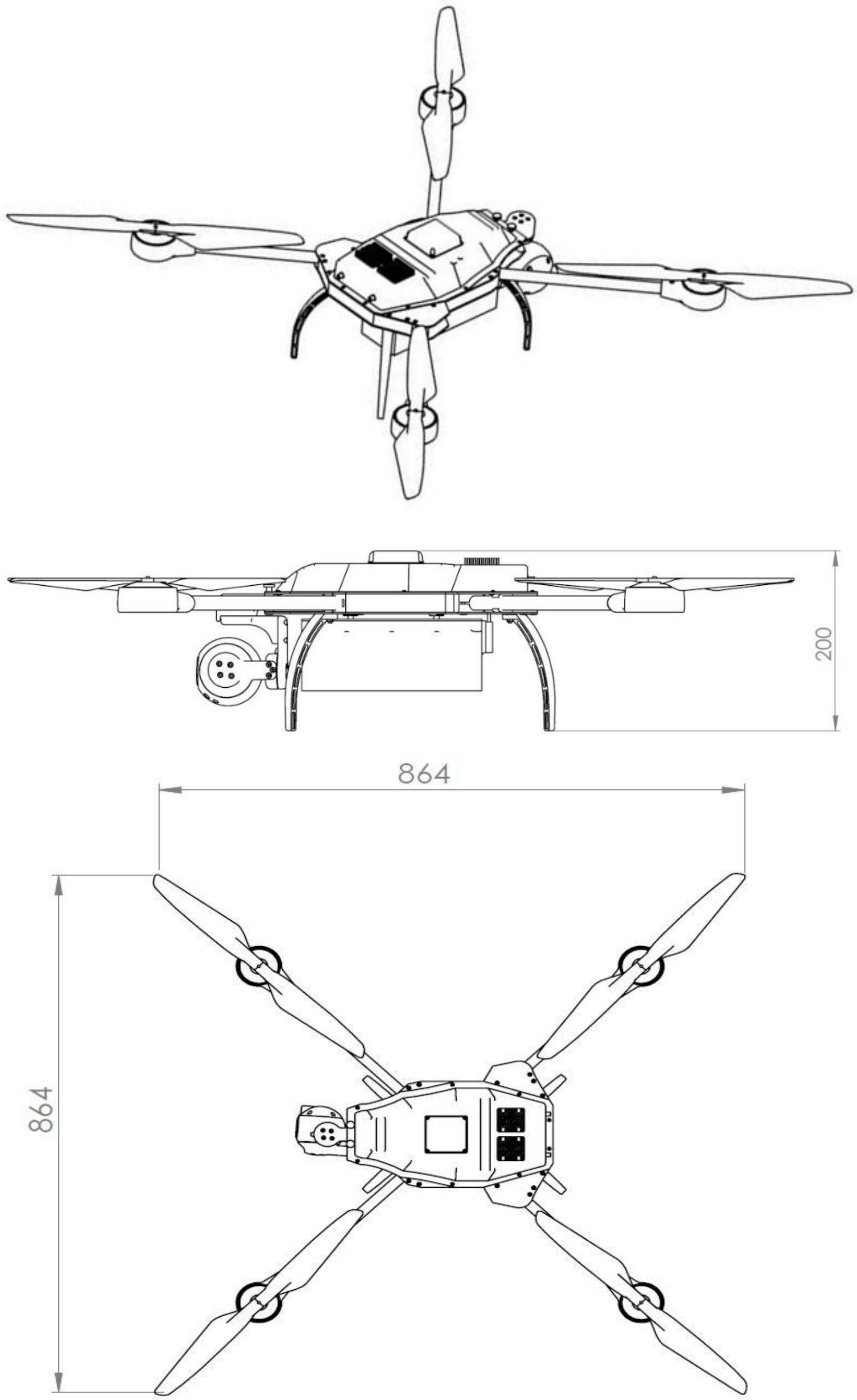


Figure 24 - General view and dimension of the AtraxM

Figure 25 - The AtraxM