AW-Drones proposed standards – 3rd iteration (U-Space)

D4.3

AW-Drones

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AW-Drones

a. Abstract

Several studies and surveys conclude that having a comprehensive regulatory and standardisation framework could be a major booster for the drone related business. In this context, the EU's Horizon 2020 Research and Innovation Program funded Project AW-Drones to support the rulemaking process by proposing guidance for the EU drone regulation.

This EU regulation is performance based and comprises of legally binding 'hard rules' (i.e. legally-binding Commission Regulations), that contain high-level performance requirements. These 'hard rules' are supplemented by so called 'soft rules' with the Acceptable Means of Compliance (AMC) approved by the European Union Aviation Safety Agency EASA. These AMCs may refer to standards produced by Standard Development Organisations (SDOs).

The Performance-Based Regulation in fact postulates that AMCs should preferably not be published by Authorities, but by Standard Development Organisations (SDOs).

The idea that regulatory material adopted by Authorities could be complemented by consensus-based standards emerged in civil aviation in 1998, through Resolution A32-14 adopted by the ICAO General Assembly. This policy is still applicable in ICAO, where meanwhile the new Resolution A39-22 of 2016 has replaced the original one. The concept in EU is often referred as 'Performance-Based Regulation' meaning that EASA could enshrine standards published by SDOs at the level of AMC, instead of directly drafting such material.

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b. Table of Contents

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1 Introduction

1.1 Assessment of U-space standards in the context of AW-Drones

The AW-Drones project supports the European Union's drone regulations by identifying standards that EASA may accept as AMC in the perspective of the 'Performance-Based Regulation' on UAS, enabling safe, environmentally sound and reliable operations of drones in the European Union.
This deliverable contains the second iteration of the U-space supporting standards (part of the third iteration of the AW-Drones project). Therefore, this third iteration of AW-Drones covers known updates in the activity of the SDOs, as assessed in 2021/Q4.

1.2 AW-drones Work Plan

In collaboration with EASA, AW-drones drafted a work plan to identify and assess standards addressing U-space specific issues, for already existing standards and for standards that are still under development. The work plan distinguishes three main technical work packages (WP):

- WP2 - Development of a methodology for categorization and assessment
- WP3 - Collection and categorization of standards that may be applicable for UAS
- WP4 - Assessment of the collected standards to evaluate their feasibility to support this process in order to derive a set of standards that are validated and found applicable.

EASA is working on AMC guidance material (GM):

- work conducted in the AW-Drones project might be used for EASA's development on AMC GM
- divided in WP's (6 out of them (15) ref. to USS's)
- the first edition of U-space AMC GM is expected to be ready by the end of 2021
- The EASA AMC GM task force is currently working on NIS, GAW and Flight Authorisation Service (FAS equivalent to acceptance of flight plan in traditional aviation, complemented by flow management)

1.3 Purpose and scope of this document

The assessments are based on the methodology [2] defined in work package (WP) 2. This document contains the summary of the identified standards (deemed suitable to support verification of conformity of identified U-Space services and related airborne functions), a gap

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assessment as well as conclusions and recommendations. The assessments of the individual standards are contained in a separate tool, based on the aforementioned methodology.

The present document provides the results of the **final iteration** of the standards deemed applicable to cover U-space requirements. The approach employed in this methodology holds some **differences with respect to the previous iteration**, namely:

The "Effectiveness to fulfil the U-space service" criterion was **removed from the multi-criteria analysis** to assess standards, and it is therefore not kept in consideration when evaluating a standard's score. As such, scores for recommended standards in this iteration are lower: a standard scoring +5 now holds the same value as one scoring +10 in the previous iteration. This was done to avoid standards with full coverage but limited scope to be penalised.

The Commission Implementing Regulation 2021/664 [9] lists 4 mandatory U-space services, plus two optional, plus possibly the 'Common Information Service' (CIS). These services are subject to certification by the competent authority, plausibly because considered safety-critical.

Note: Draft International Standard (DIS) ISO 23629-12 lists 30 possible digital U-space services, categorised as safety-critical, safety-related or operation support. The additional 24 UTM (U-space) services listed in ISO DIS 23629-12 are out of scope of this document.

In case of gaps preventing full coverage, or where no standards are identified to provide at least partial coverage SDO's could discuss in the European UAS Standard Coordination Group (EUSCG) how to fill these.

1.4 Structure of the document

Based mainly on the Commission Implementing Regulation 2021/664 on a regulatory framework for the U-space [9], an architecture (chapter 2.2) has been taken as a starting point for collecting standards related the mandatory U-space services, supporting services and related services.

The structure of this document is based on the above-mentioned U-space services (4 mandatory + 2 optional) listed in regulation 2021/664. For each service, there is a separate chapter including a description of the service and the identified standards (offering at least a partial coverage), a summary, gaps identified and conclusions & recommendations. The assessments themselves are done in a separate Excel file: 'AW-Drones_D4.3_Annex_U-Space_Standards assessment.xlsx' [Annex V].

In chapter 2 some background information is given on U-space, as well as a schematic presentation of the U-space architecture used in the project, based on the already mentioned publications (sources [2] & [3]).

Chapter 3 to 8 addresses said U-space services, while chapter 9 contains a general conclusion of the assessments.

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Annex I presents the identified standards per USS/Category and per SDO. It also presents a table suggesting additional standards and publications to be screened as potentially being suitable to cover U-space requirements.

1.5 How to read this document

This section includes the used abbreviations and highlights the main features of the tables describing the assessment of the standards. It explains how the information is presented and how to effectively read the results presented.

1.5.1 List of acronyms

AMC	Acceptable Means of Compliance
ASTM	American Society for Testing and Materials International
ATM	Air Traffic Management
CD	Committee Draft
CISP	Common Information Service Provider
CMS	Conformance Monitoring Service
CU	Command Unit
DOC	Designated Operational Coverage
DRI	Direct Remote Identification
EASA	European Union Aviation Safety Agency
EDPS	European Data Protection Supervisor
EU	European Union
EUSCG	European UAS Standards Coordination Group
FAS	Flight Authorisation Service
FCS	Flight Clearance (alias authorisation) Service
GAW	Geo-Awareness service

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MOPS	Minimum Operational Performance Specification
MS	Member State
NIS	Network Identification Service
SDO	Standard Development Organization
SORA	Specific Operations Risk Assessment
TIS	Traffic Information Service
ToR	Terms of Reference
TRS	Tracking Service
UAS	Unmanned Aircraft System
UCS	UTM Communication Service
USSP	U-space (alias UTM) service provider
UTM	UAS Traffic Management (equivalent to U-space)
WIS	Weather Information Service
WP	Work Package

1.5.2 Summary table

The summary table in each chapter includes the identified standards that could be considered by EASA as candidates to be recognised by the Agency as possible AMCs for the U-space services. Such tables include following columns:

Table 1 Example of Summary Table

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score

Standard title

The title of the document assessed, which can be a in a Planning, Drafting, Internal Consultation, External Consultation or Published phase. Please note different maturity

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terminologies are used amongst different SDO's, therefor a Maturity Correlation Table is provided in Annex III.

SDO

The Standard Design Organisation (alias standard making body) which has published, or which is producing the standard.

Doc. Ref.

The respective document reference

Status, scope & compatibility

Contains more info on the status of the document (Planning, Drafting, Internal Consultation, External Consultation, or Published), the scope of the document that matches the U-space service, and if this standard doesn't, partially of fully covers the requirements. It might also contain the name of the working group.

Since different SDOs use different semantics to identify stages of respective developments, a correlation table is provided in Annex III.

Global score

This column presents a global score obtained by assessing each standard according to the methodology described in [2].

1.5.3 Gap summary

The gap summary table highlights the identified gaps missing to cover the requirements for the specific U-space requirement. The columns are divided as follows:

Table 2 Example of Gaps' Summary table

Gap #	Gap Description	Conclusion Recommendation

Gaps and Gap Description

Provides a number for each gap identified, explaining the nature of the gap and its rationale. The gaps listed in this table are generally not the same identified in the assessment of the individual standards, but rather gaps to fully cover the U-space service requirement, taking in consideration all currently available standards.

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Conclusions and Recommendations

It provides conclusions on gaps which have been identified, with recommendations in relation to the severity of each respective score.

In the framework of identifying gaps related to U-space service requirements, no quantitative assessments of the consequences of the gaps has been carried out.

1.5.4 Conclusions & recommendations

This section gives an overview of the current coverage of each requirement identified for the specific U-space service, providing a table with the best identified standards that cover the requirement at present, alongside any associated limitations and gaps.

Table 3 Example of Conclusions table

Requirement	Coverage	Recommended standards	Limitations/notes	Gaps

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2 Background information

2.1 U-space Services

AW-Drones considered only the 6 U-space Services listed in Chapter IV (U-space services) of Regulation 2021/664 high level framework for the U-space, since the Common Information Service (CIS) could be delivered directly by States.
The considered 6 services are:

1. **Network identification service (NIS)**
   A network identification service should provide the identity of UAS operators and location of UAS during operations and share relevant information with other U-space airspace users.

2. **Geo-awareness service (GAW)**
   A geo-awareness service should provide UAS operators with the information about the latest airspace constraints and defined UAS geographical zones information made available as part of the common information services.

3. **(UAS) flight authorisation service (alias Flight Clearance Service – FAS or FCS)**
   A flight authorisation service should ensure that authorised UAS operations are free of intersection in space and time with any other notified flight authorisations within the same U-space airspace.

4. **Traffic information service (TIS)**
   A traffic information service should alert UAS operators about other air traffic that may be present in proximity to their UAS.

5. **Weather information service (WIS)**
   A weather information service should support the UAS operator during the flight planning and execution phases, as well as improve the performances of other U-space services provided in the U-space airspace.

6. **Conformance monitoring service (CMS)**
   A conformance monitoring service should provide real-time alerting of non-conformance with the granted flight authorisation and inform the UAS operators when deviating from it.

Note: It could be noticed that these listed 6 U-space services are all mentioned in draft ISO ISD 23629-12 [5]; but the latter, based on CORUS, identifies 30 UTM services, categorised into 'safety-critical', 'safety-related' and "operation support". Also, CIS is covered by that standard. This standard is still under development though.

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2.2 U-space architecture

EASA and the Commission defined that the architecture needed for a successful implementation of U-space would be one with two types of service providers, being the 'Common Information Service Providers' and the 'U-space Service Providers'.

Common Information Service Provider (CISP)

A Common Information Service Provider will be designated by Member States for every U-space airspace, as a single trustworthy source of reference information for the given U-space airspace for authorities, service providers and operators to enable the safe management of UAS operations. The CISP will support the exchange of information and the coordination between U-space service providers and air traffic service providers, without discrimination, to enable the safe management of unmanned aircraft traffic and segregation of manned aircraft from unmanned aircraft in the U space airspace under his jurisdiction.

A single standard of data will be needed:

- standard to be identified by EASA, currently left to the MS
- an open communication protocol standard is requested by EASA
- consider SWIM standards/profiles

U-space service providers (USSP)

U-space service providers will act as gateway to U-space for Unmanned Aircraft Operators, providing as a minimum the following minimum mandatory U-space services:

- Network Identification Service (safety-related in [5])
- Geo-awareness Service (safety-critical in [5])
- UAS Flight Authorisation Service (safety-critical in [5])
- Traffic Information Service (safety-critical in [5])

Mandatory vs optional services

Next to the mandatory services above, following services are seen as optional services but may be obligatory if deemed necessary by a Member State (MS):

- Weather Service (safety-related in [5])
- Conformance monitoring service (safety-critical in [5])

Unmanned aircraft operators may only operate in U-space airspace if they use the mandatory U-space services that are indispensable to ensure safe, secure, and efficient operations.

Note: in the Opinion No 01-2020 - high level framework for the U-space [3] 'tracking' service (TRS) was proposed as a U-space service, this however is currently not mentioned in the Commission Implementing Regulation 2021/664 on a regulatory framework for the U-space

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Definition

No formal UTM (alias U-space) definition is yet published either by ICAO, EC or EASA. In this document the following definition from [5] is hence used:

> UAS Traffic Management (UTM):
>
> Set of traffic management and air navigation services aiming at safe, secure, and efficient integration of multiple manned and unmanned aircraft flying inside the respective DOC of each service.
>
> *Note 1 to entry: The definition is adapted from the ICAO Common UTM Framework with Core Principles for Global Harmonisation, 2nd edition, Nov. 2019*
>
> *Note 2 to entry: In compliance with ICAO, Global Air Traffic Management Operational Concept, Doc 9854, 1st edition, 2005, UTM services initiate when the UAS operator files a request for clearance to enter airspace and terminates when the UA reaches the parking position, the primary propulsion systems are switched off and the operational plan is closed.*

Architecture

The architectural diagram below is based both the Agency's Opinion No 01-2020 - high level framework for the U-space [3] precursor of the now promulgated Regulation 2021/664 Commission Implementing Regulation on a regulatory framework for the U-space.

The services which will be provided by the USSP are mentioned and described in the following chapters. The services/data which are mentioned in the architecture in the CISP system are interpreted as required to be provided by the CISP.

The architectural diagram displays the information flows. The services and flows are displayed as in the legend below. Optional/supporting services are dependent per Member State (MS).

The following legend is used:

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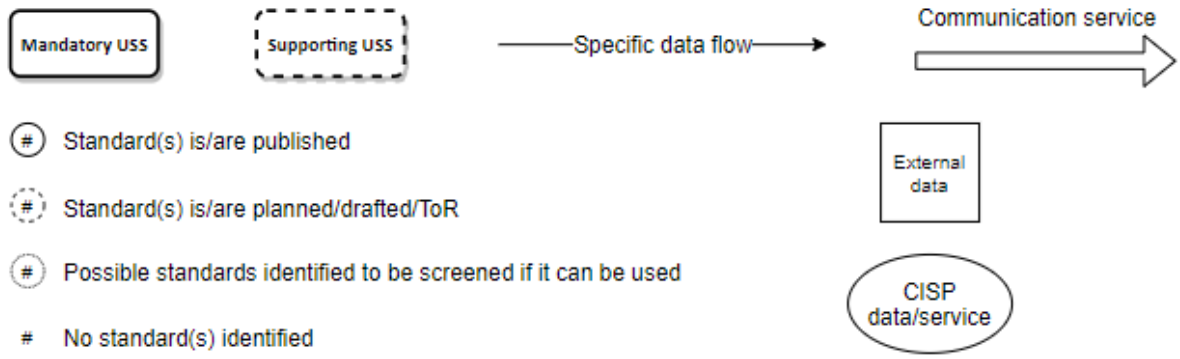

Figure 1: legend

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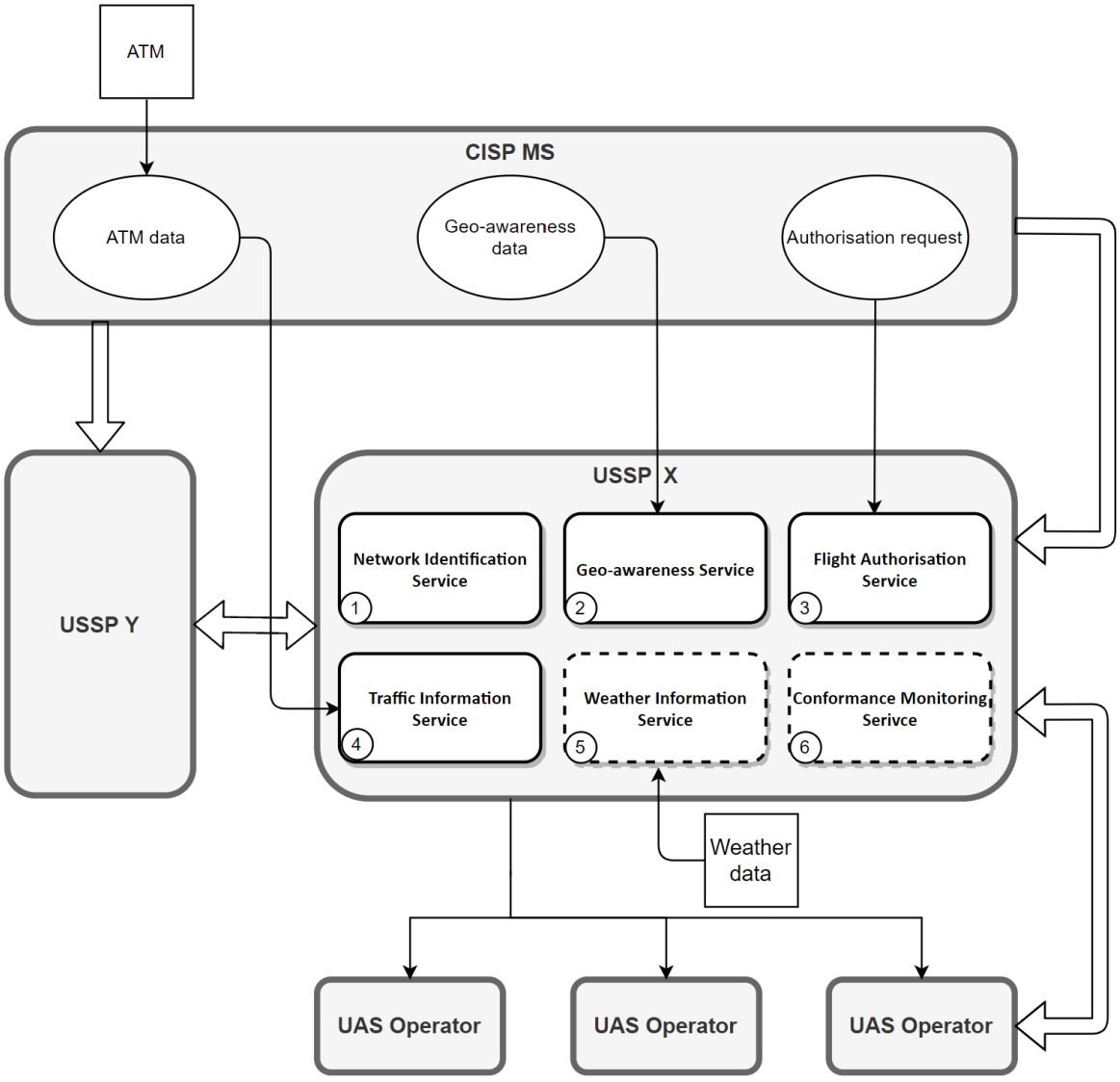

Figure 2: U-space architecture

Note: Project Flying Forward FF2020 https://www.ff2020.eu/ is developing the architecture of a digital ecosystem, encompassing also non-aviation users, in line with draft ISO 23629-5.

In particular, this project is envisaging that three Information Technology (IT) entities would be under managerial control of the UAS operator:

a) *The unmanned aircraft (UA) itself, which during the flight is able to exchange digital data;*
b) *The Command Unit (CU) of the Remote Pilot, which is also able to transmit and receive digital data and which, like the drone, is switched on only during the flight, and*
c) *The workstation of the 'Fleet Manager', potentially active 24/7 and mainly used during the planning phase.*

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Typically, CIS, GAW, FAS and WIS could be available also at the Fleet Manager station, as well as potential additional services as listed in ISO DIS 23629-12.

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3 Network identification service ①

3.1 Description

The description of this service, according to the Regulation 2021/664 (Article 8), is:

1. *A network identification service shall allow the continuous processing of the remote identification of the UAS throughout the duration of the flight and shall provide the remote identification of the UAS to the authorised users referred to in paragraph 4 in an aggregated manner.*

2. *The network identification service shall allow for the authorised users to receive messages with the following content:*

    a) *the UAS operator registration number;*
    b) *the unique serial number of the unmanned aircraft or, if the unmanned aircraft is privately built, the unique serial number of the add-on;*
    c) *the geographical position of the UAS, its altitude above mean sea level and its height above the surface or take-off point;*
    d) *the route course measured clockwise from true north and the ground speed of the UAS;*
    e) *the geographical position of the remote pilot or, if not available, the take-off point;*
    f) *the emergency status of the UAS;*
    g) *the time at which the messages were generated.*

3. *The information provided by the network identification services shall be updated at a frequency that the competent authority has determined.*

4. *The authorised users shall be:*

    a) *the general public as regards information that is deemed public in accordance with applicable Union and national rules;*
    b) *other U-space service providers in order to ensure the safety of operations in the U-space airspace;*
    c) *the air traffic services providers concerned;*
    d) *when designated, the single common information service provider;*

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e) the relevant competent authorities.

3.1.1 Network Identification Service (NIS) vs Direct Remote Identification (DRI)

The Implementing Regulation (EU) 2019/947 defines Direct Remote Identification (DRI) as a requirement for an airborne function in the Open Category. The network identification service requirements, in case a drone in either class C1, C2 or C3 would be equipped with such function, are included in Commission Regulation (EU) 2020/1058, which has amended Regulation 2019/945. The difference between direct remote identification and network identification is described below.

Direct remote identification means a system that ensures the local broadcast of information about an unmanned aircraft in operation, including the marking of the unmanned aircraft, so that this information can be obtained without physical access to the unmanned aircraft.

Direct remote identification is a method where the UAS is broadcasting the identification information which should be able to be received by mainstream smartphones.

Network Identification Service is a service where identification information is transmitted to the USSP through infrastructure such as LTE or satellite) where the identification and position information is continuously exchanged between service providers, if authorised.

Note: in the ASD STAN the terminology used for NIS is NRI (Network remote Identification), while in [5] it is NIS.

Neither DRI nor NIS are necessary to ensure airworthiness of the drone. In fact, DRI is necessary for enforcement, security, and privacy considerations. Conversely NIS may be an operational requirement stemming from the airspace access rules.

3.1.2 Readiness of the mobile network to communication in U-space

The existing mobile networks can be reused without the need to deploy dedicated infrastructure for coverage in the air but limited in altitude due to antenna's directed towards the ground. In future deployments of 5G infrastructure the antenna pointing could be improved to allow NIS at higher altitudes. 3GPP standards are defined to provide global interoperable and secure connectivity. At present, mobile networks have sufficient capabilities to deliver connectivity, real-time data, security, and identity management for supporting U-space requirements. As providers of mobile communications maintain and upgrade their existing infrastructure to 5G, their networks' capabilities will expand further.

There are concerns when using existing infrastructure in combination with the current LTE connectivity. Having too many drones in the air connected to the same pylon may decrease connectivity for all mobile users.

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In any case [5] already contains safety and quality requirements for the related UCS providers, being this service considered safety-related by current ISO DIS 23629-12. Conformity with the applicable requirements could hence be verified through industry mechanisms, without involvement of the aviation authorities, using the principles in AMC1 to rule ARO.GEN.305(b);(c);(d);(d1) on the oversight programme in Regulation 965/2012, which sets the criteria to credit certification by Notified Bodies (NB) based on industry standards.

This AMC, for ease of reference is reproduced in Annex IV.

3.1.3 ASTM - F3411 – 19: UAS Remote ID and Tracking

During operation of the UAS, a Unique Operator's ID, (and possibly other codes, like e.g. the drone serial number) along with location and vector (speed/direction) will be communicated at a regular interval such that a compliant receiver will be able to identify an aircraft that is within operating range of the receiver for broadcast mechanisms and network range for network mechanisms.

Remote ID allows public and civil (i.e., government law enforcement agencies and private citizens) identification of UAS for safety, security, and compliance purposes, including for security and privacy purposes. The objective is to increase UAS operator accountability by removing anonymity while preserving operational and personal privacy for remote pilots, businesses, and their customers (with the European GDPR regulation [7] in mind).

This standard defines message formats, transmission methods, and minimum performance standards for two forms of Remote ID: broadcast and network. Broadcast Remote ID is based on the transmission of radio signals directly from a UAS to receivers in the UAS's vicinity. Network Remote ID is based on obtaining UAS remote identification information via the internet from a Network Remote ID Service Provider (Net-RID SP) that interfaces directly or indirectly with the UAS, or with other sources in the case of Non- Equipped Network Participants.

The term Broadcast Remote ID in this standard is equivalent to DRI in Commission Delegated Regulation 2019/945.

This standard is partially suitable to support the EU U-space draft Regulation, but gaps are being addressed in ASTM's current revision 1.1.

NIS is currently not needed in FAA regulation, Meetings between EASA, Standardisation committee and Industry revealed that a standard for NIS is not required, as the number of parties involved cannot guarantee the transmission and receipt of the data (aka the 4G network is not controlled by the drone manufacturers)
ASTM is working with EUROCAE to address a global standard for NIS. This effort is coordinated by ISO TC 20 SC 16, which is developing a global standard on remote identification of unmanned aircraft (i.e. 23629-8).

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3.1.4 EUROCAE - ED-282: MOPS for UAS E-Identification

EUROCAE is developing ED-282 in coordination with ASD-STAN D05/WG08 for DRI. The 'Open' (alias external) consultation on this standard was closed in August 2020. In 2021 EUROCAE is disposing the received comments to prepare the ED for publication.

Draft ED-282 'Minimum Operational Performance Standard for UAS E-Identification' specifies the minimum performance expected from e-Identification solutions for UAS and focuses on the E-Identification function meant to provide surveillance information generated by the UAS itself or its remote pilot station (RPS).

It does neither contrast ASTM F3411-19 nor prEN 4709-002, but the ED focuses on the network segment enabling the TRS.

3.1.5 ASD-STAN - prEN 4709-002: Aerospace series - Unmanned Aircraft Systems - Part 002: Direct Remote identification

This standard is defined in coordination with EUROCAE WG-105 SG-32 'UTM E-Identification' and ASTM. This standard was under 'Enquiry' (i.e. external consultation) by CEN until 25 February 2021, is published on October 31st 2021 and has a focus on Direct Remote Identification, which is a requirement in the implementing regulation for the open category.

Current outstanding challenges: in the delegated act it is specified that all information for DRI must protect the identification of the user.

The EDPS recommends that the Commission encourages RPAS manufacturers to implement privacy by design and by default and data controllers to carry out data protection impact assessments where processing operations present specific risks to the rights and freedoms of data subjects (i.e. citizens) by virtue of their nature, scope or purposes. As a consequence, the CEN prEN4709-002 standard does not cover the Remote Pilot/Operator privacy and data protection by design, and by default. The privacy of the identification of the remote pilot/operator is somehow guaranteed by the validation of the Operator registration ID, which consists of a public (12 chars), a checksum (1char) and a private (3 chars) part. A successful checksum validation is only possible with the private 3 chars, only known by the Remote pilot/operator.

3.1.6 ISO - 23629-8: Remote identification

ISO started the development of an international standard on Remote ID. having approved the New Work Item Proposal (NWIP) on 22 June 2020.

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Two rounds of written consultation have been carried out inside WG 4 of SC 16 of ISO TC 20 at the 'Working Draft' stage. The second round of consultation was closed on 14 October 2021 and now WG 4 is responding the received comments.

The next step would be to publish a 'Committee Draft' for one more round of written consultation.

3.2 Summary

Table 4

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
UAS Remote ID and Tracking	ASTM	F3411-19	• Published • Version (date): February 28th 2020 • Prep. by WK65041 • Broadcast (BLE or Wifi) • Network (between USS) • Compliant with draft U-space regulations: partially, but gaps are being addressed in ASTM's current revision 1.1., revision going to ballot as soon as December 2021 to more closely reflect both European regulatory requirements and FAA Part 89 Rule	10
MOPS for UAS E-Identification	EUROCAE	ED-282	• External consultation • Version (date): June 2020 • Prep. by WG-105 SG-32 • NIS + DRI • Compliant with draft U-space regulations: yes, but demanding and thus expensive requirements • Progress delayed due to the need to coordinate with ASD-STAN D5 WG8	-3
Aerospace series - Unmanned Aircraft Systems - Part 002:	ASD-STAN	prEN 4709-002	• Published • Version (date): 31 October 2021 • Prep. by D05/WG08 UAS Unmanned Aircraft Systems	10

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Direct Remote identification			• DRI system for UA of the open Category • Compliant with draft U-space regulations: Not completely, only DRI (no NIS)	
UAS Traffic Management (UTM) — Part 8: Remote identification	ISO	ISO 23629-8	• Internal Consultation • Version (date): September 2021 • Broadcast (BLE or Wifi) • Network (between USS) • Compliant with draft U-space regulations: Maybe /partially (based on the not complete maturity of the draft)	0

3.3 Gap summary

Table 5

Gap #	Gap Description	Conclusion Recommendation
1	Absence of standard covering: the limitation to direct remote identification leaves air traffic control and authorities without a situational awareness of drones flying around in their area of responsibility	The lack of a standardisation of UTM communication services and to compose an overall drone traffic information platform for authorities might compromise uniform safety. Standardisation would be beneficial for uniform safety and EU industry perspectives. ISO 23629-12 is promising and satisfactory for the safety and quality of the related service providers, but additional technical standards (e.g. EUROCAE ED-282 or ISO 23629-8) may be necessary. *Latest draft U-Space regulation introduces in Article 8 the notion of Network Identification Service.* *ASTM F38 committee has published in 2019 F3411-19 "Standard Specification for Remote ID and Tracking" and it is highly expected that EASA will recognise this standard as AMC to the future U-Space regulation Article 8.* *Still, two areas are currently not completely covered by ASTM F3411-19 standard:*

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		Identification Framework *A mapping of the needs shall be performed:* *Do we need a registration ID beyond what is currently requested per (EU) 2020/639 Article 14? If yes, for which part (the aircraft, the pilot, the operator,…) and what are the legal implications?* *At a given time, how will each flying object be identified in an unambiguous manner?* ***Authentication*** *The identity of each flying object shall be trusted. A standard needs to cover this part. This part of the standard will need to consider on-going work from ICAO Global Aviation Trust Framework. With the high-level objective of tackling U-Space/UTM future security challenges, the ICAO TF is working on concept of unique ID for all U-Space/UTM users and authentication issues.* *These two areas are proposed to be addressed by Eurocae WG-105."*

3.4 Conclusions & recommendations

Requirement	Coverage	Recommended standard(s)	Limitations/notes	Gaps
1. A NIS shall allow the continuous processing of the remote identification of the UAS	Partial coverage	ASTM F3411	The ASTM F3411 standard describes NIS in detail, but as the required received messages do not comply with the EU legislation it does not fit NIS requirements completely (see requirement 2)	A European NIS standard is required in order to cover for the full NIS description on not only what to exchange, but also how to exchange, define a minimum security to protect the data, define which data to provide to which users.
		Eurocae ED-282	The Eurocae standard details which messages to transmit, but does not detail the format	

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			in order to exchange messages between multiple USSP's	
2. The NIS shall allow for the authorised users to receive messages with the following content:			ASD STAN prEN4709-002 covers the requirements but only for DRI, not NIS ASTM F3411 only partly covers the messages to receive (see gap analysis)	Absence of a standard coverage for NIS to receive following mandatory messages: - UAS operator registration number -the emergency status of the UAS - the geographical position of the remote pilot or, if not available, the take-off **point** As these requirements are specific to the European union, it is recommended to establish a European NIS standard.
2.a) the UAS **operator registration number**;	N/A	/	/	This requirement is not covered by any identified standard.
2.b) the unique **serial number** of the unmanned aircraft **or**, if the unmanned aircraft is privately built, of **the add-on**;	Full coverage	ASTM F3411	This requirement is covered by ASTM F3411	No gaps
2.c) *the geographical **position** of the UAS, its **altitude above mean sea level** and its **height above the surface or take-off point***	Full coverage	ASTM F3411	This requirement is covered by ASTM F3411	No gpas

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2.d) the **route course** measured clockwise **from true north** and the **ground speed** of the UAS;	Full coverage	ASTM F3411	This requirement is covered by ASTM F3411	No gaps
2.e) the geographical **position of the remote pilot or**, if not available, the **take-off point**;	Partial coverage	ASTM F3411	Is an optional field in ASTM F3411	Is not a mandatory field in ASTM F3411
2.f) the **emergency status** of the UAS;	N/A	/	/	This requirement is not covered by any identified standard.
2.g) the **time** at which the **messages** were **generated**	Full coverage	ASTM F3411	/	No gaps
3. The **information** provided by the NIS shall be **updated** at a **frequency** that the competent **authority has determined**.	N/A	/	/	This requirement is not covered by any identified standard.
4.The authorised users shall be:		ASTM F3411	• The ASTM F3411 standard describes NIS in detail, but as the required received messages do not comply with the NIS requirements in the EU legislation. • Further screening and assessment of communication	A European NIS standard is required in order to cover for the full NIS description on not only what data messages to exchange, but also how to exchange, define a minimum security to protect the data, define which data to provide to which users.

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			requirements will be handled in 9.3.	
4.a) the **general public**	Partial coverage	ASTM F3411	/	Not all the required content in communication to the general public (stated in requirement 2a-2f) is addressed, having a negative impact on EU Industry competitiveness
4.b) **other USSPs**	Partial coverage	ASTM F3411	/	Not all the required content in communication to the other USSPs (stated in requirement 2a-2f) is addressed, having a negative impact on EU Industry competitiveness
4.c) the **ATS providers** concerned;	Partial coverage	ASTM F3411	/	Not all the required content in communication to the ATS providers (stated in requirement 2a-2f) is addressed, having a negative impact on EU Industry competitiveness
4.d) when designated, **the CISP**				
*4.e) the relevant **competent authorities***	Partial coverage	ASTM F3411	/	Not all the required content in communication to the competent authorities (stated in requirement 2a-2f) is addressed, having a negative impact on EU Industry competitiveness
Exchange of drone tracking information over NIS on any drone traffic in the Designated Operational	Not covered	/	No European standards are currently identified	The EU Commission Regulation (EU) 2020/1058 covers the requirements for the airborne function supporting Network Remote Identification, however standardisation of the communication

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Coverage (DOC)[5].				protocol is missing, development of such protocol would be beneficial for uniform safety and EU industry perspective. To cover these communication interfaces, ISO, on 10 October 2021, approved development of 23629-9 (UTM Part 9) on the interface between UTM service providers and users.
Display of the drone tracking information in the DOC	Not covered	/	No European standards are currently identified	Standardisation of the communication protocol is missing, development of such protocol would be beneficial for uniform safety and EU industry perspective. To cover these communication interfaces, ISO is initiating development of 23629-9 (see above row).
Exchange of drone tracking information between multiple USSPs, which cover different DOCs	Not covered	/	No European standards are currently identified	Standardisation of the communication protocol is missing, development of such protocol would be beneficial for uniform safety and EU industry perspective. To cover these communication interfaces, ISO is initiating development of 23629-9 (see first row in this table).

Table 6

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a) NIS presupposes that identity and position are transmitted by the unmanned aircraft in flight;
b) But also manned aircraft may be electronic conspicuous, based on Commission Regulation 2021/666. On 31/08/2021 a workshop organized by EASA presented the results of a study to evaluate if mobile technology can be used to make unmanned aircraft electronically conspicuous in U-space. EASA proposed to organize a follow up on the questions and finalize the study.
c) DG MOVE and EASA should avoid proliferation of standards, meaning that that the same standard should be used for 'electronic identification' of unmanned aircraft and for 'e-conspicuity' of manned aircraft flying in the same volume of airspace;
d) DG GROW should withdraw the mandate to CEN (ASD-STAN) for EN 4709-002, again to avoid proliferation of standards;
e) The EUSCG should promote harmonisation of ASTM F3411-19 and EUROCAE ED-282 under the global umbrella of ISO 23629-8;
f) EU members of ISO TC 20 SC 16 should promote insertion of technologies for Communication in ISO 23629-9;
g) EASA should publish an AMC to 2021/664, similar to AMC1 to rule ARO.GEN.305(b);(c);(d);(d1) on the oversight programme related to Regulation 965/2012, so clarifying that for the UTM Communication Service (UCS) Provider, industry certification based on ISO 23629-12 would suffice.

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4 Geo-awareness service ②

4.1 *Description*

The description of this service, according to the Regulation 2021/664 (Article 9), is:

1. *A geo-awareness service consisting of the following geo-awareness information shall be provided to UAS operators:*

   a) *information on the applicable operational conditions and airspace constraints within the U-space airspace;*
   b) *UAS geographical zones, relevant to the U-space airspace;*
   c) *temporary restrictions applicable to airspace use within the U-space airspace.*

2. U-space service providers shall dispatch the geo-awareness information in a timely manner to allow contingencies and emergencies to be addressed by UAS operators and shall include its time of update together with a version number or a valid time, or both.

Each Member State (MS) can determine where and how they want to implement UAS geographical zones based on Article 15 of [1]. The MS are also empowered to determine which restrictions, conditions, administrative procedures or mandatory functionalities apply in these UAS geographical zones (so called 'geozones').

The laudable efforts of individual EU MS on the matter, may ensure a high level of safety, but not necessarily a 'uniform' level of civil aviation safety which is also in the principal objective of the EASA Basic Regulation [8].

Furthermore, this situation would neither facilitate the free movement of goods and services in the internal aviation market, nor improve the competitiveness of the Union's aviation industry, which is also a political objective established by the Legislator in Art. [1](2)(b) of mentioned [8].

It is therefore important to standardise at EU level conditions, limitations and administrative procedures to access UAS geozones to further promote drone operations under harmonised criteria in the internal market.

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Note: For instance, Belgium[1] has institutionalised the role of the 'geozone manager', while Italy[2] has established criteria for unmanned aircraft to enter controlled airspaces around aerodromes (either ATZ or CTR), below the Obstacle Limitation Surfaces. These are only two examples of the topics which could be harmonised at EU level in relation to Article 15 of Regulation 2019/947.

MS would still be empowered to design and establish the geozones according to their needs. The standardised limitations, conditions, and administrative procedures, could be established by EASA through one or more AMC to Art. 15 of [1], referring therein as appropriate to consensus-based standards produced by SDOs.

Because the CISP is providing information on the UAS geozones in a digital format to all the USSPs it is important that the USSP is passing these restrictions correctly and providing this data in an unambiguous way to UAS operators. This data source originates from the CISP.

This service is not requiring data to be exchanged amongst U-space service providers.

4.1.1 EUROCAE - ED-269: Minimum Operational Performance Standard for Geo-Fencing

This document contains Minimum Operational Performance Standards (MOPS) for the airborne Geofencing function of Unmanned Aircraft Systems. This standard specifies the minimum performance expected from this Geofencing function, without prescribing its design and implementation as far as possible. As such, it is not originally intended to be used to exchange information in the framework of U-space and CIS, USSP's and UAS operators.

Compliance with this standard is recommended as one means of assuring that the function will perform its intended sub-functions satisfactorily under all conditions normally encountered in routine aeronautical operation and will comply to the applicable regulations.

The UAS geographical zones in this standard are mentioned as 'UAS Geozone'.

Basically, the data model contains a few classes to define the geographical and temporal boundaries of the UAS geozone but also other information such as contact information of the designated authority and conditions defining the access to the UAS geozone.

Some of the most notable attributes in this model are 'restriction' and 'restriction-Condition'. Each UAS zone will have a restriction type:

[1]. Arrêté ministériel établissant les zones géographiques UAS fixes et les conditions d'accès aux zones géographiques UAS fixes du 21 Décembre 2020.

[2] ENAC Circular ATM 09A of 24 March 2021 http://www.enac.gov.it/sites/default/files/allegati/2021-Mar/ATM-09A.pdf

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- PROHIBITED,
- REQ_AUTHORISATION,
- CONDITIONAL or
- NO_RESTRICTION.

For each UAS geozone with the conditional restriction type, it is possible to indicate the conditions to access to the UAS zone through logical expression which should be interpreted by the UAS.

The following example is given in the standard publication:

- *The UAS is **PERMITTED XOR PROHIBITED** (exclusive choice) to fly in this zone at this time IF (Characteristic1) **CHARTYPE1** = (Value1) **CHARVAL1** AND **CHARTYPE 2 = CHARVAL 2** AND … AND End IF OR (…..)*
  …
  End OR
- Only the fields in bold need to be edited in the character string, separated by"/". Others are implicit.
- Examples of CHARTYPE and CHARVALUE:
  - CHARTYPE: operator type ; Acceptable CHARVAL values: Military/Police/Firefighting
  - CHARTYPE: Operator ID (registration number) ; Acceptable CHARVAL values: as per registration format
  - CHARTYPE : Operation type : A1 as per EASA Open Types or S1 (National standard Scenario 1), STS01 (EASA Specific standard scenario) or …
  - CHARTYPE : UTM operation type: Planned/Unplanned,
  - CHARTYPE: passengers on board : yes /no
- Another code example to illustrate the prohibition of image capture in a zone: *PERMITTED/IMAGE CAPTURE=NO/NOISE CLASS=A/OR/OPERATOR=POLICE*
  - Meaning: the fight is permitted in this zone at that time if 'No image' are 'captured' (removed or deactivated) and if 'noise class' = 'class A' (following a known classification) or if the 'UAS operator' is the 'Police'
- The need to obtain approval from the geozone manager designated by the State (e.g. the Operation Manager of an aerodrome, the Prefet of a province, the municipality, the director of a prison and else) could be covered under 'REQ_AUTHORISATION'.
- Similarly, the label 'CONDITIONAL' would contain information on the required on-board functionality (e.g. DRI or RNP 0.01) or on the required procedures for coordination with ATS (e.g. the control Tower of the nearby aerodrome).

So far Chapter 8 of ED-269, containing the above highlighted standards for encoding the geozone information is the most detailed document on the matter.

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Preliminary implementation efforts through some projects show though that the proposed standard has some shortcomings to make fully use of it in the framework of U-space. Some examples are mentioned below:

- The scheduling possibilities are limited and e.g. don't allow to enter 'sunrise/sunset' (which is frequently the case with NOTAM scheduling.
- The current scheduling only allows for 'weekly' schedules and not e.g. monthly/yearly
- There is no possibility for exclusions e.g. taking into account official holidays.
- The exchange mechanism only describes actions like 'create' and 'update' but no 'deletion'
- The current restriction types are not suited to define a 'U-space geozone'.

Updates may be necessary in the future to align with ISO 23629-7 containing more general semantic provisions.

4.1.2 ASTM - WK63418: New Specification for UAS Traffic Management (UTM) UAS Service Supplier (USS) Interoperability

The ASTM WK63418 standard uses the term 'Constraints' as method to inform operators of specific temporal and geographic limitations of the airspace.

The standard mentions a constraint will be defined by 4D volume (area specified in x, y and z coordinates, plus start and end times) and a constraint type and associated metadata.

According to the ASTM UTM standard, constraints are managed in the Constrain Management Service by authorized constraint provider (which is an organization or individual authorized by competent authority for the region to create constraints). After the creation of the constraint, it will be made discoverable through the Discovery and Synchronization Service. USS(P) ingest constraints through the Constraint Ingestion service to detect intersection between operational volume with constraint areas.

The ASTM standard doesn't provide any formats on geographical zones and as such in not applicable in the framework of the Geo-awareness service.

In other words, while ED-269 complements the EU regulatory framework, 3.1.2. ASTM WK63418 seems tailored on the USA/FAA context.

The ASTM standard, having a limited scope, is hence not compliant with the restrictions requested by Commission implementing regulation 2021/664, which in fact states that 'restrictions must be able to be added per UAS geographical zone', so implicitly referring to Art. 15 of 2019/947 and related decisions (e.g. on the geozone manager) taken by MS.

In other words, while ED-269 may supplement at the level of AMC the EU regulatory framework, the ASTM WK63418 seems tailored on the USA/FAA context.

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This standard has been published and specifies the data model that is related to various spatial information for common use between the UA operator and the system for operation control/UTM. The document specifies the names of the items for the data model, while the communication architecture and responsibilities of actors to define the items are not included.

ISO has developed a very generic data model for all data within UTM, which could be nicknamed an 'umbrella standard'. This standard splits the data model up in four packages, being:

- obstacles,
- ground map,
- virtual data
- and dynamic data.

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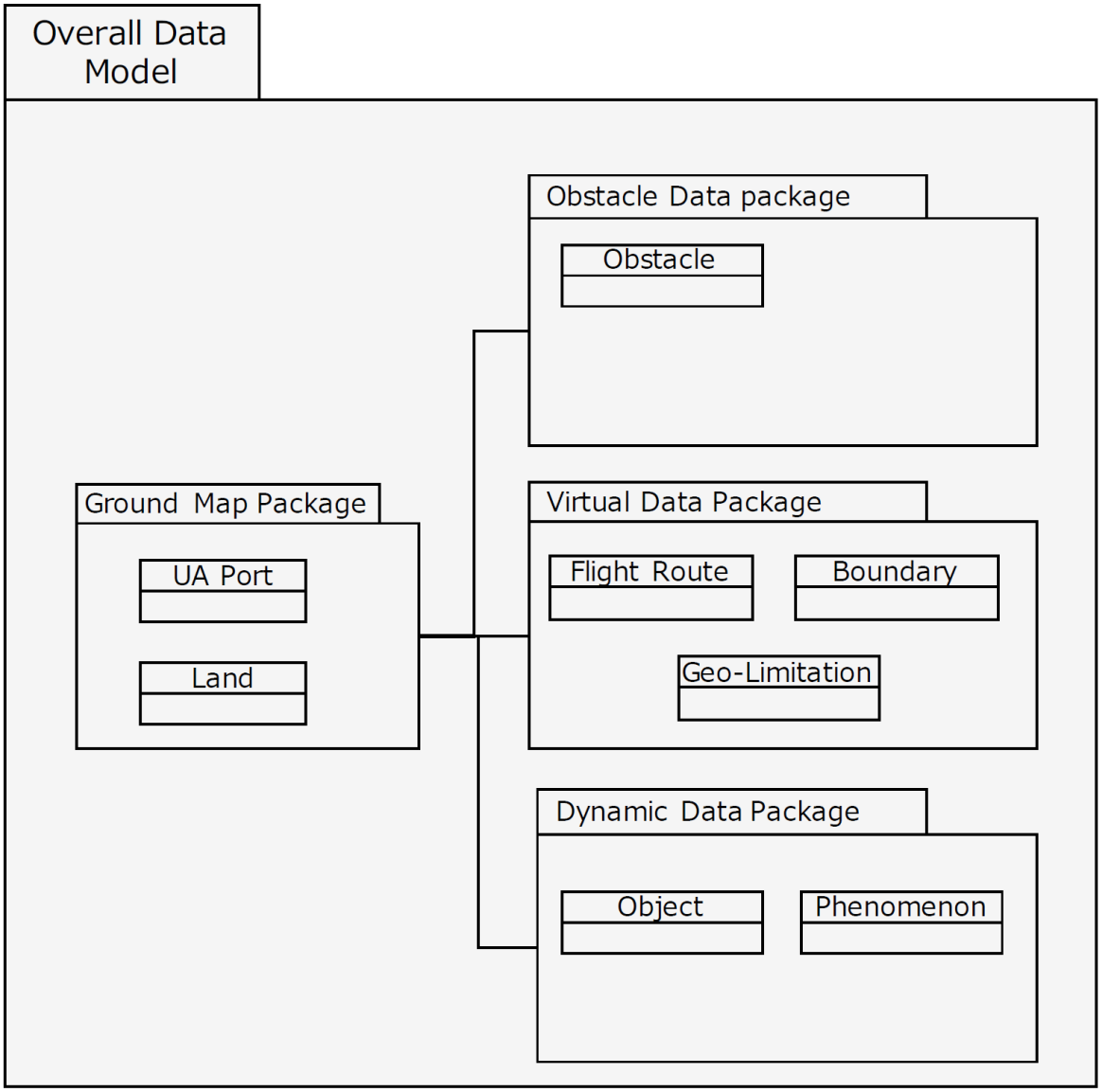

Figure 1 ISO 23629-7 model

Source: *ISO 23629-7:2021 - UAS Traffic Management (UTM) – Part 7: UTM data and information transfer at interface of traffic management integration system and UAS service providers - Data model related to spatial data for UAS and UTM*

4.1.3 ASD-STAN - prEN 4709-003: Aerospace series - Unmanned Aircraft Systems - Part 003: Geoawareness

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Although developed for functionality to be implemented on drones operating in the open category, this standard may be applied also to equipment and UAS functions in the U-space airspace in the context of other categories of operations, on a voluntary basis.

This standard however focuses on functions at aircraft and Command Unit (CU) level. It is therefore not applicable to U-space service provision.

4.2 *Summary*

Table 7

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
Minimum Operational Performance Standard for Geo-Fencing	EUROCAE	ED-269	• Published • Version (date): June 2020 • Prep. by WG-105 SG-33 • Standardisation of UAS Geozones in compliance with the Implementing regulation 2021/664 • Compliant with EU-space regulations: Yes • Not conflicting with 'umbrella' standard ISO 23629-7:2021	4
New Specification for UAS Traffic Management (UTM) UAS Service Supplier (USS) Interoperability	ASTM	WK63418	• Committee ballot (external consultation) • Version (date): November 2020 • Prep. by WK63418 Task Group Name: ASTM Collaborative Airspace Management Standards Working Group • Exchange of all UTM data according to a federated deployment model. • Compliant with draft U-space regulations: No • EUROCAE ED-269 already covers sufficiently the matter: further development of WK 63418 might be unnecessary	0
UAS Traffic Management (UTM) – Part 7: UTM data and information transfer	ISO	DIS 23629-7	• External Consultation: Draft (DIS stage) • Version date: September 2021	7

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at interface of traffic management integration system and UAS service providers - Data model related to spatial data for UAS and UTM			• A very generic ('umbrella') data model to exchange all types of data in UTM. • Compliant with draft U-space regulations: Yes, although not containing sufficient technical details, but complementary to more detailed ED-269.	
Aerospace series - Unmanned Aircraft Systems - Part 003: Geoawarenes	ADS-STAN	prEN 4709-003	• Status: Approved by CEN External consultation (ENQ) • Screened version: voted version 25 February 2021 • Prep. by D05/WG08 UAS Unmanned Aircraft Systems • Functions for geoawareness implemented in UA or CU, required in the open Category • Compliant with 2019/945. 2019/947 and 2021/664, but covering functions at product level and not at service level.	3

4.3 Gap summary

Table 8

Gap #	Gap Description	Conclusion Recommendation
1	No standard has been developed specifically for this purpose. Though no major gaps are identified using the complementary standards ED-269 and ISO 23639-7	The ED-269 data model has been put forward to describe the geozones though is lacking some nomenclature/features which should be added in a next iteration of the standard. Not clear which 'restriction type' will be used to describe a U-space geozone.

4.4 Conclusions & recommendations

Requirement	Coverage	Recommended standard(s)	Limitations/notes	Gaps

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1. A GAS consisting of the following geo-awareness information shall be provided to UAS operators:				
1.a) Information on the applicable **operational conditions** and **airspace constraints** within the designated **U-space airspace**;	Partial coverage	Eurocae ED-269	Conditions are available as logical expression for each UAS geographical zone. It's assumed that the standard can be used for the conditions on a U-Space airspace as for a UAS geographical zones	The standard is mostly used for UAS geographical zone, the requirement focuses the conditions within a designated U-space airspace.
1.b) **UAS geographical zones**, relevant to the designated U-space airspace	Partial coverage	Eurocae ED-269	The standard can be used to exchange UAS geographical zones. The standard only contains uspace type and doesn't contain a reference of a specific U-space instance	A reference to a designated U-space airspace could have covered the requirement fully
1.c) **temporary restrictions** applicable to airspace use **within** the **U-space airspace**	Full coverage	Eurocae ED-269	The standard is capable storing time validity period for a UAS geographical zone	No gaps, but need for some more fexible time annotations (see above)
2. U-space service providers shall dispatch the geo-awareness information in a timely manner to allow **contingencies and emergencies** to be addressed by UAS	Partial coverage	Eurocae ED-269	The standard can describe a version for a UAS zone and assign a time frame to it. Requirement of the standard: The	Dispatching geo-awareness information: standard it is the responsibility of the remote pilot to ensure

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operators and shall **include its time of update** together with a **version number or a valid time, or both**.			Geoawareness function shall provide the remote pilot with a clear indication of the time since the last successful update of the UAS geographical zones data. It is the responsibility of the remote pilot to ensure the update is made appropriately before and during flight, as defined by the applicable regulation	the update is made appropriately before and during flight, as defined by the applicable regulation. The standard doesn't cover the dispatching requirement.
Information on the applicable operational conditions and airspace constraints within the designated U-space airspace;	Partial coverage	ED-269	Conditions are available as logical expression for each UAS geographical zone.	More general data model applicable beyond GAW
Dynamic airspace restrictions temporarily limiting the area within the designated U-space airspace where UAS operations can take place.	Partial coverage	ED-269	The standard is capable storing time validity period for a UAS geozone	
U-space service providers shall dispatch the geo-awareness information in a timely manner to allow contingencies and emergencies to be addressed by UAS operators and shall include its time of update together with a version	Partial coverage	ED-269	The standard can describe a version for a UAS zone and assign a time period to it.	

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number or a valid time, or both.				
U-space service providers shall: (a) exchange any information that is relevant for the safe provision of U-space services amongst themselves; (b) adhere to an appropriate open communication protocol …	Partial coverage	ISO 23629-7	Generic data model to exchange all types of data in UTM. It is complementary to more detailed ED-269	Scope covering all exchanges relevant in the U-space, but not sufficiently detailed.

Table 9

In summary it it is recommended to:

a) Propose ED-269 as GM to Regulation 2021/664;
b) Through EUSCG encourage development of a second edition of ISO 23629-7, mentioning in it EUROCAE ED-269 for more detailed specifications; and

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5 UAS flight authorisation service ③

5.1 *Description*

The Flight Authorisation Service (FAS) (or Flight Clearance Service (FCS)) is very extensive service comprising a lot of underlying connected services. The description of this service, according to the Regulation 2021/664 (Article 10), is:

1. *The U-space service providers shall provide UAS operators with the UAS flight authorisation for each individual flight, setting the terms and conditions of that flight, through a UAS flight authorisation service.*

2. *Where U-space service providers receive from the UAS operator an UAS flight authorisation request, they shall:*

   a) *check if the UAS flight authorisation request is complete and correct and submitted in accordance with Annex IV**

      *: of Regulation 2021/664;

   b) *accept the UAS flight authorisation request if the flight under the UAS flight authorisation is free of intersection in space and time with any other notified UAS flight authorisations within the same U-space airspace in accordance with the priority rules set out in paragraph 8*;*

      *: the established priority rules which goes beyond the traditional process for accepting a flight plan, being closer to traditional flow management;

   c) *notify the UAS operator about the acceptance or rejection of the UAS flight authorisation request*;*

      *: differently from traditional ATM, this notification is simultaneously the acceptance of the plan and the clearance to take-off)

   d) *when notifying the UAS operator about the acceptance of the UAS flight authorisation request, indicate the allowed UAS flight authorisation deviation thresholds.*

3. *When issuing a UAS flight authorisation, the U-space service providers shall use, where applicable, weather information provided by the weather information service as referred to in Article 12*.*

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*: of Regulation 2021/664

4. *Where U-space service providers are unable to grant an UAS flight authorisation in accordance with the UAS operator's request, U-space service providers may propose an alternative UAS flight authorisation to the UAS operator*.*

   *: which is equivalent to the traditional Air Traffic Flow and Capacity Management.

5. *Upon receiving the request for an UAS flight authorisation activation referred to in Article 6(5)*, the U-space service providers shall confirm the activation of the UAS flight authorisation without unjustified delay.*

   *: of Regulation 2021/664

6. *U-space service providers shall establish proper arrangements to resolve conflicting UAS flight authorisation requests received from UAS operators by different U-space services providers.*

7. *U-space service providers shall check the request for UAS flight authorisations against U-space airspace restrictions and temporary airspace limitations.*

8. *When processing UAS flight authorisation requests, the U-space service providers shall give priority to UAS conducting special operations as referred to in Article 4 of Implementing Regulation (EU) No 923/2012.*

9. *When two UAS flight authorisations requests have the same priority, they shall be processed on a first come first served basis.*

10. *U-space service providers shall continuously check existing flight authorisations against new dynamic airspace restrictions and limitations, and information about manned aircraft traffic shared by relevant air traffic service units, in particular regarding manned aircraft known or believed to be in a state of emergency, including being subjected to unlawful interference, and update or withdraw authorisations as may be necessitated by the circumstances.*

11. *U-space service providers shall issue a unique authorisation number for each UAS flight authorisation. This number shall enable the identification of the authorised flight, the UAS operator and the U-space service provider issuing the UAS flight authorisation.*

    As currently described, the flight authorisation service is a gathering of several other services, among which we could identify:

    - Flight Plan/Authorisation Validation,
    - Strategic deconfliction,
    - Priority Management.

    Standards which have been assessed is this framework are the following:

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5.1.1 ASTM - WK63418: ASTM - New Specification for Service provided under UAS Traffic Management (UTM)

ASTM WK63418 describes multiple 'operational states' which of which some states (e.g. Accepted, Activated) show some similarity with the states in the U-space regulation. These 'operational states' are part of a of a data exchange model between USSP's This standard can't be copied as such as the implementation of the FAS service is different in then standard compared to the U-space regulation.

As recommended in previous Chapter 4, the EUCSG should discourage further development of such standard to avoid unnecessary duplication.

5.1.2 ISO - DIS 23629-7: Data model for spatial data

ISO/DIS 23629-7 has developed a very generic data model for spatial data; suggesting an attribute model to exchange data between the UAS and UTM operators.

This standard is quite useful, but not sufficiently detailed to implement FAS.

5.1.3 ISO - AWI 23629-9: Interface between UTM Service Providers and Users

ISO TC 20 SC 16, through its WG 4, has proposed development of new ISO 23629-9 on interfaces between users and several U-space service providers, as depicted in the figure below.

This New Work Item Proposal (NWIP) has been approved by the members of ISO TC 29 SC 16 on 10 October 2021, but not even a Working Draft (WD) of the proposed new standard is presently available.

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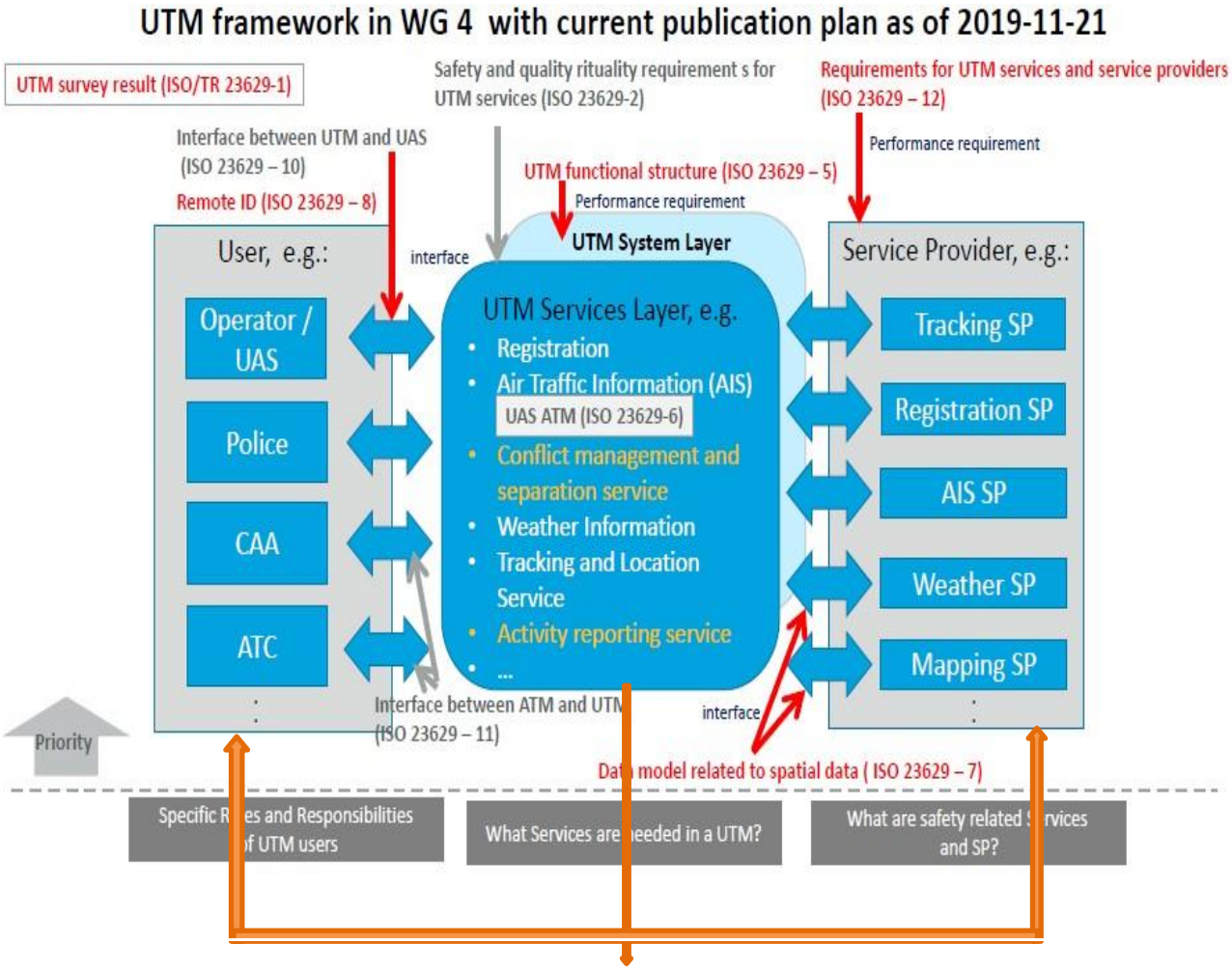

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5.2 *Summary*

In general, the service 'Flight Authorization' on its own, is as such not affected by the lack of any standardization. Though, the description in the regulation on the 'operation States' and logical flow might need further clarification and is ideally based on a clear 'concept of operations. Standards come into the loop when the data need to be exchanged between multiple stakeholders (in the case USSP's).

Table 10

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
New Specification for Service provided under UAS Traffic Management (UTM)	ASTM	WK63418	• Committee ballot (external consultation) • Version (date): June 2021 • WK63418 • Exchange of all UTM data according to a federated deployment model. • Compliant with draft U-space regulations: partially, since the USA context in which the FAA is also a service provider, is quite different from the EU one, although alignment is currently in progress.	2
Data model for spatial data	ISO	DIS 23629-7	• Published • Version date: September 2021 • A very generic data model to exchange all types of data in UTM. • Compliant with draft U-space regulations: Partially; based on the deployment model this standard is not sufficient, since not covering the interfaces among several service providers.	9
Interface between UTM service providers and users	ISO	23629-9	• Planned: Approved Work Item (AWI). • Version date: 10 October 2021 • Interface model to exchange all types of data among several UTM actors, including several Service Providers. • Compliant with draft U-space regulations: Yes, though still work in progress.	-2

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5.3 *Gap summary*

Table 11

Gap #	Gap Description	Conclusion Recommendation
1	Absence of standard covering the interface among several FCS Providers	ASTM F38 is developing a UTM interoperability standard for a set of services such as strategic conflict detection (to support strategic deconfliction), conformance monitoring and geo-awareness (constraint management). Though this standard is not directly applicable to the U-space FAS service. Latest draft U-Space regulation introduces in Article 10 the notion of Flight Authorisation Service with the intent to setting the terms and conditions of UAS flights within U-Space. Eurocae WG-105 SG3 intends to work with EASA expert group on U-Space AMC/GM – Sub-group 5 to identify the need of new standard(s) in support of the future Flight Authorisation service.

5.4 *Conclusions & recommendations*

The Flight Authorisation Service (alias FCS) as currently defined in the U-space regulation 2021/664 implies interaction among a variety of individual services (e.g. strategic deconfliction, priority management, dynamic, authorisation management) and actions needed which are grouped together. This means that in the future several standards will apply fully or partially to these services but also that currently there is no standard mature enough to support the interfaces necessary for this service. The standards or drafts assessed for this service were either in a premature phase (or were applicable to this service but only covered a small, though important aspect. This is the case for standard ISO 23629-7.

It is not foreseeable that a single standard would cover completely the 'flight authorization service'. ISO 23629-9, is developing a standards covering necessary interfaces but is still being drafted.

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Table 12

Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
1. The **USSPs shall provide** UAS operators with the UAS **flight authorisation** for each individual flight, setting the **T&C** of that flight, through a **UAS flight authorisation service**	Not covered	/	/	This requirement is not covered by any identified standard.
2. Upon receiving an UAS flight authorisation request USSP shall: (a) check if request is complete and correct (b) accept the request if the intended flight is free of intersection in space and time with any other notified flight (c) notify UAS operator about acceptance or rejection (d) when accepting, indicate allowed flight authorisation deviation thresholds.	Not covered	/	/	Data exchanges between UAS operator and USSP, including response from USSP to a flight authorisation request, possibly covered by ISO 23629-9, whose development was however approved only on 10 October 2021 (i.e. still in the planning stage).
3. When issuing a flight authorisation, the USSP shall use, where applicable,	Full coverage	ISO 23629-7	This standard covers the geospatial data, including "phenomena" and	Nog gaps

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weather information provided by WIS			associated geographical position and time	
4. USSPs may propose an alternative UAS flight authorisation to the UAS operator.	Full coverage	ISO 23629-7	This standard covers the geospatial data, including description of the intended route.	No gaps
5. Upon receiving the request, the USSP shall confirm the activation of the UAS flight authorisation without unjustified delay	Not covered	None	Maximum permissible times related to transaction, might be included in ISO 23629-9	Maximum permissible times for data exchanges between UAS operator and USSP, including response from USSP to a flight authorisation request, possibly covered by ISO 23629-9, which is however only in the planning stage.
6. USSPs shall establish proper arrangements to resolve conflicting UAS flight authorisation requests received from UAS operators by different USSPs.	Not covered	ASTM - WK63418 Or ISO 23629-9	Both standards are in the planning stage.	Not even a preliminary draft of either candidate standard is available. ISO 23629-9 should be preferable, since oriented to the global market and not to a single country.
7. USSP shall check the request for UAS flight authorisations against U-space airspace restrictions and temporary airspace limitations.	Covered	ISO 23629-7	This standard covers the geospatial data, including attributes of the geo-limitations.	No gaps

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8. When processing UAS flight authorisation requests, the USSPs shall give priority to UAS conducting special operations as referred to in Article 4 of Implementing Regulation (EU) No 923/2012	Covered	ISO 23629-12	standard covers the organisation of the service providers and does not require detailed technical standards. ISO 23629-12 covers safety and quality of all USSPs, including a monitoring functions to verify compliance of procedures with applicable regulations.	No gaps
9. When two UAS flight authorisations requests have the same priority, they shall be processed on a first come first served basis	N/A			
10. USSP shall continuously check existing flight authorisations against new dynamic airspace restrictions and limitations, and information about manned aircraft traffic shared by relevant ATS units, and update or withdraw authorisations as may be necessitated by the circumstances.	Partial coverage	ISO 23629-7	ISO 23629-7 contains a "dynamic data package", but however limited to aircraft and whether phenomena	The "dynamic data package" in ISO 23629-7 should be amended, to include also dynamic airspace restrictions and limitations.
11. USSP shall issue a unique authorisation number for each UAS flight authorisation.	Partial	ISO 23629-7	ISO 23629-7 contains a UAS "Object", including the flight identifier.	The "UAS object" in ISO 23629-7 should be amended, to include standards

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			However, how to encode this identifier is not specified therein.	to encode the flight identifier. Alternatively, this should be covered by ISO 23629-9

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6 Traffic information service ④

6.1 *Description*

No standards for TIS tailored to the needs of UAS are currently identified, although for manned aviation TIS is covered by EUROCAE ED-102B, while service provisions are covered by ISO 23629-12. Further investigation by SDO's of Asterix and AWCIES is advised as source or base to develop standards for coding the TIS messages.

Standards can be identified as an AMC for a Traffic information service when covering following service requirements according to Regulation 2021/664 (Article 11):

1. *A traffic information service provided to the UAS operator shall contain information on any other conspicuous air traffic, that may be in proximity to the position or intended route of the UAS flight.*

2. *The traffic information service shall include information about manned aircraft and UAS traffic shared by other U-space service providers and relevant air traffic service units.*

3. *The traffic information service shall provide information about other known air traffic and shall:*

   a) *include the position, time of report as well as speed, heading or direction and emergency status of aircraft, when known;*
   b) *be updated at a frequency that the competent authority has determined.*

4. *Upon receiving the traffic information services from the U-space service provider, UAS operators shall take the relevant action to avoid any collision hazard:*

6.1.1 EUROCAE - ED-102B: MOPS for ADS-B and TIS on 1090 MHz

This document contains Minimum Operations Performance Standards (MOPS) for airborne equipment for Automatic Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Service - Broadcast (TIS-B).

However, Commission Regulation 2021/666 (amending SERA) requires 'electronic conspicuity' even of manned traffic in the U-space airspace, but on a frequency different from 1090 MHz. This standard is hence not applicable to U-space.

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6.1.2 ISO - DIS 23629-7: Data model for spatial data

Specifies the data model that is related to various spatial information for common use between the UAS service provider and the system for operation control, e.g. UTM. The data model is included in the scope in the way that it specifies the names of the items for the model, while the communication architecture is not included in the scope of this 'umbrella' standard.

6.1.3 ISO - 23629-9: Interface between UTM service providers and users

This standard, whose development was approved by ISO on 10 October 2021 is promising, since an essential enabler for FCS and TIS. It will describe the interface model to exchange all types of data among several UTM actors, including flight objects (manned or unmanned).

Furthermore, ISO TC 20/SC 16 has established a liaison with ISO/IEC Joint Technical Committee (JTC/1) which is developing general standards for the so called 'Internet of Things' (IoT).

In this context the UAS operator will manage at least three Information Technology (IT) entities:

a) The computer on board the unmanned aircraft, which is able to exchange information with other entities (e.g. the Command Unit (CU) of the Remote Pilot, one or more U-space SPs, the vertiport IT entity covered by draft ISO 5491, etc.); this computer is however active only during the flight;
b) The CU of the Remote Pilot which, in addition to the UA, may also exchange digital data with several service providers, but again only during the flight time; and
c) The workstation of the 'Fleet Manager' (a job position more or less equivalent to today's Flight Dispatcher) which is instead potentially active 24/7 and used mainly for planning the mission, using several services from those listed in ISO DIS 23629-12.

6.1.4 ISO - 23629-12: UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers

This standard includes only requirements for Services and Service Providers in the context of UAS Traffic Management (alias U-Space) for Unmanned Aircraft Systems (UAS) and other equipped airspace users, and covers minimum safety, quality, security, and privacy requirements for safety critical and safety related UTM services and related SPs and for operation support services.

In addition, it specifies technical requirements enabling the Service Provider of Aeronautical Information Management for UAS (AIMU), UTM users and other service providers (SPs) to exchange digital data and information.

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Since any service requires a provider, compliance with this standard may be an AMC to Regulation 2021/664 for safety-critical U-space SP certified by the competent authority.

Safety-related and operation support services do not require certification by the competent authority. Based on SORA OSO #13 also the safety of these 'external services' should be verified by the UAS operator. Compliance with ISO 23629-12 would greatly facilitate the operator in discharging this responsibility.

6.2 *Summary*

Table 13

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
MOPS for ADS-B and TIS on 1090 MHz	EUROCAE	ED-102B	• Published • Version date: December 2020 • Specification of avionics for ADS-B at 1090 MHz and receiving TIS-B at 1030 MHz, applicable to manned aviation • Compliant with draft U-space regulations: No, since covering the needs and frequencies related to manned aviation, while Regulation 2021/666 requires different means for electronic conspicuity, even of manned traffic, in the U-space airspace.	0
Data model for spatial data	ISO	DIS 23629-7	• Published • Version date: September 2021 • Contains data models for flight object, either if the aircraft is manned or unmanned. • Compliant with draft U-space regulations: Partially, being an 'umbrella' standard not containing sufficient technical details for implementation.	9
Interface between UTM service providers and users	ISO	23629-9	• Planned: Approved Work Item Proposal (AWI), but text yet not even drafted. • Version date: October 2021 • Interface model to exchange all types of data among several UTM actors,	-2

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			including flight objects (manned or unmanned). ● Compliant with draft U-space regulations: Yes, since covering the possibility of several FCS or TIS providers. ● Potentially harmonised with ISO/IEC standards on the 'Internet of Things'	
UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers	ISO	ISO 23629-12	● External consultation (DIS stage) ● Version: DIS of 21 September 2021 ● It contains requirements for the safety and quality of the TIS SP ● Compliant with draft U-space regulations: Partially, since technical details for TIS are not covered	3

6.3 *Gap summary*

Table 14

Gap #	Gap Description	Conclusion Recommendation
1	Absence of standard covering the technical details for transmission of TIS information on a frequency different from 1030/1090 MHz or for exchange if data between USSP and UAS Command Unit (CU).: information on any other conspicuous air traffic, which may be in proximity to the position or intended route of the UAS flight.	Flight objects, necessary to exchange TIS information, are covered by ISO 23629-7. However, lack of a standardisation of communication means might compromise uniform safety. Standardisation would be beneficial for uniform safety and EU industry perspectives.
2	Information about manned aircraft and UAS traffic shared by other U-space service providers and relevant air traffic service units.	The lack of a standardisation of communication and to exchange information on TIS across several providers might compromise uniform safety. Standardisation would be beneficial for uniform safety and EU industry perspectives.
3	Information about the position of other known air traffic	Content of the traffic information has been defined, standardisation of the communication protocol is missing,

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		development of such protocol would be beneficial for uniform safety and EU industry perspectives. The case that the TIS information is provided to the CU and not directly to the unmanned aircraft should be considered.

6.4 *Conclusions & recommendations*

The standards used for General Aviation must be further investigated. A potential problem is that U-space will use different device requirements, based on Regulation 2021/666.

Table 15

Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
1. TIS provided to the UAS operator shall contain information on any other conspicuous air traffic, that may be in proximity to the position or intended route of the UAS flight.	Partial	ISO 23629-7 and ISO 23629-12	These standards cover the definition of the "flight object" (whether manned or unmanned), and the safety and quality of the TIS provider. However, they do not cover the communication means to exchange the TIS information between the USSP and the UAS operator	Interface requirements are planned to be covered through ISO 23629-9
2. TIS shall include information about manned aircraft and UAS traffic shared by other U-space service providers and relevant air traffic service units.	Not covered	/	No standards are currently identified	No requirements are currently covered by a potential AMC
3. TIS shall provide information	Covered	ISO DIS 23629-7	This standard contains definition of flight "objects",	No gaps

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about other known air traffic and shall: (a) include the position, time of report as well as speed, heading or direction and emergency status of aircraft, when known; (b) be updated at a frequency that the competent authority has determined.			whether the aircraft is manned or not.	
4. Upon receiving the traffic information services from the U-space service provider, UAS operators shall take the relevant action to avoid any collision hazard.			Procedures needed to fulfil this requirement, according to best practices described in ICAO's 'Rules of the Air'	

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7 Weather information service ⑤

7.1 *Description*

Standards can be identified as an AMC for a Weather information service when covering following service requirements according to Regulation 2021/664 (Article 12):

1. *When providing a weather information service, U-space service providers shall:*
    a) *collect weather data, provided by trusted sources, to maintain safety and support operational decisions of other U-space services;*
    b) *provide the UAS operator with weather forecasts and actual weather information either before or during the flight.*

2. *The weather information service shall include, as a minimum:*
    a. *wind direction measured clockwise through the true north and speed in metres per second, including gusts;*
    b. *the height of the lowest broken or overcast layer in hundreds of feet above ground level;*
    c. *visibility in metres and kilometres;*
    d. *temperature and dew point;*
    e. *indicators of convective activity and precipitation;*
    f. *the location and time of the observation, or the valid times and locations of the forecast;*
    g. *appropriate QNH with geographical location of its applicability.*

3. *U-space service providers shall provide weather information that is up-to-date and reliable to support UAS operation.*

ASTM has published a Terms of Reference (ToR) for the safety and quality of the WIS Provider. For the requirements on the Service Provider, ISO 23629-12 is already in the pre-final consultation phase (DIS consultation until 13 Dec 2021). Furthermore, ISO 23629-7 defines information on “phenomena”. Based in this ToR a preliminary assessment has been conducted.

Note: Nothing prevents a vertiport operator to collect also part of the necessary meteo information or a WIS Provider to implement equipment and provide services at a vertiport.

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7.1.1 ASTM - WK73142: New Specification for Weather Supplemental Data Service Provider (SDSP) Performance.

Potentially suitable as all requirements are being referred to are being addressed. But only ToR are available.

The objective is to define minimum performance-based standards for Weather Supplemental Data Service Provider (SDSP) data and services to UAS Service Suppliers/Providers (USS/USP) and Operators in a UAS Traffic Management (UTM) ecosystem.

Requirements on WIS provider may unnecessarily duplicate ISO 23629-12 already in the DIS phase.

Furthermore, ISO 23629-12 covers all possible U-space providers in a comprehensive and risk-based vision. Standardising each provider in a separate document might lead to inconsistencies, while making life more burdensome for providers of multiple services.

Conversely, ISO 23629-12 does not detail specific requirements for WIS.

In other words, ASTM WK 73142 may complement ISO 23629-12 and a note in the latter should refer to ASTM, so allowing ISO Notified Bodies to verify conformity of the safety related WIS providers.

Traditionally, following the performance-based and risk-based approach to aviation safety regulation, ICAO requires a quality system for the AIS and MET providers. But ICAO does not require certification of these service providers by the competent authority, considering an ISO certification sufficient.

The EU went much beyond this ICAO provisions, requiring certification also for the MET and AIS providers for traditional aviation in Regulation 2017/373, based on 2018/1139.

Even Regulation 2021/664 required certification by the competent authority for the provision of the safety related WIS, which may be disproportionate.

7.1.2 ISO - DIS 23629-7: Data model for spatial data

Specifies the data model that is related to various spatial information for common use between the UAS service provider and the system for operation control, e.g. UTM. The data model is included in the scope in the way that it specifies the names of the items for the model, while the communication architecture is not included in the scope.

7.1.3 ISO - 23629-12: UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers

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This standard includes the requirements for all Services and Service Providers in the context of UAS Traffic Management (alias U-Space) for Unmanned Aircraft Systems (UAS) and other equipped airspace users.

Note: This standard, largely based of the recommendations form the EU funded CORUS project, lists 30 possible U-space services, among which WIS is considered safety-related but not critical.

This document covers in fact minimum safety, quality, security, and privacy requirements for safety critical and safety related UTM services and related SPs and for operation support services.

This document, in addition, specifies technical requirements enabling the Service Provider of Aeronautical Information Management for UAS (AIMU), UTM users and other service providers (SPs) to exchange digital data and information.

This standard is however not detailed enough to define the performance requirements for WIS. In other words, ASTM WK73142 and ISO 23629-12 may be considered complementary.

7.2 *Summary*

Table 16

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
New Specification for Weather Supplemental Data Service Provider (SDSP) Performance.	ASTM	WK73142	• Planned: Drafting • Version (date): April 2020 • Good basis to fulfil the requirements as these are being addressed in the ToR • Conclusion: ToR indicate a full coverage, but may unnecessarily overlap with requirements to the service provider already covered in ISO 23629-12	-1
Data model for spatial data	ISO	DIS 23629-7	• Ongoing: Published • Version date: September 2021 • Contains data models for meteorological phenomena. • Compliant with draft U-space regulations: Partially, because only defining which information should be exchanged. ASTM 73142 may complement it, adding more detailed specifications.	9

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UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers	ISO	ISO 23629-12	• External consultation (DIS stage) • Version: DIS of September 2021, under consultation until 13 December 2021 • It contains requirements for all U-space SPs in a risk-based approach, including safety and quality of the WIS SP • Compliant with draft U-space regulations: Partially, but it may be complemented by ASTM WK73142	5

7.3 *Gap summary*

Table 17

Gap #	Gap Description	Conclusion Recommendation
1	Provision of weather data before and during the flight	Further standards on interfaces between USSPs and UAS Operators should be developed. One possibility is ISO 23629-9, being progressed by WG4 of ISO TC/20 SC/16. ASTM F38 has a WK73142 working on the development of a 'Specification for weather supplemental data service provider (SDSP) performance'.
2	Content and format of weather data messages	No gaps identified, once ASTM WK73142 will be issued
3	Safety and quality of weather information	No gaps identified at the level of consensus-based standards since ISO 23629-12 covers this topic. However, a general AMC published by EASA and specifying under which conditions consensus-based industry standards may constitute presumption of compliance with the rules, is highly desirable. AMC to AIR-OPS already contain a similar AMC, which, for ease of reference is reproduced in Annex IV.

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7.4 *Conclusions & recommendations*

More research on how to convert from geodetic height to barometric altitude, for both manned and unmanned aviation is underway through the EU funded project ICARUS[3].

ICARUS has proposed three additional U-space services for this purpose, covering also vertical separation from obstacles. These three services are listed in ISO DIS 23629-12.

The Commission should consider limiting the requirement for certification by the authority only to safety-critical services.

For such services, certification based on ISO 23629-12 may be credited, as it already happens in Regulation 965/2012.

For service other than safety-critical, voluntary certification based on ISO 23629-12 could be sufficient, for UAS operators to discharge their responsibility related to SORA OSO #13.

The EUSCG could recommend to:

a) ASTM not to include requirements on the organisation of the WIS provider in their WK73142; and
b) ISO to mention the ASTM standard in a note in 23629-12, since the former would contain more technical details on the WIS service.

Table 18

Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
1. Provision of weather data before and during the flight	Partial coverage	ISO CD 23629-7	• Contains data models for meteorological phenomena. • Partially compliant with draft U-space regulations, because only defining which information should be exchanged, but not interfaces	236297 should be complemented by 235629-9 specifying the interfaces to exchange the information, as necessary also for weather related data
2. Content and format of	Full coverage	ISO CD 23629-7	• Contains data models for	No gaps

[3] https://www.u-spaceicarus.eu/

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weather data messages			meteorological phenomena.	
3. Safety and quality of weather information	Full coverage	ISO CD 23629-12	• Contains safety and quality requirements for all USSPs, including WIS	No gaps

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8 Conformance monitoring service ⑥

8.1 *Description*

Standards can be identified as an AMC for a Conformance monitoring service when covering following service requirements according to Regulation 2021/664 (Article 13):

1. *A conformance monitoring service shall enable the UAS operators to verify whether they comply with the requirements set out in Article 6(1) and the terms of the UAS flight authorisation. To this end, this service shall alert the UAS operator when the flight authorisation deviation thresholds are violated and when the requirements in Article 6(1) are not complied with.*

2. *Where the conformance monitoring service detects a deviation from the flight authorisation, the U-space service provider shall alert the other UAS operators operating in the vicinity of the UAS concerned, other U-space service providers offering services in the same airspace and relevant air traffic services units, which shall acknowledge the alert.*

(1): 1. When operating in the U-space airspace, UAS operators shall:

- *a. ensure that the UAS to be operated in the U-space airspace have the capabilities and performance requirements determined in accordance with Article 3.4.a(2)*
- *b. ensure that during their operations, the necessary U-space services referred to in Article 3.2 and 3.3(3) are used, and their requirements complied with;*
- *c. comply with the applicable operational conditions and airspace constraints referred to in Article 3.4.c(4)*

(2): 4. For each U-space airspace, based on the airspace risk assessment and using the criteria set out in Annex I [4], Member States shall determine:

- *a. the UAS capabilities and performance requirements;*

(3): 3.2 All UAS operations in the U-space airspace shall be subject to at least the following mandatory U-space services:

- *a. the network identification service referred to in Article 8;*
- *b. the geo-awareness service referred to in Article 9;*
- *c. the UAS flight authorisation service referred to in Article 10;*
- *d. the traffic information service referred to in Article 11.*

3.3 For each U-space airspace, based on the airspace risk assessment MS may require additional U-space services selected from the services referred to in Articles 12 and 13.

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(4): 3.4 For each U-space airspace, based on the airspace risk assessment and using the criteria set out in Annex I, Member States shall determine:

d. the applicable operational conditions and airspace constraints.

Two standards have been identified:

8.1.1 EUROCAE - ED-270: MOPS for Geocaging

The standard is a Minimum Operational Performance Standard, and this specifies the minimum performance expected for geocaging but does not prescribe design or implementation.

8.1.2 ASTM – WK63418: New Specification for UAS Traffic Management (UTM) UAS Service Supplier (USS) Interoperability

ASTM standard WK63418 is considering conformance monitoring. The purpose of conformance monitoring in this standard is to determine if a UA remains in conformance with its operational intent and preserves strategic separation. This is accomplished by comparing position data received from the UAS on an ongoing basis with the operational intent. It describes the logical flow and actions with respect to conformance monitoring according tho the standard.

However, as the overall implementation in the standards is different than with U-space, only some minor parts of the standard can be re-used e.g. latency of data provision.

8.2 *Summary*

Table 19

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
MOPS for Geocaging	EUROCAE	ED-270	● Published ● Version (date): June 2020 ● MOPS for geocaging ● design or implementation details	4
New Specification for UAS Traffic Management (UTM) UAS Service	ASTM	WK63418	● Ballot in November 2021, still under draft ● WK63418	2

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Supplier (USS) Interoperability			• Exchange of all UTM data according to a federated deployment model. • Compliant with draft U-space regulations: partially, since the USA context in which the FAA is also a service provider, is quite different from the EU one	

8.3 *Gap summary*

Table 20

Gap #	Gap Description	Conclusion Recommendation
1	Identified standards lack full coverage and design and implementation details.	It is recommended to detail the design and implementation. The lack of the latter might affect the efficiency of UAS operations.

8.4 *Conclusions & recommendations*

Identified standards lack full coverage and design and implementation details.

Table 21

Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
1. alert the UAS operator when the flight authorisation deviation thresholds are violated	Partial coverage	WK63418	• Applicability limited to some guidance in latency	Alignment with the U-space regulation difficult as conformance monitoring within WK63418 is part of distinct workflow implementation and operational intents which are different from U-space

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2. alert the other UAS operators operating in the vicinity of the UAS operators violating the deviation thresholds	Partial coverage	WK63418	Applicability limited to some guidance in latency	Alignment with the U-space regulation difficult as conformance monitoring within WK63418 is part of distinct workflow implementation and operational intents which are different from U-space

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9 General conclusion on U-space standards

UTM in general and the U-space regulation assumes indirectly a connected environment. Further, UTM is based on a (automated) digital infrastructure connecting the different stakeholders exchanging in a (near-) real time manner information on planned operations, geo-graphical data, and ongoing manned and unmanned operations. A few examples of stakeholders are (but not limited to) UAS operators, USSP's, CIS(P), Traffic Information Service Providers and ATM service providers.

The previous paragraphs have assessed several standards with respect to the several individual services described in regulation 2021/664. No standard, however, has been identified which fully suits and individual service or the U-space regulation. In case standards are retained, they only cover a small portion of a service or are originally not designed to serve the purpose and adaption of the standards might be recommended.

Further the assessment methodology based on the individual review of standards and services poses a risk of incompatibility and fragmentation. Exchange of information, given the digital nature of the UTM infrastructure, happens at all levels and with multiple stakeholders for all the different services. The individual services and the stakeholders providing the several services should be considered as one ecosystem and not on an individual basis. To ensure compatibility and avoid fragmentation, it's advised that future standardisation efforts consider a larger framework and scope i.e. a set of UTM services including their proposed data formats and exchange mechanisms.

Therefore, as suggestion, it might be useful to work closer with the individual SDO's to better coordinate and align the needs for standardisation.

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10 Annex I: Standards and publications identified

10.1 *Standards per USS/Category*

Table 22 Standards per USS/Category

USS/Category	Standard title	SDO	Doc./WG Ref.
network identification service	UAS Remote ID and Tracking	ASTM	F3411-19
	MOPS for UAS E-Identification	EUROCAE	• ED-282 • Prepared by WG 105 (UAS) SG 32 (e-identification)
	Aerospace series - Unmanned Aircraft Systems - Part 002: Direct Remote identification	ASD-STAN	prEN 4709-00
	UAS Traffic Management (UTM) — Part 8: Remote identification	ISO	PWI 23629-8
geo-awareness service	UTM Geo-Fencing - Minimum Operational Performance Standard for UAS Geo-Fencing	EUROCAE	ED-269
	New Specification for UAS Traffic Management (UTM) UAS Service Supplier (USS) Interoperability	ASTM	WK63418
	UAS Traffic Management (UTM) – Part 7: UTM data and information transfer at interface of traffic management integration system and UAS service providers - Data model related to spatial data for UAS and UTM	ISO	ISO 23629-7:2021

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	Aerospace series - Unmanned Aircraft Systems - Part 003: Geoawarenes	ASD-STAN	prEN 4709-003
UAS flight authorisation service	New Specification for Service provided under UAS Traffic Management (UTM)	ASTM	WK63418
	UAS Traffic Management (UTM) – Part 7: UTM data and information transfer at interface of traffic management integration system and UAS service providers - Data model related to spatial data for UAS and UTM	ISO	ISO 23629-7:2021
	Interface between UTM service providers and users	ISO	23629-9
traffic information service	MOPS for ADS-B and TIS on 1090 MHz	EUROCAE	ED-102B
	Data model for spatial data	ISO	DIS 23629-7
	Interface between UTM service providers and users	ISO	23629-9
	UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers	ISO	ISO 23629-12
weather Service	New Specification for Weather Supplemental Data Service Provider (SDSP) Performance	ASTM	WK73142
	Data model for spatial data	ISO	DIS 23629-7
	UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers	ISO	ISO 23629-12
	MOPS for Geocaging	EUROCAE	ED-270

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conformance monitoring service	New Specification for Service provided under UAS Traffic Management (UTM)	ASTM	WK63418

10.2 *Standards per SDO*

Table 23 Standards per SDO

SDO	Standard title	Doc./WG Ref.	Comments
ASTM	UAS Remote ID and Tracking	F3411-19	Linked to: ● Network identification service
	New Specification for Service provided under UAS Traffic Management (UTM)	WK63418	Linked to: ● Geo-awareness service ● Flight authorisation service ● Conformance monitoring service
	New Specification for Weather Supplemental Data Service Provider (SDSP) Performance	WK73142	Linked to: ● Weather information service
	Standard Specification for Detect and Avoid System Performance Requirements	F3442-20	Linked to: ● Conformance monitoring service
EUROCAE	MOPS for UAS E-Identification	ED-282	Linked to: ● Network identification service
	UTM Geo-Fencing - Minimum Operational Performance Standard for UAS Geo-Fencing	ED-269	Linked to: ● Geo-awareness service
	MOPS for Geocaging	ED-270	Linked to: ● Conformance monitoring service
ISO	UAS traffic management (UTM) — Part 5: UTM functional structure	CD 23629-5	Linked to: ● All services considered in this document

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	UAS traffic management (UTM) — Part 7: Data model for spatial data	23629-7:2021	Linked to: ● All services considered in this document
	UAS Traffic Management (UTM) — Part 8: Remote identification	WD 23629-8	Linked to: ● Network Identification Service
	UAS traffic management (UTM) — Part 9: Requirements for interfaces between UAS operators and UTM SPs	AWI 23629-9	Linked to: ● Flight authorisation service ● Traffic information service
	UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers	DIS 23629-12	Linked to: ● Traffic information service ● Weather information service
ASD-STAN	Aerospace series - Unmanned Aircraft Systems - Part 002: Direct Remote identification	prEN 4709-002	● Not applicable for U-space requirements: only DRI ● specifies the messages listed, EXCEPT for the emergency status if the unmanned aircraft, this does NOT apply for add-on devices

10.3 *Other standards, publications and references identified*

Following standards, publications and references have been identified and either used as reference and/or background information, either further screening might be useful in the further development of GM and AMCs.

Table 24 Standards to be screened

SDO	Standard
ASTM	WK69690, Specification for Surveillance UTM Supplemental Data Service Provider Performance

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IEEE	IEEE P1939.1, Standard for a Framework for Structuring Low Altitude Airspace for Unmanned Aerial Vehicle (UAV) Operations
IETF	Secure UAS Network RID and C2 Transport
JARUS	JARUS WG-6 UTM Subgroup (Annex H) is developing recommendations on roles and responsibilities of USP in the context of Safety Assessments of UAS Operations
OTHER	1) Network Identification a) ADS-B: ED-102B 06/01/21 (or RTCA DO-260C) + ED-129B Technical Specification for a 1090 MHz Extended Squitter ADS-B Ground System b) EUROCONTROL-SPEC-0149-12 ASTERIX CAT021 v2.5 18/02/21 (latest but they get updated frequently) i) SESAR ADS-B surveillance of aircraft in flight and on the surface #110/Release 5 ii) SESAR Composite surveillance ADS-B / WAM #114/Release 3 iii) SESAR Multi-Constellation / Dual Frequency GNSS PJ.14-03-02 /Release 2019 iv) SESAR Increased waveform capacity with phase overlay PJ.14-W2-84d c) Mode S Extended Squitters (ADS-B): EUROCONTROL-SPEC-0149-4 ASTERIX CAT048 v1.29 10/08/21 (CAT34 if you need to send requests) d) Mode S Surveillance coordination: Eurocontrol SUR.ET2.ST03.3111-SPC-02-00 ASTERIX CAT17 v1.0 10/04 e) MLAT: ED-117A MOPS for Mode S Multilateration Systems for Use in Advanced Surface Movement Guidance and Control Systems (A-SMGCS) + Eurocontrol **SUR.ET1.ST05.2000-STD-14-02** ASTERIX CAT020 v1.4 14/11/07 f) EUROCONTROL Specification for European Mode S Station (EMS) g) Surveillance Data Exchange: EUROCONTROL-SPEC-0149-9 ASTERIX CAT062 v1.19 11/12/2020 h) SESAR updated surveillance monitoring tools lower costs PJ.14-W2-84e i) ASTM WK69690 New Specification for Surveillance UTM Supplemental Data Service Provider (SDSP) Performance: Draft under development 2) Geo-awareness a) AIXM General Page, messages are exchanged on SWIM Yellow Profile (See infrastructure below) b) AIXM 5.1 2010 c) AIXM v5.1.1 05/03/19 d) AIXM v5.2 Ongoing (online event Wednesday 27th of October from 15:00 to 18:00) e) AIXM is based on standards below: i) ISO 19115-1:2014 Geographic information — Metadata ii) ISO 19107:2019 Geographic information — Spatial schema iii) ISO 19136-1:2020 Geographic information — Geography Markup Language (GML) iv) OGC

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	f) ICAO Map Symbols: Guidance Material for Aeronautical Chart – ICAO 1 : 500 000 v1.6 14/11/11 g) Digital NOTAM: Overview, specification v1 08/06/11 (v2 in progress) h) SESAR The Common Service for Aeronautical Information Management (Future of EAD) PJ.15-10 /Release 9 i) SESAR Aeronautical Digital Map Common Service PJ.15-11 /Release 9 j) SESAR Aeronautical Dataset Service PJ.18-04a /Release 9 2) Flight Authorization Service a) FIXM general website, messages exchanged on SWIM b) FIXM v4.2 28/02/20 c) FF-ICE ICAO Global Air Navigation Plan 9750 5ed i) SESAR Extended Flight Plan #37/Release 5 ii) eXtended Flight Plans with 4D trajectory information: Overview iii) SESAR AOC data increasing trajectory prediction accuracy #67/Release 2 iv) aFUA: Advanced Flexible Use of Airspace: Overview & Concept (ASM 3 Dynamic Airspace Configuration (DAC)) (1) SESAR Management of Dynamic Airspace Configurations PJ.08-01 /Release 2019 (2) SESAR Dynamic Airspace Configuration Supporting Moving Areas PJ.08-02 /Release 2019 (3) SESAR Dynamic Airspace Configurations (DAC) PJ.09-W2-44 /Release 10 v) Specification for the application of the Flexible Use of Airspace EUROCONTROL-SPEC-0112 v1.1 10/01/09 vi) SESAR variable profile military reserved areas and enhanced civil-military collaboration #31/Release 5 vii) SESAR Optimised Airspace Users Operations PJ-07 (1) SESAR Mission trajectories management with integrated dmas type 1 and type 2 PJ.07-W2-40 /Release 10 (2) SESAR Enhanced integration of au trajectory definition and network management processes PJ.07-W2-38 /Release 10 (3) SESAR AU Processes for Trajectory Definition PJ.07-01 /Release 2019 (4) SESAR Airspace user fleet prioritization (UDPP) PJ.07-02 /Release 2019 (5) SESAR Mission Trajectory Driven Processes PJ.07-03 /Release 2019 d) SESAR Free Routing: i) Free route through the use of free routing for flights both in cruise and vertically evolving in cross acc/fir borders and within permanently low to medium complexity environments #33/Release 5 ii) SESAR User Preferred Routing #65/Release 2 iii) SESAR Optimised Traffic Management to enable Free Routing in high and very high complexity environment PJ.06-01 /Release 2019 iv) SESAR Performance-Based Free Routing in Lower Airspace PJ.06-02 /Release 2019

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	e) OLDI Specification for On-Line Data Interchange: EUROCONTROL-SPEC-106 v5.0 14/07/20 f) SESAR automated support for traffic complexity detection and resolution #19/Release 5 g) SESAR calculated take-off time (CTOT) and target time of arrival (TTA) #18/Release 5 h) SESAR Trajectory Based Prediction Common Service PJ.15-08 /Release 2019 and PJ18-W2-88 /Release 10 i) SESAR research project METROPOLIS 2 metropolis 2 - a unified approach to airspace design and separation management for u-space j) SESAR research project **USEPE** - U-space separation in Europe 2) Traffic Information Service a) Flight Object Interoperability Specification: ED-133 (under review and should not be used "as is") based on SWIM Blue Profile i) SESAR Trajectory Based Operations PJ.18-02a /Release 2019 ii) SESAR Flight Object Interoperability PJ.18-02b /Release 9 iii) SESAR Increased Automation in Planning and Tactical Separation Management PJ18-W2-53A /Release 10 iv) SESAR EFPL Supporting SBT Transition to RBT PJ.18-02c /Release 9 b) OLDI Specification for On-Line Data Interchange: EUROCONTROL-SPEC-106 v5.0 14/07/20 c) SESAR development of new services similar to flight information system broadcast (fis-b) to support ads-b solutions for general aviation PJ.14-02-05 /Release 2019 d) SESAR Tactical and NM trajectory performance improvement PJ.18-06b /Release 2019 e) NATO STANAG 4586: Standard Interfaces of UAV Control System (UCS) for NATO UAV Interoperability Extract - Specification Ed3 2012 f) Traffic Alert and Collision Avoidance System (TCAS) ED-224 02/2014 g) SESAR extended projected profile (EPP) availability on ground #115/Release 5 i) ED-228A Safety and Performance Requirements Standard for Baseline 2 ATS Data Communications (Baseline 2 SPR Standard) ii) ED-229A Interoperability Requirements Standard for Baseline 2 ATS Data Communications (Baseline 2 Interop Standard) h) SESAR research project DACUS demand and capacity optimisation for u-space 4. Weather Information Service h. WXXM 2.0 2014 (Website was down when I tried) or Weather Exchange Conceptual Model (WXCM). Eurocontrol website i. SESAR Improved MET Information PJ.18-04b /Release 9 j. Monoradar Derived Weather Information (also bird flocks for some semsors): EUROCONTROL-SPEC-0149-3 v1.3 01/04/21 k. TAF/METAR/ …will be digitized and published with WXXM in the future but we can read the current format? 1) Conformance Monitoring Service

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	a) ACAS Xu: Airborne collision avoidance for remotely piloted aircraft systems. SESAR project PJ.11-A2 /Release 2019 will lead to a EUROCAE & RTCA standard. i) SESAR airborne collision avoidance for remotely piloted aircraft systems – ACAS XU PJ.11-A2 /Release 2019 ii) SESAR Collision Avoidance for IFR RPAS PJ.13-W2-111 /Release 10 iii) SESAR Enhanced Airborne Collision Avoidance System (ACAS) operations using the autoflight system #105/Release 1 (manned aircrafts) b) SESAR P-RNAV in a complex TMA #62/Release 1 c) SESAR Time-Based Separation #64/Release 2 d) SESAR advanced short-term ATFCM measures (STAMS) #17/Release 5 e) SESAR Integration of RPAS under FIR PJ-10-05/Release 2019 and in Airspace Class A to C PJ.13-W2-117 /Release 10 f) SESAR Research project BUBBLES formulation and validation of a concept of separation management for UAS in the U-space 1) Infrastructure (didn't know where to put the infrastructure that support all these services above) a) Specification for SWIM Information Definition: EUROCONTROL-SPEC-169 v1.0 01/12/2017. SWIM is based on IP, web-services…standards (not listed here). There are also some security standards (encryption), ISO quality of services... b) Specification for SWIM Technical Infrastructure (TI) Yellow Profile: EUROCONTROL-SPEC-170 v1.1 05/07/20 (for ground) c) SESAR SWIM TI Purple profile for air-ground safety critical information sharing PJ.17-07 /Release 2019 (for air/ground) d) SESAR SWIM TI green profile for ground/ground civil- military information sharing PJ.14-W2-101 e) Specification for SWIM Service Description: EUROCONTROL-SPEC-168 v1.0 01/12/07 f) SESAR Initial system-wide information management (SWIM) technology solution #46 g) SESAR initial collaborative network operations plan (NOP) #20/Release 5 h) ISRM (Information Service Reference Model) i) AIRM General website (data models + SWIM services) j) SWIM Discovery Service (SDS) Implementation Specification k) OLDI messages are based on the FMTP protocol and ADEXP message formatting (ground communication): i) FMTP Flight message transfer protocol address coordination ii) ADEXP Specification for ATS Data Exchange Presentation: EUROCONTROL-SPEC-107 v3.3 14/07/20 l) BADA: Base of Aircraft Data. Knowing aircraft performance enables trajectory optimization. m) SESAR air traffic services (ATS) datalink using iris precursor #109/Release 5 n) SESAR CNS Environment Evolution PJ.14-01-01 /Release 2019 o) SESAR Future Communication Infrastructure (FCI) Terrestrial Datalink PJ.14-02-01 /Release 2019

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	p) SESAR Future Satellite communications Datalink PJ.14-02-02 /Release 2019 q) SESAR Public wireless networks complement imperfect legacy radio PJ.14-W2-61 r) SESAR Collaborative U-space-ATM interface PJ.34-W3-01 s) Highly-automated collaborative U-space-ATM interface PJ.34-W3-02 t) SESAR research project AURA ATM U-space interface u) SESAR Satellite outage PJ.14-W2-81

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11 Annex II: Sources

[1]	European Union (2019), Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft, as lastly amended by Commission Regulation 2020/746.
[2]	AW-Drones (2020) D2.3: Methodology for the assessment of drone standards
[3]	Opinion No 01-2020 high level framework for the U-space
[4]	Draft Commission Implementing Regulation on a regulatory framework for the U-space
[5]	ISO Committee Draft (CD) 23629-12 UAS Traffic Management (UTM) — Part 12: Requirements for UTM Services and Service Providers
[6]	ISO CD 23629-5, UAS traffic management (UTM) — Part 5: UTM functional structure
[7]	Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)
[8]	Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and amending Regulations (EC) No 2111/2005, (EC) No 1008/2008, (EU) No 996/2010, (EU) No 376/2014 and Directives 2014/30/EU and 2014/53/EU of the European Parliament and of the Council, and repealing Regulations (EC) No 552/2004 and (EC) No 216/2008 of the European Parliament and of the Council and Council Regulation (EEC) No 3922/91
[9]	Commission Implementing Regulation (EU) 2021/664 of 22 April 2021 on a regulatory framework for the U-space
Web site	EUROCAE (https://www.eurocae.net/)
Web site	ASTM (https://www.astm.org/COMMITTEE/F38.htm)
Web site	ISO https://www.iso.org/committee/5336224.html
Web site	FAA (https://www.faa.gov/uas/research_development/remote_id/industry/)

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Web site	Using Mobile Networks to Coordinate – Unmanned Aircraft Traffic – GSMA white paper (https://www.gsma.com/iot/wp-content/uploads/2018/11/Mobile-Networks-enabling-UTM-v5NG.pdf)

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12 Annex III: Maturity Correlation Table

Different SDOs use different terminology for the phases of respective development projects. A correlation table for their respective semantics is provided:

Table 25 Maturity correlation of standards

AW-Drones maturity	ORGANISATION					
	JARUS	**ISO**	**CEN CENELEC**	**EUROCAE**	**ASTM**	**RTCA**
Planning	Terms of Reference (ToR)	Stage 10 (New Work Item)	New Work Item	ToR	ToR	ToR
Drafting	Drafting	Stage 20 (Preparatory – WD)	Drafting (including through ASD-STAN)	Drafting (DP)	Drafting	Drafting
Internal consultation	Internal consultation	Stage 30 (Committee State – CD)	ASD-STAN consultation (prEN)	Peer review (ED)	Sub-Committee ballot	N.A.
External consultation	External consultation	Stage 40 & 50 (Enquiry & Approval stages – DIS & FDIS)	Enquiry (FprEN)	Open Consultation (ED)	Committee ballot	Final Review and Comment (FRAC)
Published	Published	Stage 60 (publication)	Published (EN)	Published (ED)	Publication	Publication (DO)
Recognised	**NA: JARUS deliverables are recommendations for regulation, not consensus-based industry standards to be recognised by EASA**	**Mentioned in at least one AMC or GM published by EASA (or proposed in an NPA)**				

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13 Annex IV: Generic EASA AMC to link rules to industry standards

The model could be the existing AMC to Part-ARO, related to EU Regulation 965/2012 (AIR-OPS)

AMC1 ARO.GEN.305(b);(c);(d);(d1) Oversight programme

INDUSTRY STANDARDS

(a) For organisations having demonstrated compliance with industry standards, the competent authority may adapt its oversight programme, in order to avoid duplication of specific audit items.

(b) Demonstrated compliance with industry standards should not be considered in isolation from the other elements to be considered for the competent authority's risk-based oversight.

(c) **In order to be able to credit any audits performed as part of certification in accordance with industry standards, the following should be considered**:

(1) the demonstration of compliance is based on certification auditing schemes providing for **independent and systematic verification**;

(2) the existence of an **accreditation scheme** and accreditation body for certification in accordance with the industry standards has been verified;

(3) certification audits are **relevant** to the requirements defined in Annex III (Part-ORO) and other Annexes to this Regulation as applicable;

(4) the scope of such certification audits can **easily be mapped** against the scope of oversight in accordance with Annex III (Part-ORO);

(5) **audit results are accessible to the competent authority** and open to exchange of information in accordance with Article 15(1) of Regulation (EC) No 216/2008; and

(6) the audit **planning intervals** of certification audits i.a.w. industry standards are compatible with the oversight planning cycle.

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14 Annex V: Standards' Assessment

The scoring table for the U-space Standards' Assessment can be found here: AW-Drones Google Drive.

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