Initial view on Principles for the U-space architecture

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Abstract

The main objective of this document is to build on the U-space blueprint, the Master Plan and the U-space Concept of Operations by providing a first view about the principles for the U-space architecture. These principles will guide the U-space projects in their implementation and in their final reporting, as well as supporting U-space implementers by establishing a common approach to defining and realizing U-space. These principles will also be embedded in the U-space CONOPS whenever needed.

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Acronyms

Acronym	Definition
AIMP	Aeronautical Information Management Provider
ANSP	Air Navigation Service Provider
API	Application Programming Interfaces
ATC	Air traffic Control
ATM	Air Traffic Management
CISP	Common Information Service Provider
CONOPS	Concept of Operations
FIMS	Flight Information Management System
GDPR	General Data Protection Regulation
SDSP	Supplemental Data Service Provider
SWIM	System Wide Information Management
USSP	U-space Service Provider

1 Introduction

The U-space blueprint [1] sets out the vision for U-space, which aims to enable all types of drone operations, including complex missions performed by vehicles with a high degree of automation, in all kinds of operational environment, including urban areas. So, the U-space services rely on a high level of digitalisation and automation of functions whether they are on the drone itself, or are part of the ground infrastructure.

U-space deployment follows a phased approach facilitating a broad range of drone missions that are currently prohibited or very constrained. U-space will provide a safe and efficient performant drone traffic management environment, along with an effective interface with traditional ATM and manned aviation, in a safe, robust and sustainable European ecosystem that is globally interoperable.

Following the publication of the U-space blueprint, the SESAR program has launched 19 projects covering demonstration activities related to U2 services, the exploration of U3/U4 and, importantly, the development of the U-space Concept of Operations (CORUS project led by Eurocontrol). The development of the Concept of Operations is closely associated with the other SESAR projects related to U-space and is integrated into the European ATM Master Plan, to be delivered in 2019.

The main objective of this document is to build on the U-space blueprint, the Master Plan and the U-space Concept of Operations by establishing the principles for the U-space architecture. These principles will guide the U-space projects in their setting and in their final reporting, as well as supporting U-space implementers by establishing a common approach to defining and realizing U-space. These principles will also be embedded in the U-space CONOPS whenever needed.

Being a live document, these principles will be reviewed in the light of the consolidation of the U-space projects outcomes (between Oct. 2019 and March 2020) and will be aligned to the coming EASA U-space regulation (planned to be delivered by the end of 2020)

In parallel to the activities performed within SESAR, ideas related to the U-space architecture have also been developed by industry (e.g. Airbus, AirMap, Unifly, GUTMA, Amazon), by different European ANSPs and telecom Service Providers; these have been considered as input when developing this document.

2 Core elements of a U-space architecture

U-space is a set of federated services and associated functions within a complete framework designed to enable and support safe and efficient multiple simultaneous drone operations in all classes of airspace. These services can be provided by different providers but such service providers will need to interoperate to performance requirements that are yet to be defined. The need to guarantee a seamless and safe operational environment will necessitate timely and accurate data transmission between implementation systems.

With the declarations of Warsaw, Helsinki and Amsterdam the European Commission wants to create a competitive U-space services market in the benefit of the final users. This implies the architecture allows multiple U-space service providers to operate in the same volume of airspace at the same moment. The architecture must then ensure that all the U-space service providers have exactly the same situational awareness and the traffic is de-conflicted (i.e. strategic or tactical deconfliction).This will require cooperation and exchange of data between the various service providers: connectivity and interoperability of the U-space services and related systems will be then essential.

However the nature of some services is so safety or security and data privacy critical that they might require to be unique and neutrally/centrally provided (e.g. registration, identification, geo-awareness, interface with ATM). The architecture has to allow this as well.

Finally, the U-space services will evolve to enable the growth in number and variety of drone operations, supported by an appropriate interface with ATM. As time goes on, the whole aviation environment is expected to evolve into a fully integrated environment supporting manned and unmanned operations in all classes of airspace.

2.1 Scope

Aiming at the challenges set for U-space, for which several projects are contributing and stakeholders are investing, it becomes essential to share a common understanding of the logical architecture in order to assure completeness, consistency and coherency of the content in the most efficient way. This can be achieved by selecting a common architecture that will critically contribute for the success of the U-space conceptual development and implementation.

The role of the architecture is therefore to support the decisions necessary to integrate U-space new concepts and technologies so that it can be responsive to change and support the improvements required to sustain aviation over the next decades.

The architecture should be agreed by stakeholders, and not prescribe any particular implementation model in order to ease co-operation between U-space architects. It should be accessible to all and supported by processes to allow access to the latest updated information while facilitating its updating as the U-space services evolve.

2.2 Actors

The list of actors here is a preliminary list, and a detailed consideration of stakeholders and roles will be elaborated in the ConOps . This section shows how they act in the U-space context.

- Authorities
  - Civil Aviation Authority
    - The main authority, which governs the airspace for the given geographical region. There is one unique certified airspace authority in a given region.
  - Military Authority
    - The main authority empowered to make decisions on military matters on behalf of his State and managing part of the airspace in a given region.
  - Local authorities
    - The optional additional authorities that manage part of the airspace in a given region or has some privileged roles permissions (e.g. cities, law enforcement, airports, local harbours, emergency services medic).
    - Provide unique data that feed the U-space services; for example complementing the AIM data for VLL. The local authority operates at the mandate of the regulating authority, which is the Civil Aviation Authority.
    - The Local authority may be delegated this role in some locations and hence there may be a Local authority which replaces or supplements the Civil Aviation Authority in that location. The Local authority may include U-space data consumers such as law enforcement bodies, emergency services (for example the creation of no-drone zones during emergency responses)
  - Other authorities
    - Registrar, airworthiness authority, radio technical compliance and similar authorities will support various U-space services, either directly or through delegated entities.
- Service Providers
  - Air Navigation Service Provider (ANSP)
    - Provides situational awareness information about the traffic they are responsible for.
  - Aeronautical Information Management Providers (AIMP)
    - Existing ATM provides sources of some data consumed by U-space service providers and users.
    - ANSPs are also consumers of U-space data.
  - Common Information Service (CIS) Provider
    - The potential entity (option) that might provide some safety or security and data privacy critical services should the need arise for being unique (e.g. registration, identification, geo-awareness, interface with ATM).
  - U-space Service Providers (USSP)
    - The entity that provides U-space service access to drone operators, to pilots and/or to drones, to other operators visiting non-controlled very-low-level airspace.

        - Multiple services could be provided by different U-space Service Providers.
    - Supplemental Data Service Provider (SDSP)
        - An entity that provides access to supplemental data like terrain, weather, cellular coverage.
        - Multiple services could be provided by different Supplemental Data Service Providers.
- Drone Operator
    - The Operator is the legal or natural person operating one or more unmanned aircraft. The drone pilot is a role of the drone operator. A drone operator can operate a drone using one or combination of two piloting techniques; it can directly operate the drone as a remote pilot or use an automatic on-board pilot system.
        - Remote pilot (role)
            - The actor (human or machine) operating the drone.
        - Automatic on-board pilot (system)
            - This refers to the level of automation of the drone; at the low levels of automation this could be limited to data collected by on-board sensors and sent to the USSP when at highest level of automation this is about piloting functions and on-board decision making with little or no human intervention.
- Aviation user
    - The pilot of a crewed aircraft, gliders, parachutists ...
- Privileged users, law enforcement, military
    - There are users serving law enforcement and military who may have special access rights to information in U-space. (For example, in some cases the military will have particular duties which will make them consumers of U-space services and data)

Different interfaces between the actors above can be envisioned in the U-space architecture (e.g. USSP to USSP, USSP to ANSP, Drone Operator to Drone Operator, Drone Operator to Aviation User) and as explained hereafter (standard-based principle) are subject to standardisation.

2.3 U-space services

From the architecture perspective, a service is the contractual provision of one non-physical object by one entity for the use by one or more others. It is also a discrete unit of functionality that can be accessed remotely, acted upon and updated independently. A service has four properties:

1. It logically represents a self-contained business activity with a specified outcome.
2. It is self-contained, in that users do not need additional services to benefit from its output.
3. It is a black box for its consumers.
4. It may make use of other underlying services.

From the perspective of a service provider, each service has three aspects: the business aspect (why), the operational aspect (what) and the technical aspect (how).

The Blueprint and the CONOPS define a list of U-space services.

The U-space services are grouped in this document according to the main actor involved:

- Services to service providers
    - Any service that is provided by an authority to the U-space service providers or between two service providers (e.g. AIMP to USSP).
    - This includes provision of services to enable safe and secure interoperability between U-space and ATM (e.g. ANSP to USSP), between U-space providers, and services that support cross border operations.
    - This includes the provision of certified services for safety oversight.
- Supplemental data services
    - Any service that provides additional data to other services from different sources; e.g. terrain, weather, surveillance, obstacle, cellular coverage...
- Services to drone operators
    - Any service that is provided by service providers to the operators prior to the execution, during, or after the flight (e.g. flight plan preparation / optimization assistance/strategic deconfliction).
    - Some services are provided by service providers directly to the pilots (human or on-board system) during the execution of the flight; e.g. tracking, tactical deconfliction.

3 Principles that lead the U-space architecture

The U-space architecture has to support the vision of the U-space blueprint [1] and related principles: U-space relies on a very high level of automation, connectivity and digitalisation for both the drone and the U-space systems. To go a step further, the U-space architecture is defined as:

- **Service Oriented Architecture**: a Service Oriented Approach shall be applied to ensure that the solutions are built based on a set of services with common characteristics.
- **Modular**: the architecture shall be decomposed in self-contained but complementing elements (Functional Blocks) which contain a meaningful set of functionalities with the required inputs/outputs that can be reused or replaced. In addition, these functional blocks allow to cope with and adapt to an increasing demand in terms of new needs or services (scalability)
- **Safety Focused**: the architecture shall always consider the safety of its stakeholders or of other people and places that may be affected by U-space operations.
- **Open**: a system architecture shall be developed which is component-based and relies on published or standardized interfaces based on SWIM principles[1] to make adding, upgrading or swapping components easier during the lifetime of the system. Some other expected benefits of an open architecture are to facilitate reuse, to increase flexibility, to reduce costs and time to market, to foster competition, to improve Interoperability and to reduce risks.
- **Standard-based**: whenever there are exchanges between roles, the interfaces have to be defined and based on open standards.
- **Interoperable**: the main purpose of the interoperability is to facilitate homogeneous and non-discriminatory global and regional drone operations. This relies on the connectivity between the various U-space systems.
- **Technology agnostic**: to allow platform independent design, the architecture shall be described independently of the later implementation specifics, e.g. platforms, programming languages and specific products, which shall be consistent with the operational architecture.
- **Based on evolutionary development (incremental approach):** architecture work is an incremental and iterative process, building upon the previously consolidated baseline.
- **Automated and digitalised**: the architecture shall be developed to facilitate the delivery of safe and secure U-space services with a high degree of automation and digitalisation of the processes as manual operations will be too labour intensive.
- **Allowing variants**: the architecture work shall allow variants and alternative solutions to be described. The principles listed in this document and later in the CONOPS aim for ensuring

[1] separation of concerns of technology stack, information model, and logical service definition. Technology stack (Yellow Profile G/G or Purple Profile A/G) and information model (as part of the AIRM) should be common for all services. The separation of concerns allows for agility in future development (which surely will be required for drones – it will evolve for quite a while)

interoperability between different implementations (see examples identified in section 5- Examples of U-space architectures).

- **Deployment agnostic**: architecture work shall support the business and regulatory framework established.
- **Securely designed**: architecture work shall address security issues such as cyber-security, encryption needs and consequences, and stakeholder authentication.

As illustrated in the figure below, this leads to a set of principles that drive any implementation of a U-space architecture.

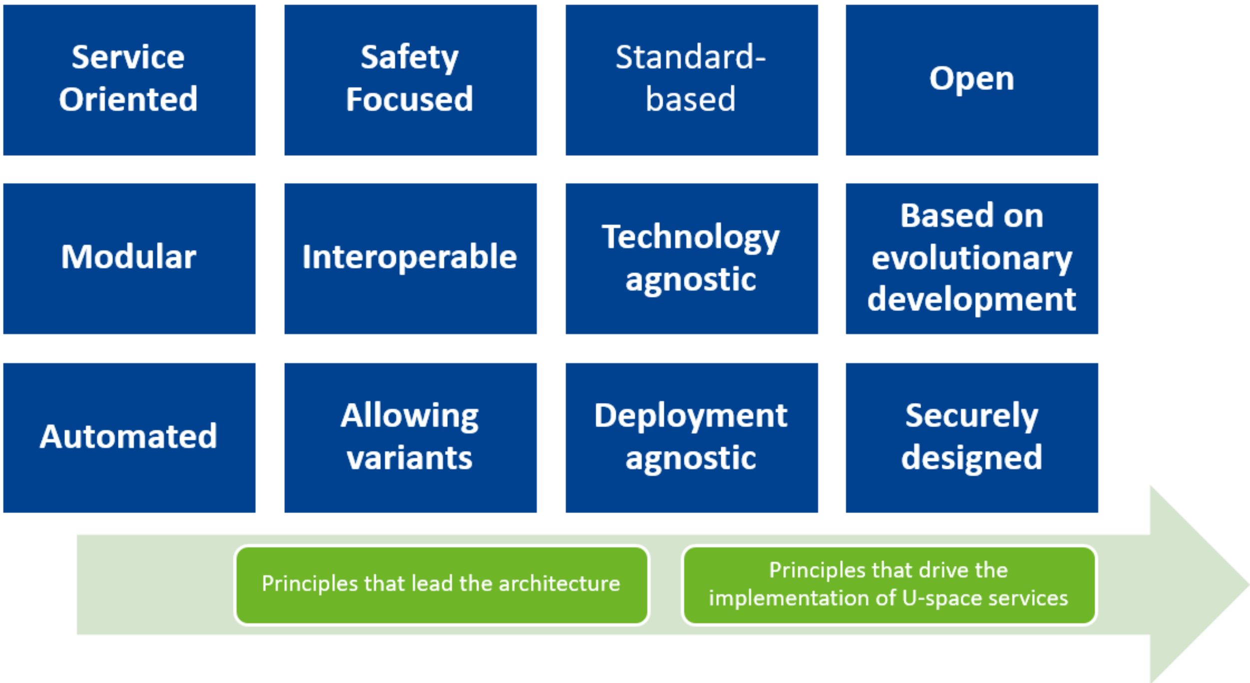

Figure 1: Principles for U-space architectures

These principles[2] are phrased here and in the related appendix in the form of a checklist to enable a U-space architect to confirm that any proposed service meets the criteria for inclusion as a service.

1. **Safe**
   The service is designed to minimise the risk to third parties on the ground, other airspace users, and passengers. It is supported by appropriate safety management systems and processes.

2. **Reusable**
   The service can be used in a multiple of operational scenarios and (where appropriate) by other U-space services.

[2] The list does not imply any weighting of importance for the architecture.

3. Autonomous units of business functionality
The service provides a business function that may be independent of other services.

4. Contract-based
The interface and policies are strictly described by a standardised interface service contracts.

5. Loosely coupled
The service contract is designed to be as independent of the service implementation as possible.

6. Platform-independent
Both the consuming and service systems can be on any platform that supports the service transport and interface requirements.

7. Discoverable and location independent
The service is located through a discoverable service registry/catalogue and accessed via universal resource locators, and therefore may move over time without disruption to consuming systems.

8. Accessible
The service is publicly accessible (with authentication or not as appropriate) for direct use.
Public/semi-public interfaces (with registration or not) exist for use by third party applications.
Access to the service is open to all (except in case of security breach, level of security being defined by regulation and/or standards).

9. Interoperable with ATC
U-space data sent to ATC complies to ATC requirements (including cyber-security and certification of the information as requested by the ATC systems) in order to minimise the impact on ATM due to the emergence of U-space.

10. Auditable
Recordings and real-time data are preserved and made available for investigation purposes if requested.
Service performance can be monitored and audited at national/European level by authorized agencies.
Authorities may make recorded data available for research, training and system development - with an appropriate anonymization / obfuscation.

11. Liable
The service design allows the determination of who is responsible for any service failure or incorrect-untruthful data sharing.

12. Data validity
The service ensures data are valid in the timeline they have to be valid. This covers as well the data integrity.

13. Performance based
The service to service providers complies with the level of performance required by the authority.
The service to service providers offers a quality of service level secured by a Service Level Agreement.

The service is robust, with the neccesary in-build resilience from a safety and security perspective (e.g. no single point of failure and filtering to ensure subsystems only have to handle data that matters to them) and need to be affordable to the users.
The service has to be delivered according to the appropriate time constraints.The latency of a service response has to comply with the identified level of performance.

14. Automated and digitalised
The service has a high degree of automation and digitalisation in order to enable rapid response and ensure low costs.
Human intervention is at a minimum: humans implement policies, monitor limits/alerts provided by automation, and intervene upon exceptions or when unsafe or unlawful operations are reported by automation.

15. Standards-based
The service is designed, implemented and consumed using standards that are appropriate to the nature of the service being provided.

16. Secure
The service is cyber-resilient and assures strong authentication of all actors.

17. Sustainable
The service is designed to minimise, when and where relevant, the environmental impact of unmanned aircraft operations, including noise, and to protect the privacy of citizens.

18. Scalable
The service is designed to scale in various dimensions, including (but not restricted to) the number of users or services, the number of concurrent flights, the number of business use cases supported, the geographical areas where U-space is deployed.
The more generic set-up the better. Anything that requires tailoring to specifics of national or regional nature should be configurable (parametrized) and certainly not hard-coded.

4 Examples of U-space architectures

There are multiple solutions for a U-space architecture, as long as they comply with the principles described in the above section. Here are some examples of U-space architecture (non exhaustive list).

4.1 The GOF USPACE U-demonstration architecture

The open GOF USPACE architecture aims to provide a framework for actors in and connected to U-space based on common principles for U-space architectures and SWIM principles.

"SWIM consists of standards, infrastructure and governance enabling the management of ATM information and its exchange between qualified parties via interoperable services." (ICAO 10039 Manual)

In consistency with the principles of an open U-space architecture standardized interfaces based on SWIM principles make adding, upgrading or swapping components easier during the lifetime of the system.

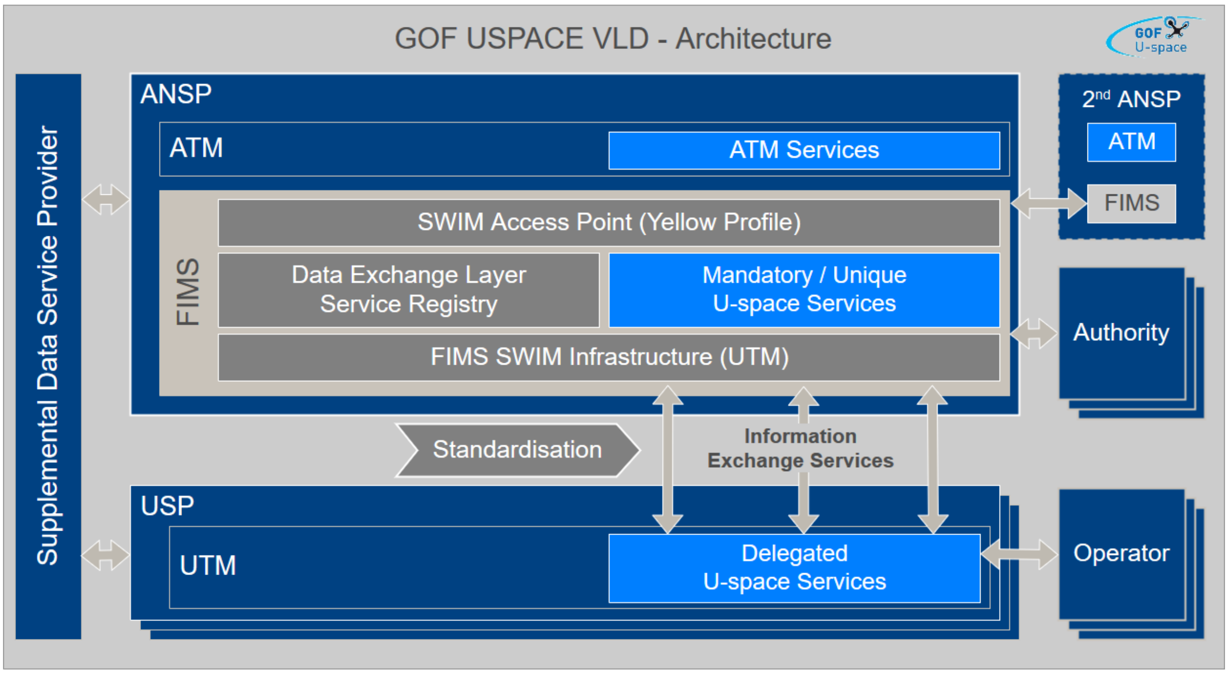

Figure 2: GOF USPACE High level design architecture

Information exchange services are introduced to facilitate standardized data exchange. They are described using formal templates, separating logical, technical and runtime concerns into different standard documents. This layered approach addresses several U-space architecture principles.

Descriptions on logical level, so called Service Specifications, are technology agnostic. They enable a modular and open system, as they are easier to keep self-contained and foster reuse of concepts while technology evolves in incremental steps.

Service specifications allow for technical variants in implementation. In technical designs, by describing interfaces and protocols clear contracts are defined for data exchange. Technical contracts are key in Service Oriented Architecture, and important to facilitate interoperability for stakeholders in the system.

For service discovery and service delegation Flight Information Management System (FIMS) provides a service registry. It contains both design time and runtime information on available services. Hosting meta information on who / how / where allows for a flexible, scalable and adaptable system. Supporting a well-defined delegation process, the service registry has positive impact on overall system safety. Automated services can be registered where possible, focussing services requiring human interaction on areas where it is necessary.

The logical description of services as well as the act of service delegation could be subject to governance by regulating and local authorities.

4.2 The Swiss U-space architecture

The Swiss U-space is a set of decentralized services (Service Oriented Architecture) and associated functions plus an all-encompassing framework designed to support multiple drone (UAS) operations. These services are separate and could be offered by different service providers (modular and open architecture) but need to guarantee a seamless experience for the end user and accurate data transmission between each other, as required for safety reasons (safety focused architecture). The services are complementary in nature to traditional ATM and several exchanges and interactions are foreseen between U-space and the ATM ecosystem.

The Swiss U-space services are organized, coordinated and managed by a federated (decentralized) set of actors in a distributed network of highly automated systems. Information is exchanged using a set of standardized application programming interfaces (APIs).

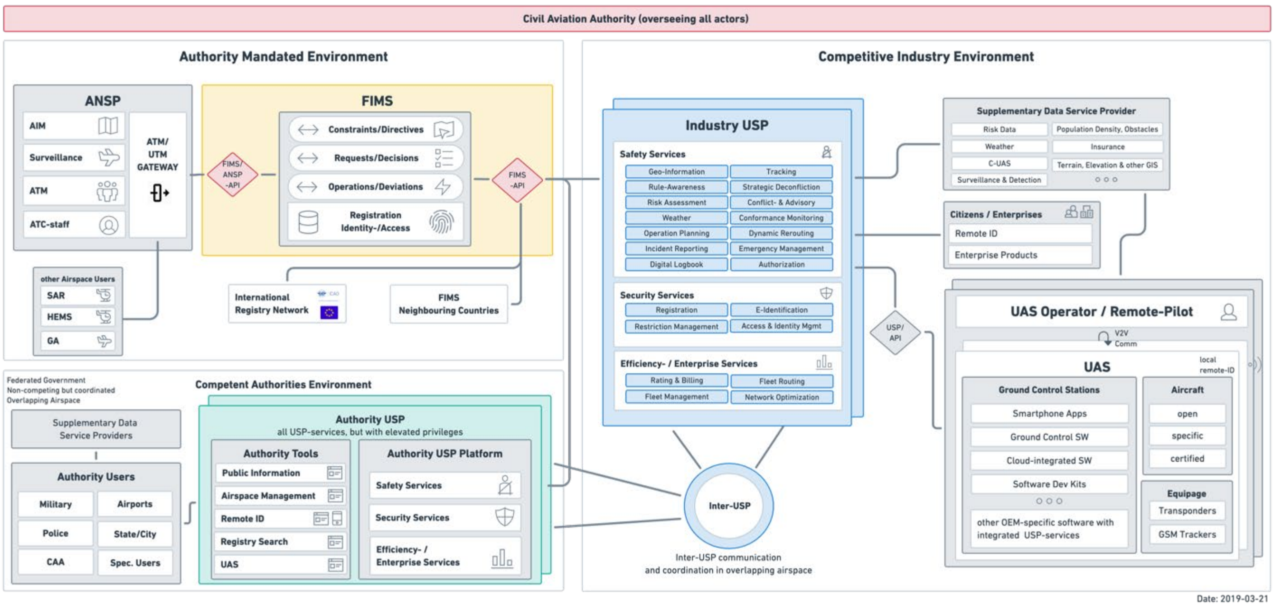

Figure 3: Swiss U-Space architecture

The Flight Information Management System (FIMS) is a gateway for data exchange between the U-space participants and Skyguide (ANSP) systems, through which Skyguide can provide directives and make relevant airspace information available to UAS operators via the U-Space system. The FIMS provides a mechanism for shared situational awareness among all U-Space participants and is a central component of the overall Swiss U-Space ecosystem.

The term “InterUSP” refers to an amalgamation of shared drone operator data. Multiple USPs can and will operate in the same geographical area and thus may support “overlapping” operations that require orchestration. In this environment, the InterUSP platform shares operational intent and other relevant details across the network to ensure shared situational awareness for U-space users. Given this need for USPs to exchange a minimum set of data, the interUSP platform must implement a shared paradigm, with methods for de-confliction or negotiation, and standards for the efficient and effective transmission of intent and changes to intent. The communication platform is then based on a standard that is global and open-source; it is scalable in order to manage large number of USPs and drones. The interUSP platform does not store or process details about the drone operations being shared and, more in general, complies with applicable privacy and data protection regulation (e.g. GDPR).

4.3 The DOMUS demonstration architecture

DOMUS stands for the ‘Demonstration Of Multiple U-Space Suppliers’, pretends to demonstrate the viability and efficiency of a National U-space solution based upon a highly modular open federated architecture, where an ‘unlimited’ number of U-Space Services Providers are enabled to deliver services to operators by managing simultaneous drone operations, in a same geographical area, under the interconnection and an efficient orchestration of an Ecosystem Manager (the Common Information Service -CIS provider)

The Ecosystem Manager acts as a proxy for both the rest of the network (i.e. federated peers) and the ATM system, freeing USPs from the complexity of having to interact with an indefinite number of peers and protocols and supporting them in their computational needs. The Ecosystem Manager also acts as a firewall between the highly critical ATM system and the network of USPs, and maintains a central database of airspace, mission plans, e-registry and tracking.

This proposed architecture brings further benefits in terms of market access and efficiency, in terms of a greater scalability or safety, security and data privacy.

Some of the U-space architecture principles in which DOMUS focuses are:

- High modularity;
- Fair access: USSPs are guaranteed a fair access to the U-space Ecosystem with less costly USSP systems thanks to less critical functionality needed as already being provided by the Ecosystem Manager for the whole community, avoiding multi-plication of investment and bringing cost-efficiency gains to the whole service. USSPs can invest in other functionalities to provide added value to their customers and differentiate from each other.
- Interoperable and standard based: In addition to the definition of the open interfaces between Ecosystem Manager and USSP, the project provides bidirectional and collaborative

interfaces with ATC that rely on well-known ATM standards (e.g. ASTERIX) to share UTM/ATM relevant information between ATC and U-Space.

- Safety focused: the global aim of the architecture is to provide a safe U-Space environment for both assets in the air and in the ground. Architecture focuses on providing ATC with the relevant information to enable ATC to keep manned aviation safe, while enabling broad access to airspace to drone operators. System relies on some key services to ensure this process like pre-flight separation measures (based on strategic de-confliction services) and real time tactical information for remote pilots. Project also investigates tactical de-confliction capabilities to enhance safety.
- Automated and digitalised: the architecture provides almost fully automated services, avoiding humans in the loop except for specific authorizations/directives/constraints provisioning and some unusual situations where safety could be compromised otherwise.
- Securely designed: the architecture provides security to the ATM system, by reducing the interaction to a single point of contact, the Ecosystem Manager. In this way, the ecosystem manager acts as a firewall between the highly critical ATM system and the federated network of USSPs.

4.4 The SAFIR demonstration architecture

The SAFIR architecture realizes the U-space conceptual model through federated DTM service providers, which collaboratively provide the necessary U-space services to drone operators. These services are provided using the DTM discovery interoperability model, which enables communication between the DTM service providers. The concept of this model is sharing the intentions and status of UAS through a federated system of interoperable, cloud-based services.

The actors in the SAFIR architecture are the multiple U-space service providers (USSP) which include Amazon DTM service provider, Skeyes DTM service provider and State Authority DTM service provider (for which the latter two are powered by Unifly software) these providers expose U-Space services and capabilities within a shared or adjacent airspace. The State Authority DTM system is the USSP, which is acting as an information exchange gateway for the centralized service interactions between the DTM service providers offering services to the drone operators and all other stakeholders. By design, the architecture requires a minimized set of these centralized services.

The other stakeholders include the Supplemental Data Service Provider (SDSP), Civil Aviation Authority (Competent Authority), aviation users & ANSP (ATM system) and public authorities (Local Authority). In the SAFIR project, the local authority will be the port authority of Antwerp.

This entire operational concept is depicted in the Figure below.

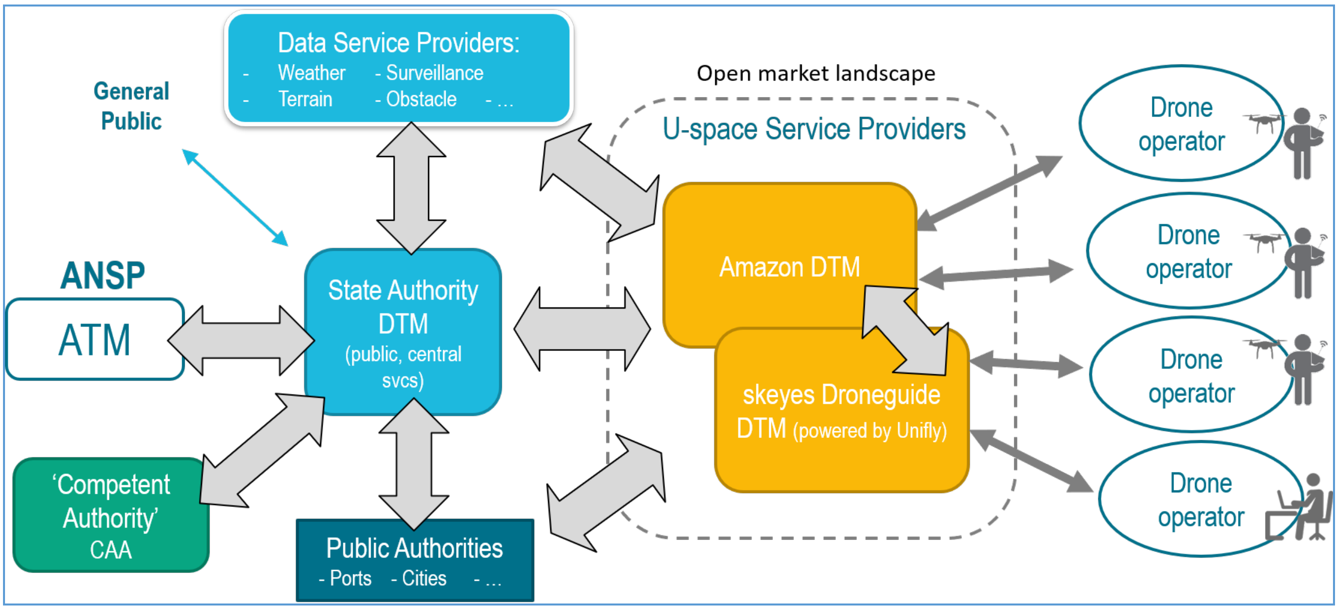

Figure 4 - SAFIR U-space architecture

SAFIR is a U-space architecture, which is fully compliant with the U-space principles.

Safety is key. The SAFIR architecture is designed to minimize the risk to third parties on the ground and other airspace users by providing situational awareness to operators and redundancy (no single point of failure design) in the deployment architecture.

The SAFIR architecture has been designed to be reusable and loosely coupled, using principles that have been implemented and tested across multiple locations and technology stacks, supporting several different CONOPS.

Each SAFIR supported U-space service has a high degree of automation and does not require human intervention to fulfil the nominal operations required for operations. Automated processes are key to have a scalable deployment.

5 References

[1] U-space blueprint - https://www.sesarju.eu/sites/default/files/documents/reports/U-space%20Blueprint%20brochure%20final.PDF

[2] Roadmap for the safe integration of drones - http://www.sesarju.eu/sites/default/files/documents/reports/European%20ATM%20Master%20Plan%20Drone%20roadmap.pdf

[3] U-space CONOPS - https://www.sesarju.eu/projects/corus

[4] Swiss CONOPS https://www.bazl.admin.ch/dam/bazl/fr/dokumente/Gut_zu_wissen/Drohnen_und_Flugmodelle/U-space_ConOps.pdf.download.pdf/Swiss%20U-Space%20ConOps.pdf

[5] GOF USPACE detailed architecture document https://www.sesarju.eu/sites/default/files/documents/projects/SESAR%202020%20GOF%20USPACE%20-%20Summary%20-%20Design%20And%20Architecture.pdf

