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

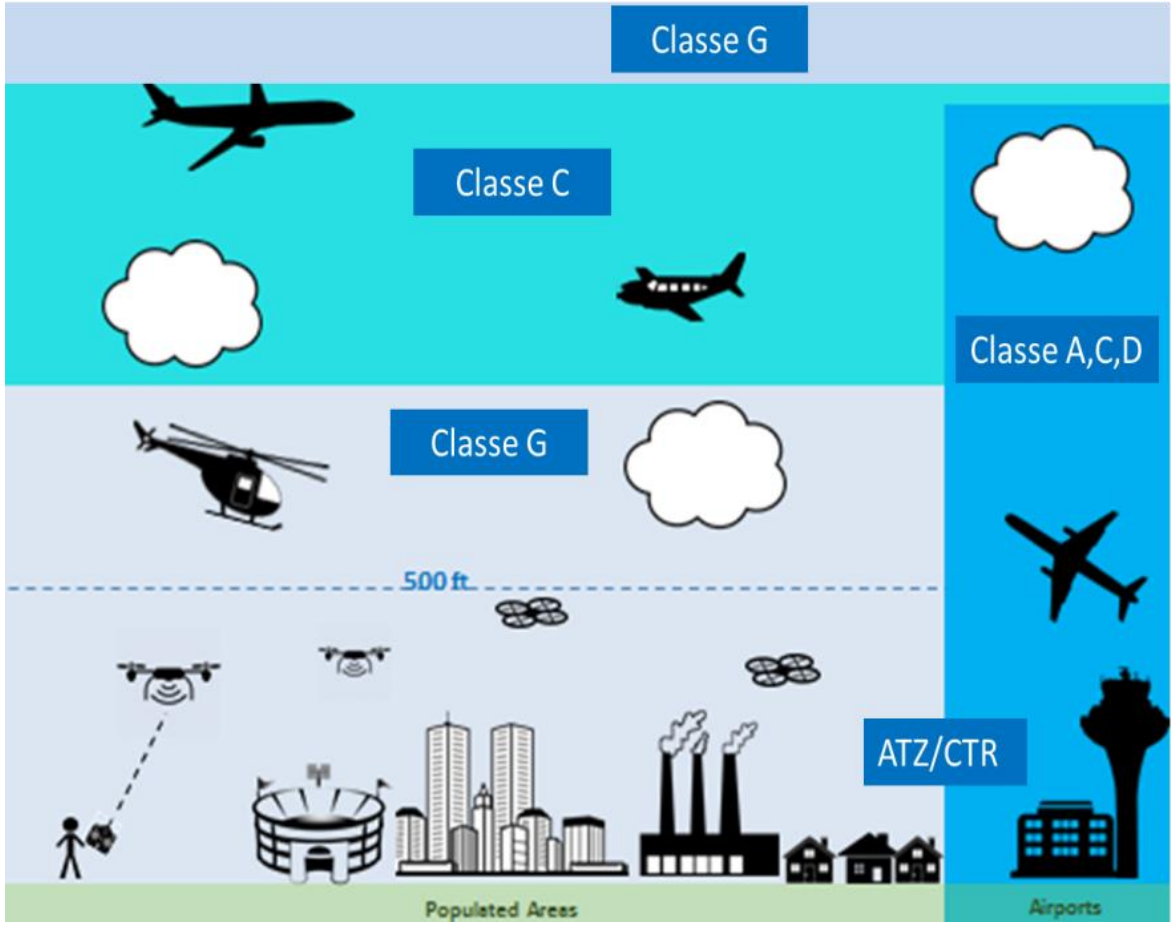
- 2006-2011: M.Sc. (Eng.) in control engineering and robotics from the **Wrocław University of Science and Technology**, Faculty of Electronics, Wrocław, Poland.
- 2011-2014: software and robotics engineer in R&D Department in **Flytronic Sp. z o.o. (WB Group)**, leading Polish constructor and R&D center 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)

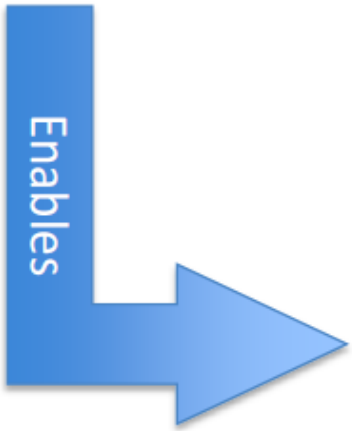
U-Space: Aiming to enable complex drone operations with a high degree of automation



U-space

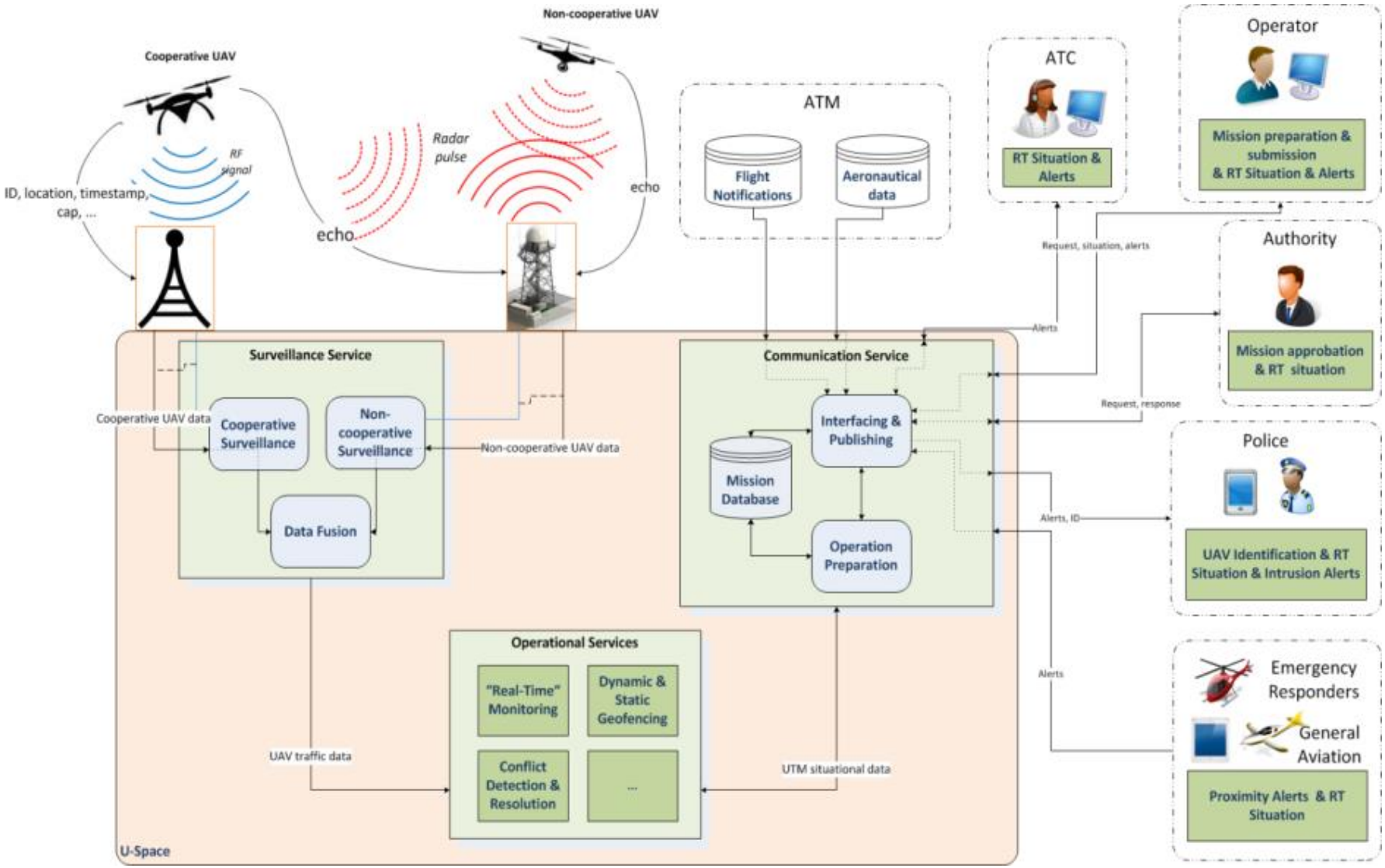
CLEAR Air Situation for uaS

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

AVEILLANT
A Thales company

Drone Identifier and Tracker

Ultra Narrow Band technology

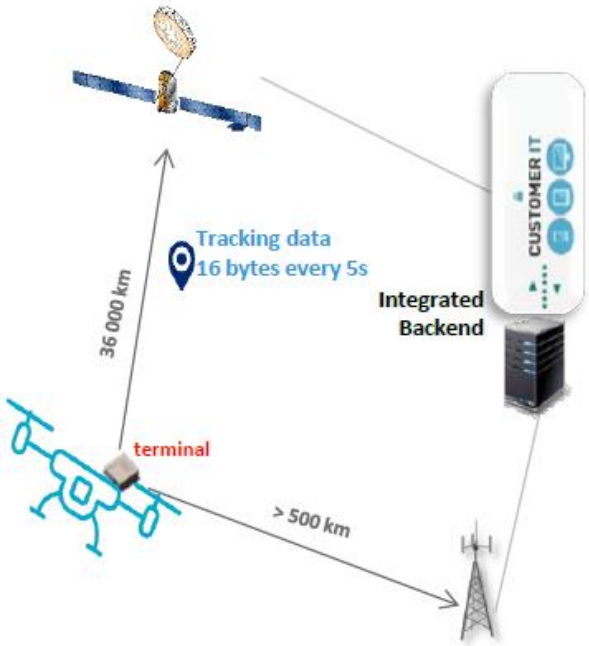
NTNU
Kunnskap for en bedre verden

Data Fusion

Fuse Cooperative and
Non-Cooperative tracks

Gamekeeper 16U

Take on drone spotting:
Stare not scan

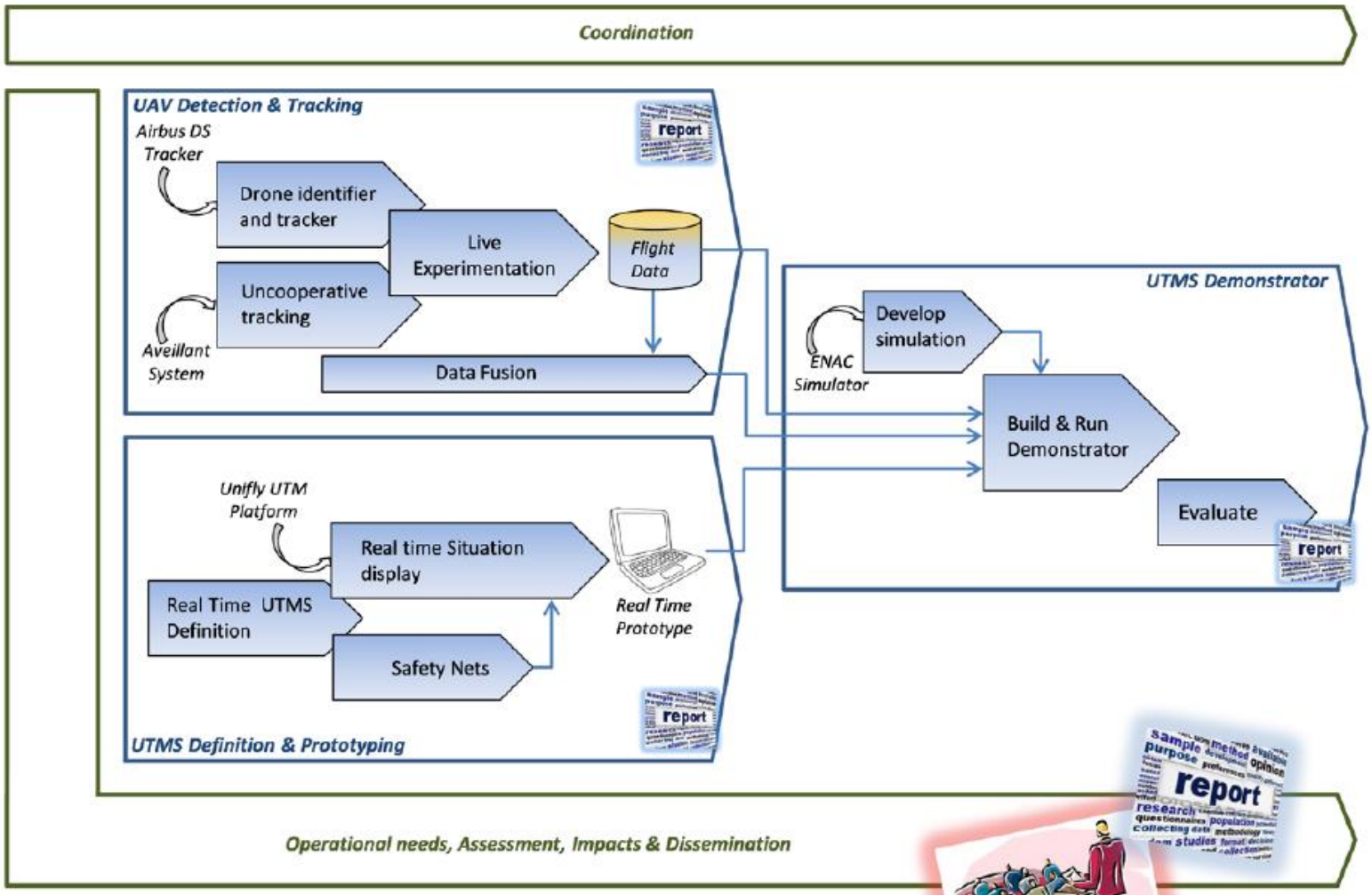


Situational Awareness and Alerts

Real Time Monitoring

UNIFLY

Study Logic of CLASS



SESAR CLASS
Component Technologies

CLASS Trial Visitor Day 18th October 2018

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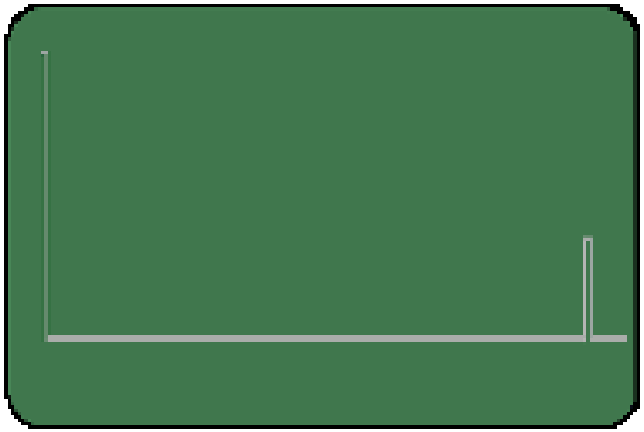
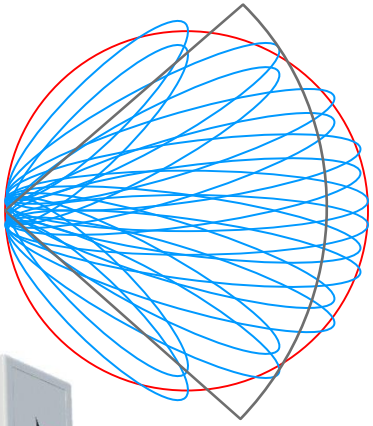
Independent Non-cooperative Surveillance (INCS) - Radar



Overcoming the challenge of detecting drones

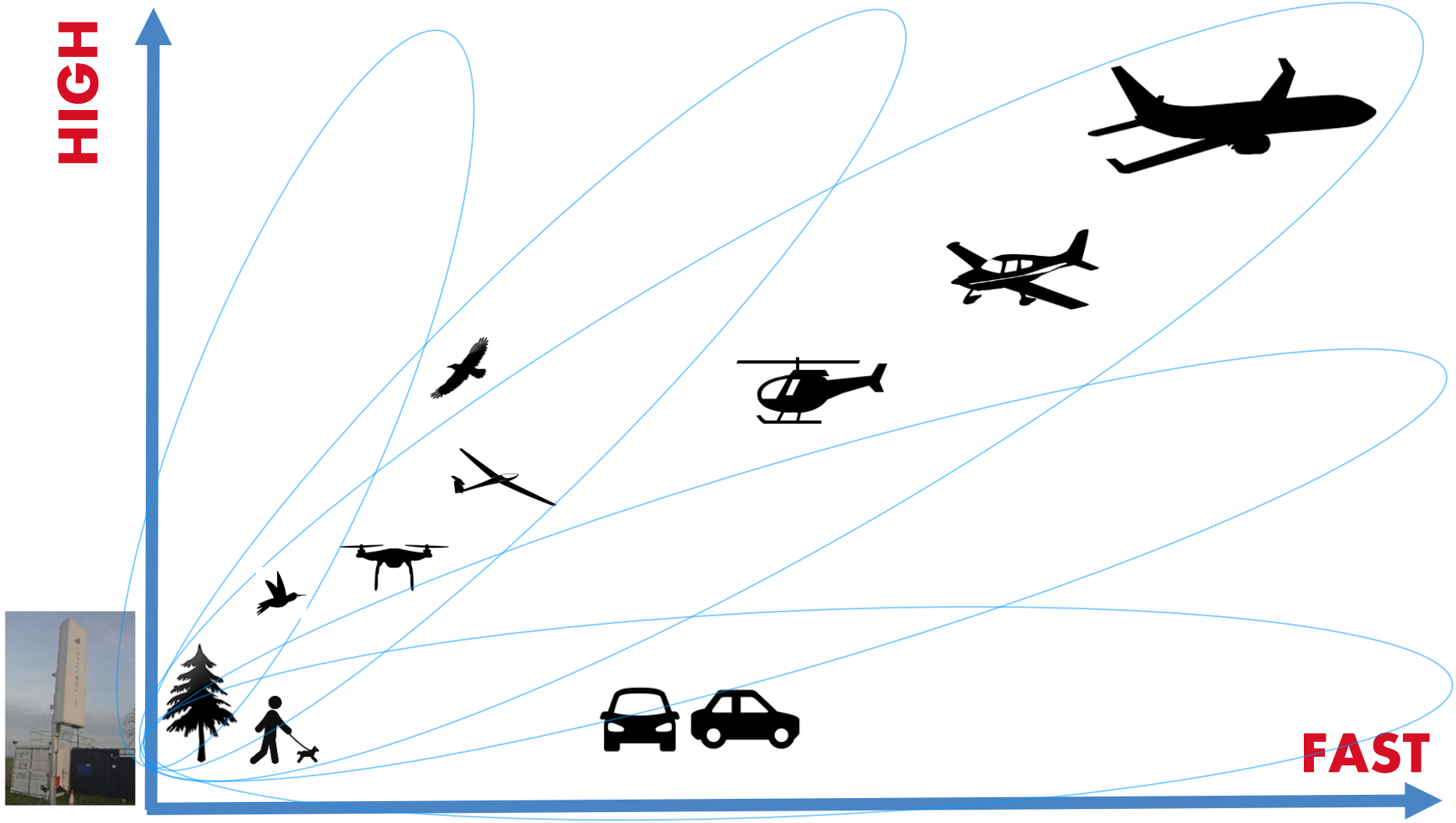


- 3D → Lower
- Fine Doppler → Slower
- Staring → Smaller
- High Update → Agile

→ Discrimination

Gamekeeper 16U - Target centric view

Highly congested space



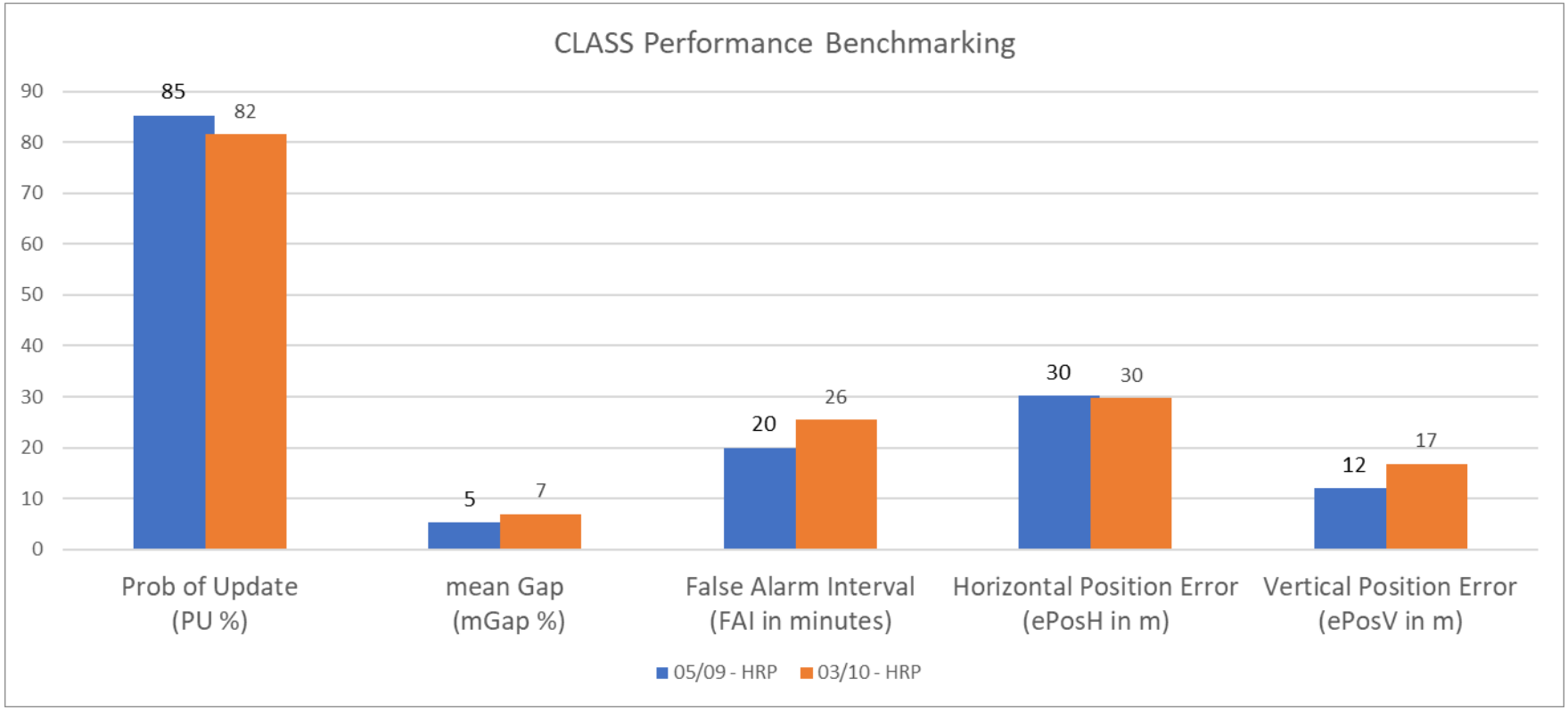
Gamekeeper – Real Data

Without Classification

Gamekeeper – Real Data

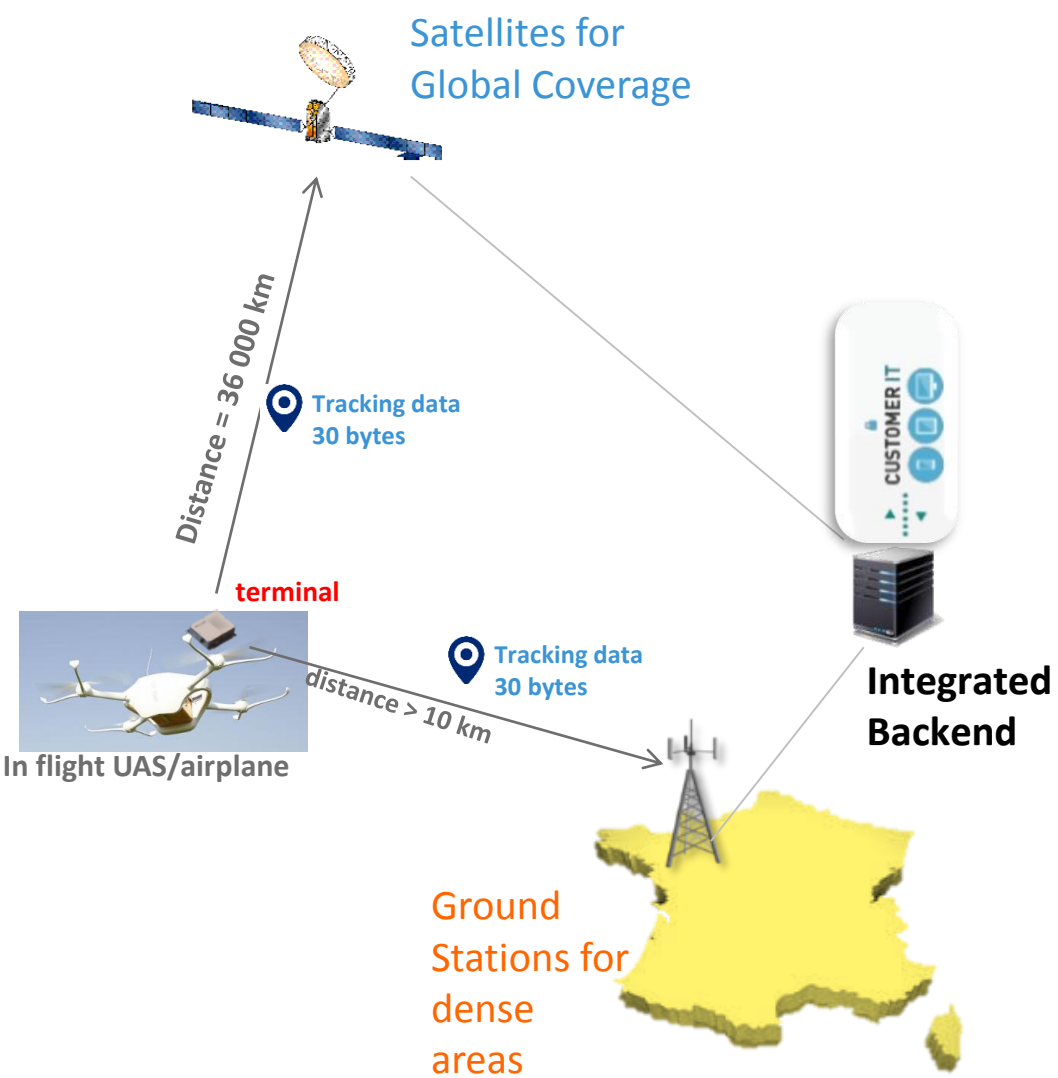
With Classification

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 µA.h
- 1 msg transmit ~ 20 µA.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

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Radar → Classified Tracks

Drone-IT! → DroneIt! Detections

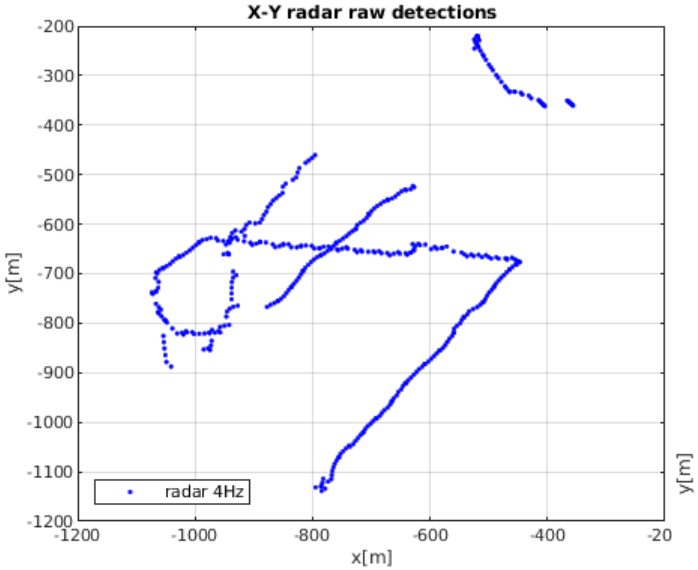
Pre-processor → Normalised data

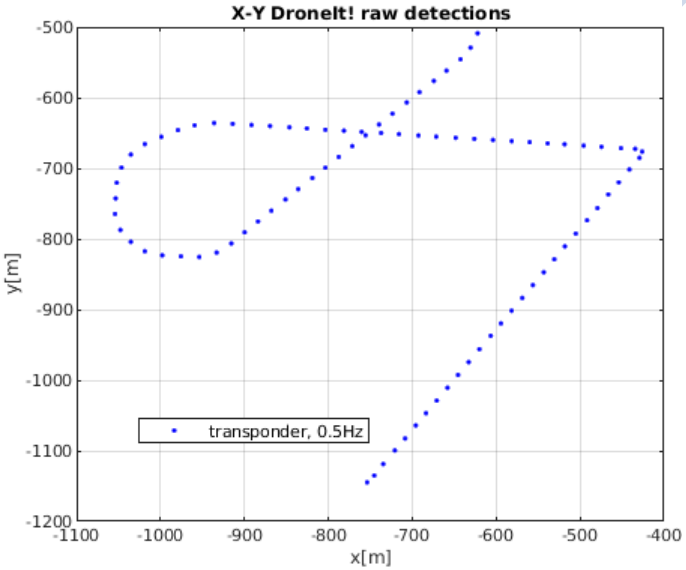
Association → Associated Detections

Analysis → Non-associated Detections

Fusion → Fused Tracks

Output → Fusion Output





Track Fusion

NTNU

CLASS SESAR JOINT UNDERTAKING

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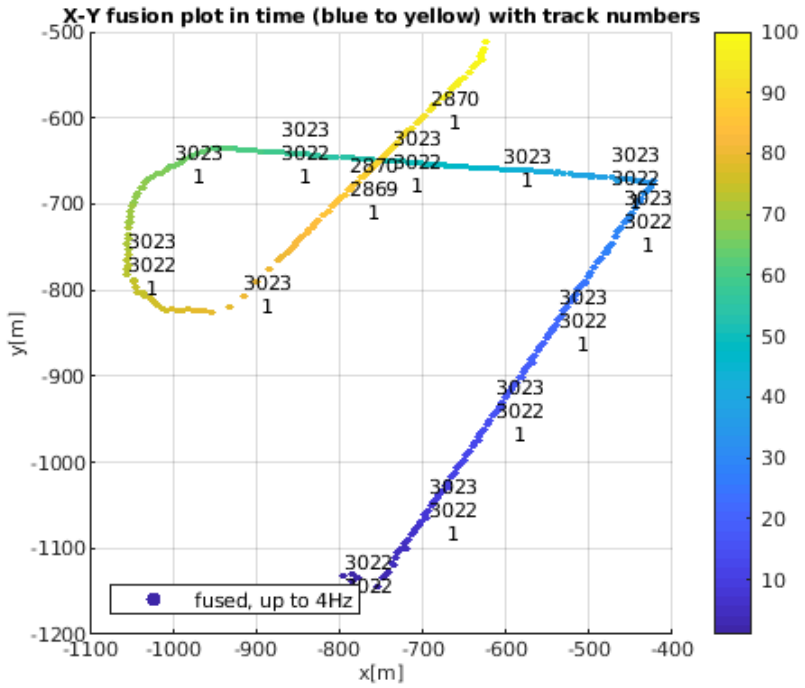
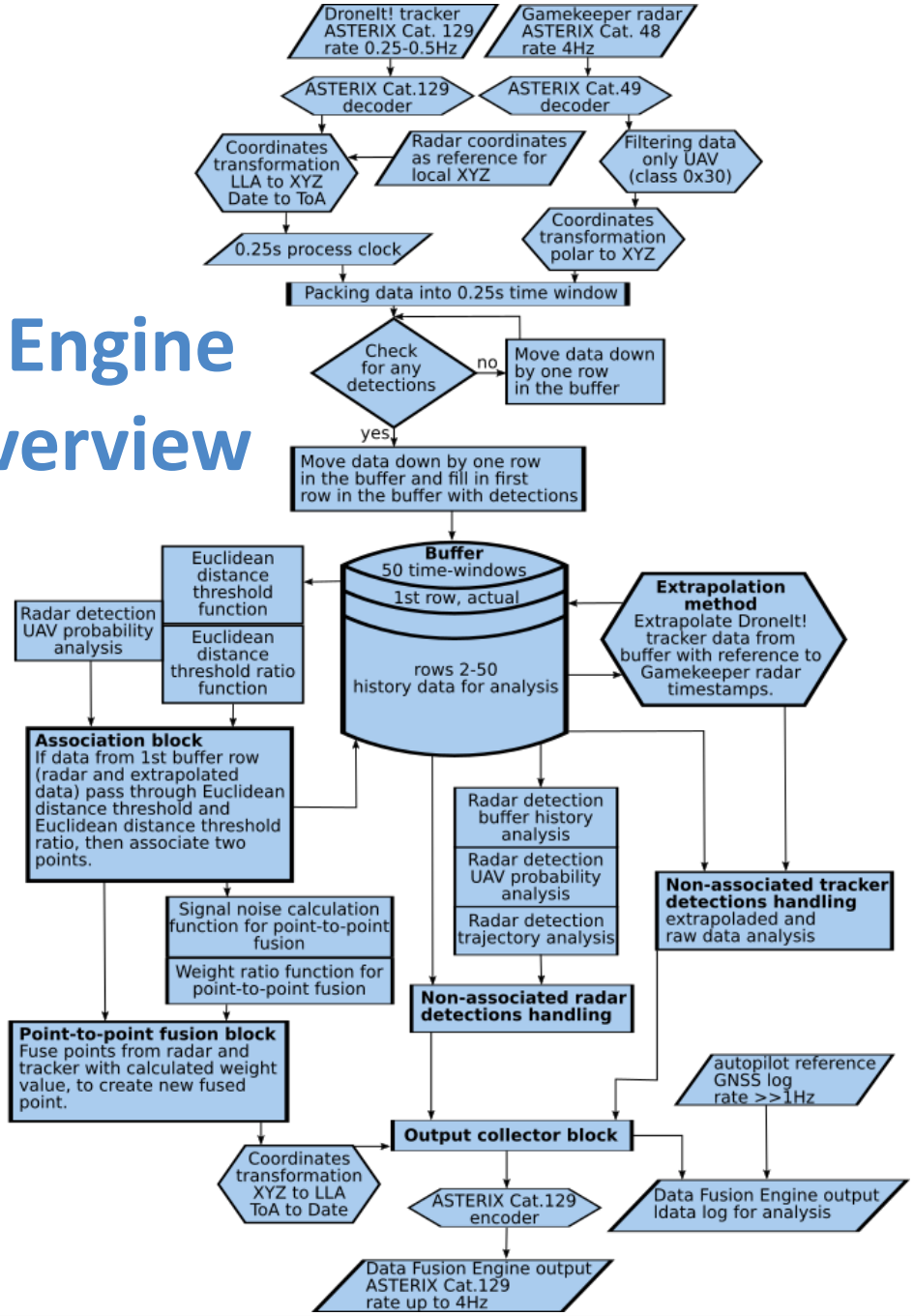
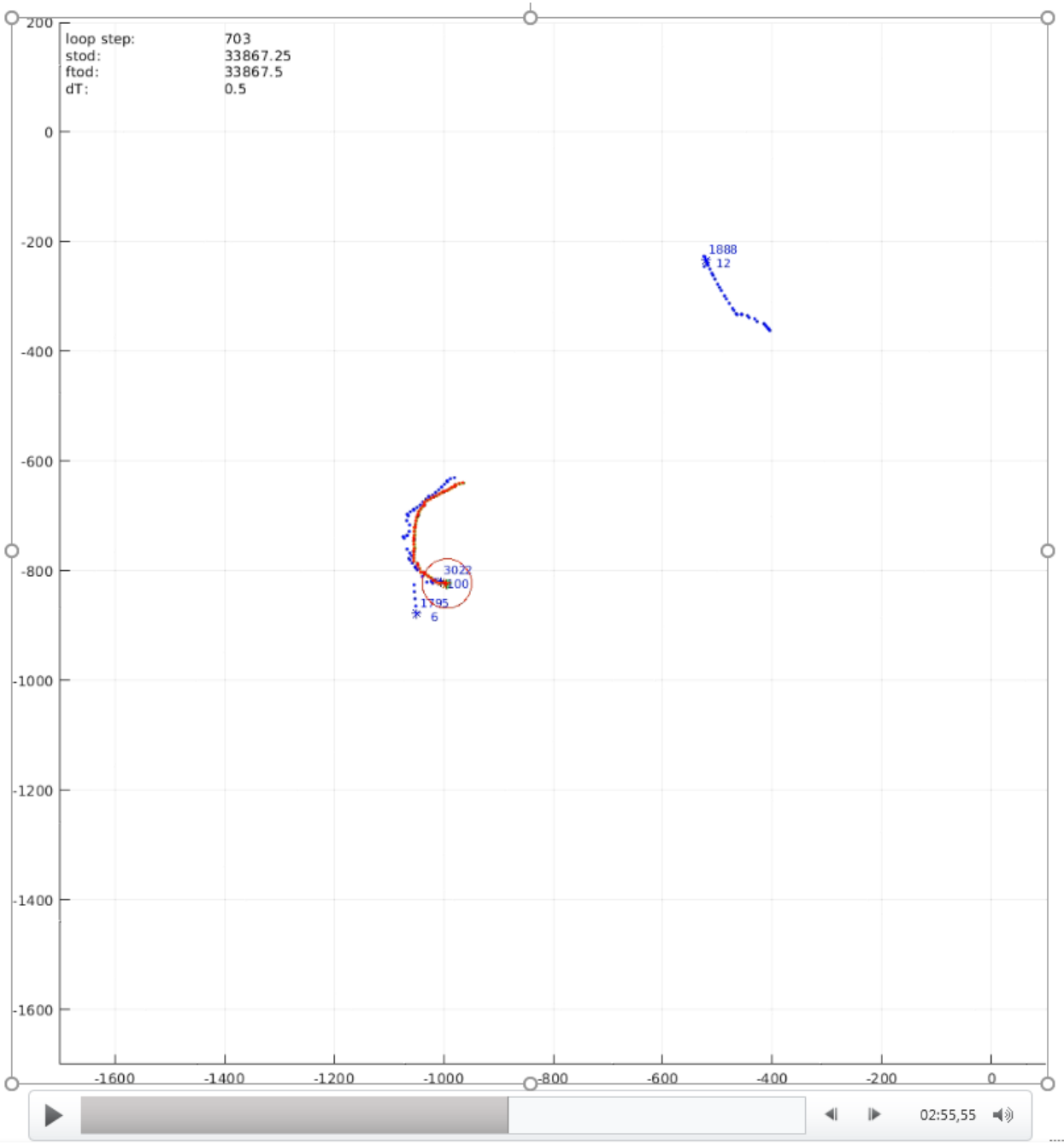


Data Fusion Engine algorithm overview





Screen-shot from video which was here.

CLASS

CLEAR AIR SITUATION FOR UAS

SESAR CLASS
Realtime UTM system

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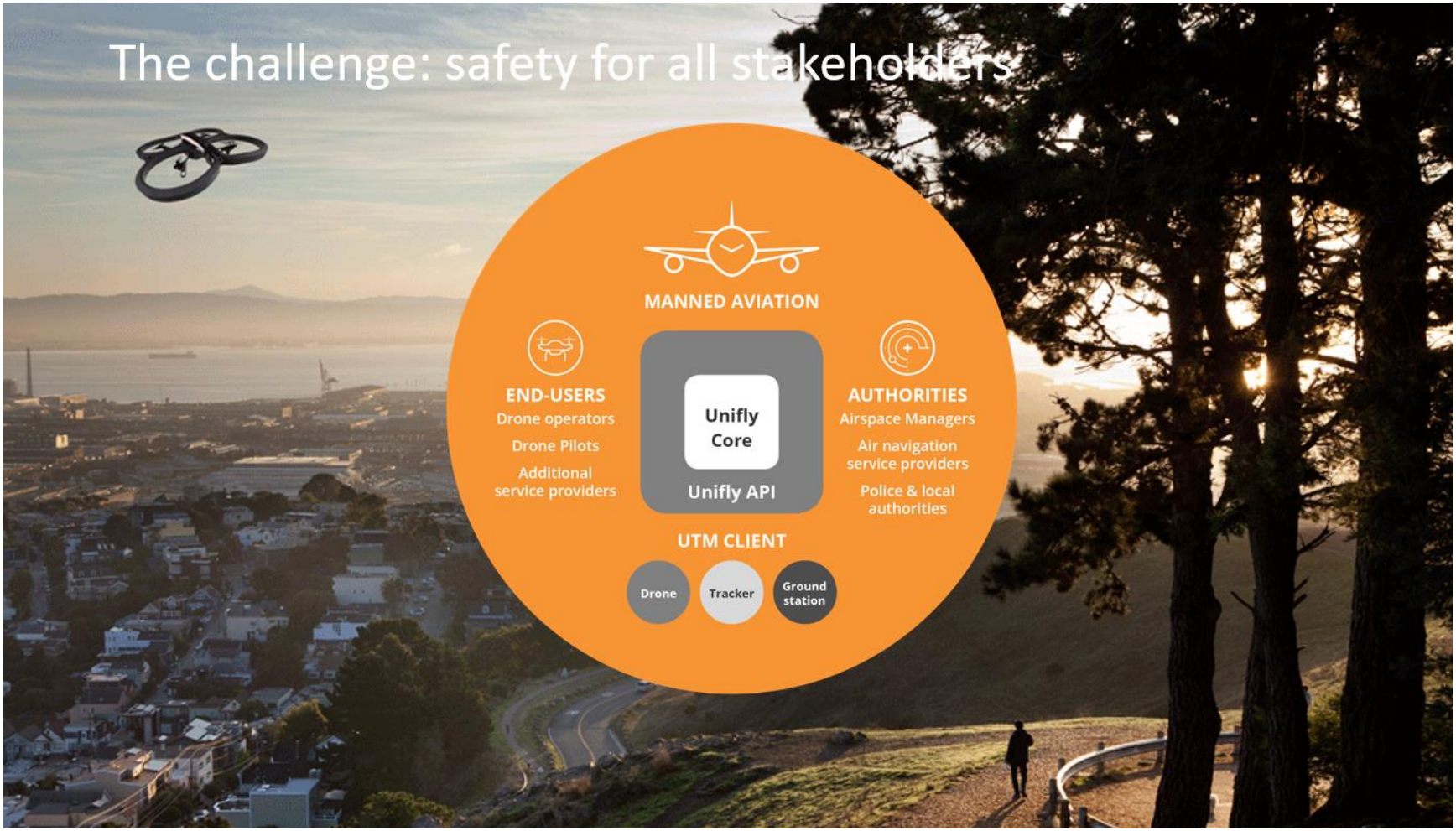
EUROPEAN UNION EUROCONTROL

Unifly introduction



Unifly introduction

Unifly introduction

Multiple customer UTM deployments

Realtime situational display

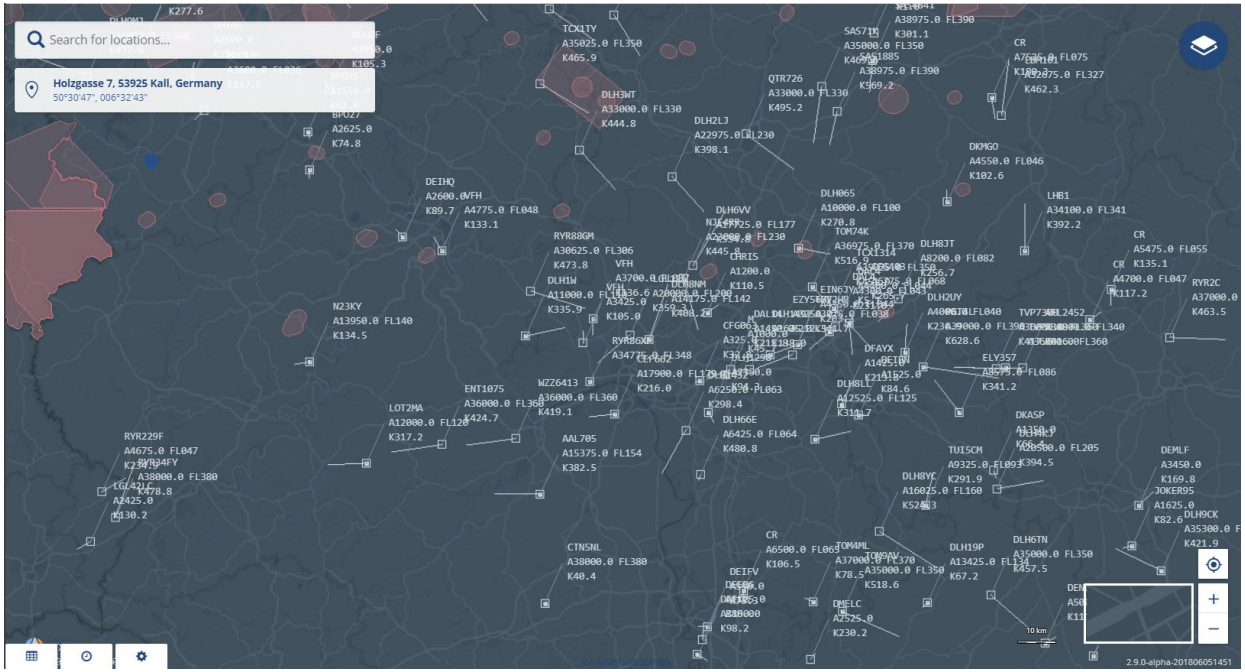
Display guidelines for the multiple stakeholders -> drone pilots

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

Realtime situational display

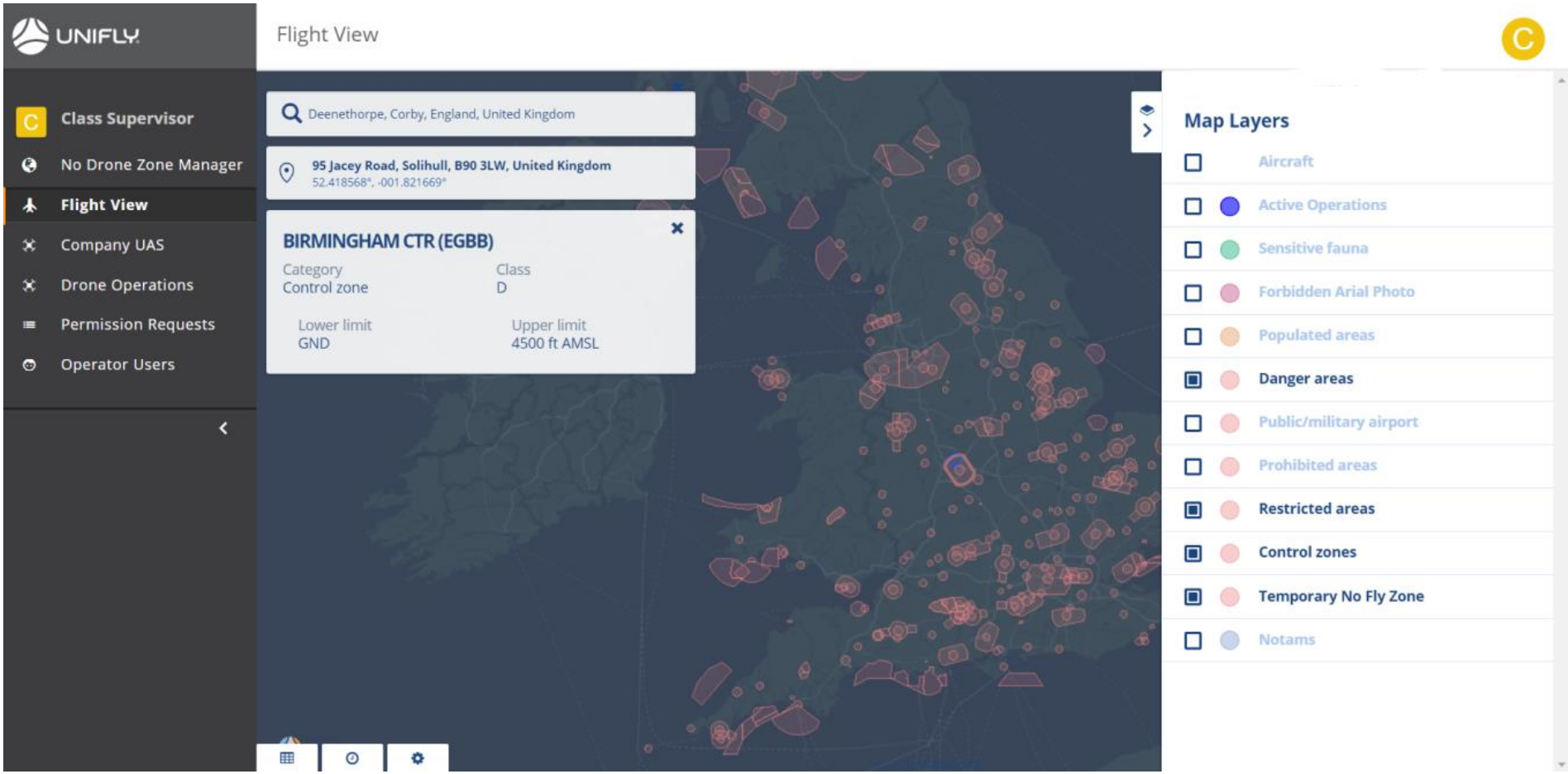
Display guidelines for the multiple stakeholders -> Authority

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



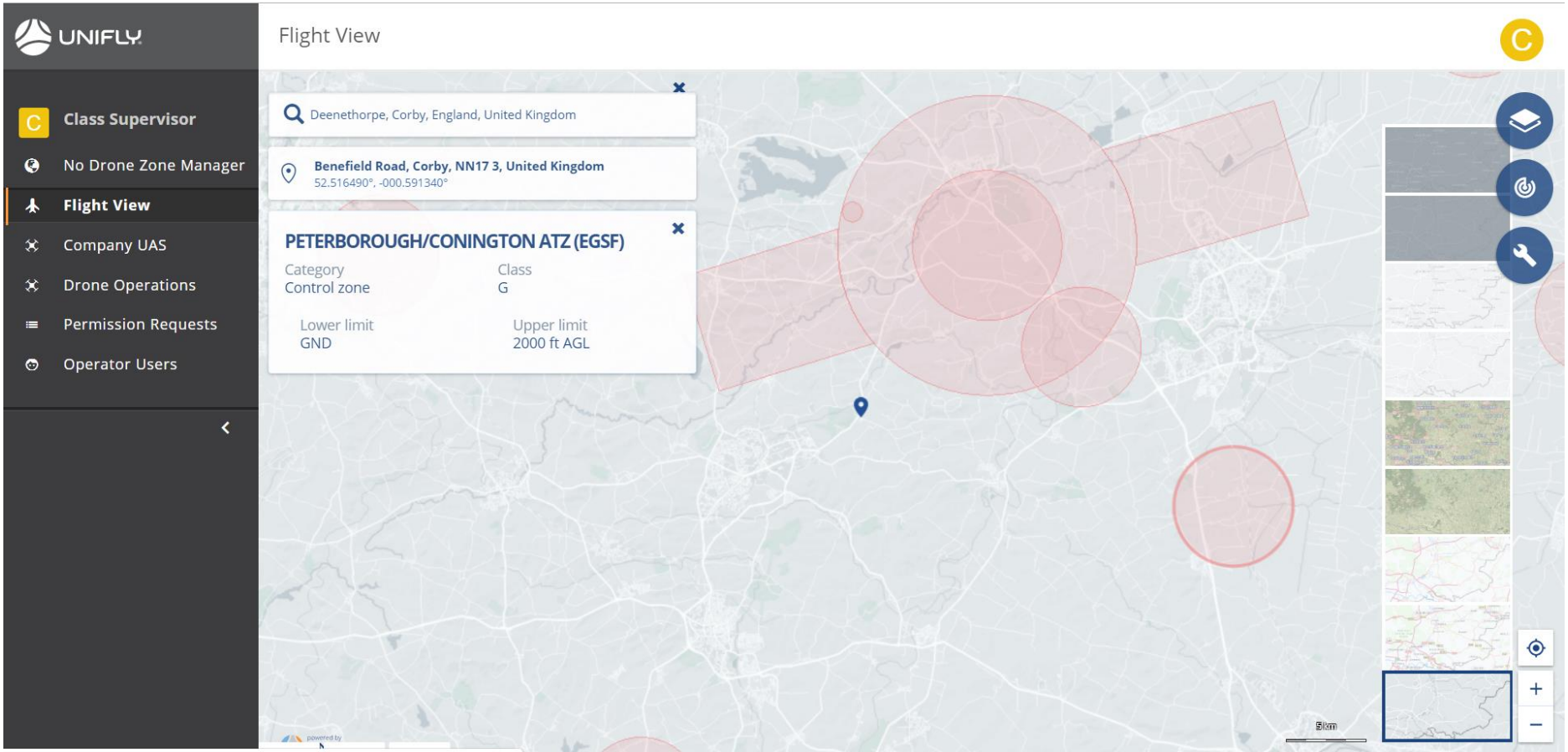
Realtime situational display

Configurable map layers



Realtime situational display

- Different base maps



Realtime situational display

- Deenethorpe test site

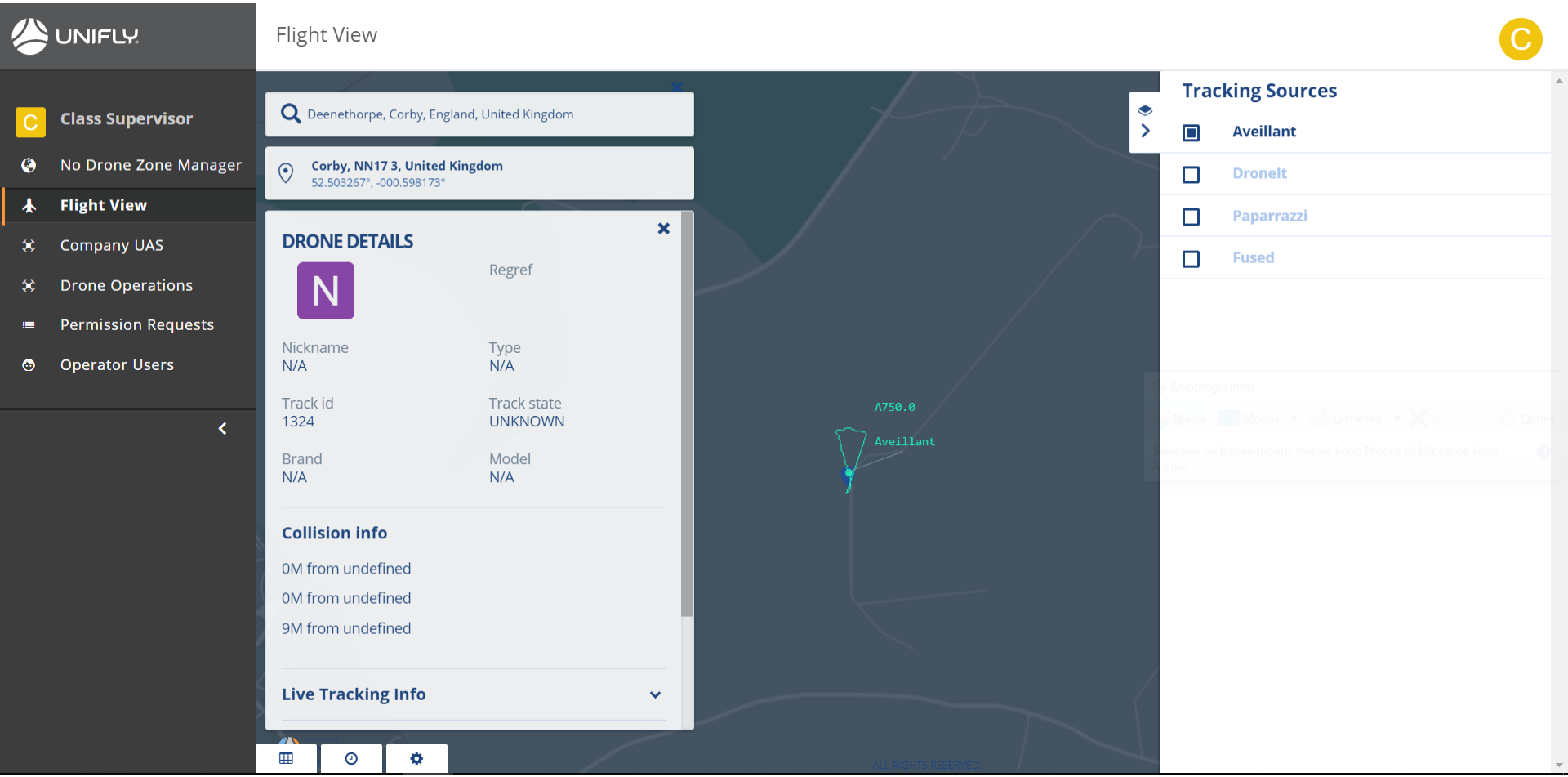
Realtime situational display

Interface from Real Time Data Collector via Asterix cat 129

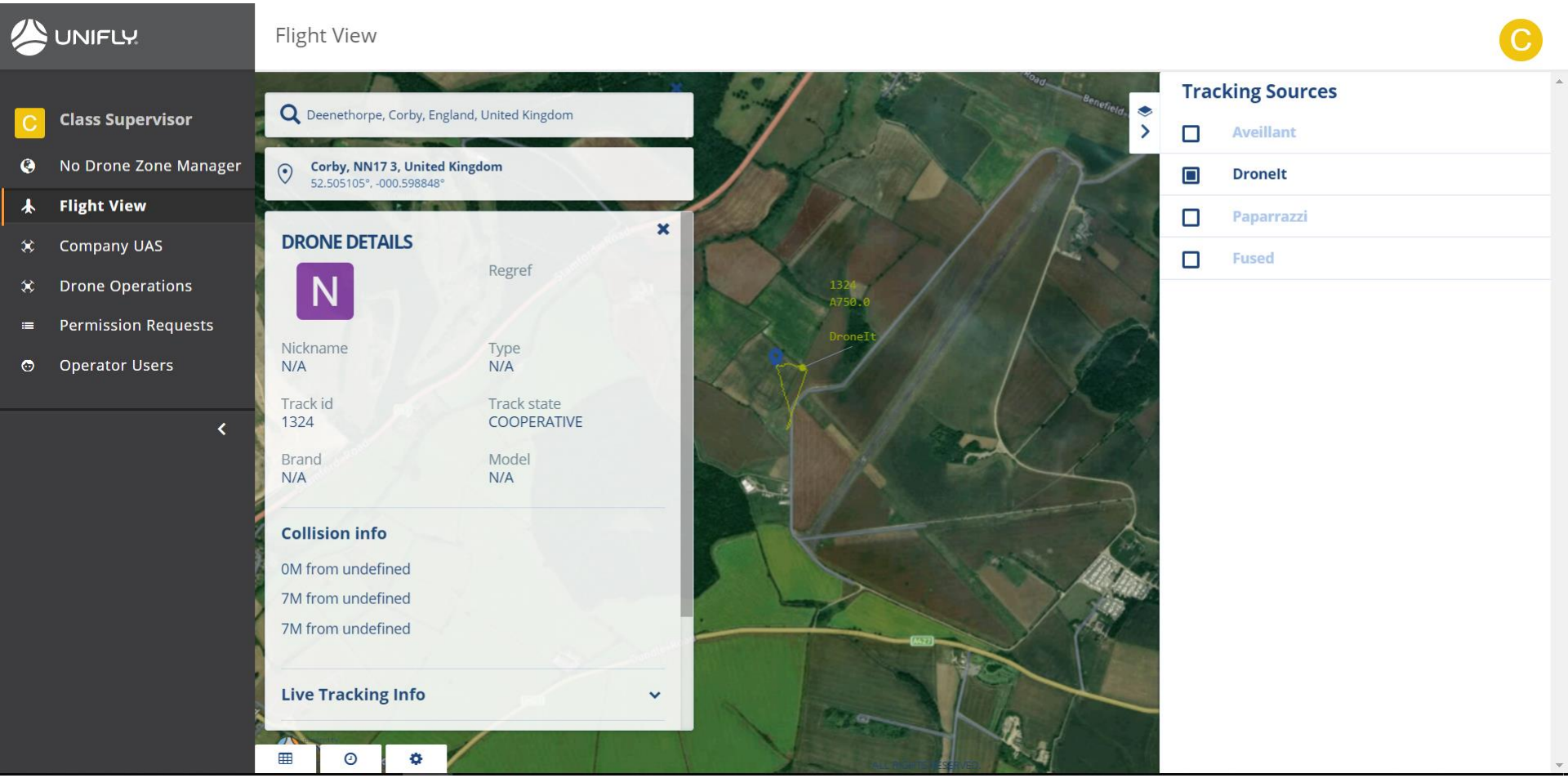
Contains 4 streams (We can differentiate on these sources)

- Drone-IT
- Aveillant
- Paparazzi
- Fused

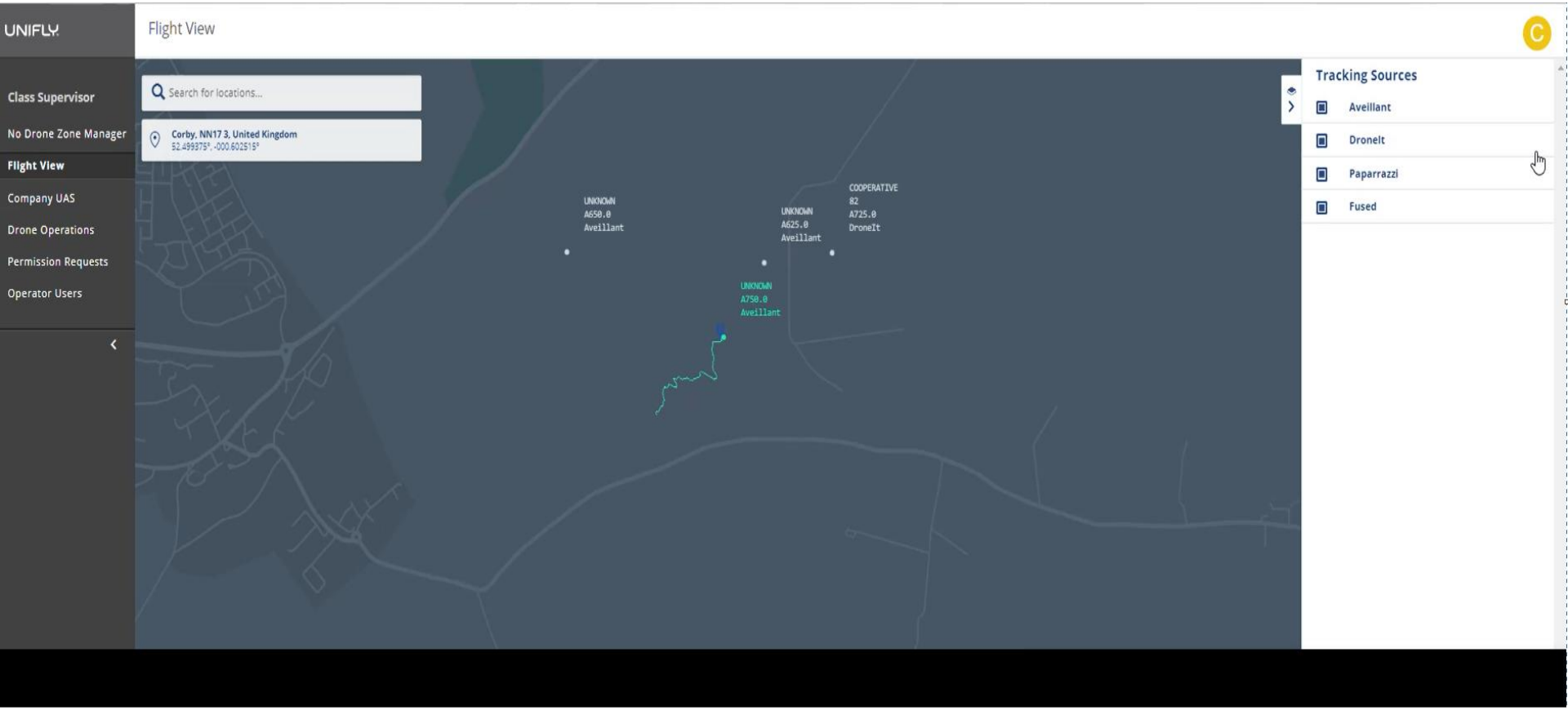
Realtime situational display



Realtime situational display



Realtime situational display



CLASS

CLEAR AIR SITUATION FOR UAS

SESAR CLASS Live Experiments

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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 16th Oct	Wed 17th Oct	Thu 18th Oct	Fir 19th Oct
Set-up	Live Day 1	Live Day 2	Visitor Day	Wrap-up

Live Flights

- Drones

- Drone Operators

AVEILLANT
A Thales company

ENAC
ECOLE NATIONALE DE L'AVIATION CIVILE

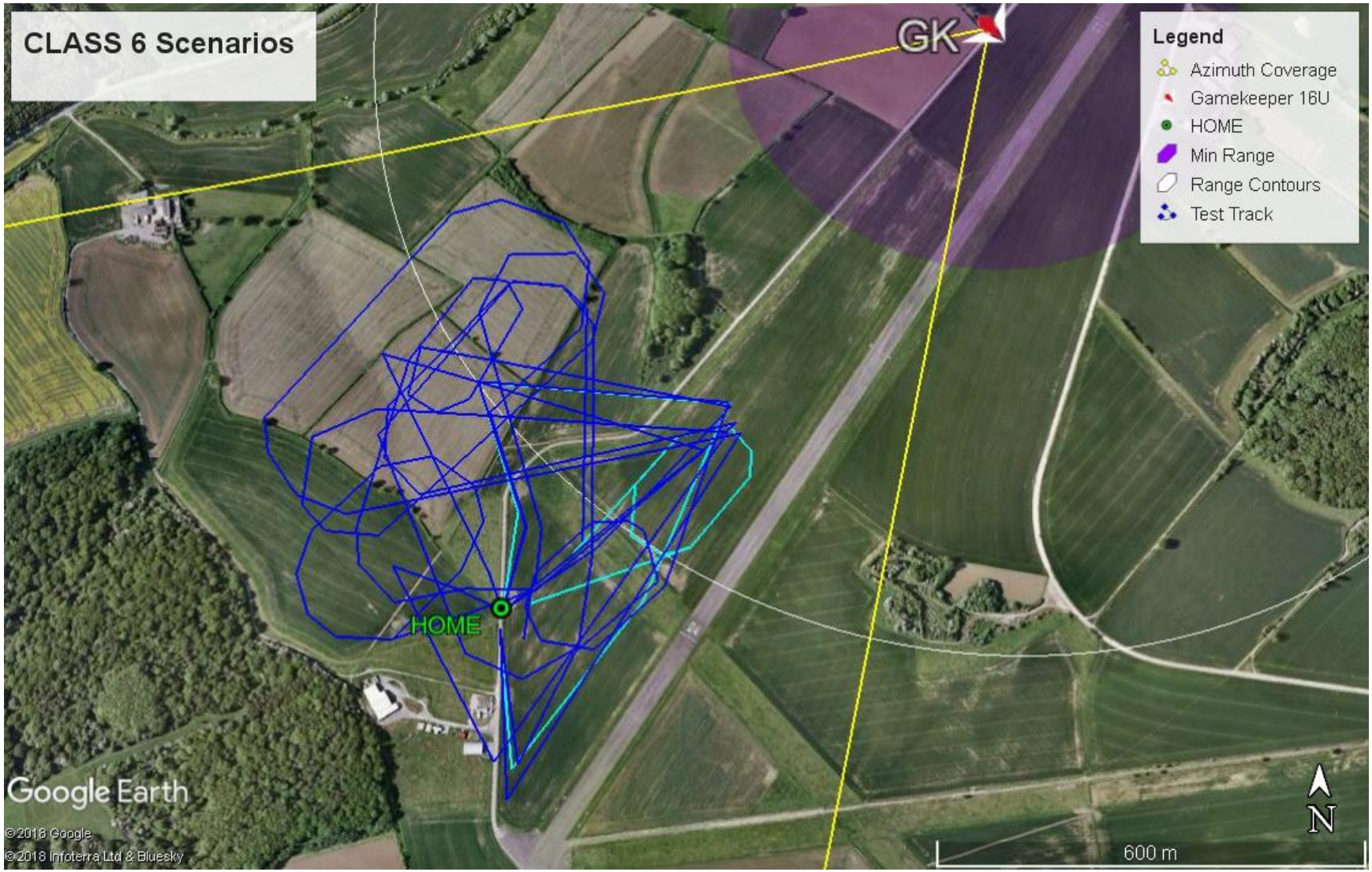
- Ground Truth Crew

Screen-shot from video which was here.

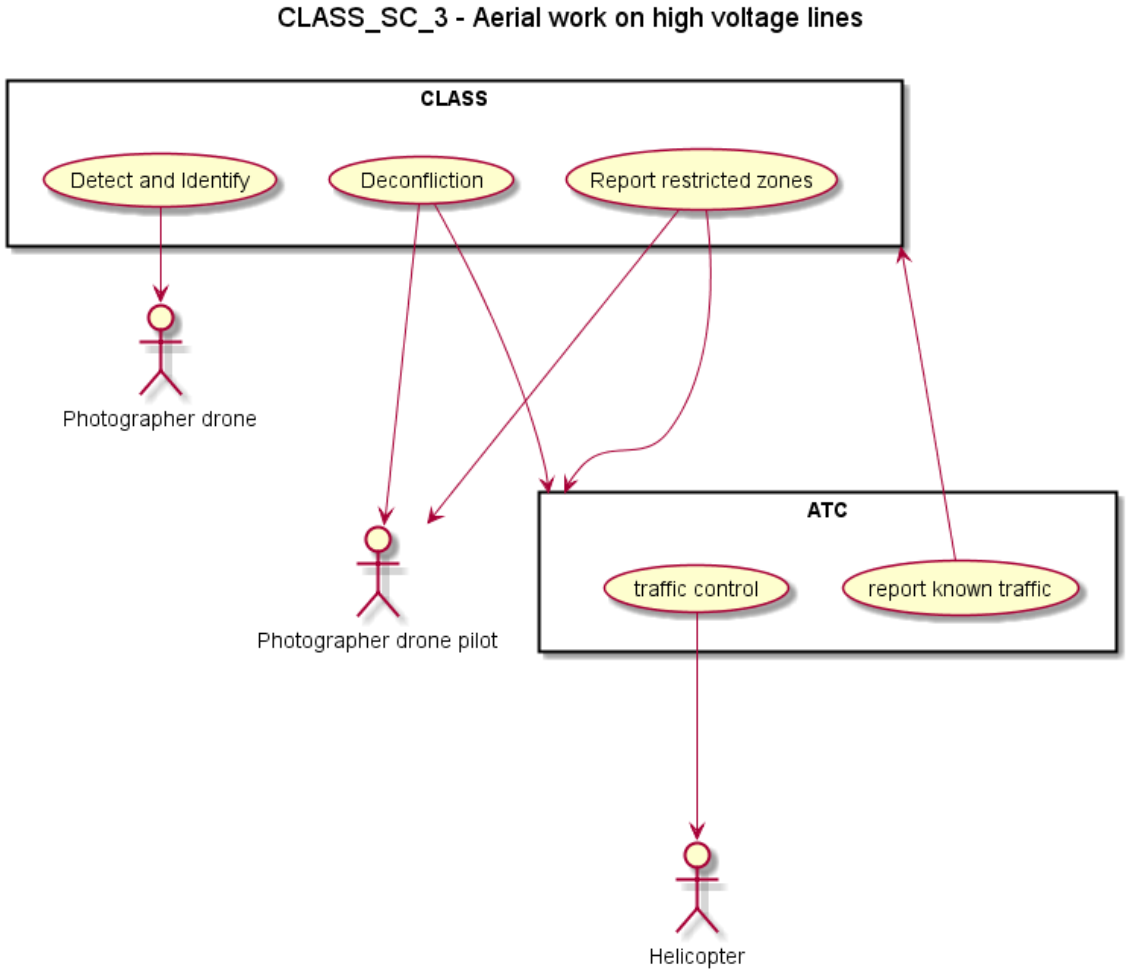
CLASS Scenarios

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



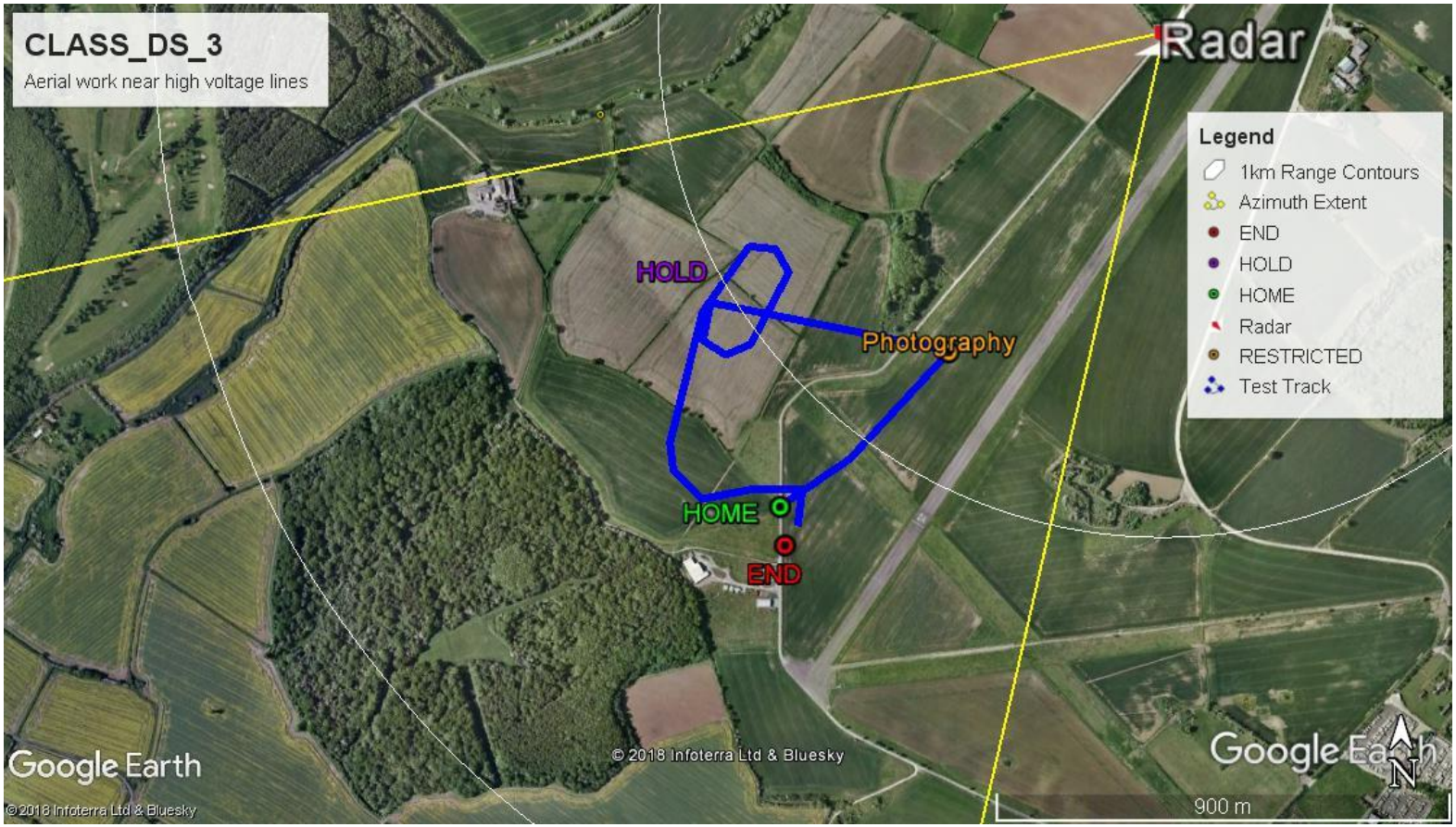
Aerial work near high voltage lines – CLASS_DS_3

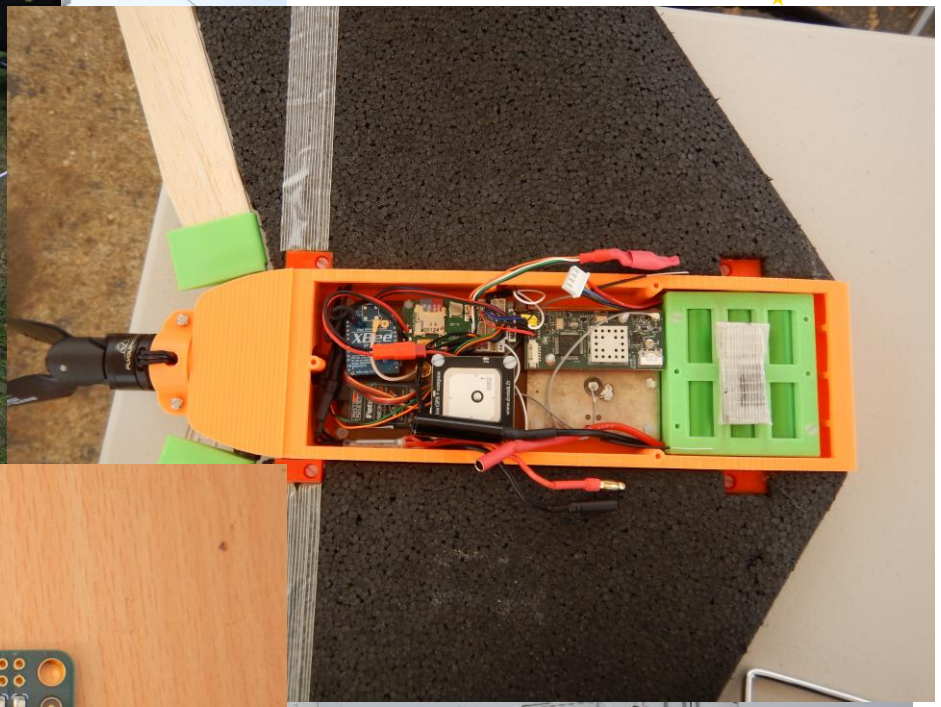


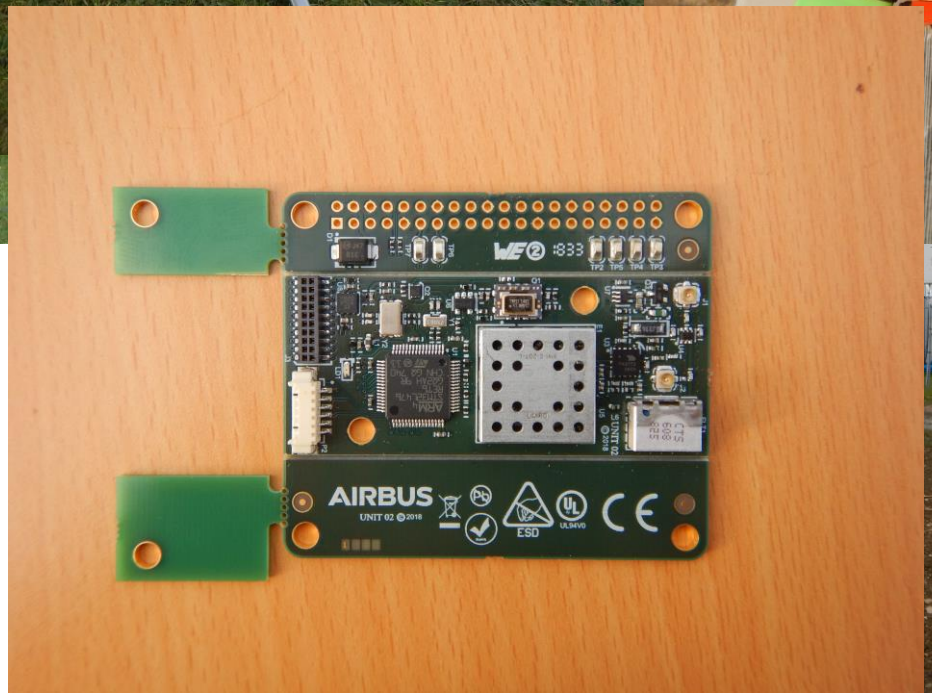
Narrative
Drone launched from HOME, circles at STANDBY and moved to photography point
Drone circles over photography point
Drone moved to HOLD to deconflict
Drone cleared to land at END

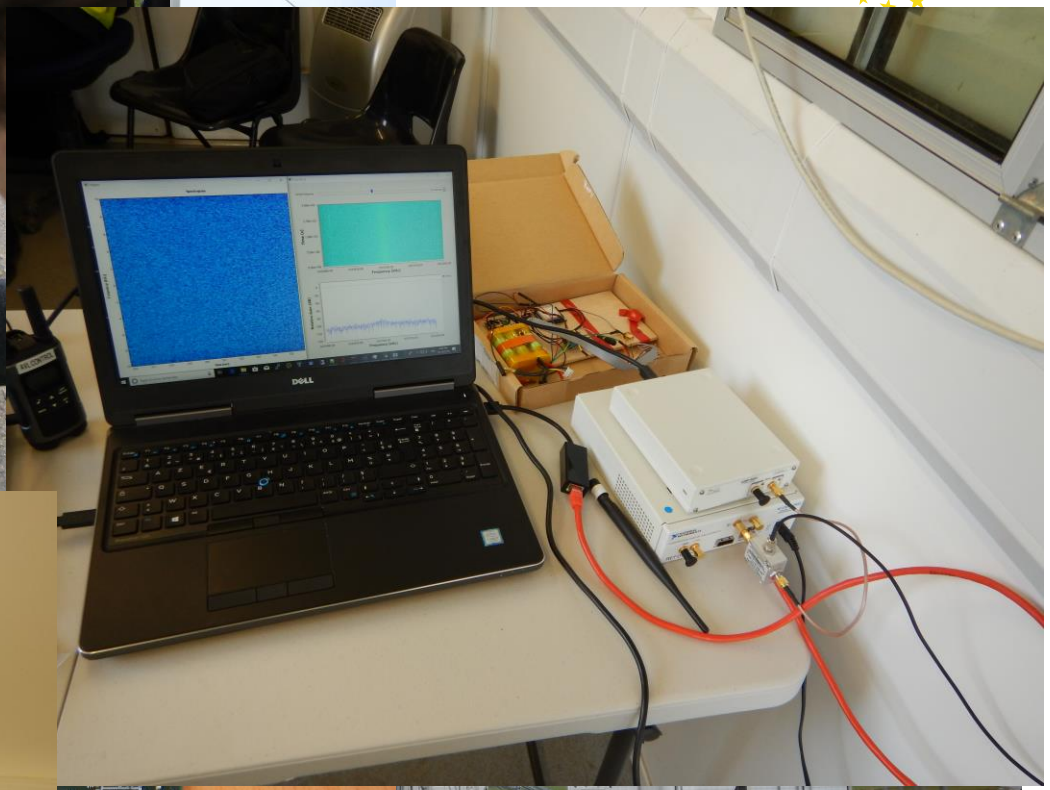
Aerial work near high voltage lines – CLASS_DS_3

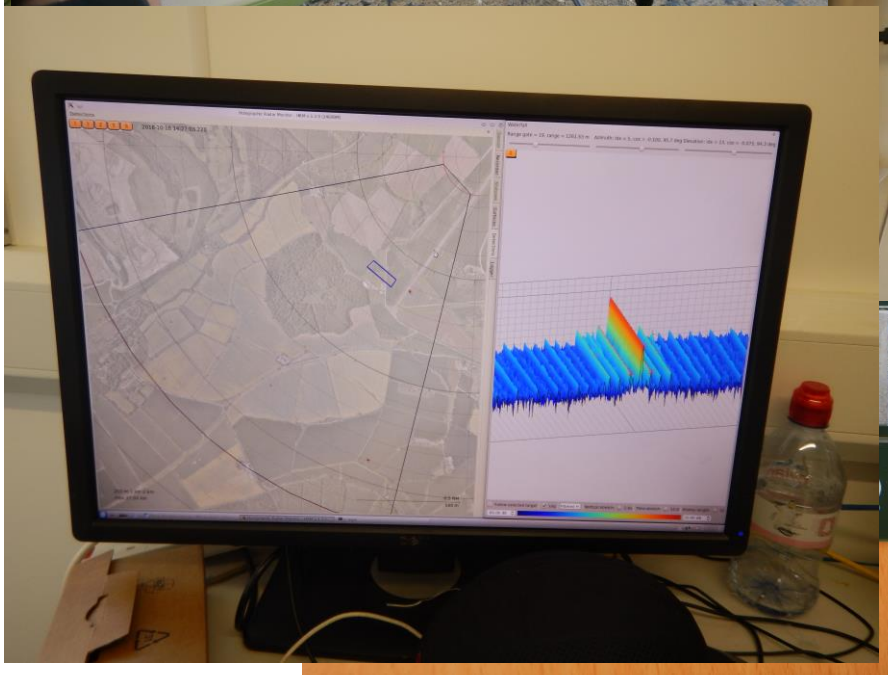
(1) Drone moving to PHOTOGRAPHY point (2) Drone moved to HOLD to deconflict with manned aircraft (3) Drone eventually cleared to land




XBee


AIRBUS
UNIT 02 ©2018
ESD





Thank you for your attention

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