CLear Air Situation for uaS

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***Abstract*—CLASS (CLear Air Situation for uaS) merges existing technologies to build core functions of U-Space. This research increases the maturity level of the main technologies required for the surveillance of drone traffic. Use Case Scenarios and Key Performance Indicators (KPIs) are defined to assess the performance of future U-Space systems. The project will also provide baseline results through live and simulated trials.**

Keywords—CLASS; UTM; U-Space; Tracking; Deconfliction; flights

I. INTRODUCTION

Drone technology is on the rise and the number of drones in the air increases at a rapid pace. Unfortunately, drones are hard to detect and they often fly literally below the radar. As a result, the chances of conflicts between drones and manned air traffic (or between drones themselves) would be very high without the current restrictive regulation. However, the different stakeholders are pushing to ease this regulation. This can only be allowed if a sufficient level of safety can be guaranteed.

CLASS is the acronym for CLear Air Situation for uaS, and is part of a Horizon 2020 SESAR-1-2016 call. The CLASS project merges existing technologies to build the core functions of an Unmanned Traffic Management System (UTMS). This research increases the maturity level of the main technologies required for surveillance of Unmanned Aerial System (UAS, also known as drone) traffic. CLASS also define use case scenarios and KPIs and will provide a baseline to assess the performance of future U-Space systems.

The CLASS consortium is composed by Airbus (France), Aveillant (England), ENAC (France), NTNU (Norway) and Unifly (Belgium).

CLASS is a sibling project of CORUS [1], which aims at defining the Concepts of Operations for UAS in U-Space.

II. THE CLASS PROJECT

CLASS functionalities include real-time tracking and display of both cooperative and non-cooperative drones.. Drones that transmit their location themselves are called cooperative, whereas for non-cooperative drones the locations are observed and tracked by the external system. In both cases, relevant aeronautical data is aggregated and the data from multiple trackers (both on the drones and on the ground-based systems) is merged through data fusion so that the location of all drones in the airspace can be known and displayed.

Based on these functionalities, a real-time centralized UTMS is being developed. This platform will propose an overall view of both the planned and the current real-time UAS traffic situation.

This information will be centralised in real-time in a UTMS to create an overall solution with advanced functions.

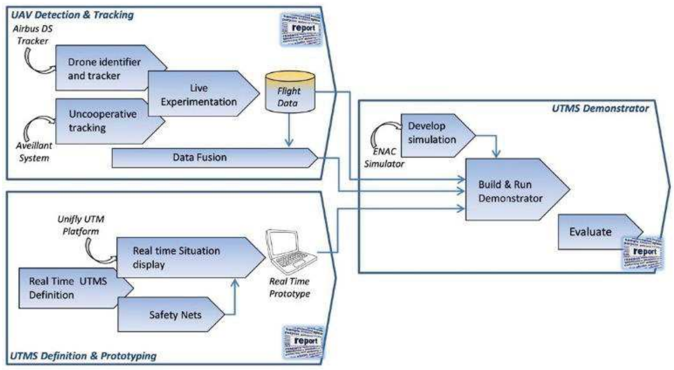

Figure 1 The CLASS architecture

III. REQUIREMENTS AND EVALUATION METRICS

A wide set of stakeholders' requirements has been gathered in a workshop and translated into six design scenarios and 17 preliminary Key Performance Areas (KPAs) [2].

The scenarios have been flown during live trials. Furthermore, simulations incorporating real flight data and modelling more challenging air traffic will be run. The KPAs will be used to assess the performance of the end system.

The six scenarios are:

- GNSS failure leading to intrusion in an airport
- Conflicts in an emergency situation
- Instrument Landing System calibration
- Aerial work on high voltage lines

- Gliding rogue drone
- Urban pollution sampling

The table 1 shows an extract of the KPIs relative to accuracy, detectability and false classification

TABLE 1 KPIS EXTRACT

KPI Name	KPI Definition
Horizontal Position Error (ePosH)	$\boldsymbol{RMS(pos_H^T - pos_H^R)}$ pos_H^T = Tracker Horizontal position pos_H^R = Reference Horizontal position
Vertical Position Error (ePosV)	$\boldsymbol{RMS(pos_V^T - pos_V^R)}$ pos_V^T = Tracker Vertical position pos_V^R = Reference Vertical position
Prob of Update (PU)	$\boldsymbol{\frac{N_{DD}^T}{N_{DD}^R}}$ N_{DD}^T= Drone Detections from Tracker N_D^R= Total Drone Detections from Reference
Mean Gap per track (mGAP)	$\boldsymbol{\frac{1 - PU}{N_{DT}^T}}$ N_{DT}^T= Drone Tracks from tracker
False Positive Rate (FPR)	$\boldsymbol{\frac{N_{AT}^T - N_{DT}^T}{\Delta t}}$ N_{AT}^T= All tracks from tracker Δt= time duration

IV. IMPLEMENTATION

CLASS is merging and increasing the maturity level of existing technologies [3]:

- Airbus' Drone-It! cooperative surveillance system emitting on L band (1525 →1625 MHz)
- Aveillant's radar (non-cooperative surveillance system) can detect small drones up to 5km away
- NTNU's Data fusion between cooperative and non-cooperative surveillance systems
- Unifly's Real-time UTMS

The drones have been built and flown by ENAC with its Paparazzi UAV [4] open source autopilot, capable of fully autonomous flight.

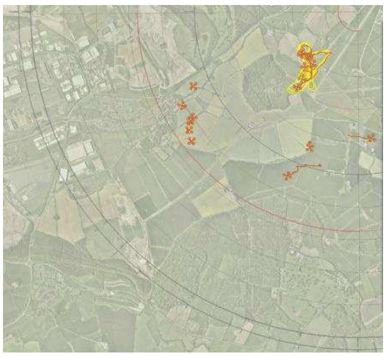

Figure 2 Aveillant's radar output

V. TESTING

The project includes two real flight campaigns based on the scenarios and KPIs:

- June 2018: training the radar with 2 fixed wing drones. Paparazzi logs provide the reference data with an horizontal accuracy of 3m.
- October 2018: Integration of Drone-It and Unifly systems to the CLASS architecture

The results obtained are currently being used to design the data fusion algorithm.

Figure 3 ENAC's "Dark Knight" drone

VI. DECONFLICTION

Deconfliction is not a core CLASS objective, nevertheless Airbus is working on a drone-drone tactical deconfliction algorithm.

In CLASS context, deconfliction relies on the tracking service and takes place at a tactical level - i.e. during the flight - and before Detect and Avoid intervention.

The Airbus algorithm

- is NOT an onboard collision avoidance system.
- will be capable of predicting more than 1,000 trajectories per seconds.
- Drone information is crucial (characteristics, navigation, constraints, weight, etc.).
- The notion of "conflict" needs to be defined further.

REFERENCES

[1] SESAR Joint Undertaking, CORUS, https://www.sesarju.eu/projects/corus

[2] CLASS Consortium, "D1.1 – Scenarios and KPIs for the U-Space System Demonstration", 2018

[3] CLASS Consortium, "D2.1 - Definition of the cooperative and uncooperative surveillance systems", 2018

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