



ER-032

EUROPEAN INDUSTRY REPORT ON RTCA SC-147 ACAS SXU

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CHAPTER 1

INTRODUCTION

1.1 PURPOSE

The purpose of this industry report is to provide an overview and analysis of the feasibility of implementing the RTCA DO-396 ACAS sXu solution in the European Union (EU). This task was assigned to WG105 SG1, as specified in the Work Program outlined in the Terms of Reference of WG-105 from the 23rd of January 2023 [Ref 1]. Within WG105 SG1, the responsibility for this task was further delegated to the subgroup responsible for developing the “Minimum Operational Performance Standard (MOPS) for Detect & Avoid (DAA) in Very Low-Level (VLL) Operations” as defined in the current Work Plan.

This document serves as the official industry report on ACAS sXu, prepared by EUROCAE WG-105 SG1, providing comprehensive insights and findings regarding the implementation of the sXu solution¹.

1.2 SCOPE

The scope of this document is to provide a detailed report on the feasibility of implementing the RTCA ACAS sXu solution in the European Union (EU), including its compatibility within U-space airspace. The information presented in this report is derived from a thorough analysis of the RTCA DO-396 ACAS sXu MOPS [Ref 2]. The primary objective of this analysis was to examine the MOPS, particularly its Operational Service and Environment Description (OSED), in order to identify any factors that may influence the operational requirements and characteristics specific to European airspaces in the event of sXu deployment within the EU. The report aims to present valuable insights and findings concerning the implementability of the RTCA ACAS sXu solution in European airspaces, while taking into account the unique considerations associated with U-space airspace.

1.3 REFERENCE DOCUMENTS

- [Ref 1] WG105 Strategy Terms Of Reference
- [Ref 2] RTCA DO-396 ACAS sXu MOPS
- [Ref 3] EUROCAE ED-271 MASPS for Detect and Avoid in Class A-C Airspaces.
- [Ref 4] EUROCAE ED-313 - OSED for Detect & Avoid [Traffic] in Class A-G airspaces under IFR
- [Ref 5] Commission Implementing Regulation (EU) 2019/947
- [Ref 6] Unmanned Aircraft Systems Traffic Management (UTM) – A Common Framework with Core Principles for Global Harmonization – Edition 4.
- [Ref 7] FAA Unmanned Aircraft System (UAS) Traffic Management (UTM) Concept of Operations V2.0
- [Ref 8] ASTM Standard F3548 - 21
- [Ref 9] Commission Implementing Regulation (EU) 2021/664 on a regulatory framework for the U-space
- [Ref 10] Commission Implementing Regulation (EU) 2021/665
- [Ref 11] Commission Implementing Regulation (EU) 2021/666
- [Ref 12] Integration Approach for Class III DAA in the UTM Environment. JHU/APL, FAA TCAS PO. February 2020.
- [Ref 13] Concept of Operations for the Airborne Collision Avoidance System X
- [Ref 14] Interoperability MASPS (DO-382/ED-264)

¹ In this document the wording sXu refers to the ACAS sXu

- [Ref 15] Commission Implementing Regulation (EU) 2020/587
- [Ref 16] A Quantitative Approach to Air Traffic Safety at Very Low Levels – MDPI - Xavier Oliver and Patrick le Blaye – 13 December 2022
- [Ref 17] OpenSky Report 2021: Insights on ADS-B Mandate and Fleet Deployment in Times of Crisis – 2021 IEEE/AIAA 40th Digital Avionics System Conference (DASC)
- [Ref 18] Mobilitätsbericht 2009, Deutsche Flugsicherung GmbH pdf
- [Ref 19] Acceptable Means of Compliance and Guidance Material to Regulation (EU) 2021/664 on a regulatory framework for the U-space
- [Ref 20] <https://www.eurocontrol.int/sites/default/files/2019-05/us-europe-comparison-operational-performance-2017.pdf>
- [Ref 21] Airborne Collision Avoidance System sXu Performance Summary ACAS_RPS_21_011_V3R0, V3R0. March 12, 2021
- [Ref 22] <https://github.com/Airspace-Encounter-Models/em-overview>
- [Ref 23] ASTM F3442/F3442M-23
- [Ref 24] Easy Access Rules for Unmanned Aircraft Systems (Regulations (EU) 2019/947 and 2019/945)

1.4 STRUCTURE OF THE DOCUMENT

Document structure is the following:

- Chapter 1: Introduction
Chapter 1 serves to outline the purpose, scope, and content of the document. It provides an overview of what can be expected in the subsequent chapters.
- Chapter 2: Implementability Analysis and Conclusions
In Chapter 2, a comprehensive list of relevant items for implementability analysis is presented. Each item is thoroughly examined, and conclusions are drawn based on the analysis conducted. This chapter aims to provide valuable insights into the feasibility of implementing the proposed solution.
- Chapter 3: Conclusion
Chapter 3 provides the overall conclusions regarding the feasibility of implementing the sXu in the European Union by consolidating the findings detailed in chapter 2.

1.5 ACRONYMS

A

A/C	Aircraft
AAM	Advanced Air Mobility
ACAS	Airborne Collision Avoidance System
ADS-B	Automatic Dependent surveillance-broadcast
AGL	Above Ground Level
ARC	Air Risk Class
ATC	Air Traffic Control

C

C2	Command and Control
CMU	Control and Monitoring Unit

D

DAA	Detect And Avoid
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E

EASA	European Union Aviation Safety Agency
e-conspicuity	Electronic Conspicuity
EU	European Union

F

FAA	Federal Aviation Administration
G	
GNSS	Global Navigation Satellite System
H	
HAE	Height Above Ellipsoid
I	
ICAO	International Civil Aviation Organization
ID	Identification
IFR	Instrument Flight Rules
M	
MASPS	Minimum Aviation System Performance Standard
MOPS	Minimum Operational Performance Standard
N	
NACP	Navigation Accuracy Category for Position
NACV	Navigation Accuracy Category for Velocity
NM	Nautical Mile
NMAC	Near Midair Collision
O	
OSED	Operational Services and Environment Definition
P	
PITL	Pilot In The Loop
POTL	Pilot On The Loop
R	
RA	Resolution Advisory
RPAS	Remotely Piloted Aircraft Systems
RTCA	Radio Technical Commission for Aeronautics
RWC	Remain Well Clear
S	
SORA	Specific Operations Risk Assessment
SWaP	Size Weight and Power
T	
TMPR	Tactical Mitigations Performance Requirements
U	
UA	Unmanned Aircraft
UAM	Urban Air Mobility
UAS	Unmanned Aircraft System
UAT	Universal Access Transceiver
UHF	Ultra High Frequency
US	United States
UTM	UAS Traffic Management
V	
V2V	Vehicle to Vehicle
VFR	Visual Flight Rules
VHF	Very High Frequency
VLL	Very Low Level
W	
WG	Working Group
WGS84	World Geodetic System 1984

CHAPTER 2

SXU IMPLEMENTABILITY ANALYSIS

2.1 ITEMS IDENTIFIED AS RELEVANT FOR SXU IMPLEMENTABILITY ANALYSIS

This paragraph presents a compilation of items extracted from [Ref 2] that are deemed relevant for the analysis of sXu implementability. Subsequently, each item is discussed in detail in Section 2.2, focusing specifically on its potential for implementation within the European Union (EU) context. By examining these items in the context of EU, a comprehensive assessment can be made to determine the feasibility and suitability of implementing the proposed solution.

Items extracted from [Ref 2] that are deemed relevant for the analysis are the following:

- sXu 'Smaller UAS' Applicability,
- Airspaces & UTM,
- Interaction with ATC,
- Functions supported by the sXu,
- Coordination,
- Remote pilot interaction,
- Altitude of operation,
- DAA performance,
- Ownship's equipment,
- Intruders,
- Traffic density,
- Intruders' equipment,
- ACAS interoperability,
- Infrastructure,
- Performances metrics.

2.2 ANALYSIS PER ITEM

2.2.1 sXu "smaller UAS" Applicability

2.2.1.1 Description from [Ref 2] subparagraph A.2.1

According to DO-396 subparagraph A.2.1 [Ref 2], sXu is applicable to "Smaller UAS" which are defined as unmanned aircrafts with a wingspan, or equivalent of 25 ft (7.6 m) or less and an effective height of 12 ft or less. This size-based definition aligns with standards such as ASTM F3442/F3442M-20 and research defining appropriate volumes.

It is expected that most of "small UAS" defined in CFR §107 with a weight of 55 lbs (25 kg) or less fall within the "smaller UAS" definition of the sXu. Nevertheless, this is not a criterion for sXu applicability.

Moreover, from [Ref 2] the sXu is a DAA solution for UA unable to meet the equipage and performance requirements of the DO-365 regardless the size of the aircraft.

2.2.1.2 Analysis

The size criterion is not relevant regarding capacity to operate UA equipped with the sXu under certain condition in the EU Airspaces. Nevertheless, from the size point of view the sXu might be adapted to UAs of the Specific category that operate in the Very Low Level (VLL) or higher in U-space airspaces.

The size criterion has been analysed regarding several operational conditions applicable in the EU, the first one is the IFR operation in airspaces A-C according to the ED-271 [Ref 3], the second one is the ED-313 - OSED for Detect & Avoid in Class A-G airspaces under IFR [Ref 4], and finally according to the EASA SORA process for UAS of the specific category [Ref 5] and [Ref 24].

It should be noted that in addition to the USA regulations (CFR § 107), the Canadian Regulations (CAR Part IX) also defines a weight of 25 kg or less for Small RPAS.

Result of the analysis is there is not today a “clear” size or weight criteria used in EU for operation in Airspaces A-G IFR, and it is believed this criterion is not relevant for such operations. For instance, in [Ref 3] exists a reference to 50kg for the smallest UA. It is likely that operation according to [Ref 3] requires equipment that makes such operations impossible for UA weight class consistent with sXu assumptions.

It is considered important to mention that the size criterion used for the sXu comes from research involved in defining appropriate protection volumes, and no such research exists in Europe. So here, the comparison is mostly done on the weight criterion, strongly correlated with the UA size by definition.

Nevertheless, the size criterion used for sXu is consistent with the Specific category UA and their operation as described in [Ref 5]. As such, sXu could fit, from this criteria point of view, with the Specific UAS category operations and associated airspaces (VLL, U-space airspaces).

2.2.1.3 Conclusion

The size requirement is not a determining factor for the ability to operate UA equipped with sXu under certain conditions in the EU. However, sXu can be adapted to meet the requirements for UA of the Specific category that operate in VLL or U-space airspace. Nevertheless, the analysis raises the justification for separation volumes used by the sXu, scaled upon ownship's and intruder's sizes. Such analysis and justification do not exist in the EU. So the use of the sXu size criteria is to be correlated with the actual sUAS size in order to be consistent with the associated separation volume.

2.2.2 Airspaces & UTM

2.2.2.1 Description from [Ref 2] subparagraph 1.2.1.2.3

DO-396 MOPS does not specify airspaces in which sXu can operate. It also stipulates that Operation in Airspace Classes B, C, D, E or G will be based on regulatory approval. In such airspace classes, UAS operation may be made safer by the support of available UAS Traffic Management (UTM) services.

2.2.2.2 Analysis

The operation of sXu-equipped UA is not solely reliant on UTM/U-space services. While sXu equipped UA can benefit from receiving UTM/U-space services to enhance situational awareness in the airspace, it is not fully dependent on them. In U-space airspace designated in uncontrolled airspaces, all manned aircraft are expected to be e-conspicuous. Consequently, sXu-equipped UA can utilise traffic information from U-space and/or e-Conspicuity systems but also operate with the assumption that all intruders are non-cooperative.

Considering sXu operation in airspaces beyond existing Part 107 restrictions with the support of UTM services [Ref 2], the discussion can be held at two levels:

- Considering UTM complementarity with the sXu and UTM coherence with U-space,
- Considering the EU environment and operations.

2.2.2.3 U-space and sXu

Regarding sXu and UTM, analysis from [Ref 2] does not bring a lot of information, as the sXu and UTM interaction is loosely defined in the document. As a consequence, it is difficult to produce an assessment on the applicability in EU of the sXu. Furthermore, operation in such conditions is based on regulatory approval, which is beyond the scope of this analysis.

Nevertheless, it can be said from the analysis of ICAO UTM common Framework [Ref 6], the FAA UTM CONOPS V2 [Ref 7], ASTM UTM standard [Ref 8] and EASA documents [Ref 9] that U-space and UTM share the four mandatory U-space services (network identification, geo-awareness, traffic information, and UAS flight authorization), and two optional services (weather information service, compliance

monitoring service). As a consequence, the framework supporting the operation with sXu might be consistent.

A mapping of the four mandatory services is provided in the Table 1 hereafter.

TABLE 1: COMPARISON OF UTM/U-SPACE MANDATORY SERVICES

ICAO UTM Framework	FAA UTM CONOPS	ASTM	UTM Standard
Identification service	Remote ID	Network identification service	Network remote identification service
		UAS flight authorization service	UAS flight authorization
	Constraint Management	Geo-awareness service	Geo-awareness
		Traffic information service	Traffic information

Document [Ref 8] defines the four mandatory UTM services as:

- Network identification service: The network identification service provides the registration number of the UAS operators, serial number of the unmanned aircraft, and live flight data of the UAS. It enables the sharing of information with any authorized users. Authorized users will be made aware of the geographical position, heading and emergency status, height, and type of the UAS, among other data elements. Based on the information provided by their UAS operators, USSPs share and consolidate UAS flight data between themselves and can, therefore, support traffic information when needed.
- UAS flight authorization service: The UAS flight authorization service provides authorizations to UAS operators for each individual flight based on other notified flight requests that may conflict with other unmanned operations within the same U-space airspace. It is a strategic de-confliction tool.
- Geo-awareness service: This service aims at supporting UAS operators to fulfil their obligations, as it provides the information on applicable operational conditions and airspace constraints with the level of accuracy and other performance requirements for which it has been certified.
- Traffic information service: The traffic information service provides information to UAS operators about other air traffic that is or may be present in proximity to the position of their UAS and supports situational awareness of the UAS operators.

Document [Ref 9] defines the four mandatory U-space services as:

- Network remote identification service: A network identification service should provide the identity of UAS operators, and the location and flight vector of UAS during normal operations and in contingency situations, and share relevant information with other U-space airspace users.
- geo-awareness service: A geo-awareness service should provide UAS operators with the information about the latest airspace constraints and defined UAS geographical zones information made available as part of the common information services. In accordance with Implementing Regulation (EU) 2019/947, the establishment of UAS geographical zones should take into account safety, security, privacy and environmental requirements.
- traffic information service: A traffic information service should alert UAS operators² about other air traffic that may be present in proximity to their UA.
- UAS flight authorization service: A UAS flight authorization service should ensure that authorized UAS operations are free of intersection in space and time with

² UAS Operator and Remote Pilot are used in this document with the same signification.