



Project insight: Clear Air Situation for UAS (CLASS)

15th November 2018
Workshop on Autonomous Aerial Vehicles, Trondheim

Krzysztof Cisek, research fellow, NTNU



Founding Members



About me

Krzysztof Cisek



Wrocław University
of Science and Technology



Norwegian University of
Science and Technology



- 2006-2011: M.Sc. (Eng.) in control engineering and robotics from the **Wrocław University of Science and Technology**, Faculty of Electronics, Wrocław, Poland.
- 2011-2014: software and robotics engineer in R&D Department in **Flytronic Sp. z o.o. (WB Group)**, leading Polish constructor and R&D center for Unmanned Aerial Vehicles and Systems for defense sector, Gliwice, Poland.
- 2014-now: research fellow and engineer at Unmanned Aerial Vehicle Laboratory (**NTNU UAVlab**), **Autonomous Marine Operations and Systems (AMOS)**, Department of Cybernetics at **Norwegian University of Science and Technology**, Trondheim Norway.
- 2018-now: principal engineer at **Scout Drone Inspection**, Trondheim, Norway.

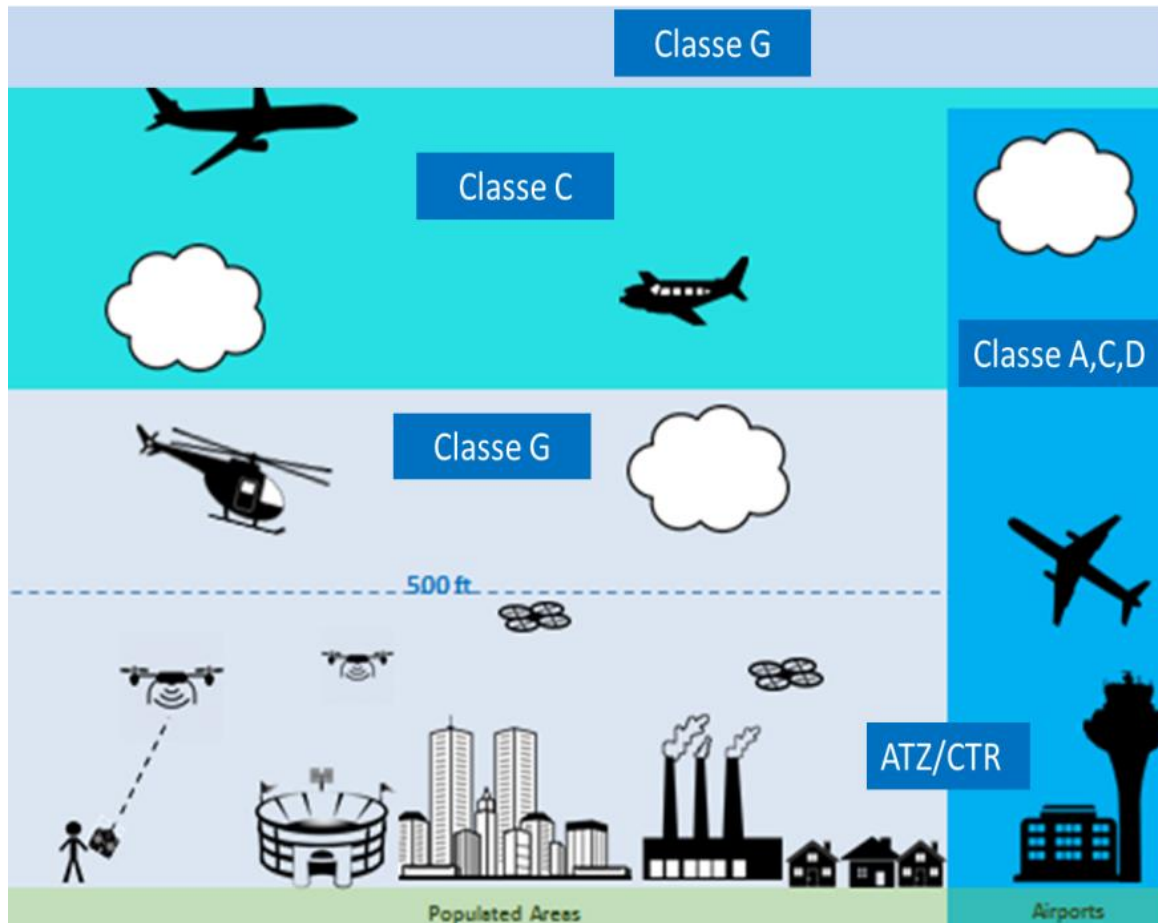
My research interests are in the areas of software/hardware development and integration of unmanned aerial systems, ultra wideband location systems and data fusion.

SESAR U-SPACE Vision

SESAR Joint Undertaking. (2017, June 9)

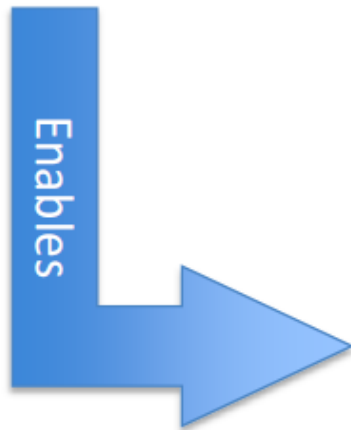


U-Space: Aiming to enable complex drone operations with a high degree of automation



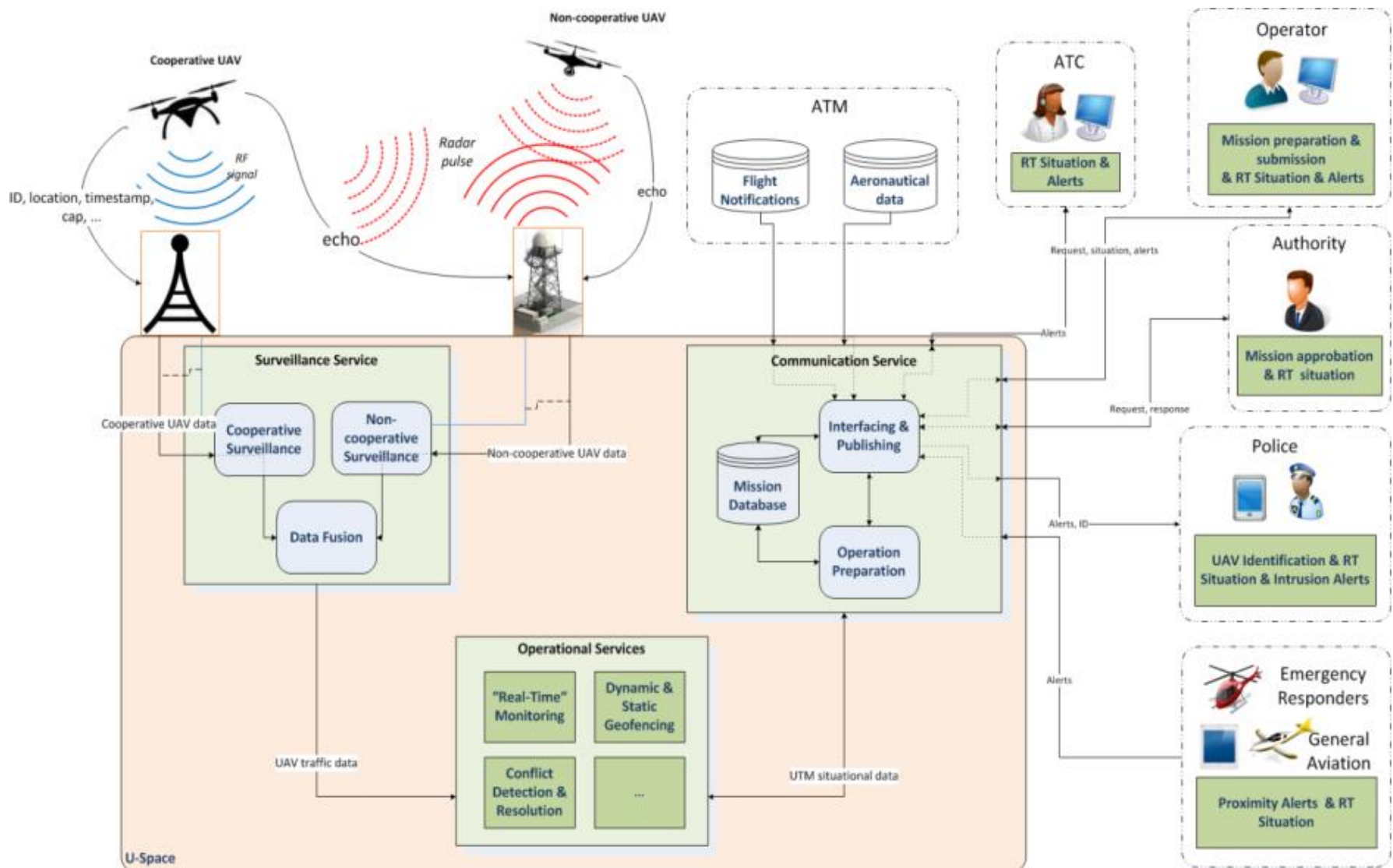
U-space

Tracking and Surveillance for U-space



- Deconfliction
- Assistance for Separation management
- Dynamic Geofencing
- Protection of restricted areas

What is the concept behind CLASS



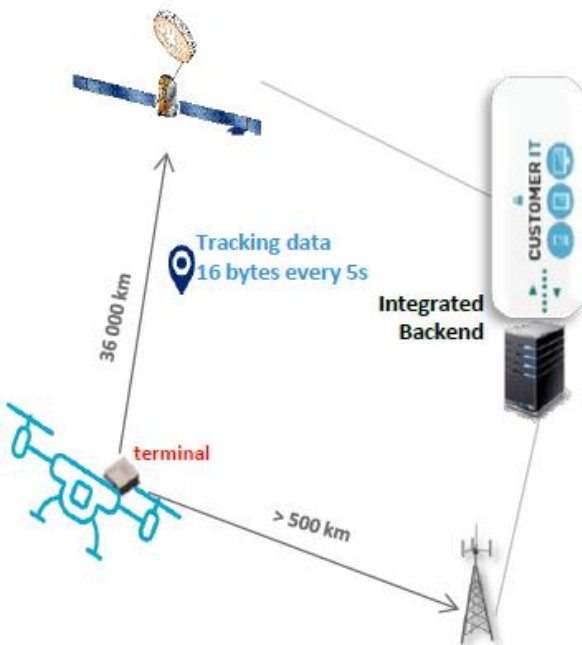
Tracking

AIRBUS



Drone Identifier and Tracker

Ultra Narrow Band technology



Data Fusion

Fuse Cooperative and Non-Cooperative tracks

Gamekeeper 16U

Take on drone spotting:
Stare not scan

Situational Awareness and Alerts

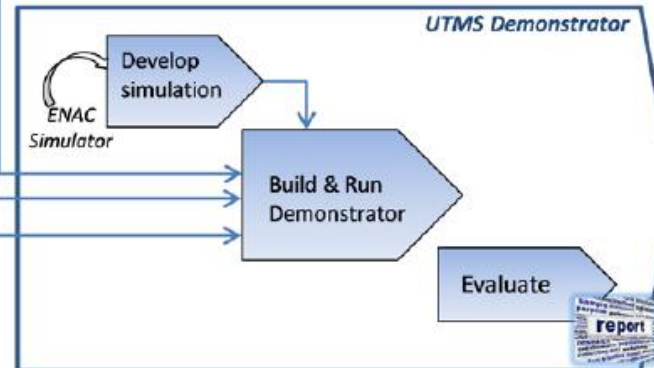
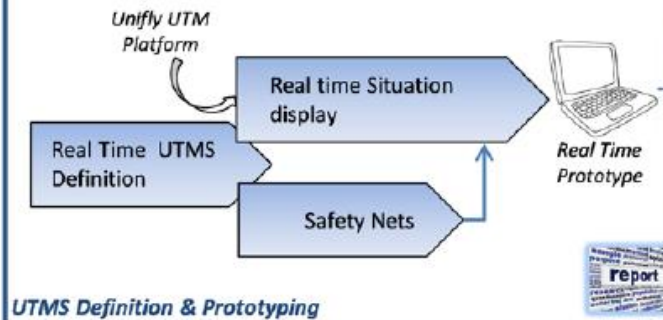
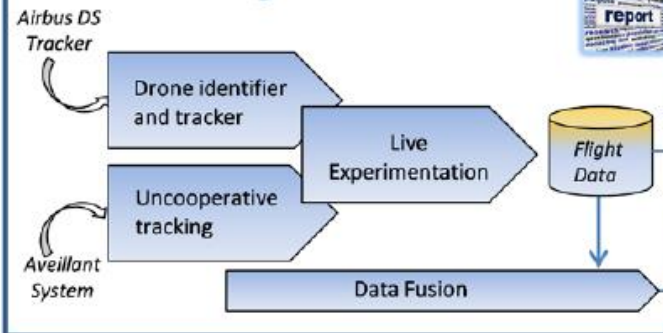
Real Time Monitoring



Study Logic of CLASS

Coordination

UAV Detection & Tracking



Operational needs, Assessment, Impacts & Dissemination

AIRBUS

 **AVEILLANT**


ENAC
 ÉCOLE NATIONALE DE L'AVIATION CIVILE

 **NTNU**


UNIFLY





SESAR CLASS

Component Technologies

CLASS Trial Visitor Day 18th October 2018



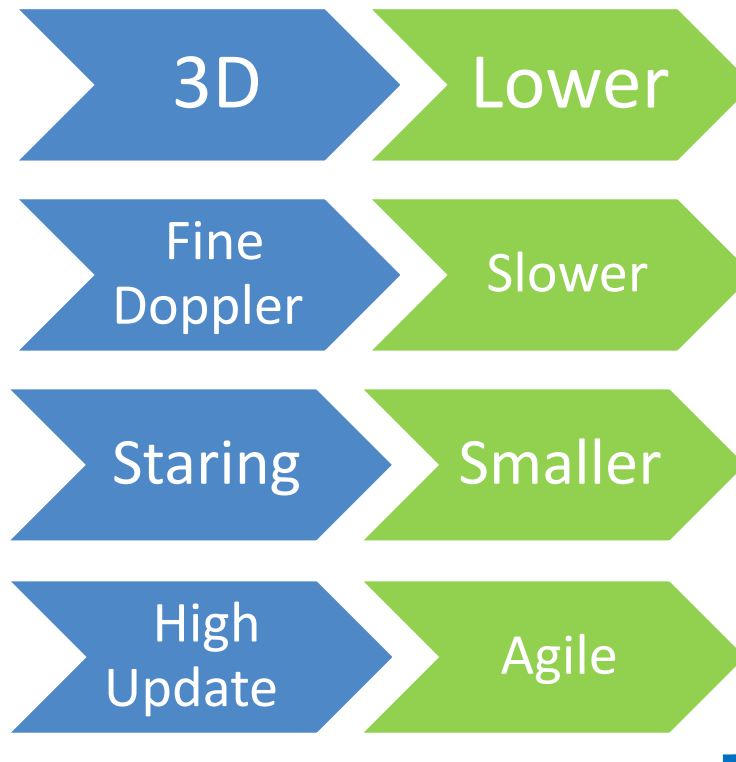
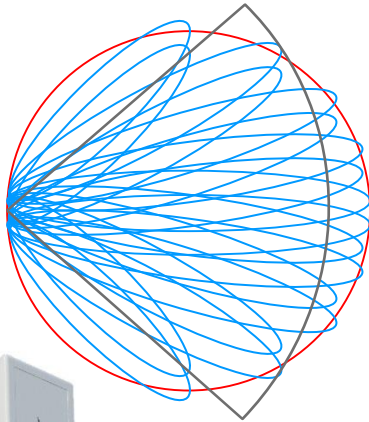
Founding Members



Independent Non-cooperative Surveillance (INCS) - Radar



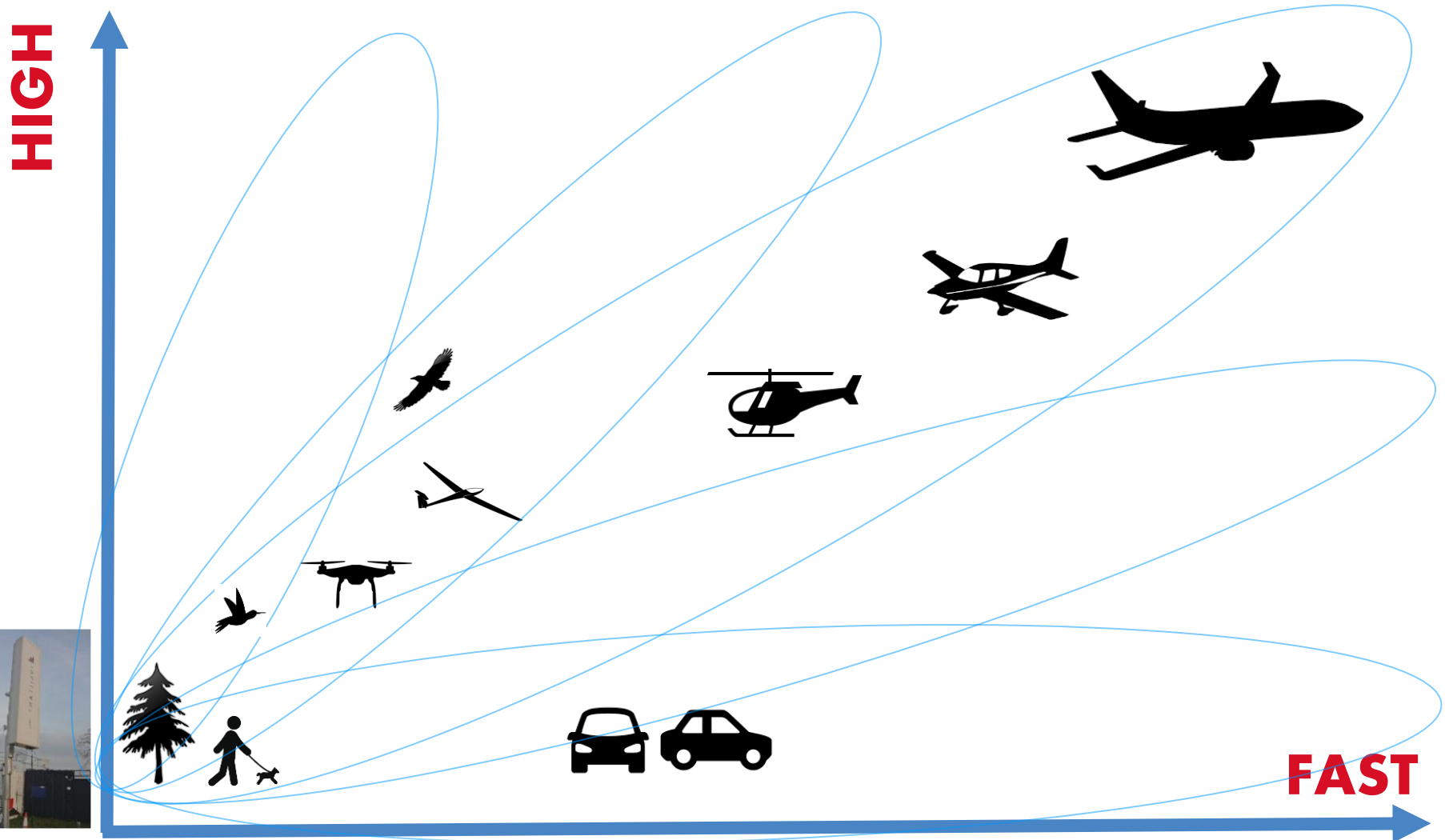
Overcoming the challenge of detecting drones



Discrimination

Gamekeeper 16U - Target centric view

Highly congested space



Gamekeeper – Real Data

Without Classification

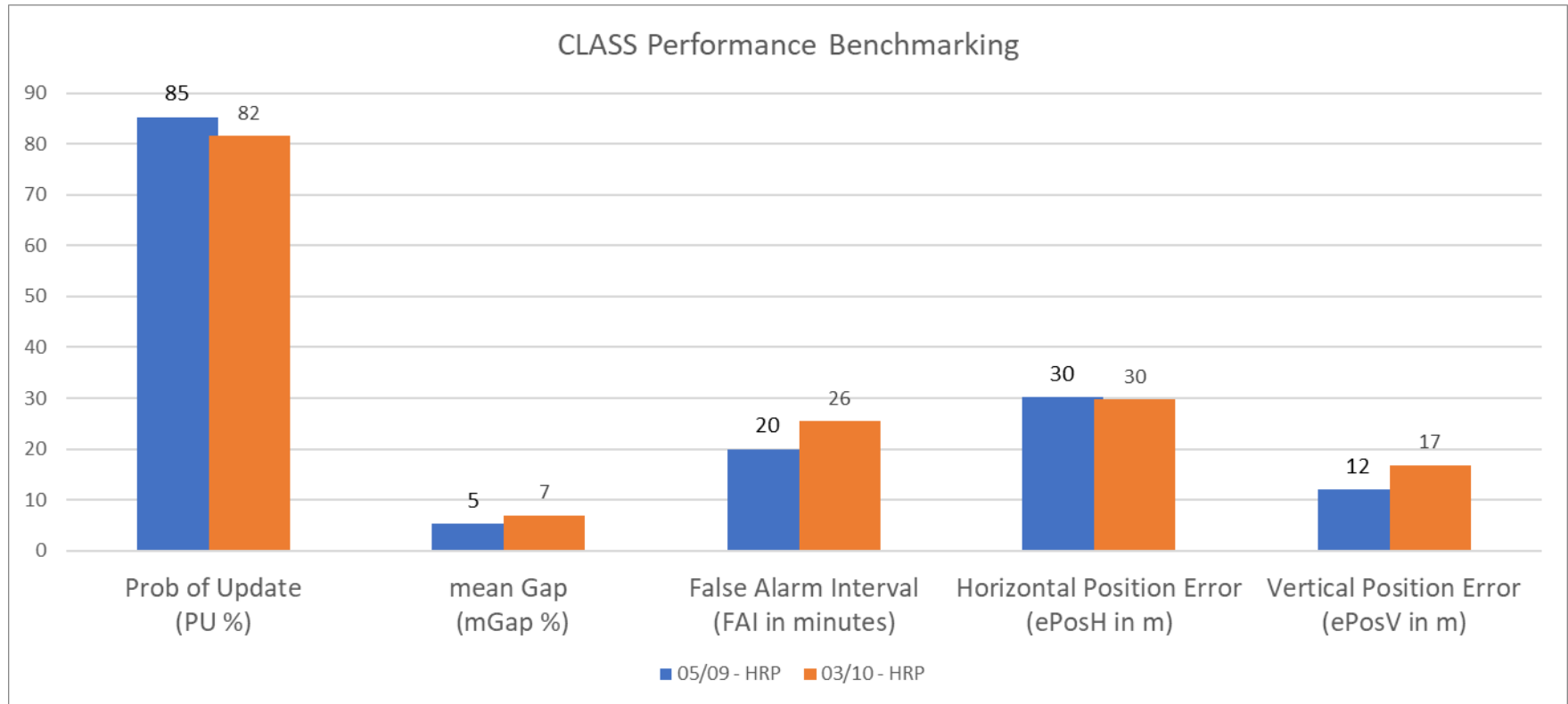


Gamekeeper – Real Data

With Classification



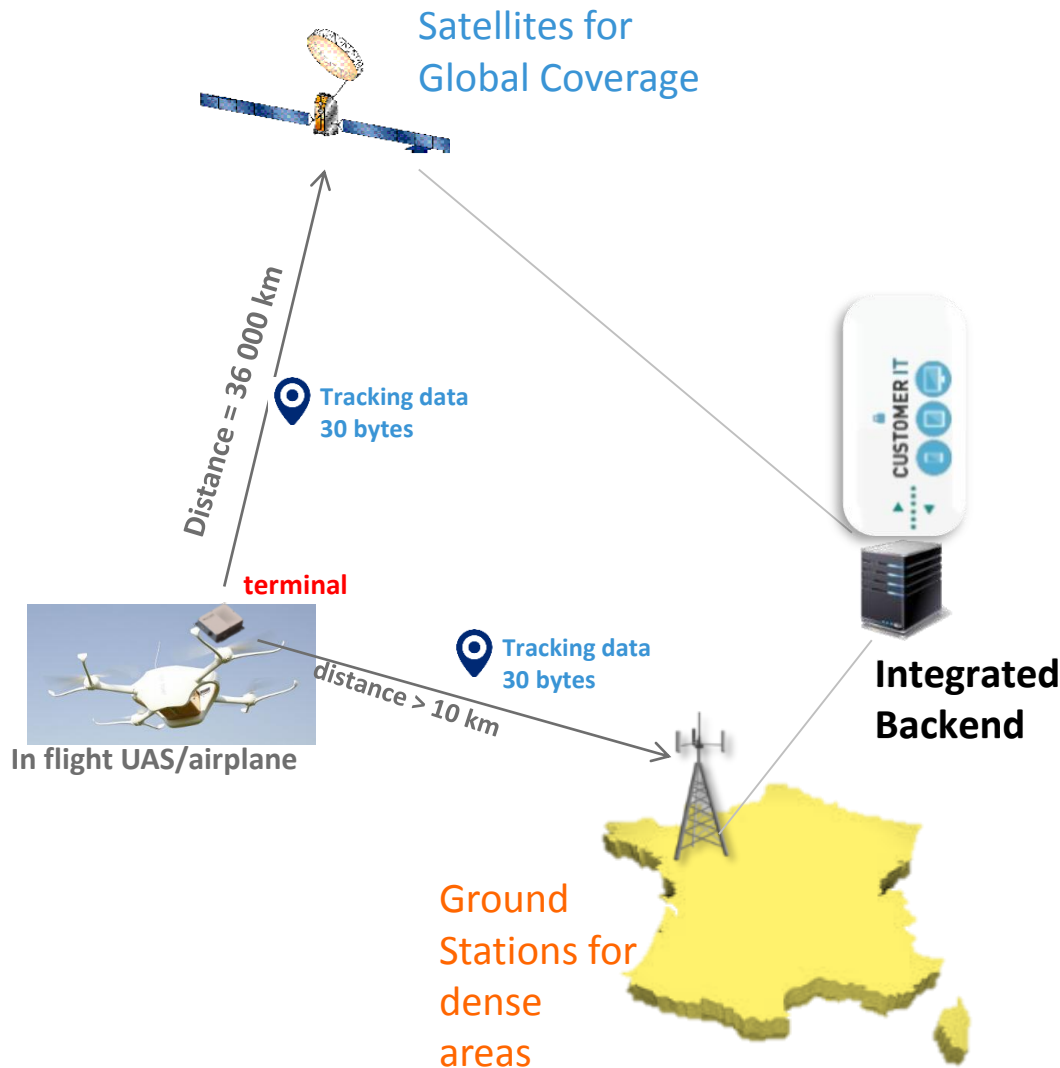
Gamekeeper Tracker Performance



Cooperative Surveillance System (CSS)



Drone-it!



Service for any Flying object

- From **big aircraft up to drones**
- Tracking and monitoring
- **30 bytes** messages
- Truly **global coverage**
- **Encryption**
- Dedicated band (~ 200 kHz)

Terminal

- **Credit-card size**
- Include GPS and accelerometer
- 1 GPS cold fix ~ 250 μ A.h
- 1 msg transmit ~ 20 μ A.h

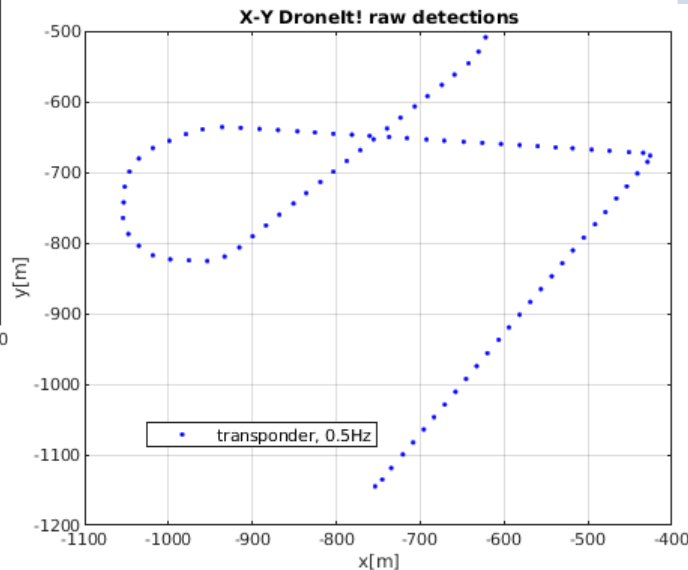
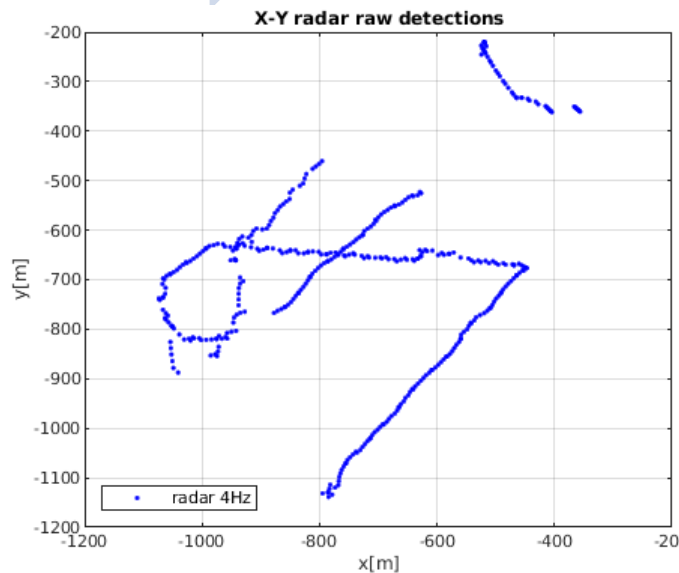
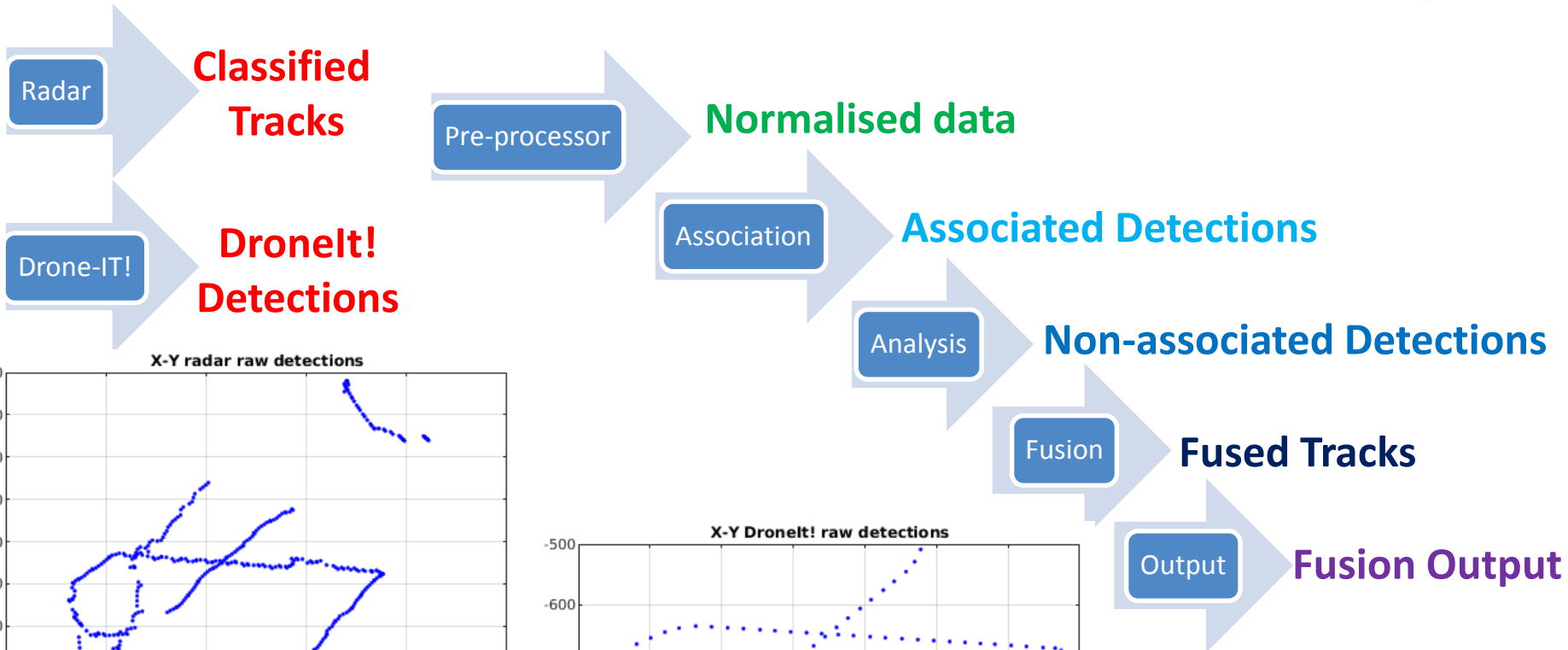
Telecom infrastructure

- Existing GEO satellites
- Ground stations for dense areas
- Integrated Network
- Single customer interface

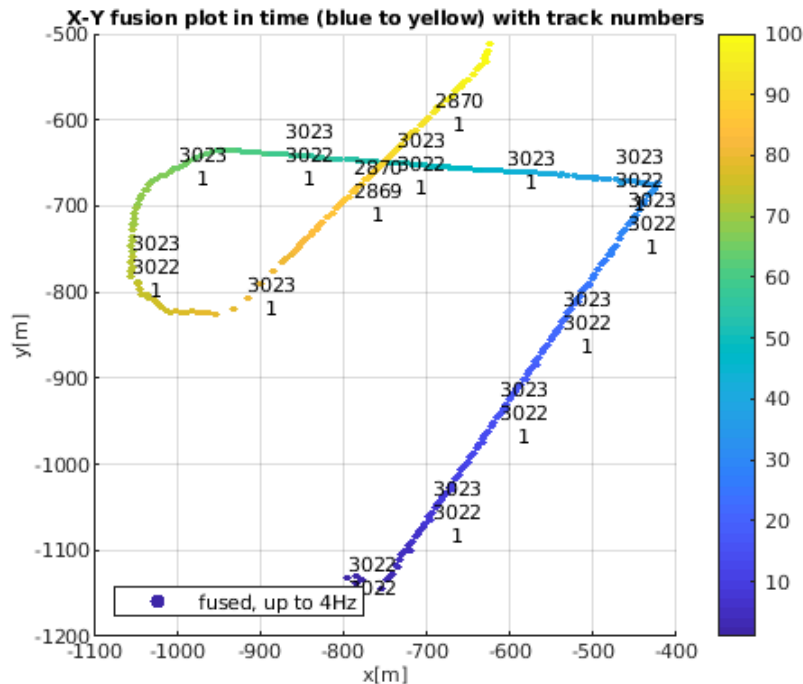
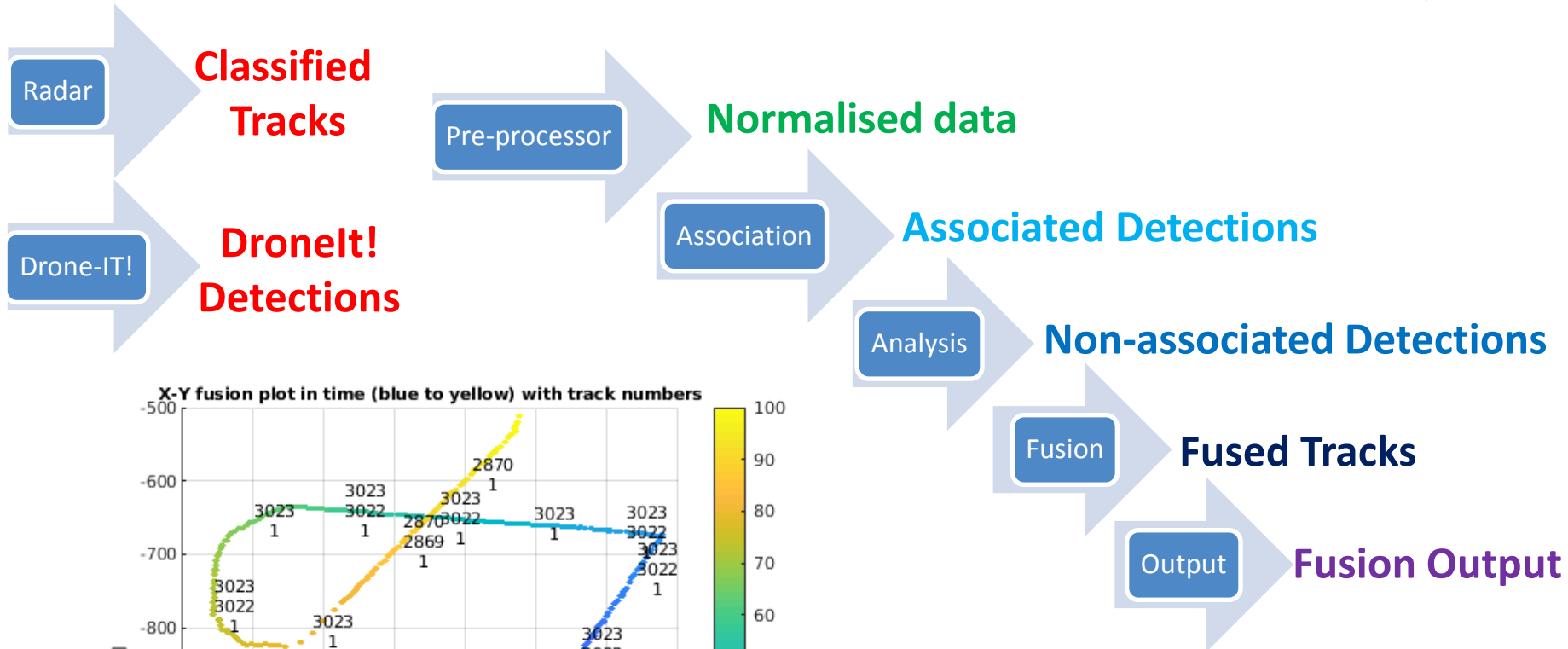
Performances

- Distance > 10 km
- > 100 drones per second
- Latency 2s so far

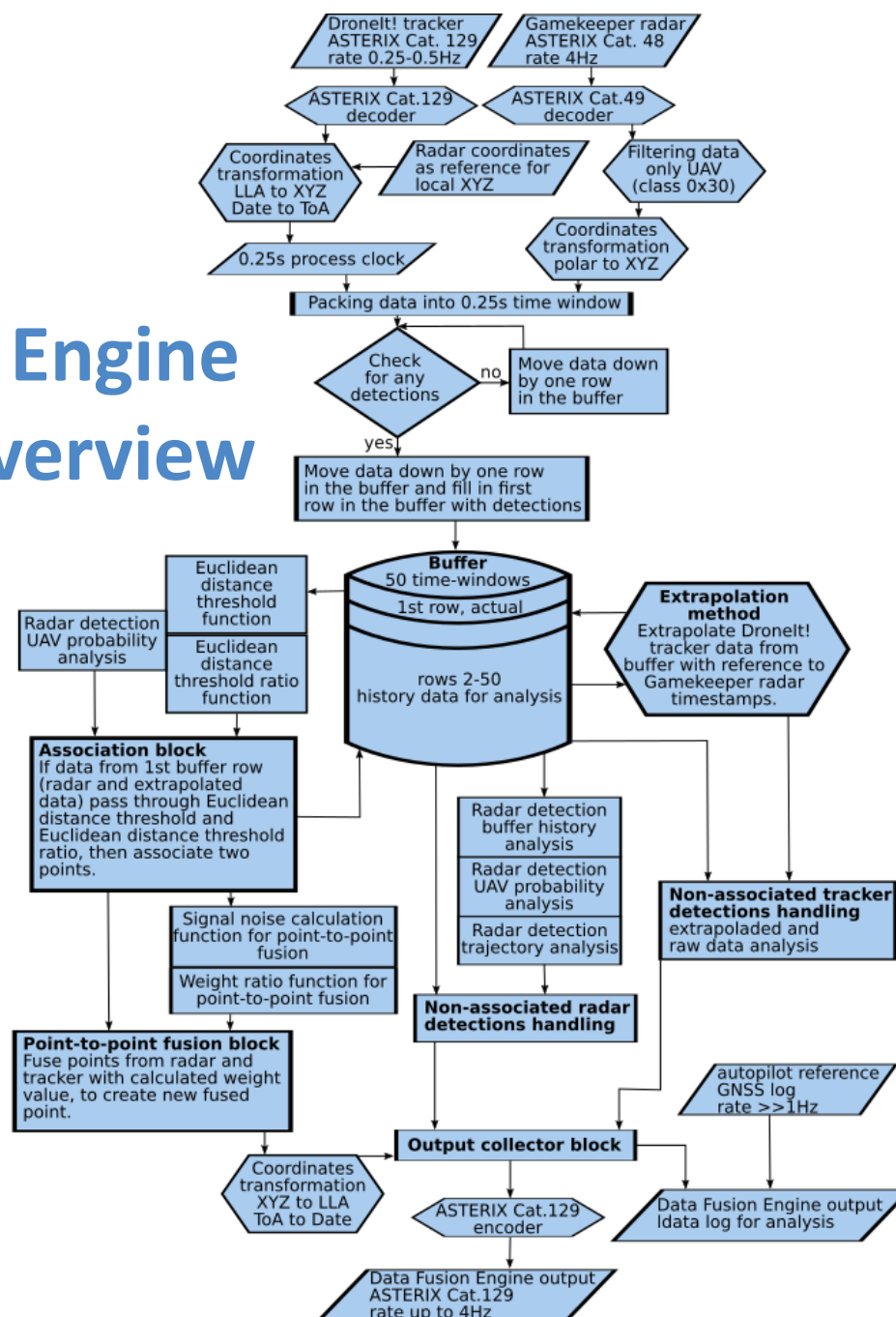
Track Fusion

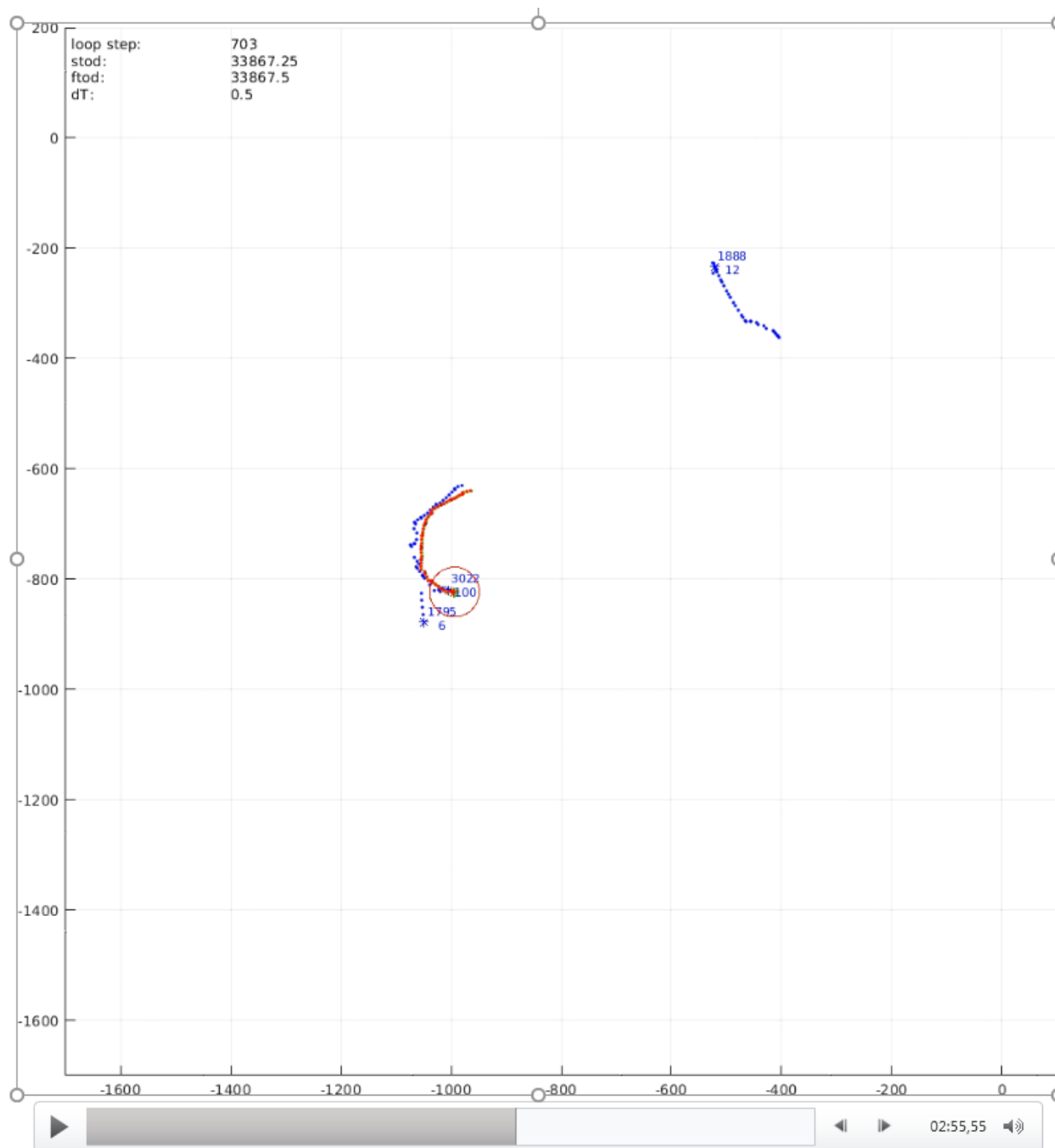


Track Fusion



Data Fusion Engine algorithm overview





Screen-shot from video which was here.



SESAR CLASS

Realtime UTM system



Founding Members



EUROPEAN UNION

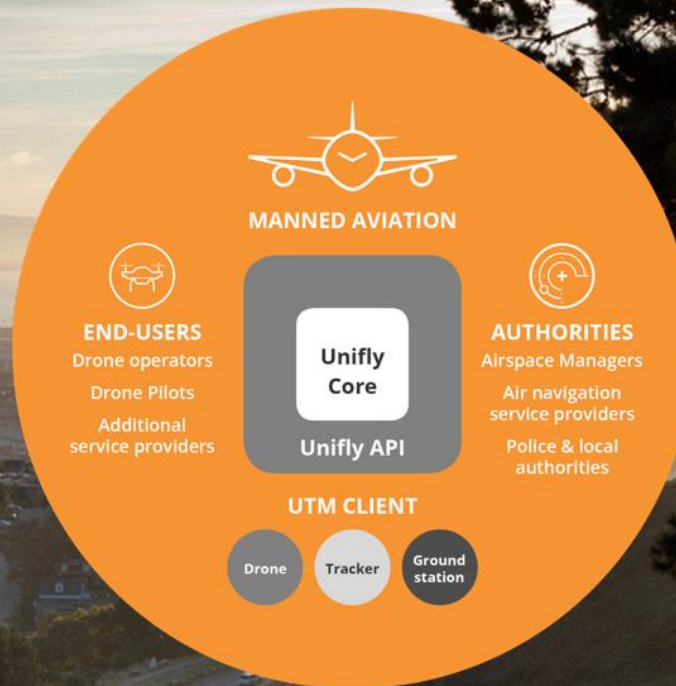


EUROCONTROL

Unifly introduction



The challenge: safety for all stakeholders



Unifly introduction



Unifly introduction



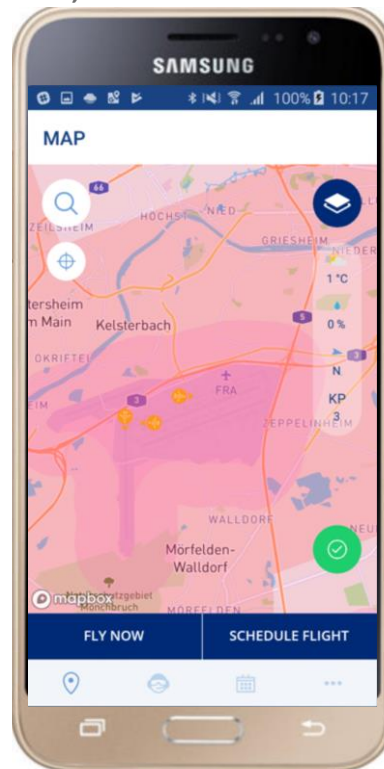
Multiple customer UTM deployments



Realtime situational display

Display guidelines for the multiple stakeholders -> drone pilots

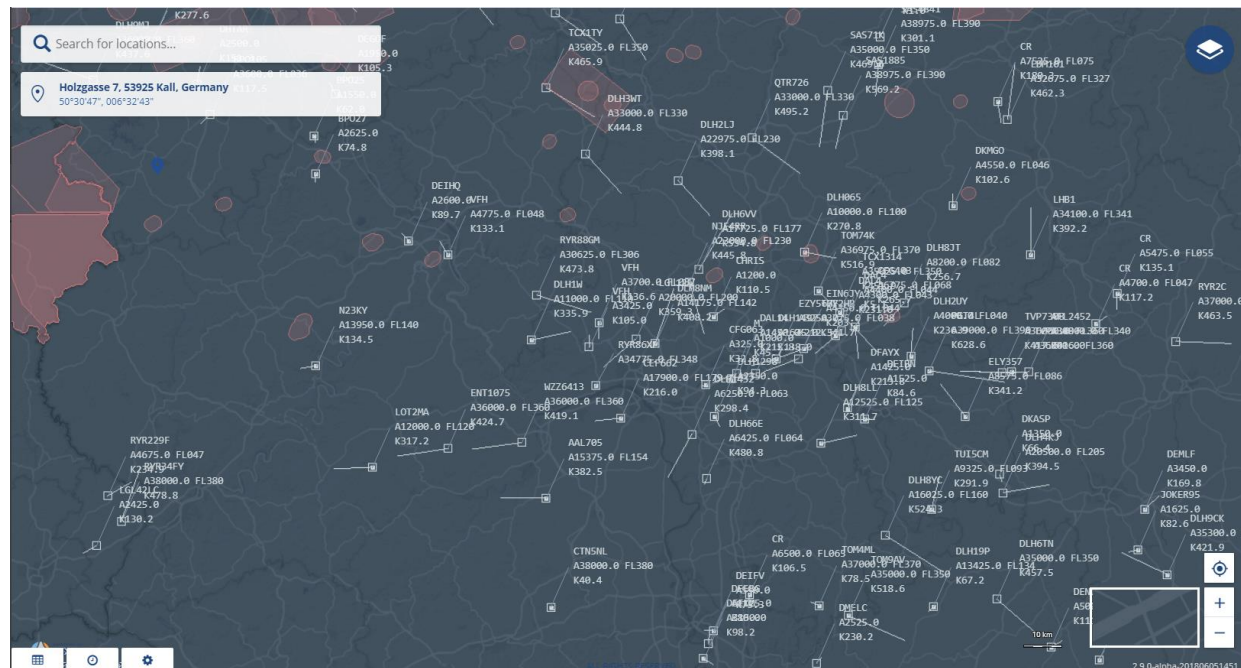
- Should be very user intuitive, with small learning curve
- Easy accessible



Realtime situational display

Display guidelines for the multiple stakeholders -> Authority

- Should be recognizable – ATC screen => ANSP
- But should be configurable to enable User-friendly screens for other authorities => Police
- Both 2D and 3D availability



Realtime situational display



Configurable map layers

The screenshot displays the UNIFLY Flight View interface. On the left is a dark sidebar with the UNIFLY logo and a menu including: Class Supervisor (highlighted with a yellow 'C' icon), No Drone Zone Manager, Flight View (highlighted with an orange bar), Company UAS, Drone Operations, Permission Requests, and Operator Users. The main area is titled 'Flight View' and shows a map of the United Kingdom. A search bar at the top left of the map contains 'Deenethorpe, Corby, England, United Kingdom'. Below it, a location pin shows '95 Jacey Road, Solihull, B90 3LW, United Kingdom' with coordinates '52.418568°, -001.821669°'. A detailed information box for 'BIRMINGHAM CTR (EGBB)' is open, showing 'Category: Control zone', 'Class: D', 'Lower limit: GND', and 'Upper limit: 4500 ft AMSL'. On the right, a 'Map Layers' panel lists various layers with checkboxes: Aircraft, Active Operations (checked with a blue circle), Sensitive fauna, Forbidden Aerial Photo, Populated areas, Danger areas (checked with a red circle), Public/military airport, Prohibited areas, Restricted areas (checked with a red circle), Control zones (checked with a red circle), Temporary No Fly Zone (checked with a red circle), and Notams (checked with a blue circle). A yellow circle with a 'C' icon is in the top right corner of the interface.

Realtime situational display



- Different base maps

Class Supervisor

No Drone Zone Manager

Flight View

Company UAS

Drone Operations

Permission Requests

Operator Users

Flight View

Deenethorpe, Corby, England, United Kingdom

Benefield Road, Corby, NN17 3, United Kingdom

52.516490°, -000.591340°

PETERBOROUGH/CONINGTON ATZ (EGSF)

Category

Control zone

Class

G

Lower limit

GND

Upper limit

2000 ft AGL

Realtime situational display



■ Deenethorpe test site

The screenshot displays the UNIFLY Flight View interface. On the left is a dark sidebar menu with the UNIFLY logo at the top. Below it are several menu items: "Class Supervisor" (with a yellow 'C' icon), "No Drone Zone Manager" (with a clock icon), "Flight View" (with a person icon and highlighted by an orange bar), "Company UAS" (with a star icon), "Drone Operations" (with a star icon), "Permission Requests" (with a list icon), and "Operator Users" (with a person icon). The main area shows a satellite map of a rural landscape with a large airfield. A search bar at the top of the map area contains the text "Deenethorpe, Corby, England, United Kingdom". Below the search bar, a location pin icon is next to the text "Corby, NN17 3, United Kingdom" and the coordinates "52.502206°, -000.595146°". On the right side of the map, there are three circular icons: a yellow one with a 'C', a blue one with a book icon, and a blue one with a target icon. At the bottom right of the map, there is a scale bar labeled "200 m" and a small inset map showing the current location within a larger regional context. The bottom of the interface has a dark bar with three icons: a grid, a clock, and a gear.

Realtime situational display



Interface from Real Time Data Collector via Asterix cat 129

Contains 4 streams (We can differentiate on these sources)

- Drone-IT
- Aveillant
- Paparazzi
- Fused

Realtime situational display



UNIFLY

Flight View

Class Supervisor

No Drone Zone Manager

Flight View

Company UAS

Drone Operations

Permission Requests

Operator Users

Deenethorpe, Corby, England, United Kingdom

Corby, NN17 3, United Kingdom
52.503267°, -000.598173°

DRONE DETAILS

Regref

Nickname
N/A

Type
N/A

Track id
1324

Track state
UNKNOWN

Brand
N/A

Model
N/A

Collision info

0M from undefined

0M from undefined

9M from undefined

Live Tracking Info

A750.0

Aveillant

Tracking Sources

☒ Aveillant

☐ Dronelt

☐ Paparazzi

☐ Fused

Knipprogramma

Nieuw

Modus

Uitstellen

Afsluiten

Opties

selecteer de knipselmodus met de knop Modus of klik op de knop

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Realtime situational display



Flight View

Class Supervisor

No Drone Zone Manager

Flight View

Company UAS

Drone Operations

Permission Requests

Operator Users

Deenethorpe, Corby, England, United Kingdom

Corby, NN17 3, United Kingdom
52.505105°, -000.598848°

N

Regref

Nickname
N/A

Track id
1324

Brand
N/A

Type
N/A

Track state
COOPERATIVE

Model
N/A

Collision info

0M from undefined

7M from undefined

7M from undefined

Live Tracking Info

1324
A750.0
DroneIt

Tracking Sources

☐ Aveillant

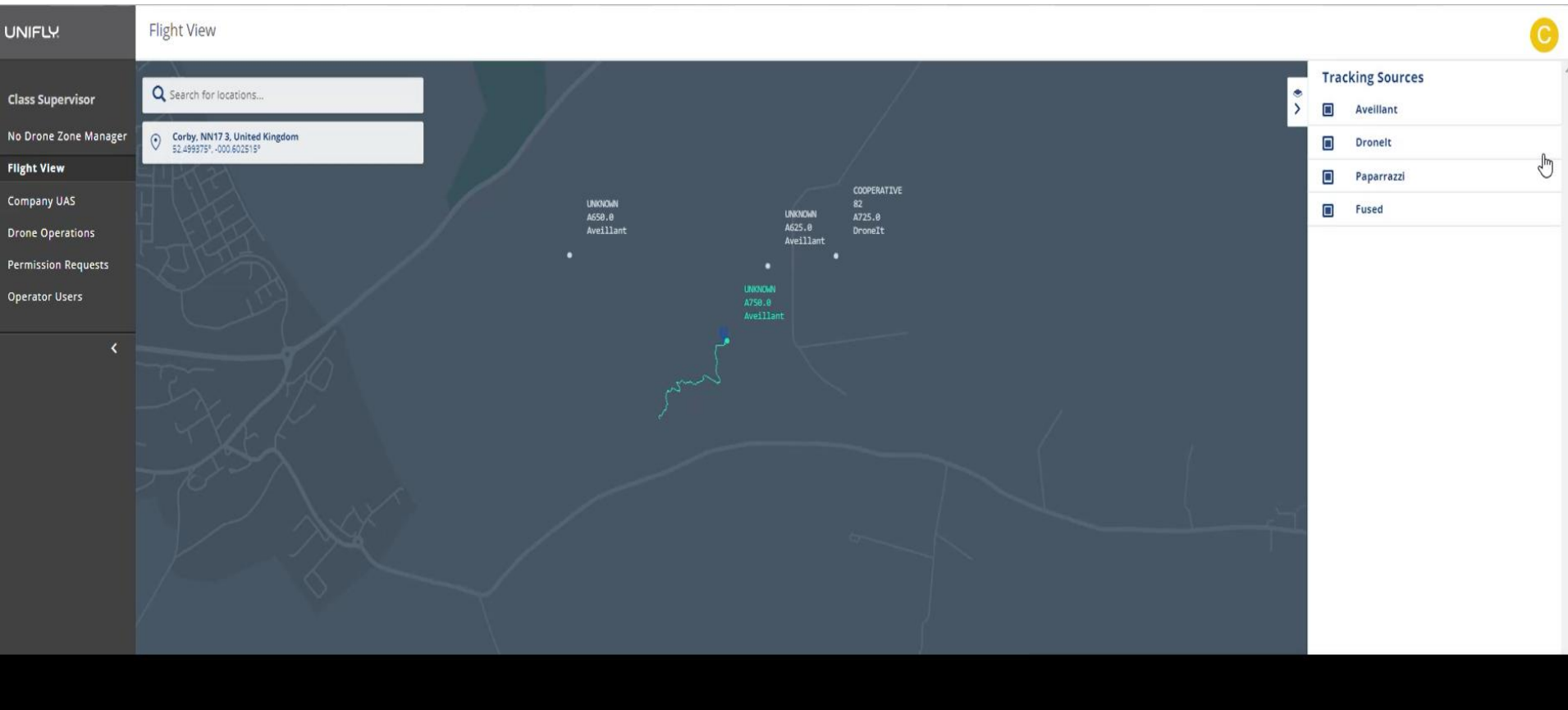
☒ Dronelt

☐ Paparazzi

☐ Fused

31

Realtime situational display





SESAR CLASS Live Experiments



Founding Members



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EUROCONTROL

CLASS Live Experiments

Real-time operation



Trial Site

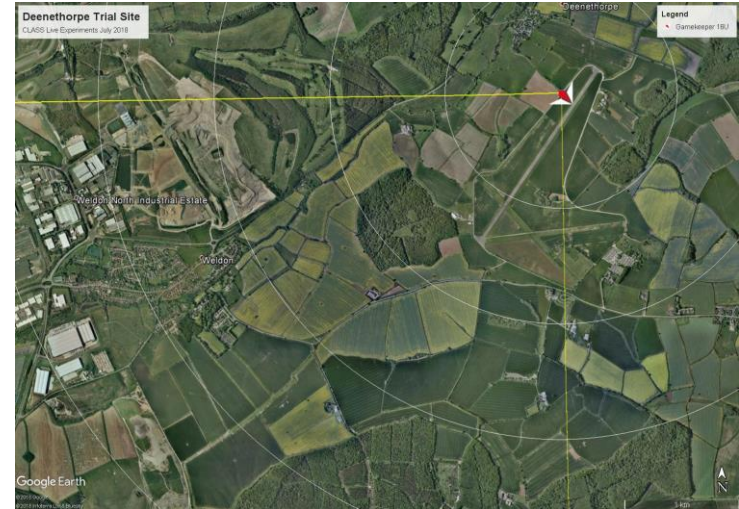
- Ex-RAF Airfield, Deenethrope

Trial Dates

- October 15th – 19th 2018

Trial Equipment

- Aveillant: Gamekeeper 16U
- ENAC: Fixed wing sUAS
- Airbus: Drone- it!
- Unifly: UTM



Mon 15th Oct	Tue 16 th Oct	Wed 17 th Oct	Thu 18 th Oct	Fri 19 th Oct
Set-up	Live Day 1	Live Day 2	Visitor Day	Wrap-up

Live Flights

- Drones



- Drone Operators



- Ground Truth Crew





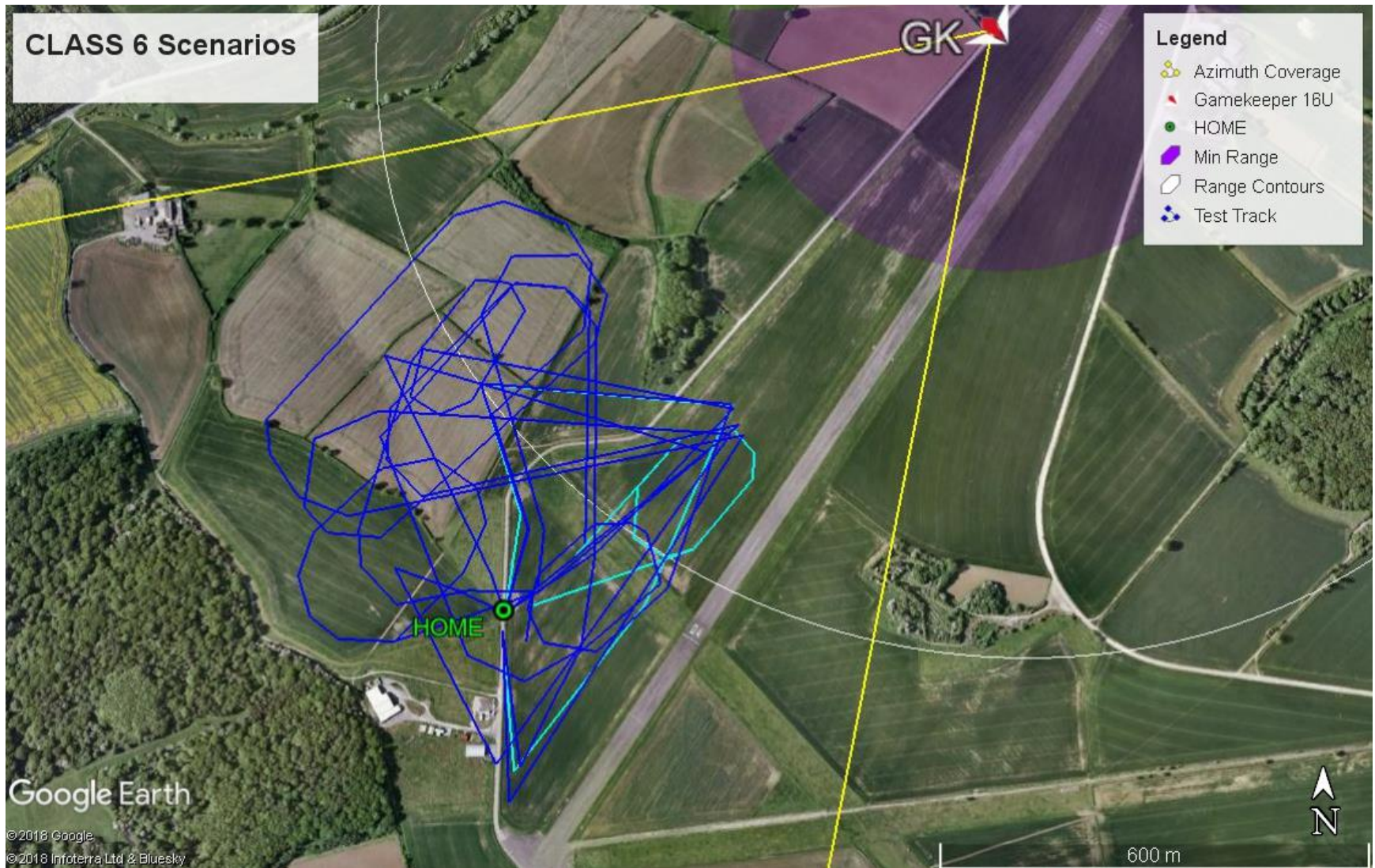
Screen-shot from video which was [here](#).

CLASS Scenarios



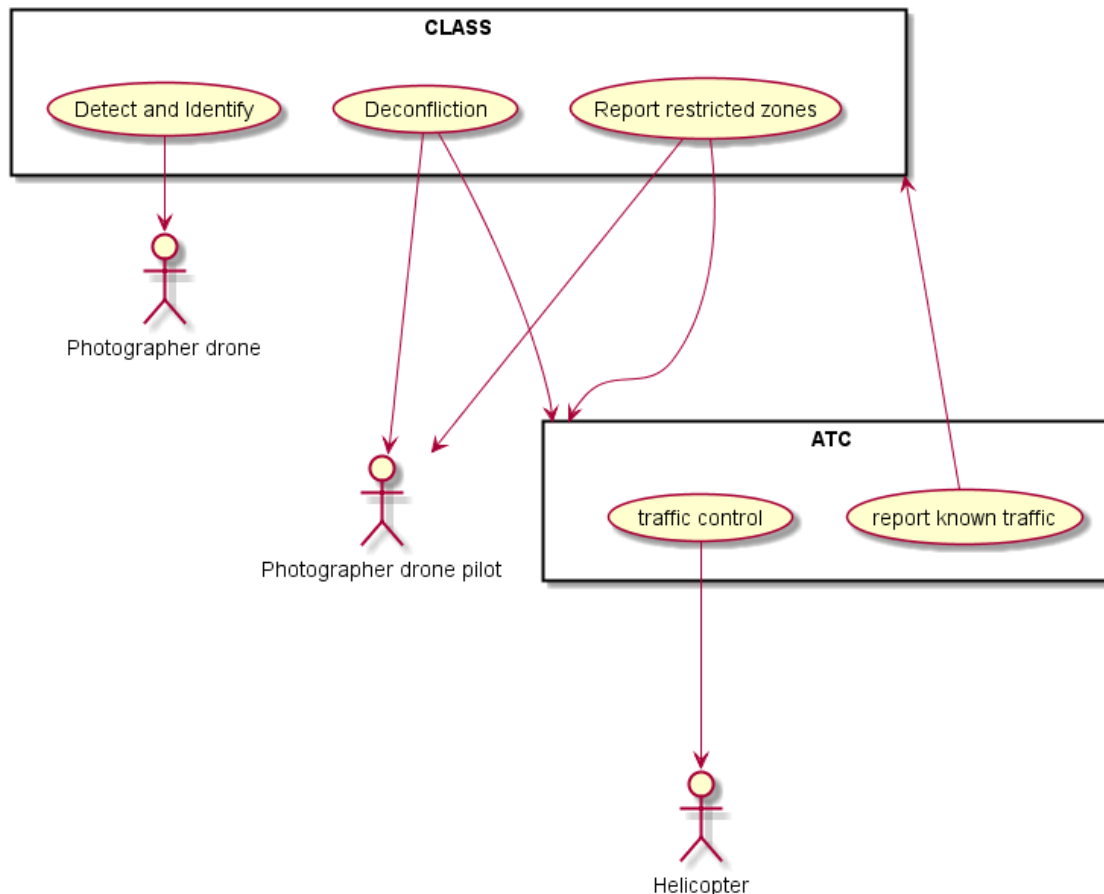
Scenario ID	Scenario Name
CLASS_DS_1	GNSS failure leading to intrusion in an airport
CLASS_DS_2	conflicts in an emergency situation (2 drones)
CLASS_DS_3	Aerial work near high voltage lines
CLASS_DS_4	Drone ILS Calibration (2 drones)
CLASS_DS_5	Gliding rogue drone
CLASS_DS_6	Urban pollution sampling

CLASS Scenarios



Aerial work near high voltage lines – CLASS_DS_3

CLASS_SC_3 - Aerial work on high voltage lines



Narrative

Drone launched from HOME, circles at STANDBY and moved to photography point

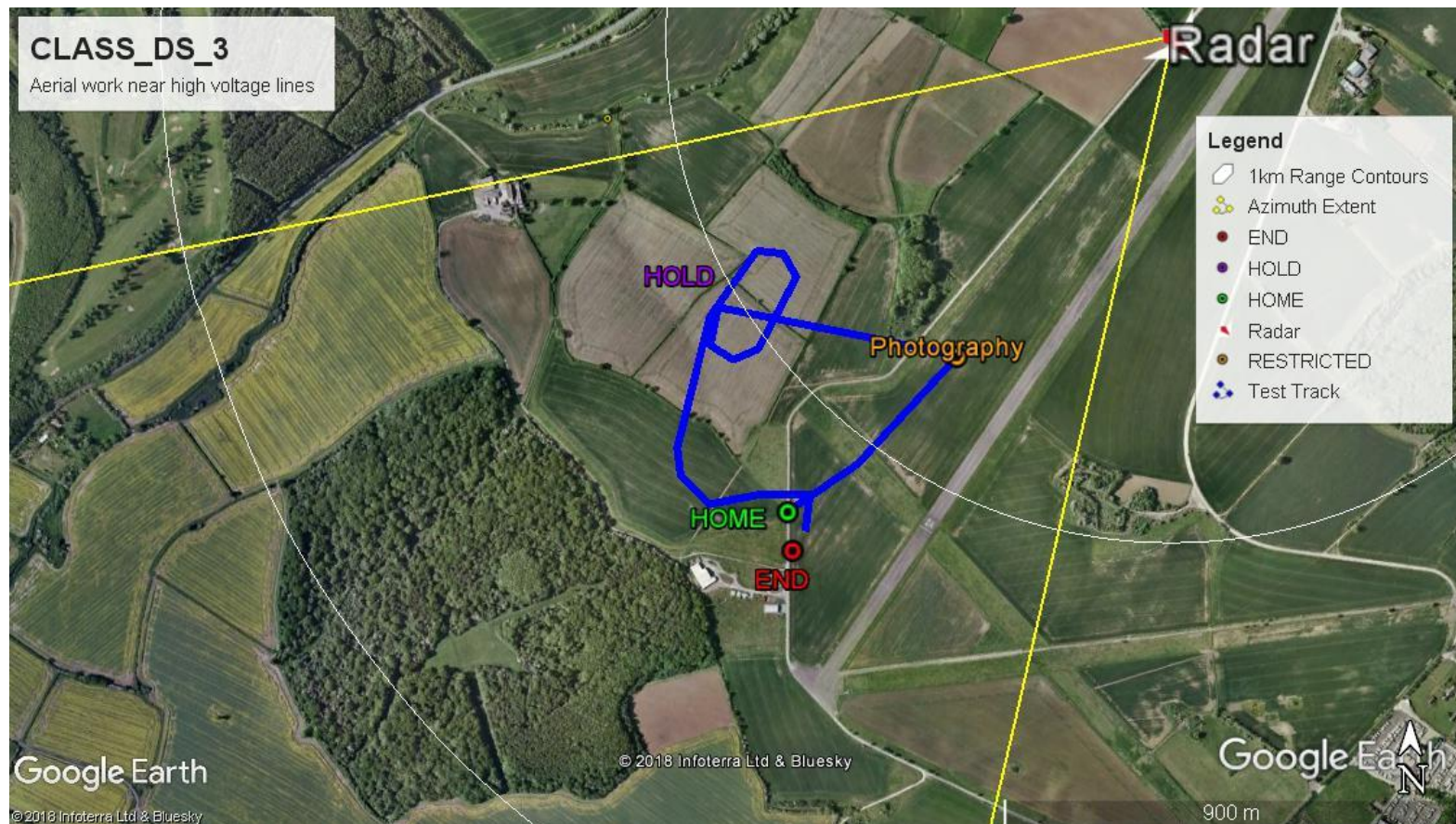
Drone circles over photography point

Drone moved to HOLD to deconflict

Drone cleared to land at END

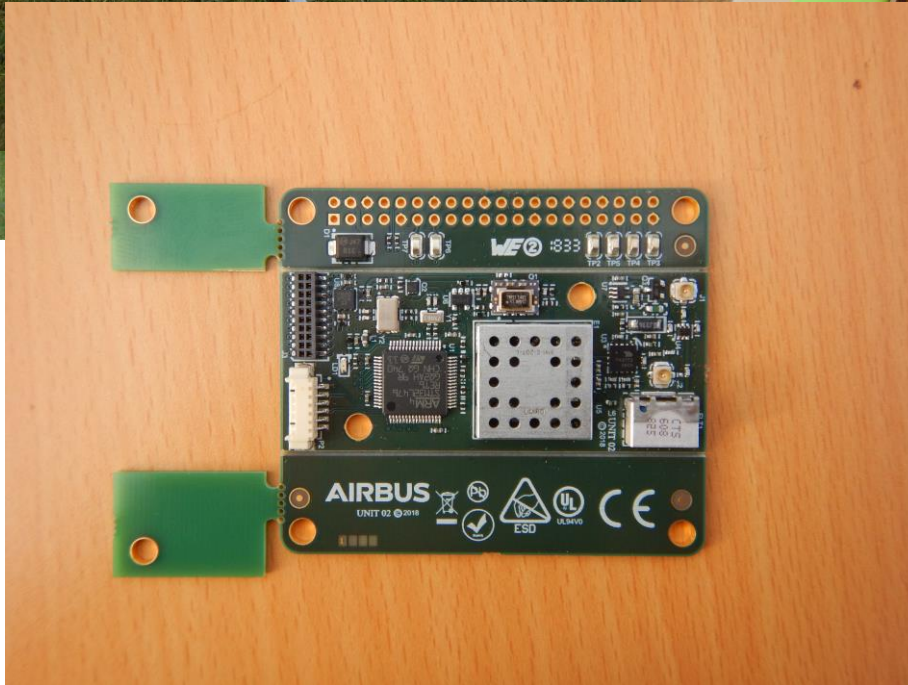
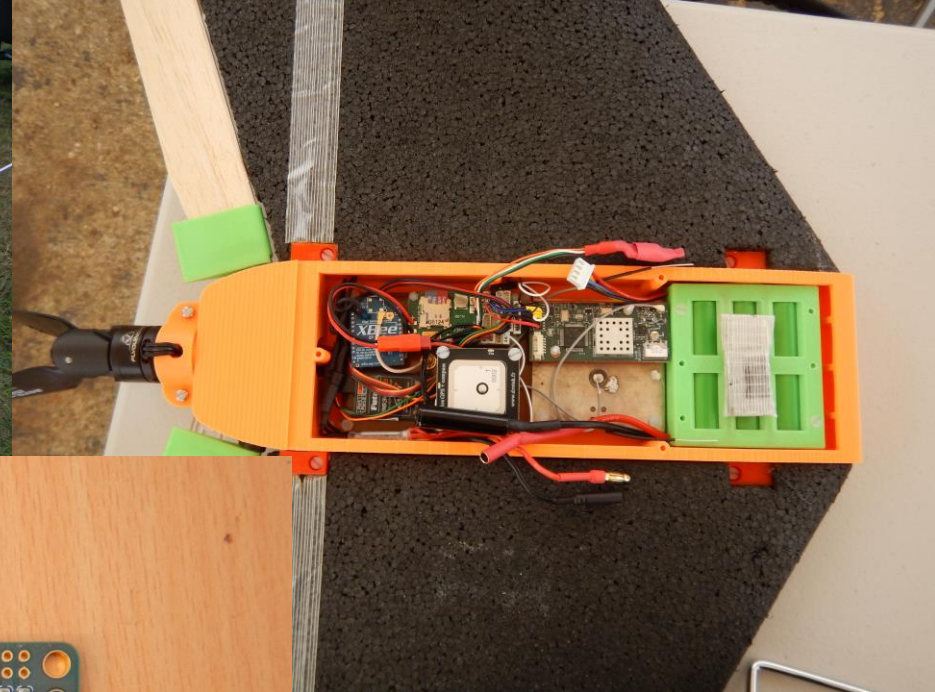
Aerial work near high voltage lines – CLASS_DS_3

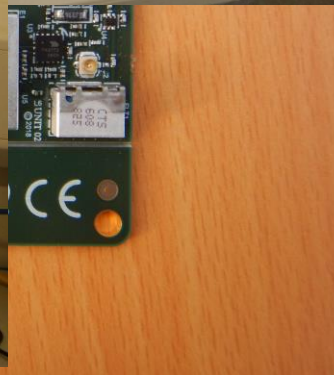
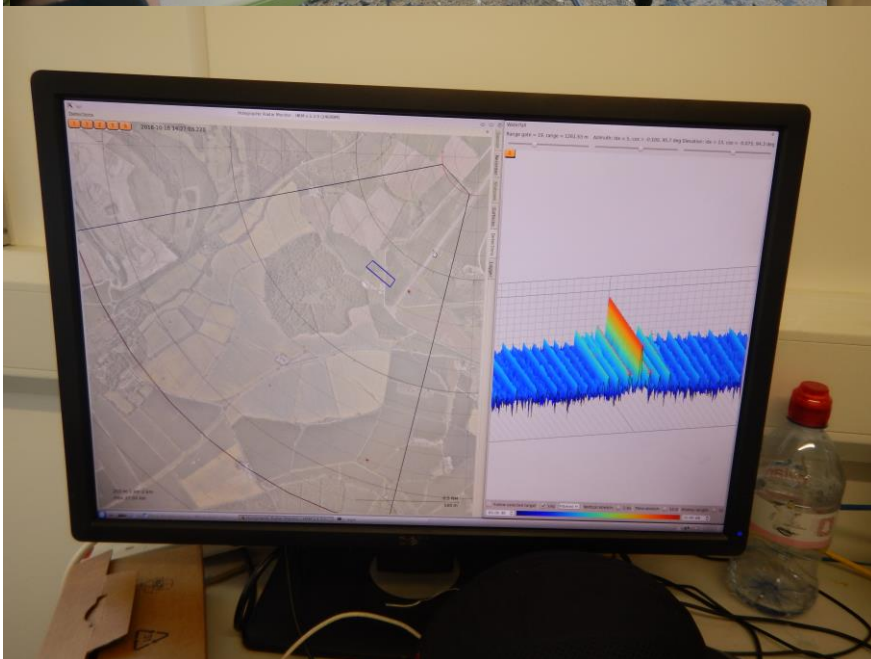
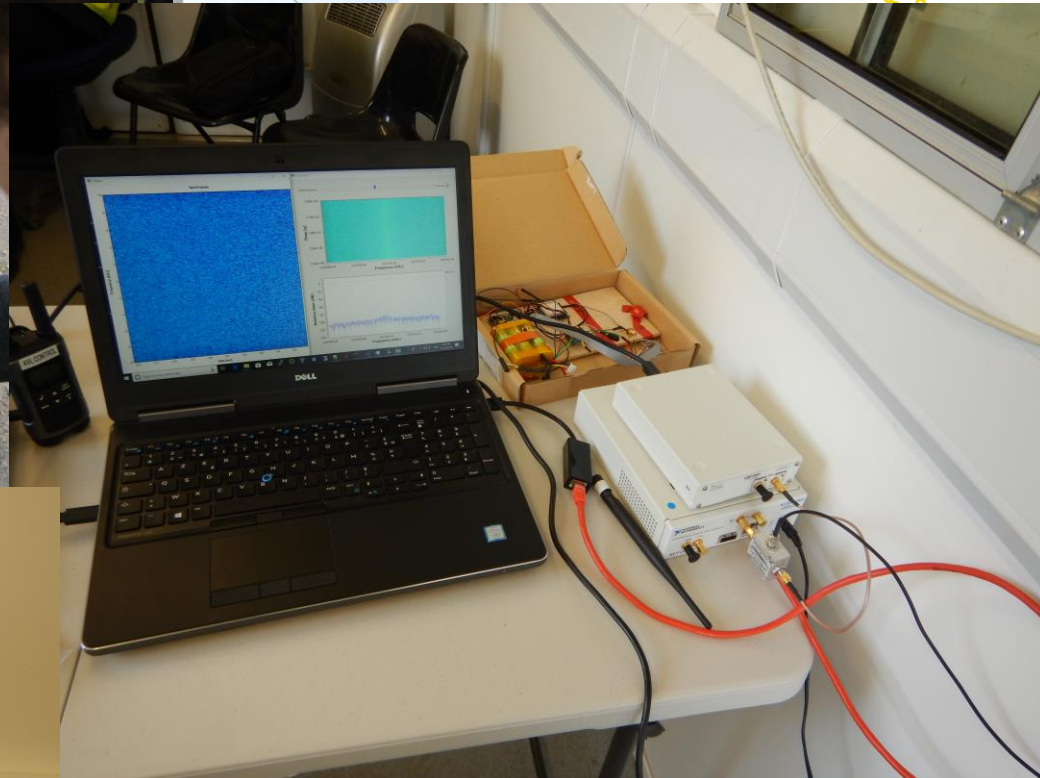
(1) Drone moving to **PHOTOGRAPHY** point (2) Drone moved to **HOLD** to deconflict with manned aircraft (3) Drone eventually cleared to land













Thank you for your attention



This project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No [763719]



Founding Members



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