RPAS Projects Collaboration Panel

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***Abstract*—This paper and the associated poster present the RPAS Projects Collaboration Panel. The group, founded in January 2021 and composed by representatives of the SESAR Exploratory Research projects INVIRCAT, SAFELAND, and URClearED as well as the Industrial Research project PJ13-W2 ERICA and the Very Large Demonstration project CORUS-XUAM, discusses and coordinates their research activities and results on the integration of Remotely Piloted Aircraft Systems.**

Keywords- Remotely Piloted Aircraft Systems (RPAS); Concept of Operations (CONOPS); SESAR; Exploratory Research; Industrial Research; Very Large Demonstration; Unmanned Aerial Systems (UAS); Urban Air Mobility (UAM); Advanced Air Mobility (AAM).

I. INTRODUCTION

Whilst Unmanned Aerial Systems (UAS) promise great market potential in the future, their introduction poses new challenges for Air Traffic Management (ATM) to maintain safe separation between all airspace participants.

ICAO [1] distinguishes two types of UAS: those that can be accommodated in airspace by segregating them from other aircraft and those that can be integrated in airspace alongside manned aircraft (i.e. Remotely Piloted Aircraft, RPA). In general, RPA will be subject to the same equipage and certification requirements as manned aircraft operating in the airspace/or conducting procedures; they will have the at least the same separation standards. RPA act like and are treated like manned aircraft.

Besides the conduction of surveillance or cargo operations, RPAS possibly facilitate the introduction of single pilot operations, especially in case of partial or total incapacitation of the pilot the aircraft could be flown and landed remotely.

Therefore, the SESAR Joint Undertaking in their updated European ATM Master Plan from 2020 [2] placed focus not only on the integration of UAS through U-space, but as well on RPAS that are capable to operate under Instrument Flight Rules (IFR). In parallel to the four stepped U-space development

U1 Foundation Services

U2 Initial Services

U3 Advanced Services

U4 Full Services

the Master Plan outlines a three-step approach for RPAS:

1. Accommodation of IFR RPAS in airspace classes A to C,
2. Accommodation of IFR RPAS in airspace classes A to G, and
3. Integration of IFR and VFR RPAS in airspace classes A to G.

The following projects are part of the SESAR 2020 program and aim to provide significant progress in the definition of operational concepts for the accommodation and integration of IFR RPAS in European airspace as well as operations in U-Space airspace like Advanced Air Mobility/ Urban Air Mobility (AAM/UAM).

II. INVIRCAT

INVIRCAT is dedicated to developing means for a safe and efficient integration of RPAS into the existing Air Traffic Control (ATC) procedures and infrastructures within Terminal Manoeuvring Areas (TMA) under IFR in airspace classes A to C.

The 30 months SESAR Exploratory Research project (01.07.2020 – 31.12.2022) has produced an initial concept of operations for remotely piloted aircraft systems in the TMA of airports, which will be assessed and validated through a set of

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human-in-the-loop simulations at different locations, including distributed simulations.

INVIRCAT focusses on the influence of RPAS specific challenges, such as communication and control latency and failure of the voice and command and control links, on human factor aspects of air traffic controllers and remote pilots, and investigates possible mitigations, such as the use of automatic take-off and landing systems and predetermined contingency procedures. Thereby, INVIRCAT considers different RPAS types, from Medium Altitude Long Endurance/ High Altitude Long Endurance (MALE/HALE) configurations to retrofitted airliners used for cargo operations, and an operational environment in which multiple RPAS at a time share the airspace of the TMA with manned aircraft.

III. SAFELAND

SAFELAND aims to develop a conceptual framework to deal with the event of pilot incapacitation in future single pilot operations for CS-25 Large Aeroplanes operated in IFR. SAFELAND focuses on the ground side and in particular on the role ATM could have in managing the transition from a single pilot operated flight to an RPA.

Based on internal project expertise and external subject matter experts, the 30 months SESAR Exploratory Research project (01.07.2020 – 31.12.2022) has developed a comprehensive concept of operations with five key attributes:

1. depending on the flight phase (departure, cruise, arrival), three different Ground Station operators will monitor the flight and take over control of the aircraft in case of single pilot incapacitation;
2. more sophisticated onboard automation is required in order to support the single pilot throughout the flight;
3. handover procedures between Ground Station and from air to ground are closely aligned with current requirements for remotely piloted aircraft handover processes (e.g., EUROCAE, ICAO);
4. the Ground Station operator is not expected to operate the aircraft under manual control;
5. no significant changes on the tasks and responsibilities of ATC are foreseen.

In a next step, the proposed concept will be assessed through a set of exercises, including real-time simulations at the German Aerospace Center (DLR). Specifically, the project will evaluate the operational feasibility of the proposed concept, together with its impact on aviation safety and human factors.

IV. URCLEARED

URClearED aims to perform relevant steps to independently define the requirements and capabilities for the Remain Well Clear (RWC) function of a Detect & Avoid (DAA) system, to be integrated on a RPAS flying under IFR in airspace classes D-G, that are indeed the most challenging environment for the design of such a function. One of the founding elements of the project is to base its definition on the previous European activities in the field, and integrate it, as much as possible, with the most relevant results achieved in the rest of the World and, particularly, in the US.

At the date, the project has defined the requirements of the proposed URClearED RWC function, as well as the operational scenarios and use cases identified as relevant for the insertion of RPAS in the airspace classes D-G. In line with the basic project approach, the definition of requirements and scenarios starts from those defined at European level in the ED-258 [3] and considers also the US requirements described in the DO-365A [4], according with the detailed analysis of its applicability to URClearED. The results from past and current European projects (SESAR PJ13-W2 ERICA, MIDCAS/EUDAAS) have been also considered.

The requirements are defined at such level to allow the following development of the RWC software prototype which in turn will be used to evaluate the effectiveness of the URClearED RWC function in the above-mentioned operational scenarios, by applying both fast-time and real-time simulations. Fast-time simulations and real-time human-in-the-loop tests, in fact, will be carried out to refine, verify and validate assumptions and requirements. The preliminary performance analysis of the requirements, as emerging from the above activities, and recommendations for the RWC function implementation of a DAA system will be the main results of the project aiming to support further European programs and projects on the same topic.

V. PJ13-W2 ERICA

The ERICA project aims to define the operational and technical capabilities that will allow RPAS to operate in controlled airspace safely, during nominal and emergency conditions. In particular, ERICA aims at providing the basis for defining, developing, and validating the key operational and technological enablers that are necessary to assure the proper insertion of RPAS into non-segregated airspace.

These aims will be achieved through the development and validation (at different maturity levels) of the three Solutions defined in PJ13 W2 “IFR RPAS” [5].

In more detail, the objectives of the project are the following:

1. “Collision avoidance for IFR RPAS”: with the objective to develop and validate a DAA system to support the Remote Pilot during his/her operations, within the airspace categories A-C, in compliance with the ATC instructions. DAA is composed of a “collision avoidance” and a “remain well clear” function that will be both taken care of, for the air and the ground segments (including the interaction with the ATM system). The integration of Collision Avoidance (CA) and Remain Well Clear (RWC) with the avionics will be considered and the remote pilot human performance will be assessed in human-in-the-loop simulations. The potential impact of DAA on controllers’ human performance will be evaluated as well as the dynamic of responsibility allocation between RWC and separation provision. RPAS on-ground operative phases are excluded. The

validation will be performed at V3 maturity level (ref. Solution PJ13-W2-111 [5]);

2. “IFR RPAS accommodation and integration in airspace Class A to C” to develop and validate, in a stepped approach, a framework for the insertion of RPAS into the non-segregated airspace of category A-C, allowing their routinely access and operations; for such a scope, two main streams of activities are foreseen as follows:

- “Accommodation” of civil and military IFR RPAS, developed in SESAR solution #115, aims at inserting IFR RPAS, in the short to medium term, during their transit phase through non-segregated controlled class A-C airspace by establishing harmonized procedures across low/medium density and low/medium complexity European airspace.

  The accommodation solution targets the initial demand (existing MALE state RPAS) with the following constraints:

  - RPAS operate as IFR General Air Traffic (GAT), with routine access (file, fly) to class A-C airspace routes and volumes
  - ATC is the separator and manages the RPAS flights co-existing with manned civil aircraft.

  The validation will be performed at V3 maturity level (ref. Solution PJ13-W2-115 [5]) and will focus on the main concept area of preparation and management of abnormal (contingency) and emergency in-flight situations.

- “Integration” of IFR RPAS, developed in SESAR solution #117, aims at inserting IFR RPAS in the medium to long term, including potential technical adaptation or new systems and their deployment in a cooperative environment, integrated with the manned aviation. The validation will be performed at V2 maturity level (ref. Solution PJ13-W2-117 [5]) and will analyze the benefit of including a ground-ground communication link in order to drastically reduce the latency, the improvement of the ground-based conflict detection tools to enhance the overall safety and, from an operational perspective, the advantages of adopting well-defined contingency procedure for managing the C2 link loss even supported by the technology of ADS-C and EPP trajectory data distribution from board to ground.

VI. CORUS-XUAM

CORUS-XUAM is a two-year Very Large-scale Demonstration (VLD) project that will demonstrate how U-space services and solutions could support integrated UAM flight operations, allowing air taxis, drones and other airspace users (unmanned and manned) to operate safely, securely, sustainably and efficiently in a controlled and fully integrated airspace, without undue impact on operations currently managed by ATM. The project is being undertaken by the consortium that delivered the SESAR JU-funded CORUS U-space Concept of Operations (ConOps) in 2019, extended by the addition of UAM expertise.

CORUS-XUAM activities started with updating of the U-space ConOps, addressing the integration of UAM and drone operations into the airspace, as well as identifying new U-space-phase U3 and U4 services. The project’s activities will continue with the preparation and execution of six VLD campaigns in Belgium, France, Germany/UK, Italy, Spain, and Sweden.

These VLD activities will be at the core of the CORUS-XUAM project. They will demonstrate integrated UAM, drone and manned aircraft operations, through advanced forms of interaction using digital data exchange, supported by integrated and advanced U-space services in urban, sub-urban, and inter-city scenarios, as well as in and near ATM-controlled airspaces and airports. The VLDs will focus on different types of mission, such as passenger transport, logistics, delivery, emergency response and surveillance, using different U-space deployment architectures and state-of-the-art technologies. They will consider coordination between ATC and U-space, including interaction with air-traffic controllers and pilots. The VLDs will combine flights by air taxis with other traffic and operations in the control zones (CTR) of major airports. Vertiport procedures, separation, and data services will be also demonstrated.

The main results of CORUS-XUAM will be used to further consolidate the ConOps at the end of the project. The project will also involve extensive consultation and communication initiatives involving authorities, U-space stakeholders and end-users.

CONCLUSION

The RPAS Projects Collaboration Panel is a group of five research projects with diverse orientations, that aim to produce operational concepts to integrate UAS and more specifically RPAS in the European airspace. With the activities, the projects aim to bridge the gap between traditional ATM and the novel U-space concept in order to achieve a safe and efficient integration of new (unmanned) airspace users. This panel has been founded to coordinate research activities, generate synergies, and exchange and discuss their results, in order to build a common concept that supports rule makers, standardization bodies, and the industry in decision making and the generation of harmonized standards.

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