



# Project insight: Clear Air Situation for UAS (CLASS)

15<sup>th</sup> November 2018  
Workshop on Autonomous Aerial Vehicles, Trondheim

Krzysztof Cisek, research fellow, NTNU



Founding Members



EUROPEAN UNION

EUROCONTROL

# 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.



Wrocław University  
of Science and Technology



Norwegian University of  
Science and Technology



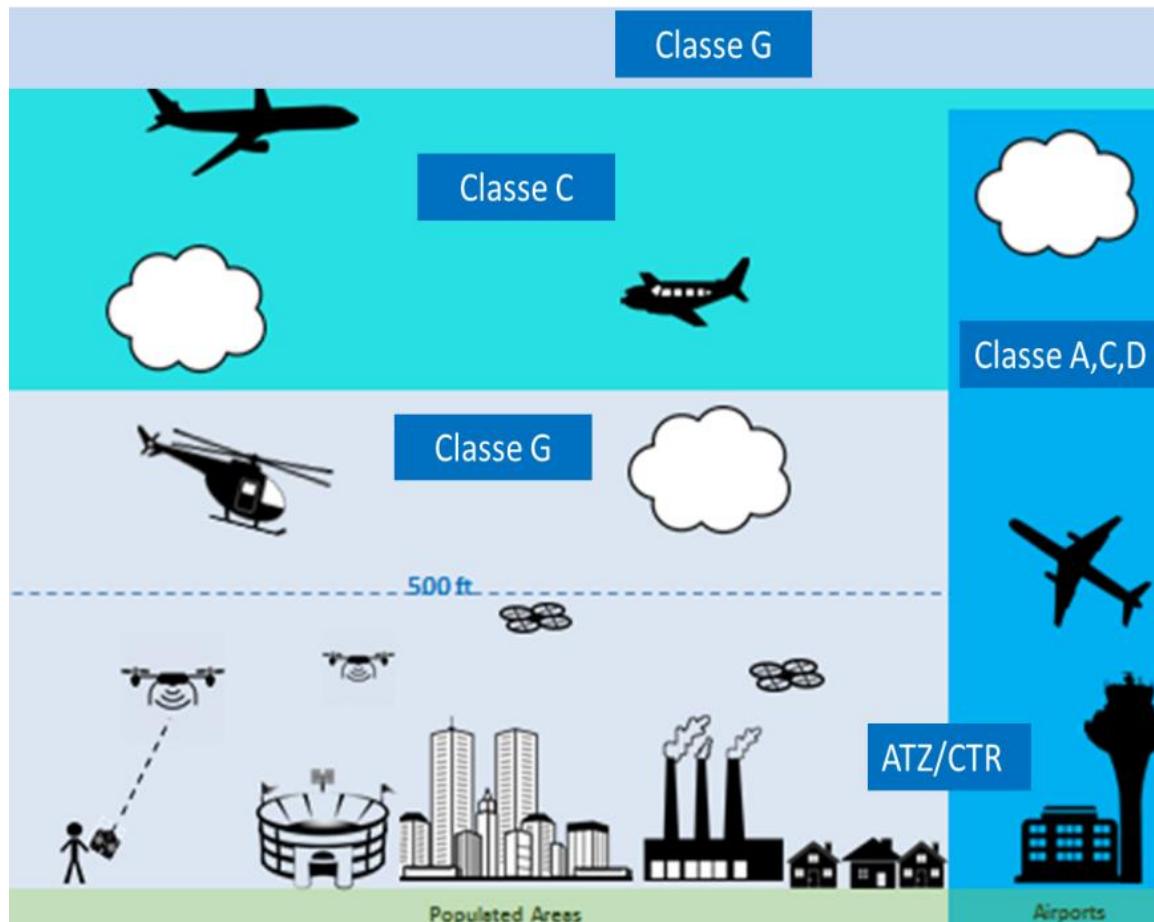
My research interests are in the areas of software/hardware development and integration of unmanned aerial systems, ultra wideband location systems and data fusion.

# 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



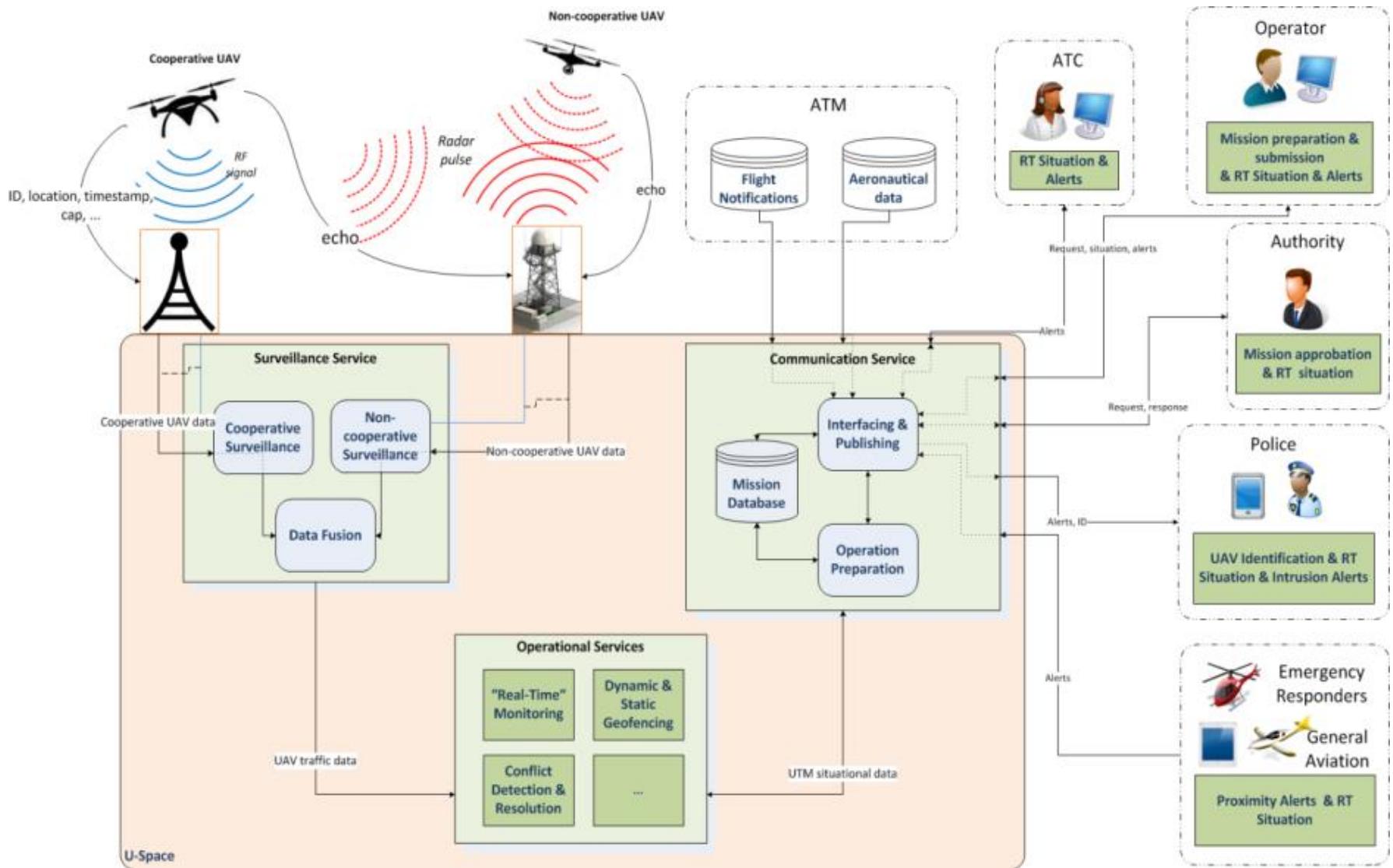
Tracking and Surveillance for

**U-space**

Enables

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

# What is the concept behind CLASS



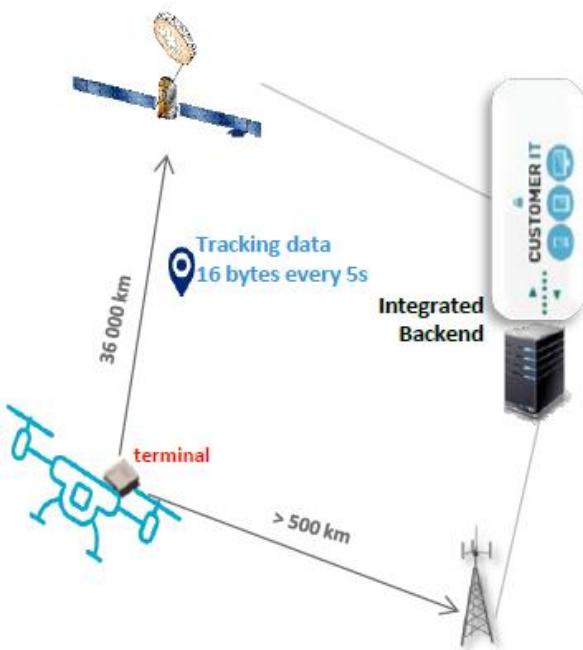
# Tracking



AIRBUS

## Drone Identifier and Tracker

Ultra Narrow Band technology



## Data Fusion

Fuse Cooperative and Non-Cooperative tracks

NTNU

Kunnskap for en bedre verden

## Gamekeeper 16U

Take on drone spotting:  
Stare not scan



## Situational Awareness and Alerts

Real Time Monitoring

UNIFLY



# Study Logic of CLASS



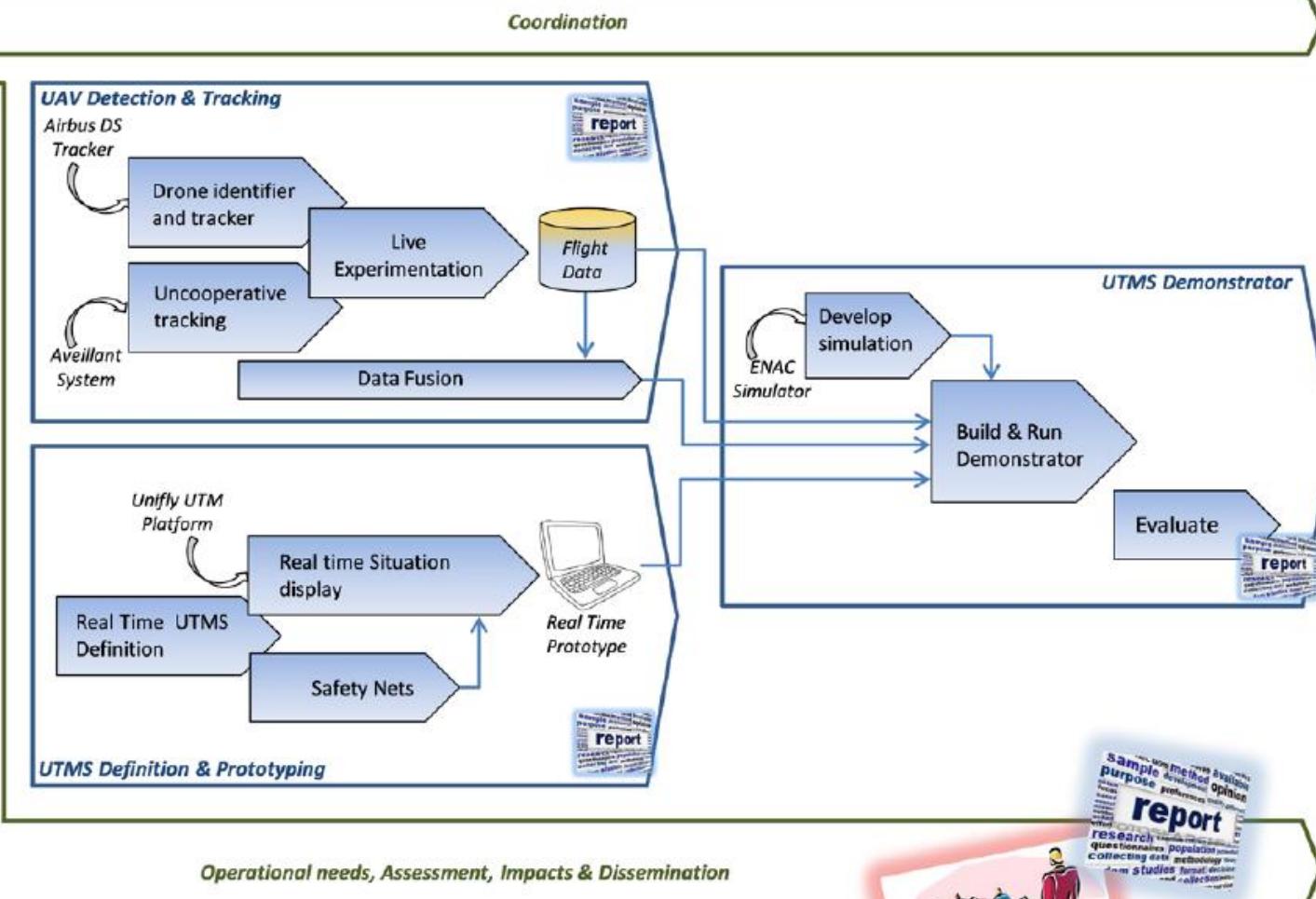
AIRBUS

AVEILLANT

ENAC  
ECOLE NATIONALE DE L'AVIATION CIVILE

NTNU

UNIFLY





# SESAR CLASS Component Technologies

CLASS Trial Visitor Day 18<sup>th</sup> October 2018



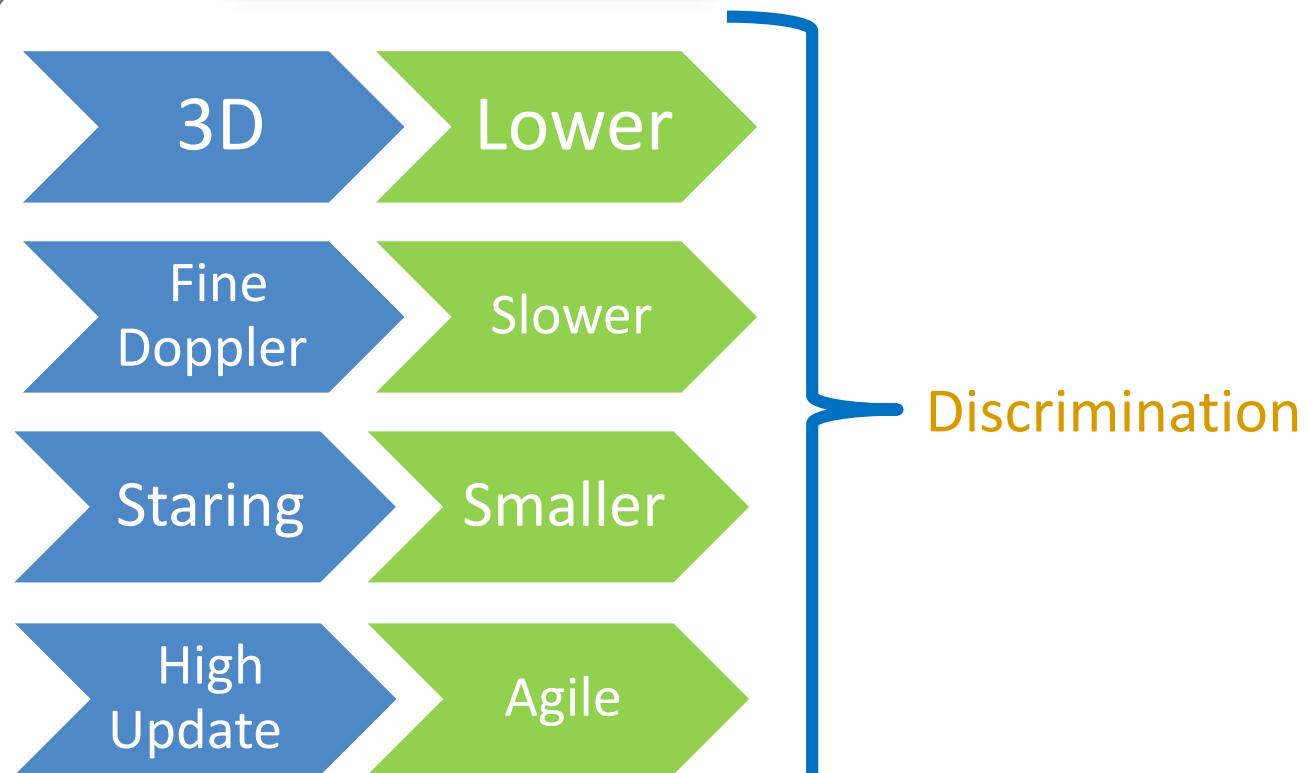
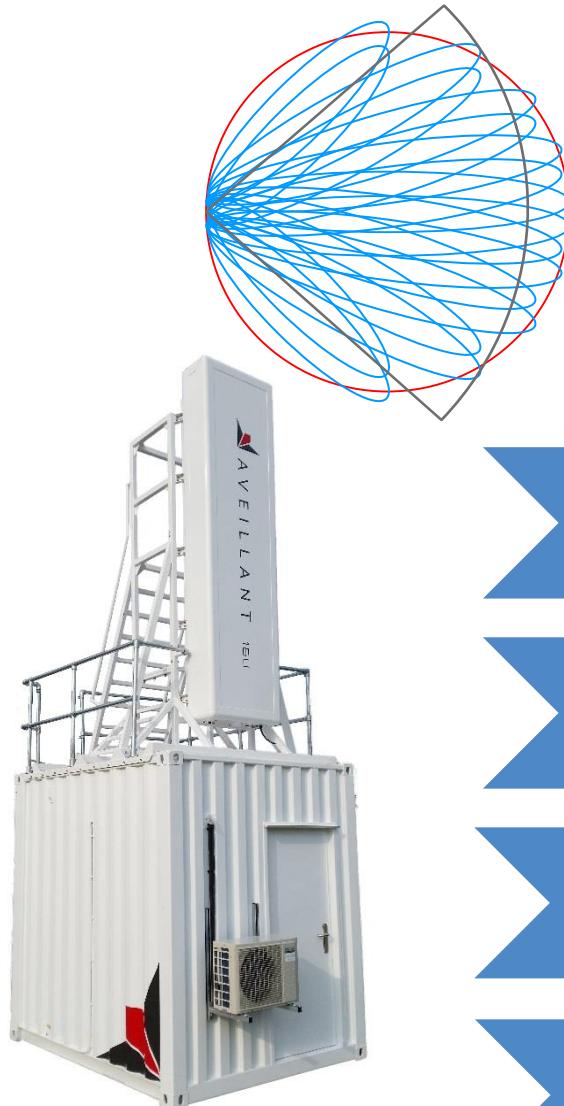
Founding Members



# Independent Non-cooperative Surveillance (INCS) - Radar



# Overcoming the challenge of detecting drones

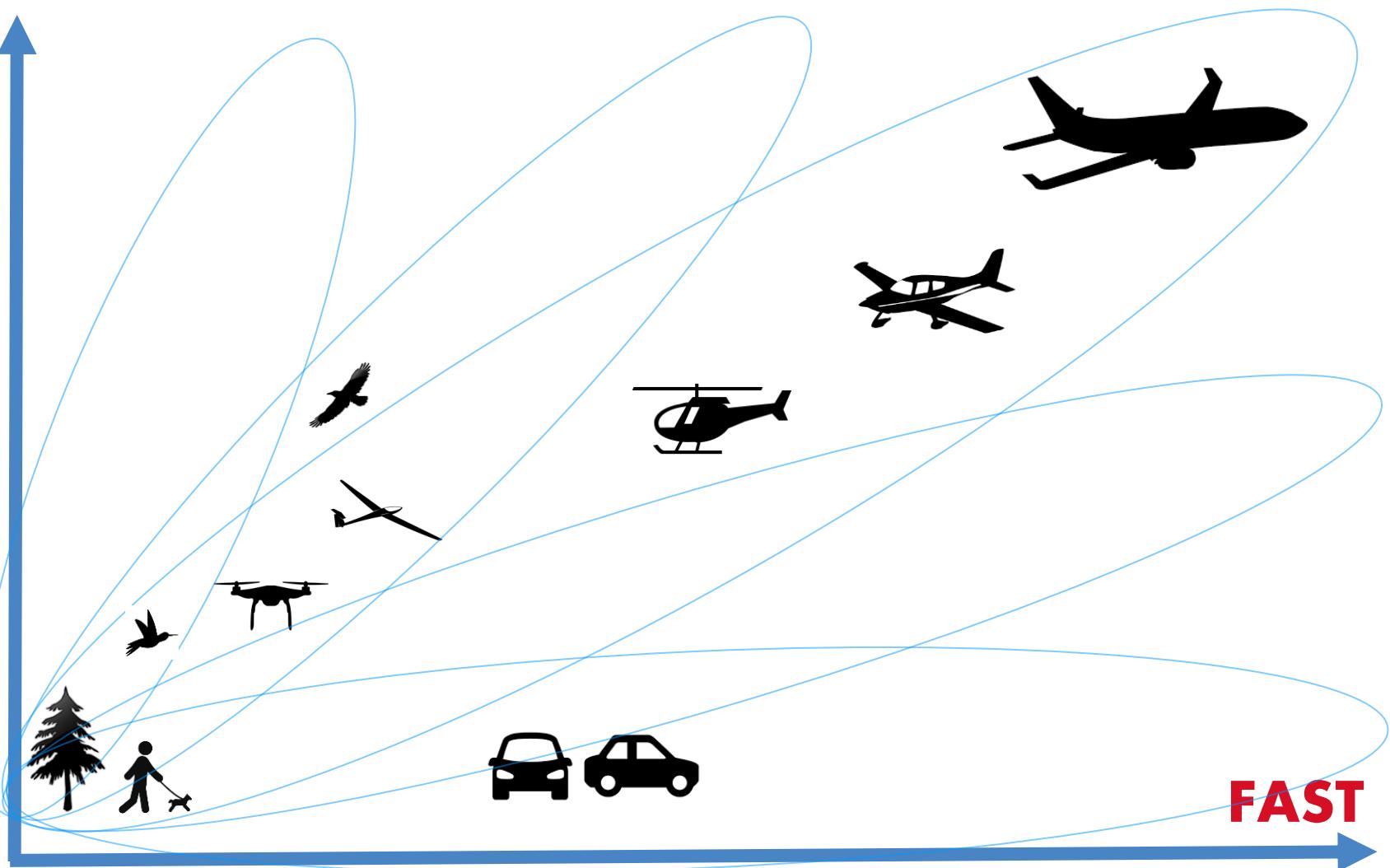


# Gamekeeper 16U - Target centric view

Highly congested space

HIGH

FAST



# Gamekeeper – Real Data

AVEILLANT  
A Thales company

CLASS SESAR  
JOINT UNDERTAKING  
CLEAR AIR SITUATION FOR UAS

Without Classification



# Gamekeeper – Real Data

AVEILLANT  
A Thales company

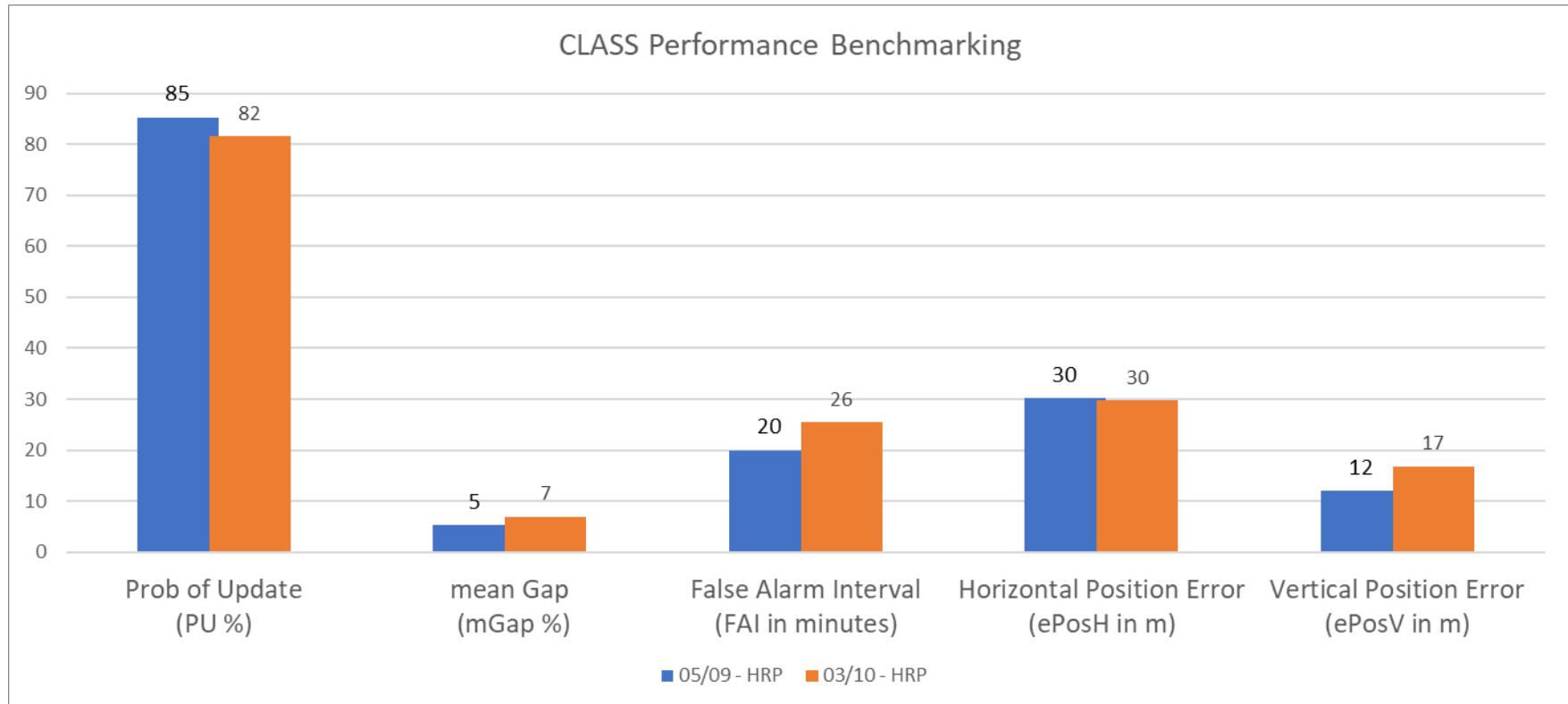
CLASS SESAR  
JOINT UNDERTAKING  
CLEAR AIR SITUATION FOR UAS

With Classification



©2018 Google  
©2018 Infoterra Ltd & Bluesky

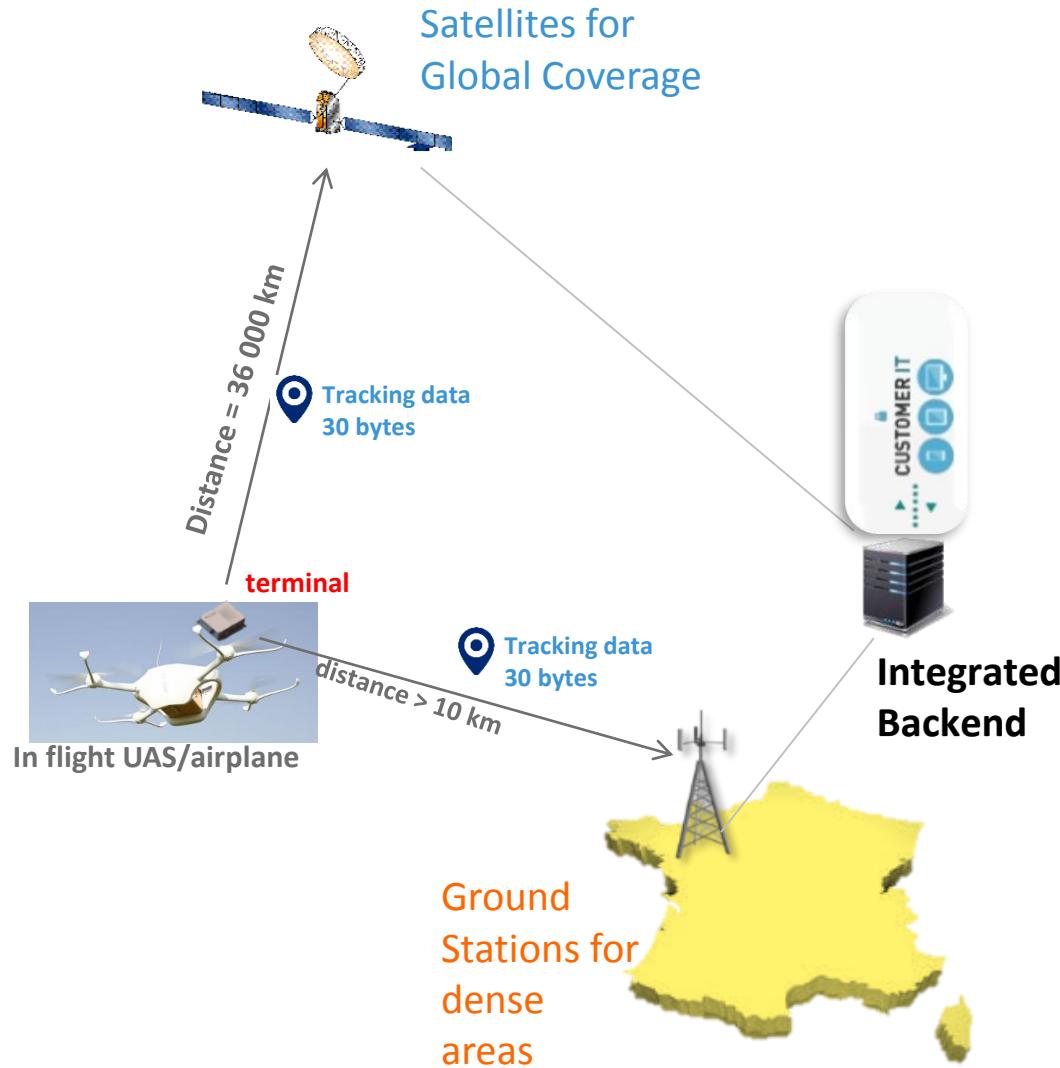
# Gamekeeper Tracker Performance



# 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 ( $\sim 200$  kHz)

Terminal

- Credit-card size
- Include GPS and accelerometer
- 1 GPS cold fix  $\sim 250$   $\mu\text{A.h}$
- 1 msg transmit  $\sim 20$   $\mu\text{A.h}$

Telecom infrastructure

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

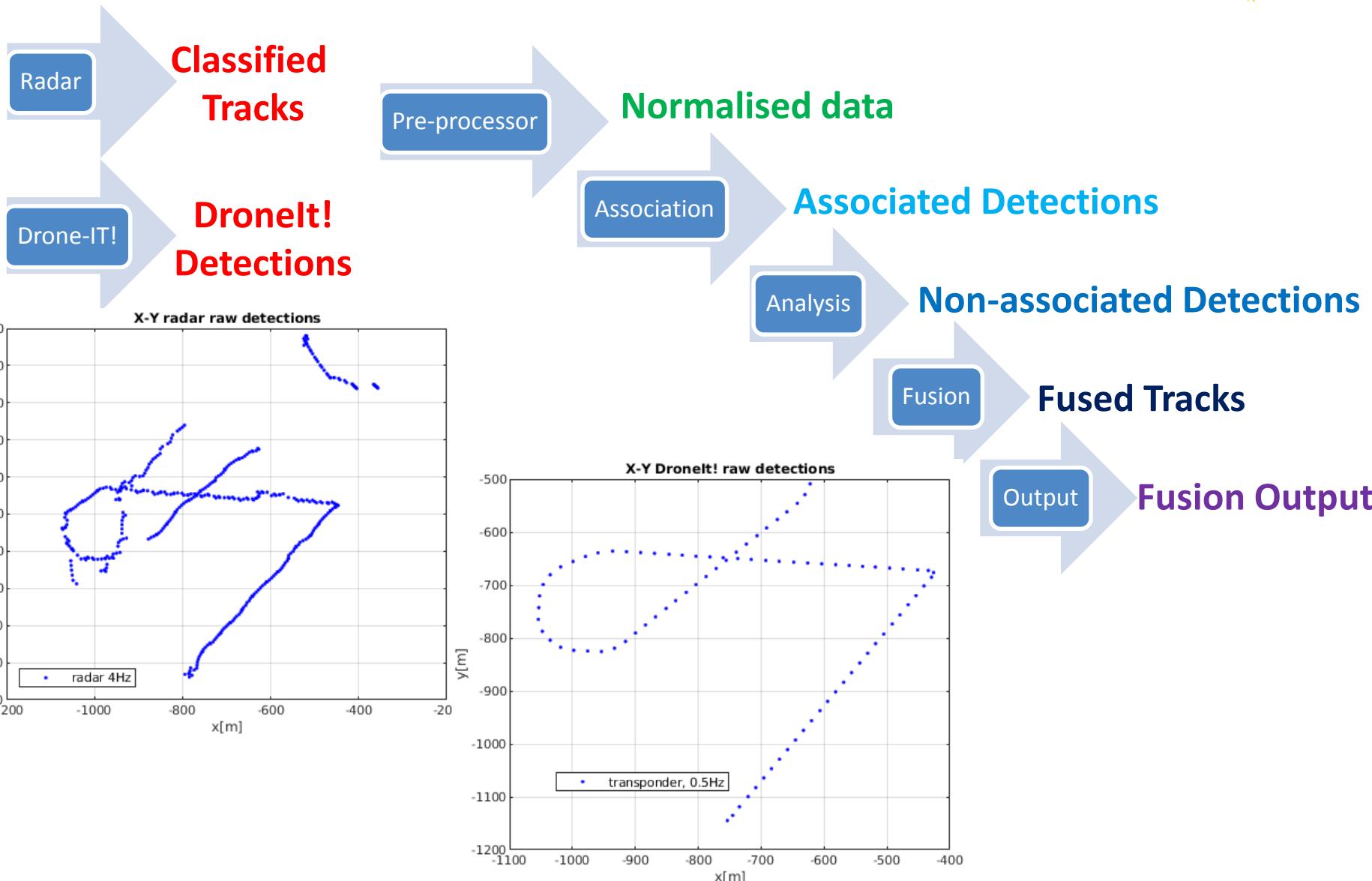
Performances

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

# Track Fusion



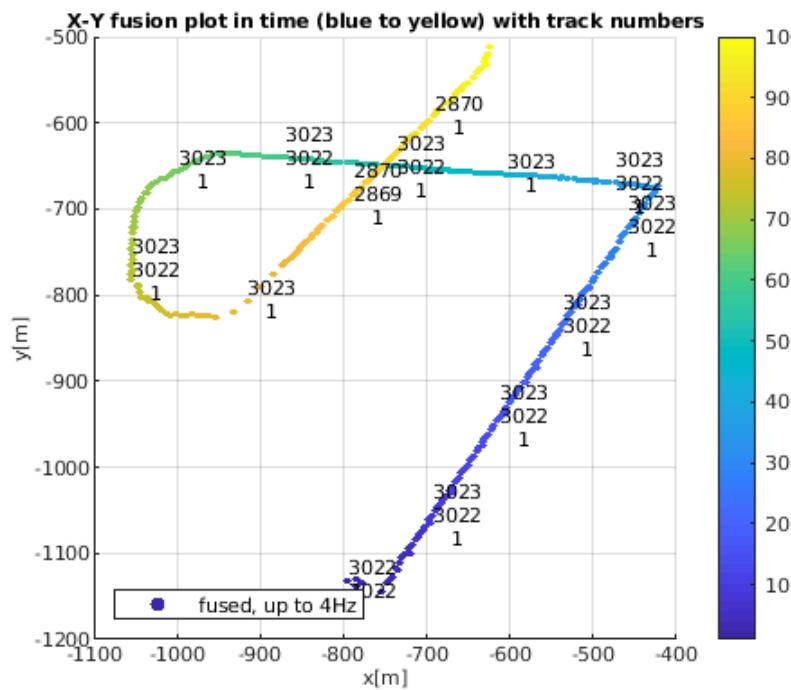
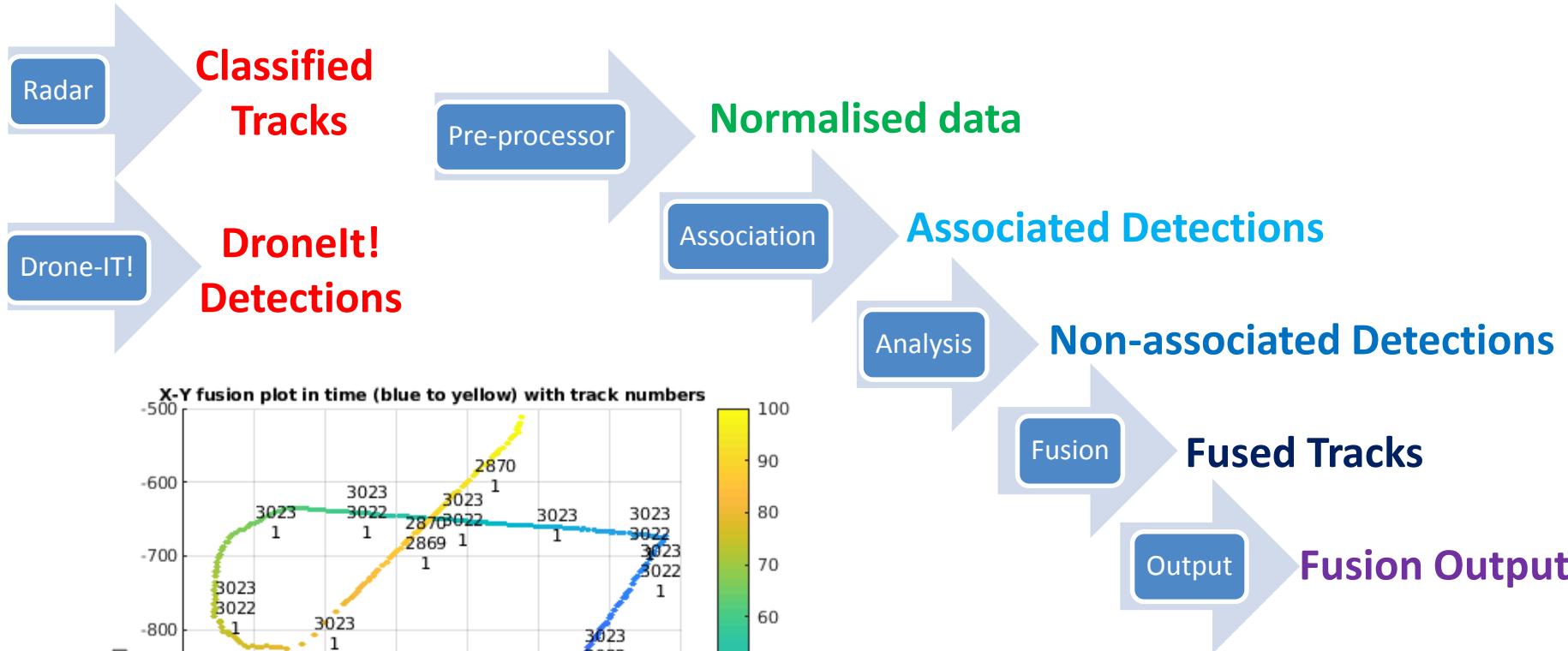
# NTNU



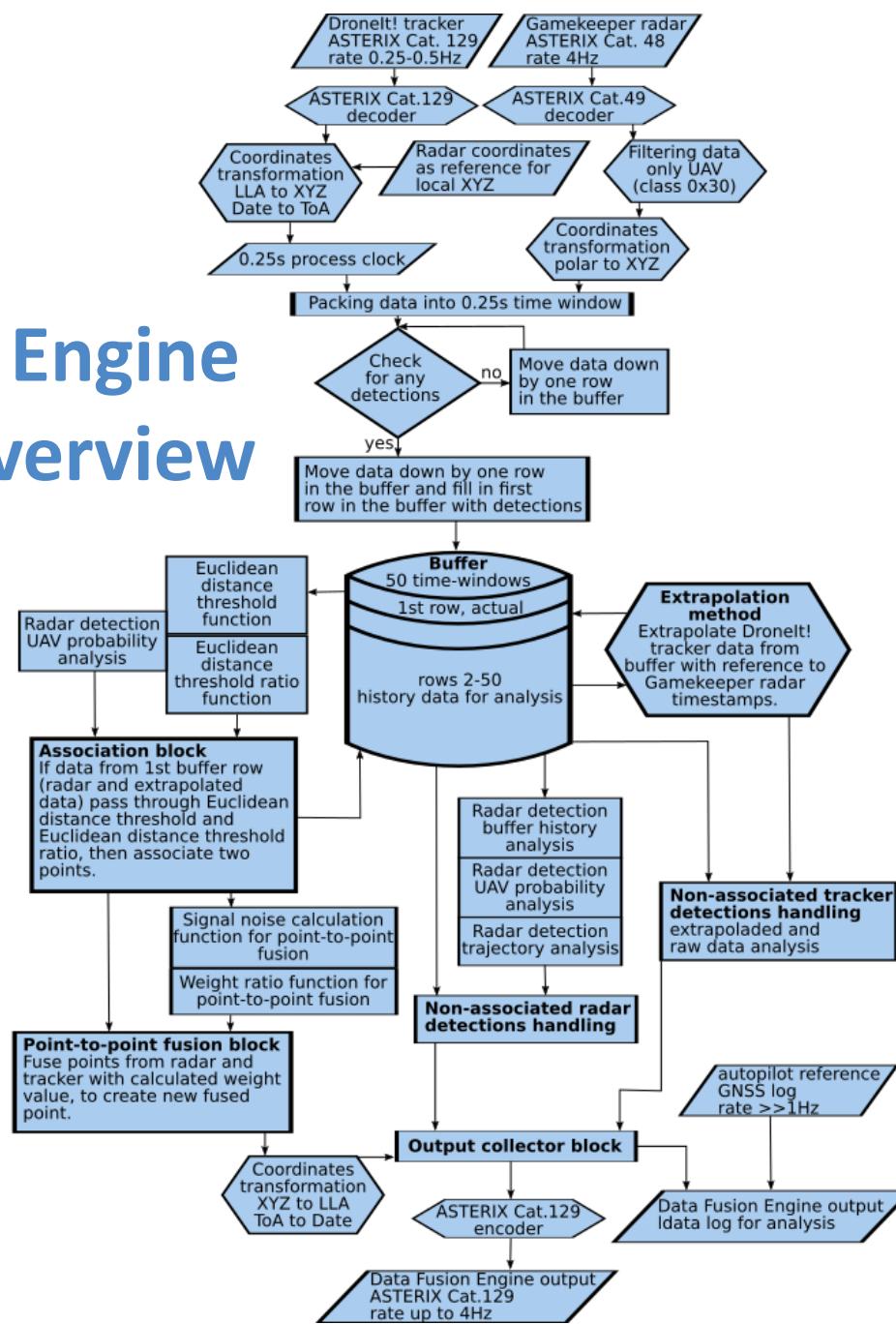
# Track Fusion

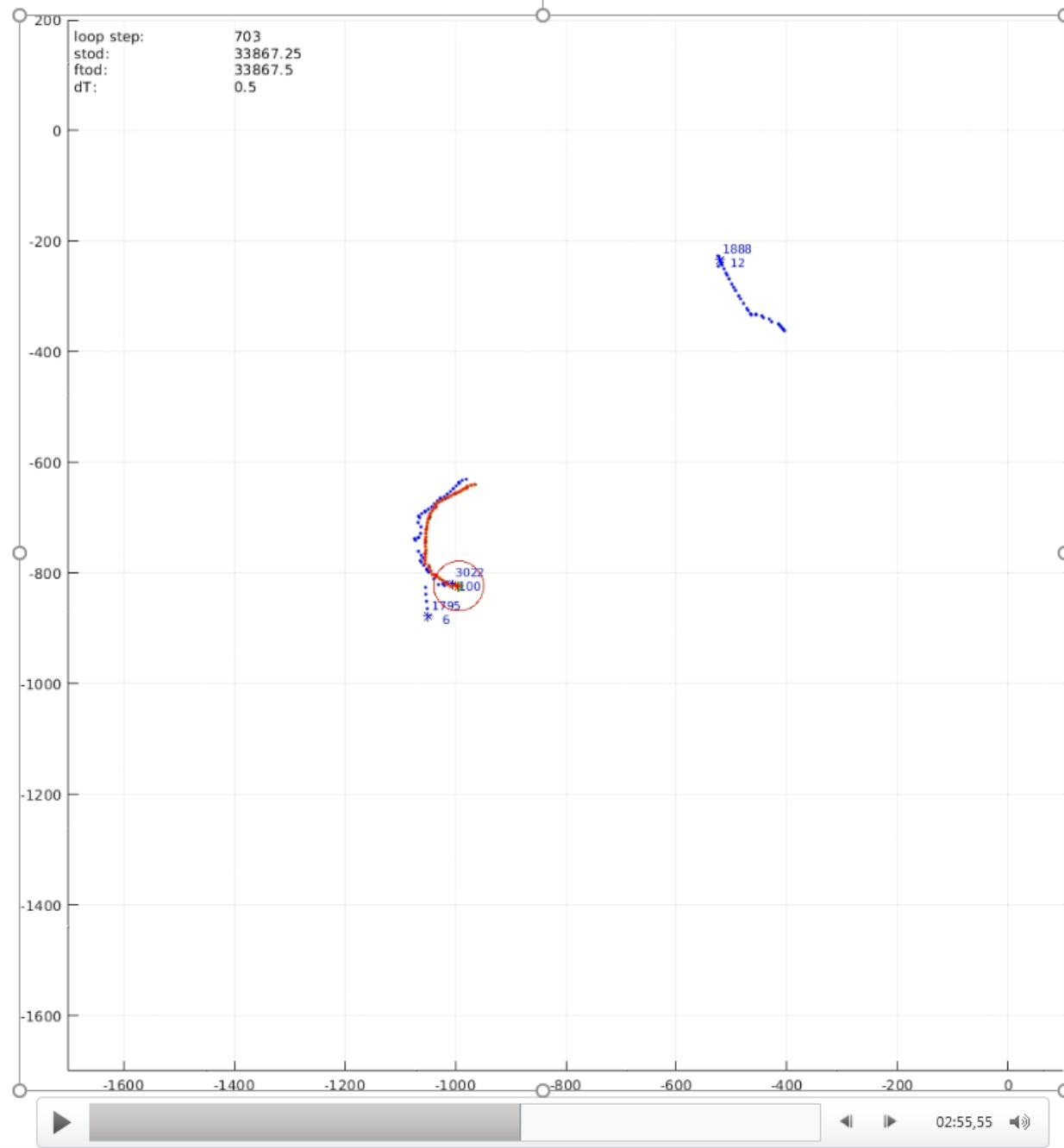


# NTNU



# Data Fusion Engine algorithm overview







# SESAR CLASS

## Realtime UTM system



Founding Members



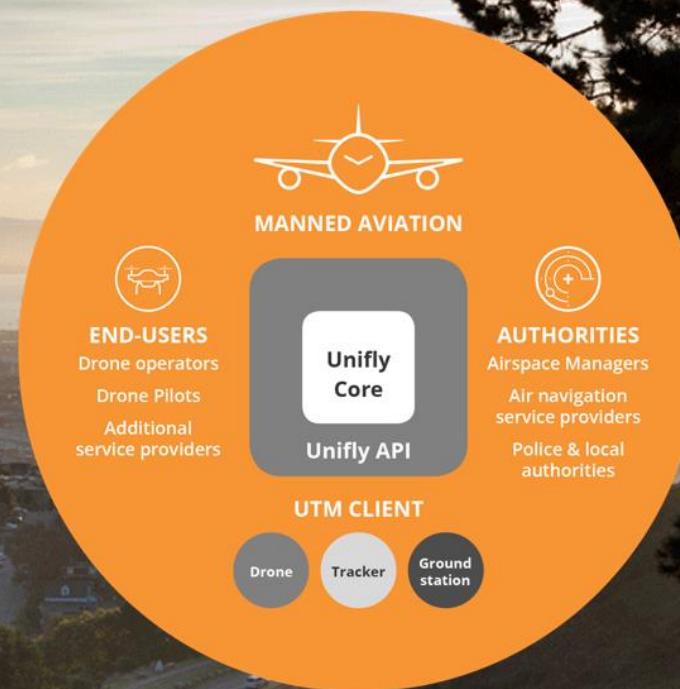
EUROPEAN UNION

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

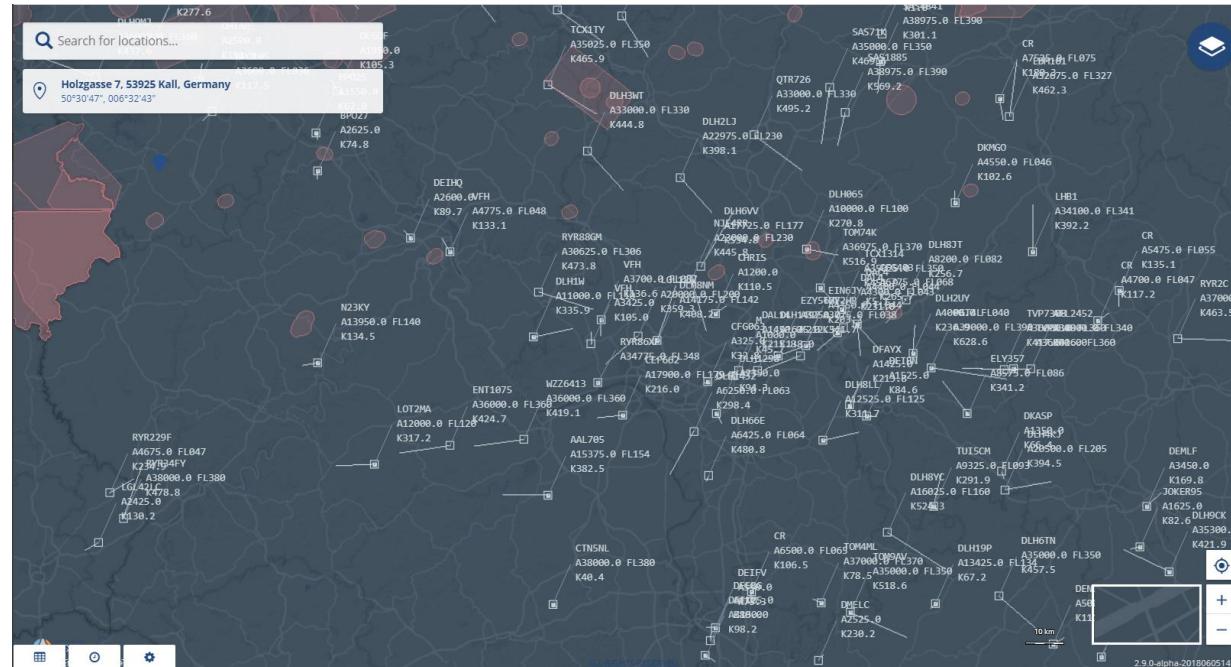


# Realtime situational display



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

Flight View

Deenethorpe, Corby, England, United Kingdom

95 Jacey Road, Solihull, B90 3LW, United Kingdom  
52.418568°, -001.821669°

**BIRMINGHAM CTR (EGBB)**

Category: Control zone  
Control zone: Class D  
Lower limit: GND  
Upper limit: 4500 ft AMSL

**Map Layers**

- Aircraft
- Active Operations
- Sensitive fauna
- Forbidden Aerial Photo
- Populated areas
- Danger areas
- Public/military airport
- Prohibited areas
- Restricted areas
- Control zones
- Temporary No Fly Zone
- Notams

# Realtime situational display



- Different base maps

The screenshot shows the UNIFLY Flight View interface. The left sidebar has a dark background with white icons and text:

- C Class Supervisor**
- No Drone Zone Manager
- Flight View** (highlighted)
- Company UAS
- Drone Operations
- Permission Requests
- Operator Users

The main area is titled "Flight View" and displays a map of an Air Traffic Zone (ATZ). A search bar at the top finds "Deenethorpe, Corby, England, United Kingdom" and "Benefield Road, Corby, NN17 3, United Kingdom". A callout box for "PETERBOROUGH/CONINGTON ATZ (EGSF)" provides details:

- Category: Control zone
- Class: G
- Lower limit: GND
- Upper limit: 2000 ft AGL

A legend on the right indicates "C" for Control zone. The map shows several red-shaded circular and rectangular areas representing different control zones. A small blue location pin is visible on the map. A zoom control in the bottom right corner shows a scale from 5 km to 1 km.

# Realtime situational display



- Deenethorpe test site

Flight View

C Deenethorpe, Corby, England, United Kingdom

Corby, NN17 3, United Kingdom  
52.50206°, -000.595146°

200 m

ALL RIGHTS RESERVED

2.12.0-201810091003

# 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



Flight View

Deenethorpe, Corby, England, United Kingdom

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

**DRONE DETAILS**

N 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**

Aveillant A750.0

Tracking Sources

- Aveillant
- Dronet
- Paparazzi
- Fused

Knipprogramma

Nieuw Modus Lijstven Selecteer de knipselmodus met de knop Modus of klik op de knop Modus.

ALL RIGHTS RESERVED.

# Realtime situational display



Flight View

C Deenethorpe, Corby, England, United Kingdom

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

**DRONE DETAILS**

Nickname: N/A      Type: N/A  
Track id: 1324      Track state: COOPERATIVE  
Brand: N/A      Model: N/A

**Collision info**

0M from undefined  
7M from undefined  
7M from undefined

**Live Tracking Info**

Regref

1324 A750.0

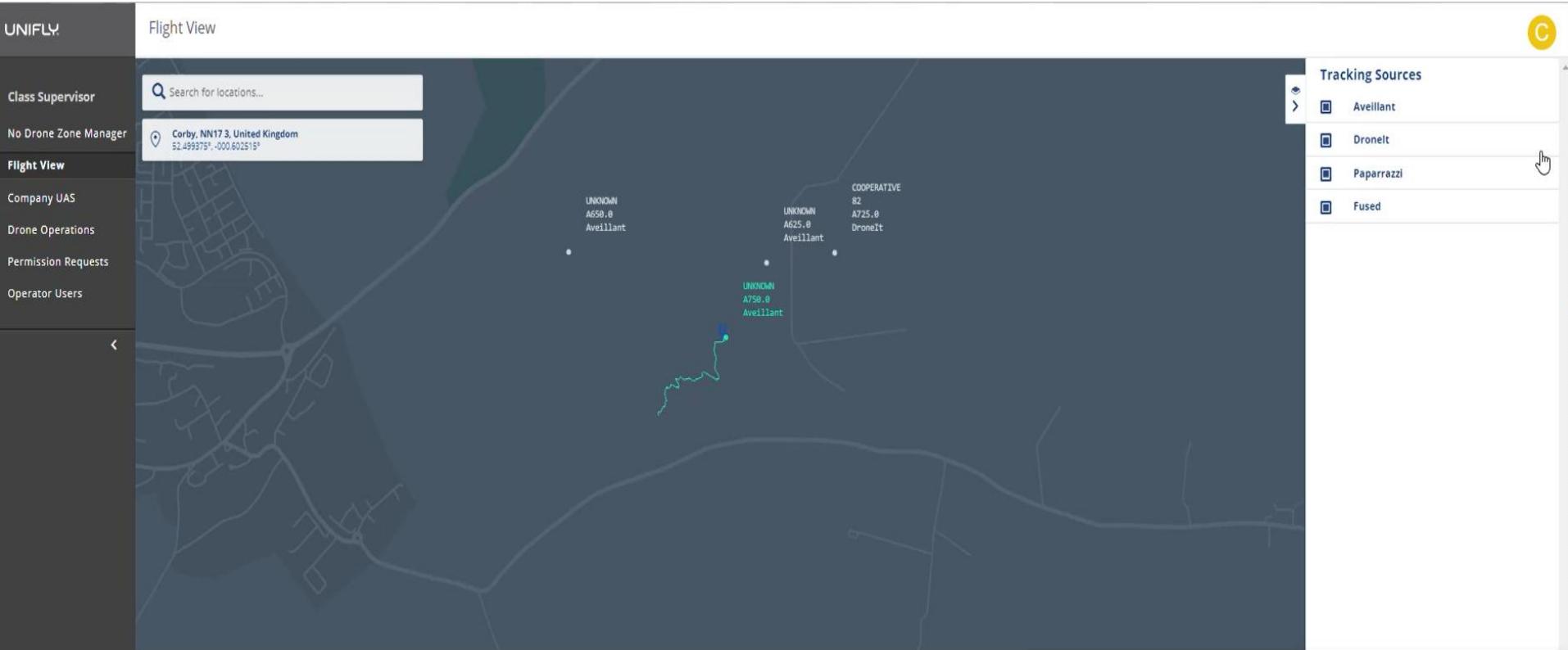
DroneIt

ALL RIGHTS RESERVED.

**Tracking Sources**

- Avellant
- Dronelt
- Paparazzi
- Fused

# Realtime situational display





# SESAR CLASS Live Experiments



Founding Members



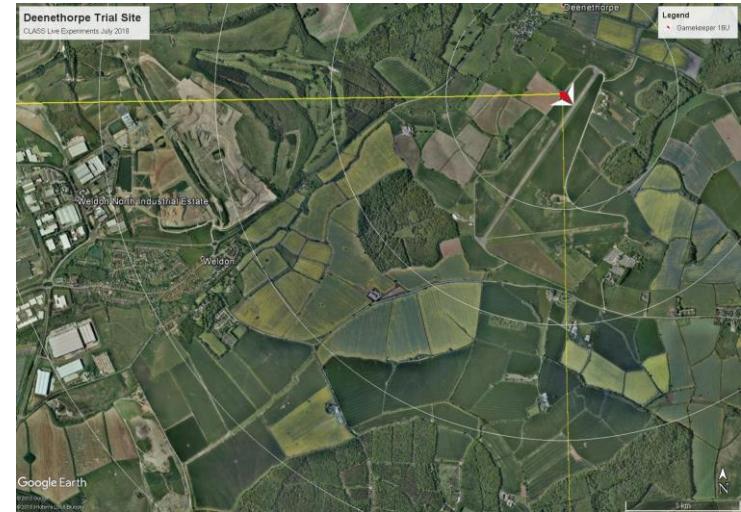
# CLASS Live Experiments

Real-time operation



## Trial Site

- Ex-RAF Airfield, Deenethrope



## Trial Dates

- October 15<sup>th</sup> – 19<sup>th</sup> 2018

## Trial Equipment

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



Mon 15th Oct	Tue 16 <sup>th</sup> Oct	Wed 17 <sup>th</sup> Oct	Thu 18 <sup>th</sup> Oct	Fri 19 <sup>th</sup> 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





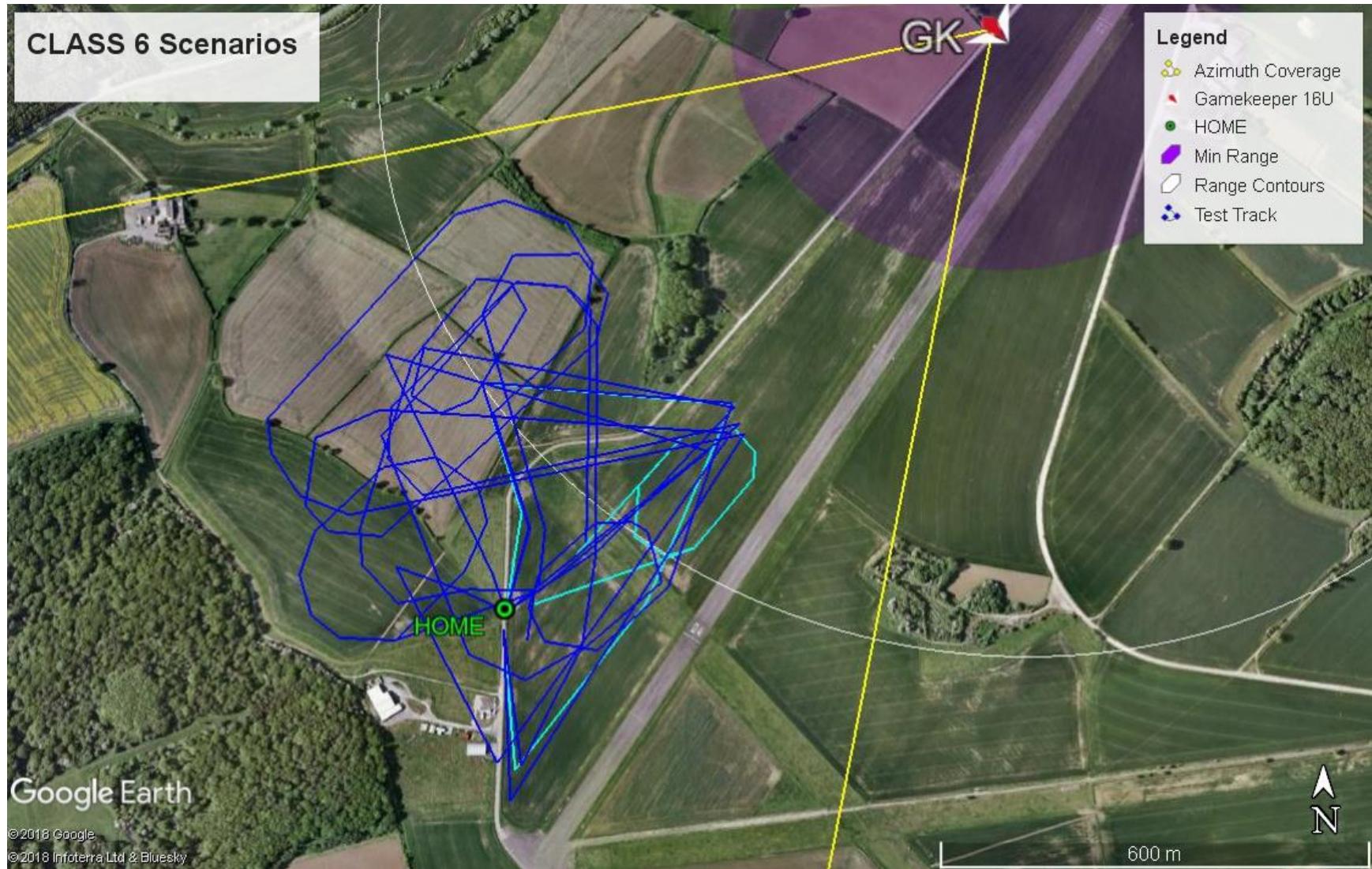
Screen-shot from video which was here.

# CLASS Scenarios



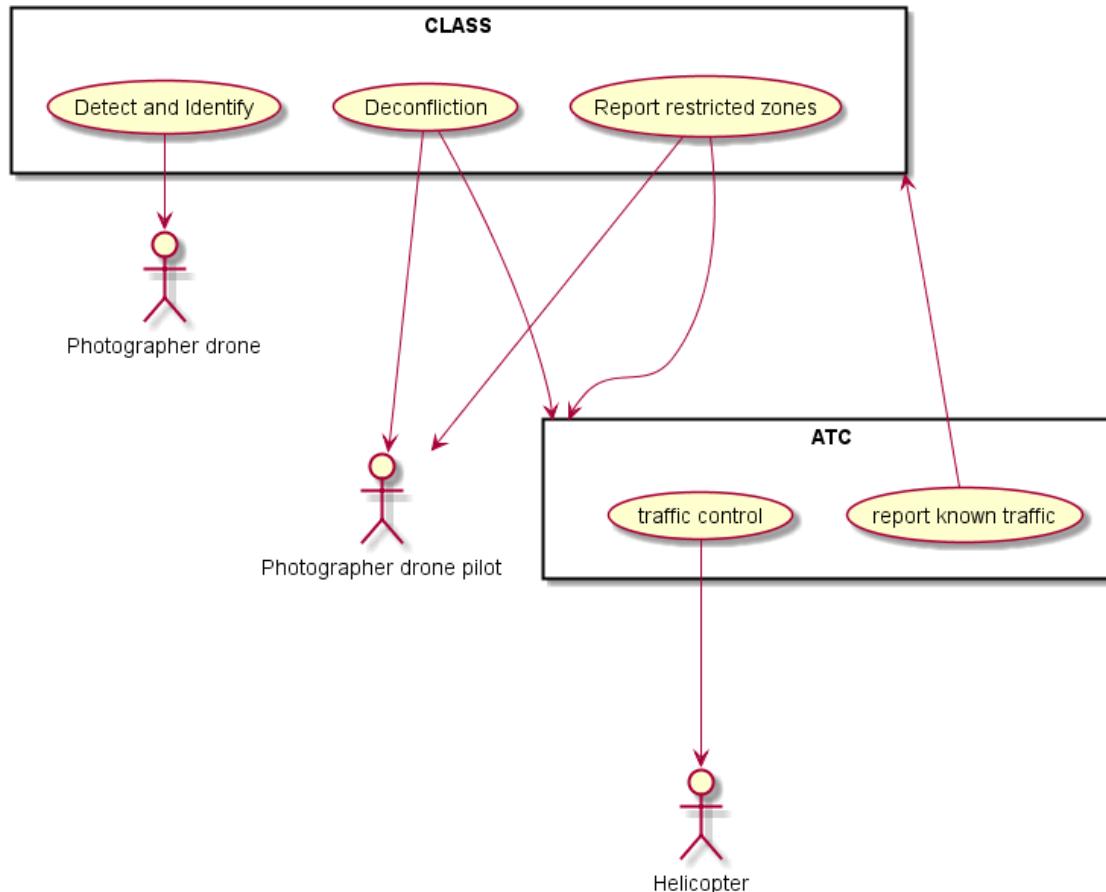
Scenario ID	Scenario Name
CLASS_DS_1	GNSS failure leading to intrusion in an airport
CLASS_DS_2	conflicts in an emergency situation (2 drones)
CLASS_DS_3	Aerial work near high voltage lines
CLASS_DS_4	Drone ILS Calibration (2 drones)
CLASS_DS_5	Gliding rogue drone
CLASS_DS_6	Urban pollution sampling

# CLASS Scenarios



# Aerial work near high voltage lines – CLASS\_DS\_3

CLASS\_SC\_3 - Aerial work on high voltage lines



## Narrative

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

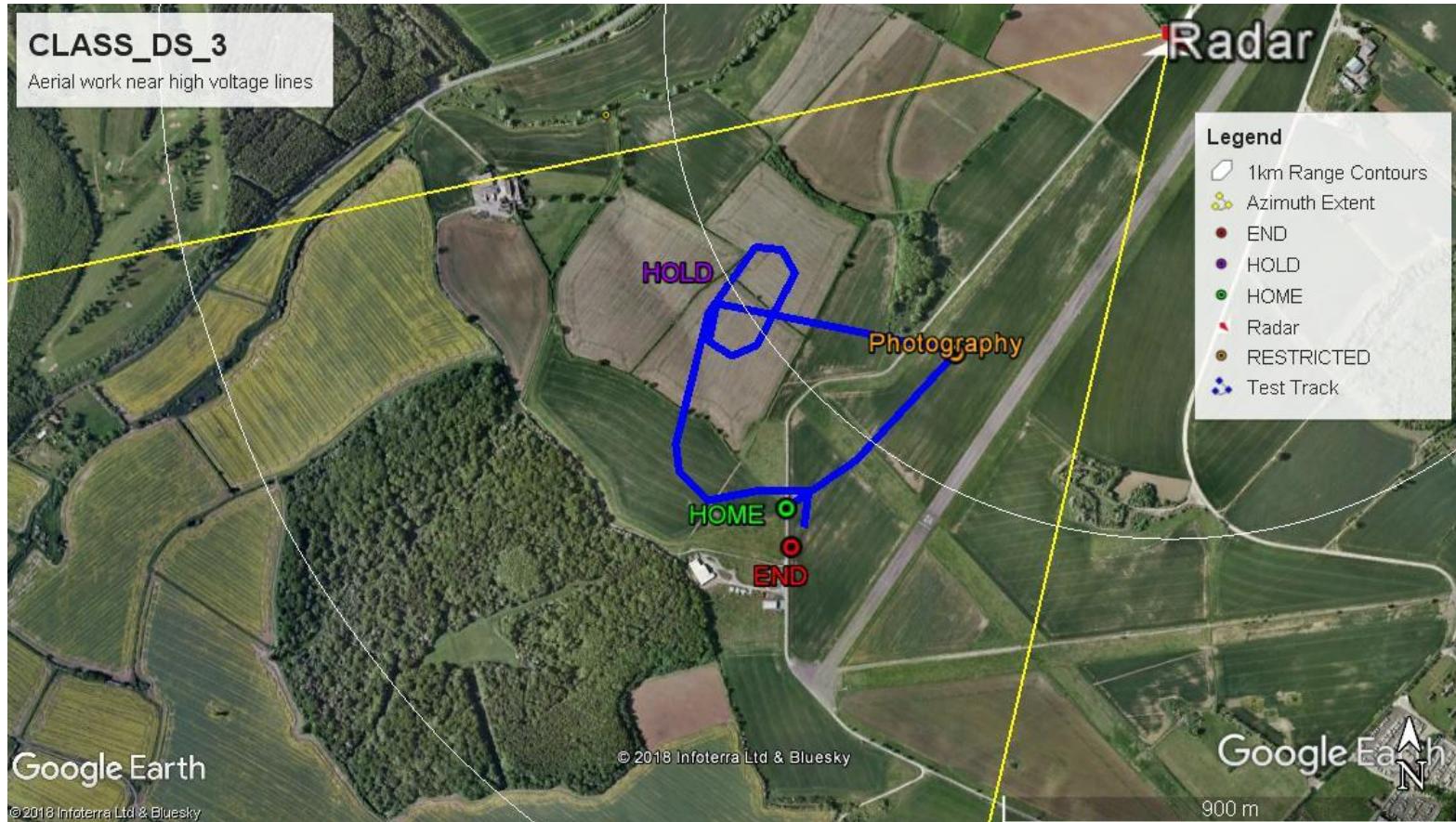
Drone circles over photography point

Drone moved to HOLD to deconflict

Drone cleared to land at END

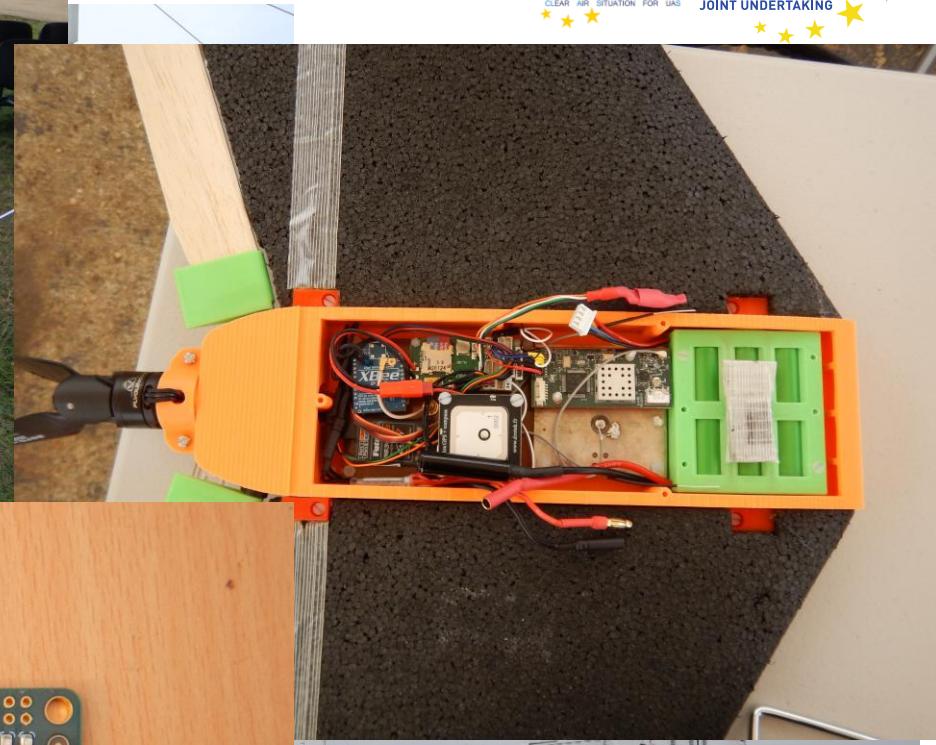
# Aerial work near high voltage lines – CLASS\_DS\_3

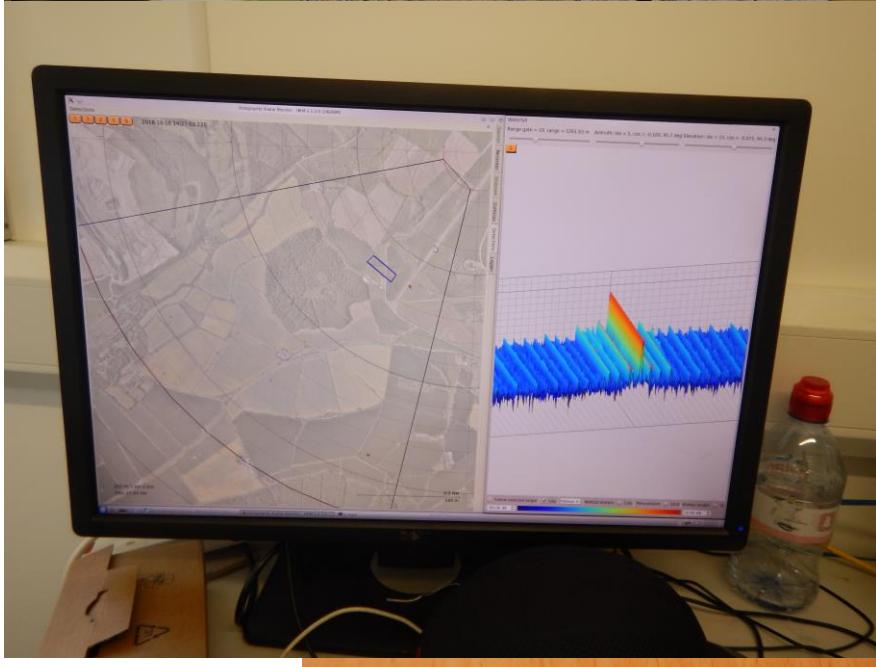
(1) Drone moving to **PHOTOGRAPHY** point (2) Drone moved to **HOLD** to deconflict with manned aircraft (3) Drone eventually cleared to land













# 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



The opinions expressed herein reflect the author's view only.

Under no circumstances shall the SESAR Joint Undertaking be responsible for any use that may be made of the information contained herein.