SESAR U-Space Demonstration

Project DOMUS

(Demonstration Of Multiple U-Space Suppliers)

Madrid 17th of September 2019

SESAR JOINT UNDERTAKING

Founding Members

Agenda

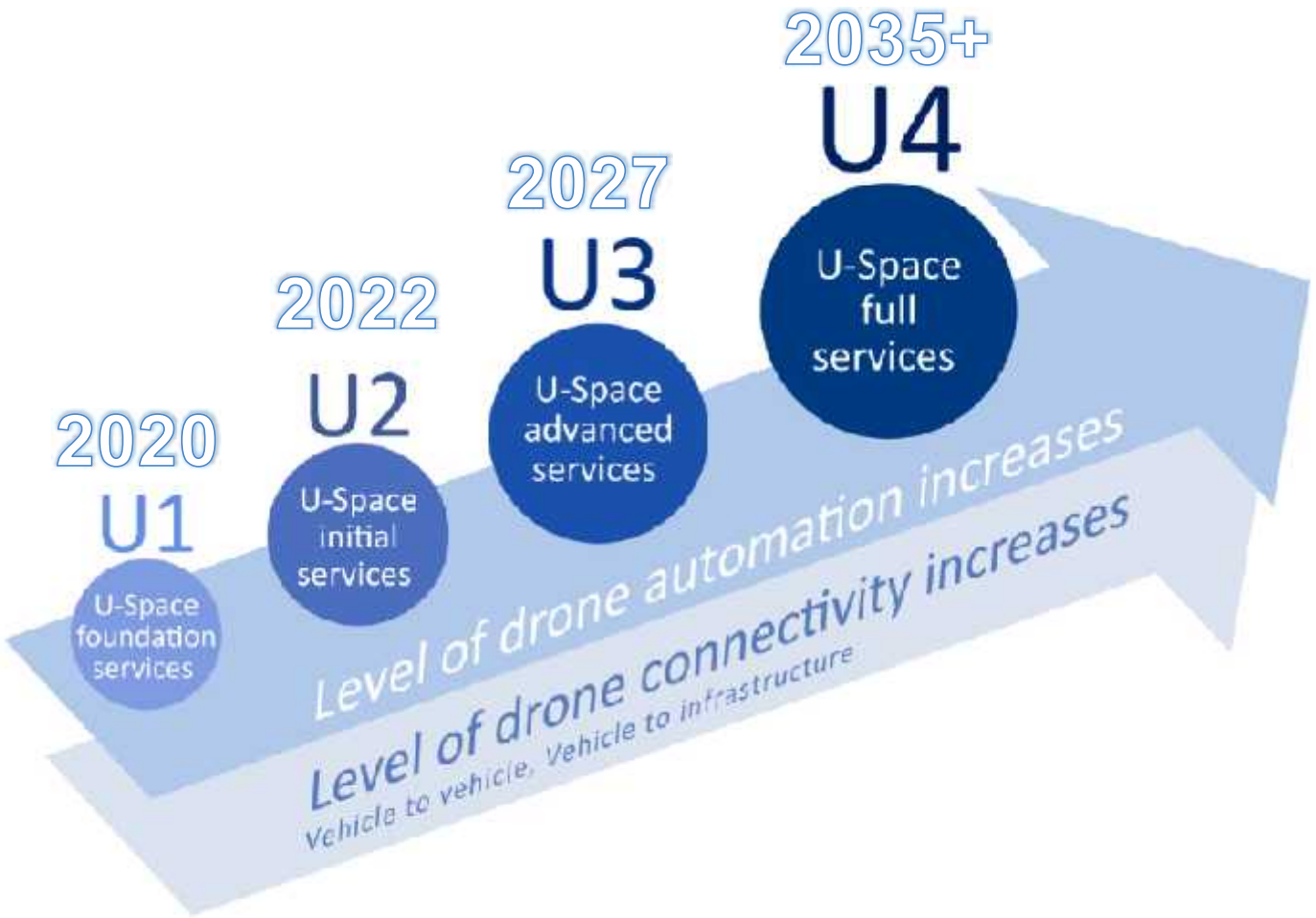
Time	17th July 2019
09:30	Reception
10:00	Opening speeches
10:15	DOMUS project introduction
10:25	First trial
10:35	Conclusions and closure of first trial
10:45	Coffee Break
11:30	Second trial
12:00	Presentation of U-space services in DOMUS
12:45	Third trial
13:10	Conclusions and closure
13:30	End of event and Catering


Por qué U-space?

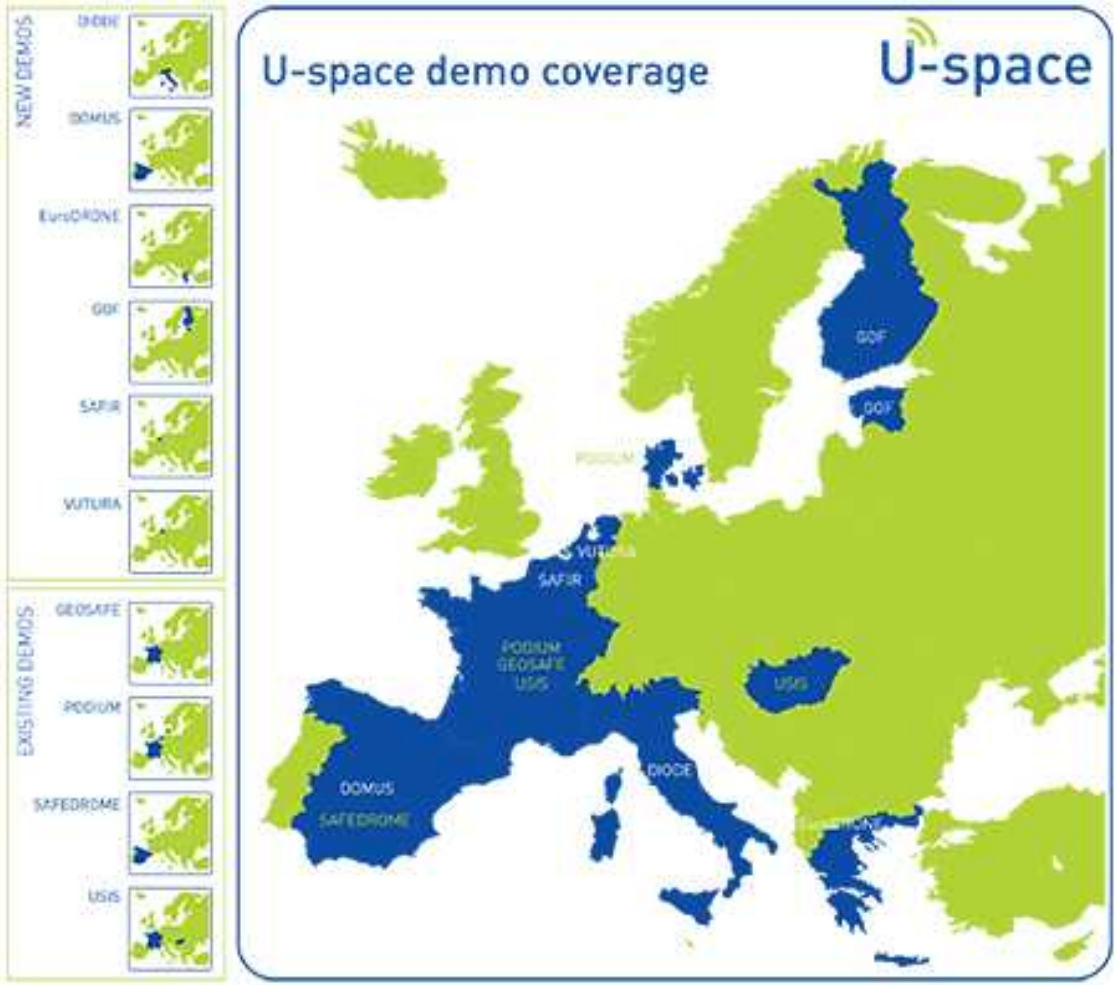
el contexto: Qué es U-SPACE?

U-Space Blueprint (SESAR Joint Undertaking)

el contexto: los plazos para el U-SPACE?



El contexto: validación del U-SPACE?



DOMUS Consortium

ENAIRE

gmv

SRS
SOTICOL Robotics Systems S.L.

FuVeX

CRIDA

Isdefe
your best ally

SCR
SISTEMAS DE CONTROL REMOTO S.L.

indra

PildoLabs
move smart

FADA

CATEC

DOMUS

AIRMAP

EARTH NETWORKS

everis

vodafone

ineco

Project Stakeholders

DGAC

AESA

Guardia Civil

Villacarrillo

Thank you all!

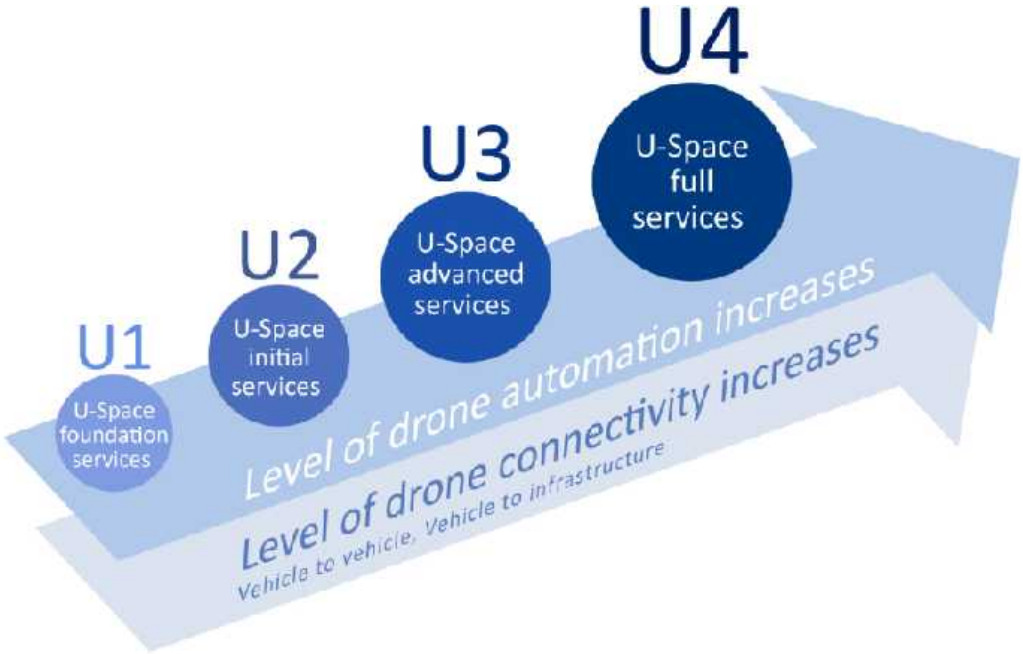
DOMUS: alcance del proyecto

U-space initial services (U1 and U2)

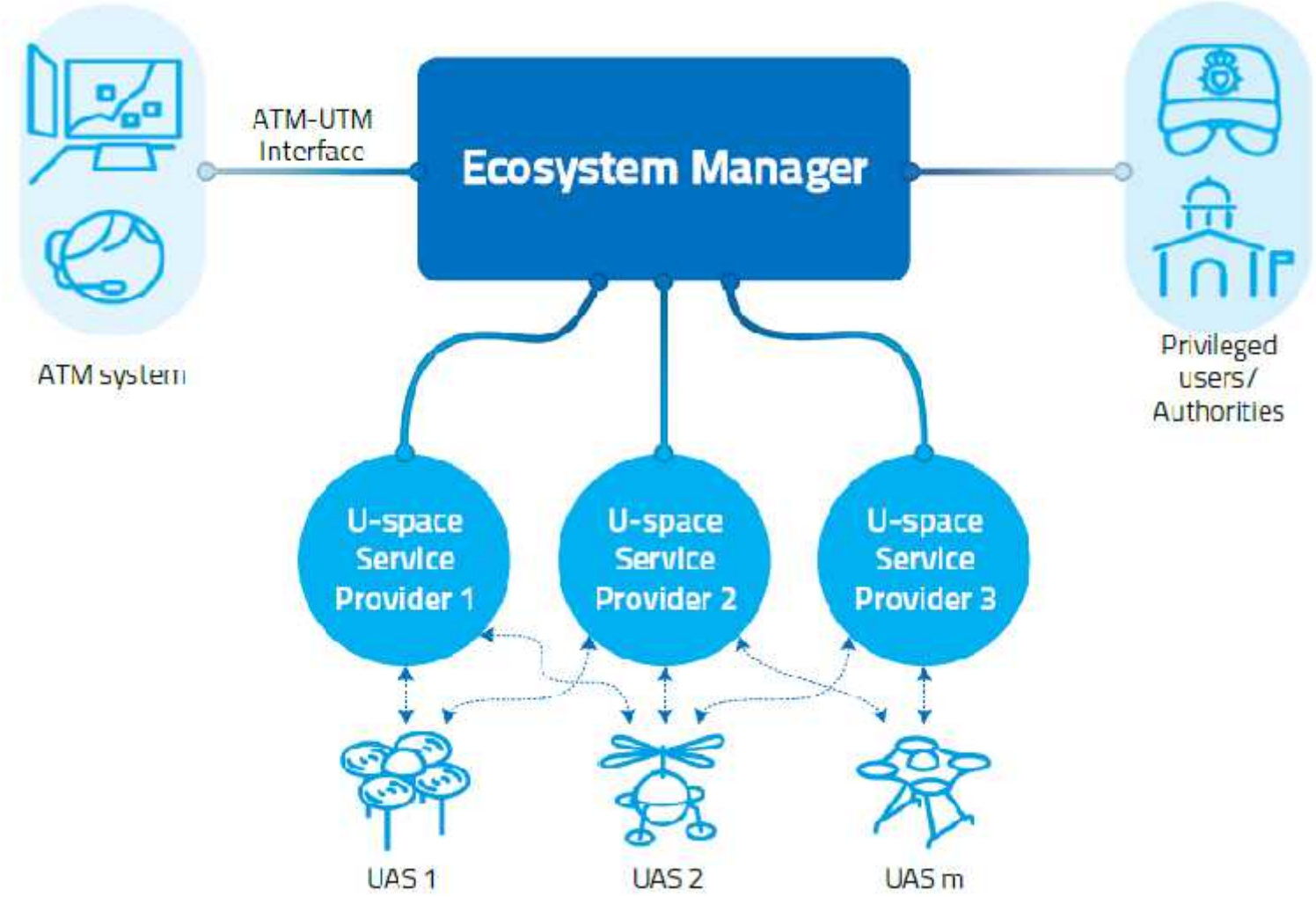
Some specific U3 services:

- Tactical Deconfliction
- Collaborative ATM

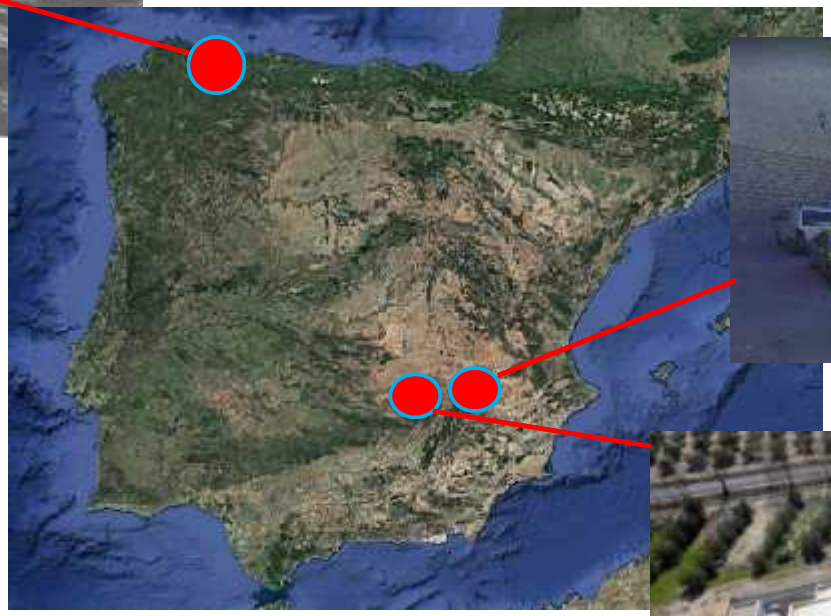
Smart City use cases



Arquitectura U-space



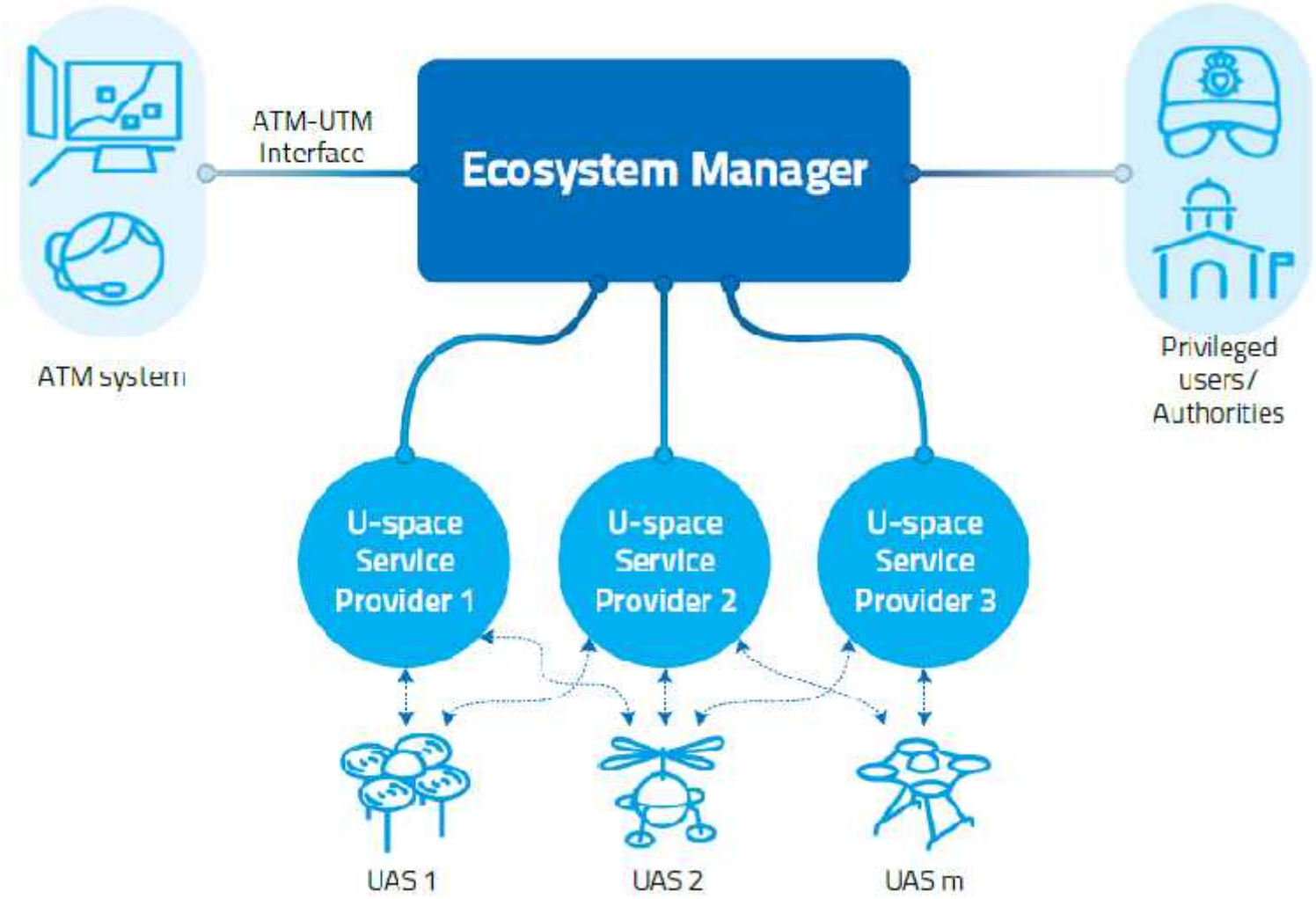
DOMUS Demonstration Place



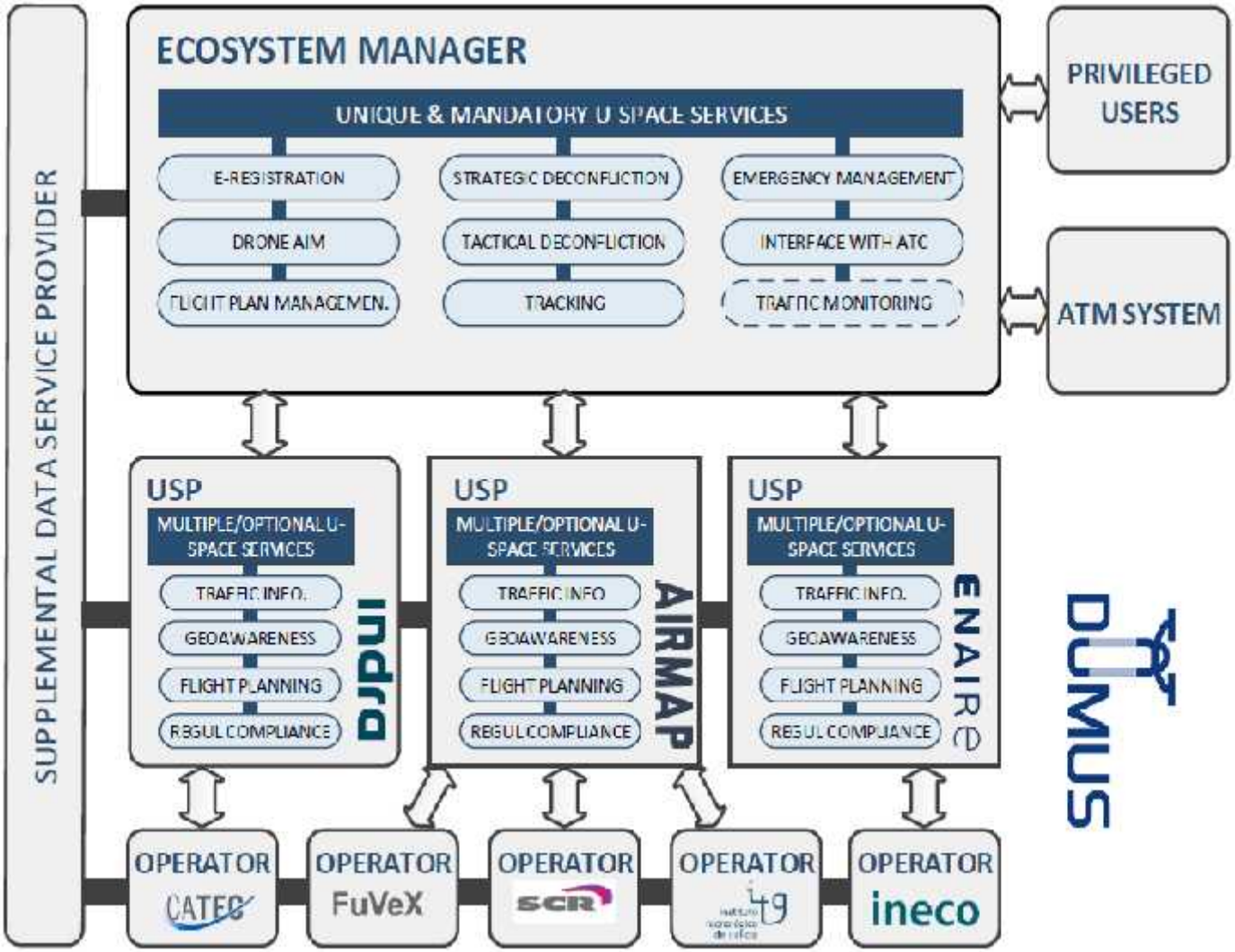
TRIAL #1

Tactical Deconfliction & Emergency Operation

U-space Architecture



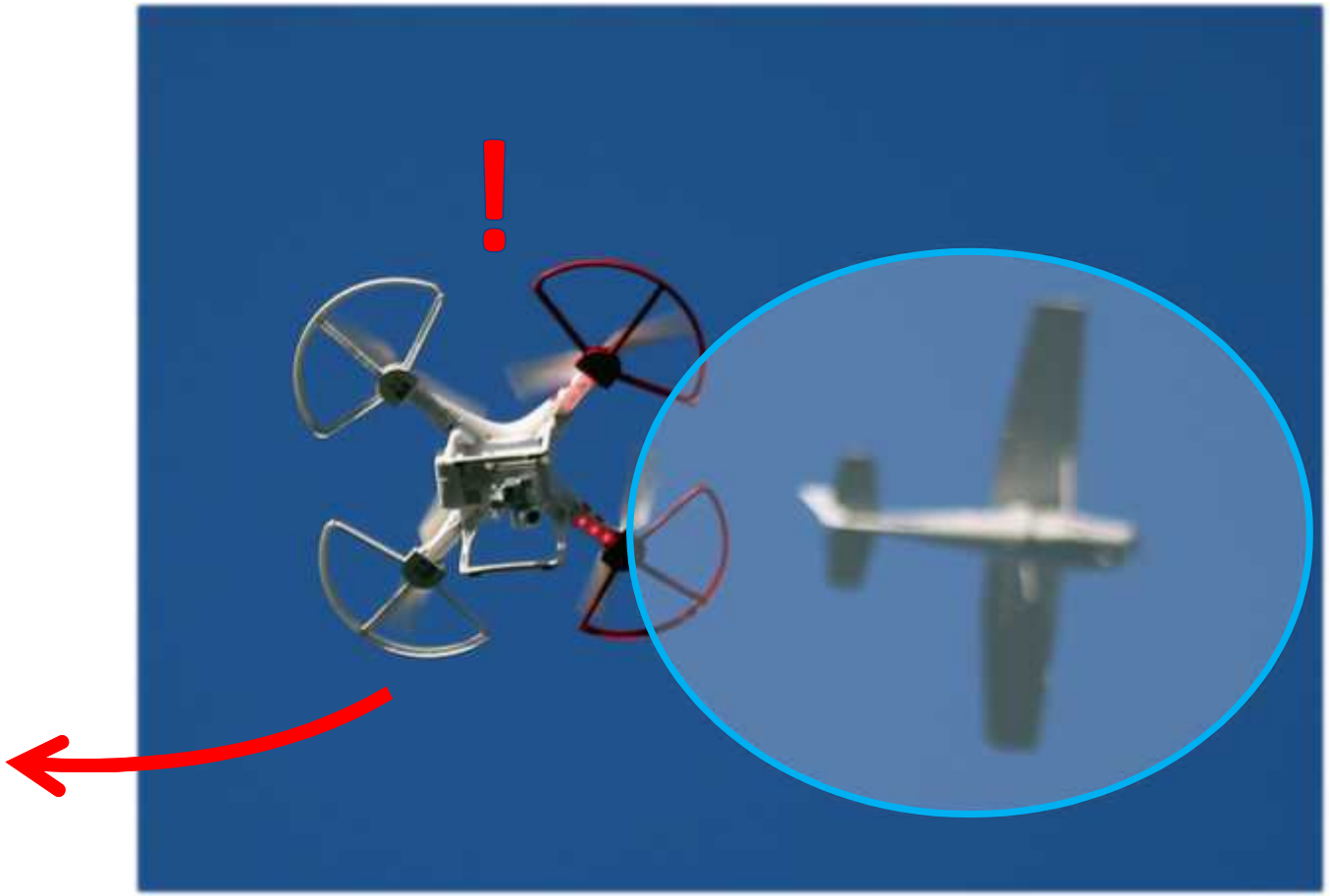
Trial #1: General Picture



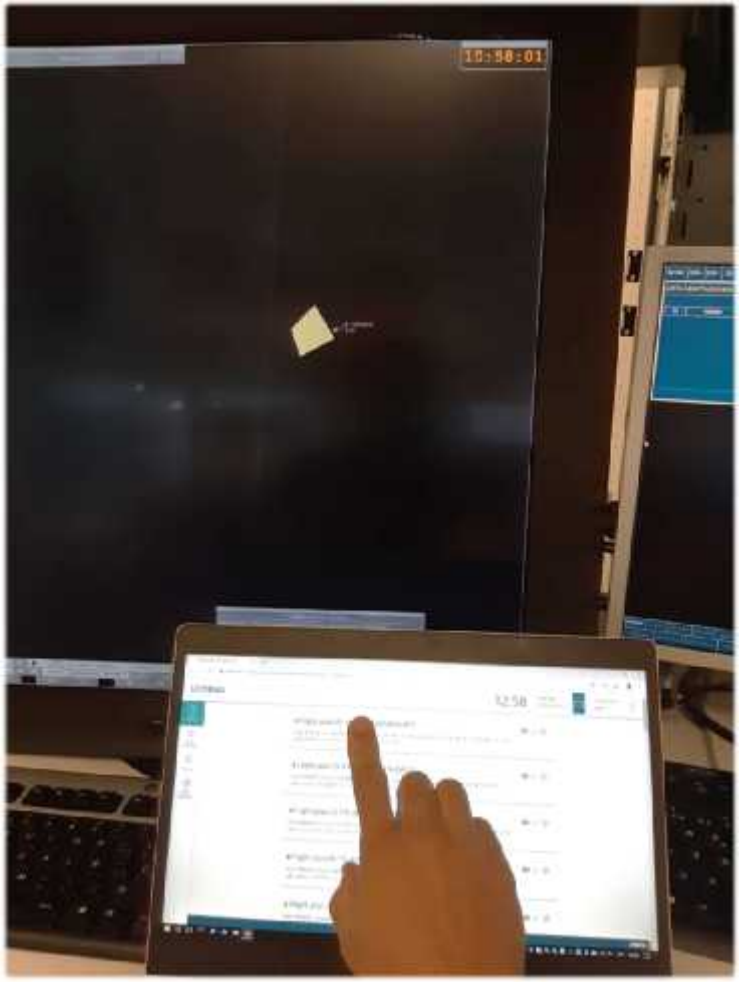
U-space Services

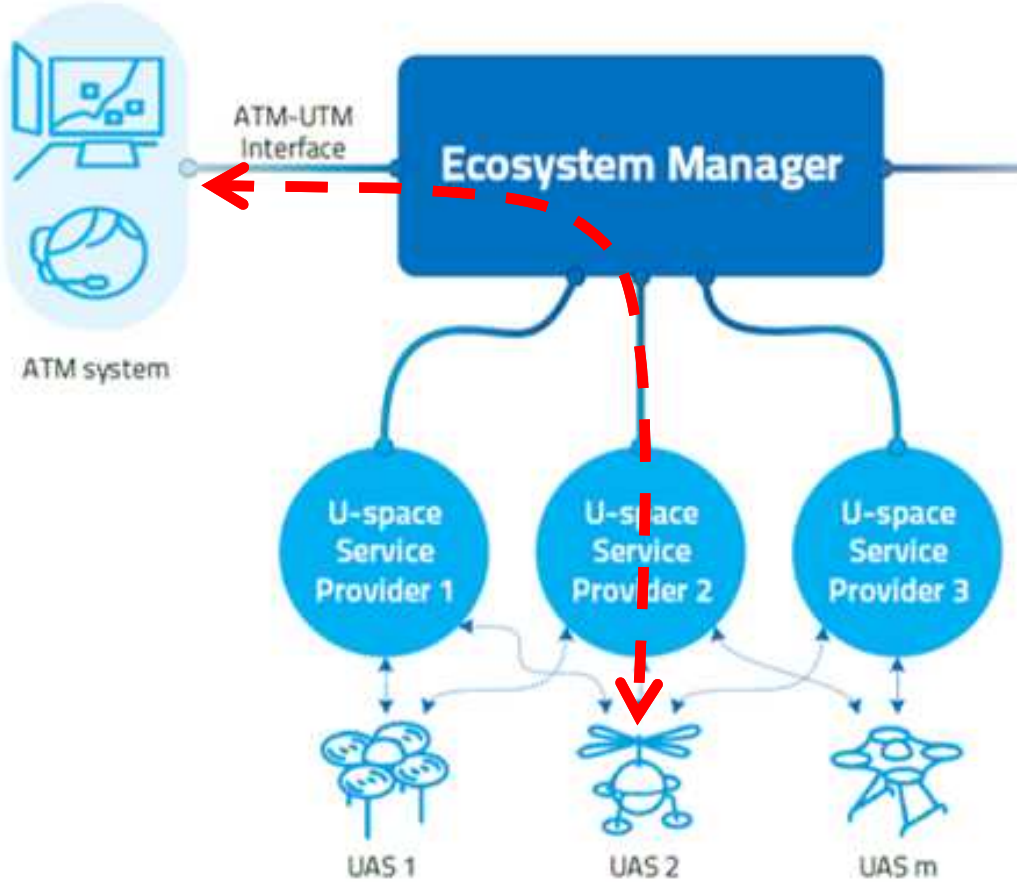
Loss of Link (Emergency Management)

Manned Aviation (Emergency Management)



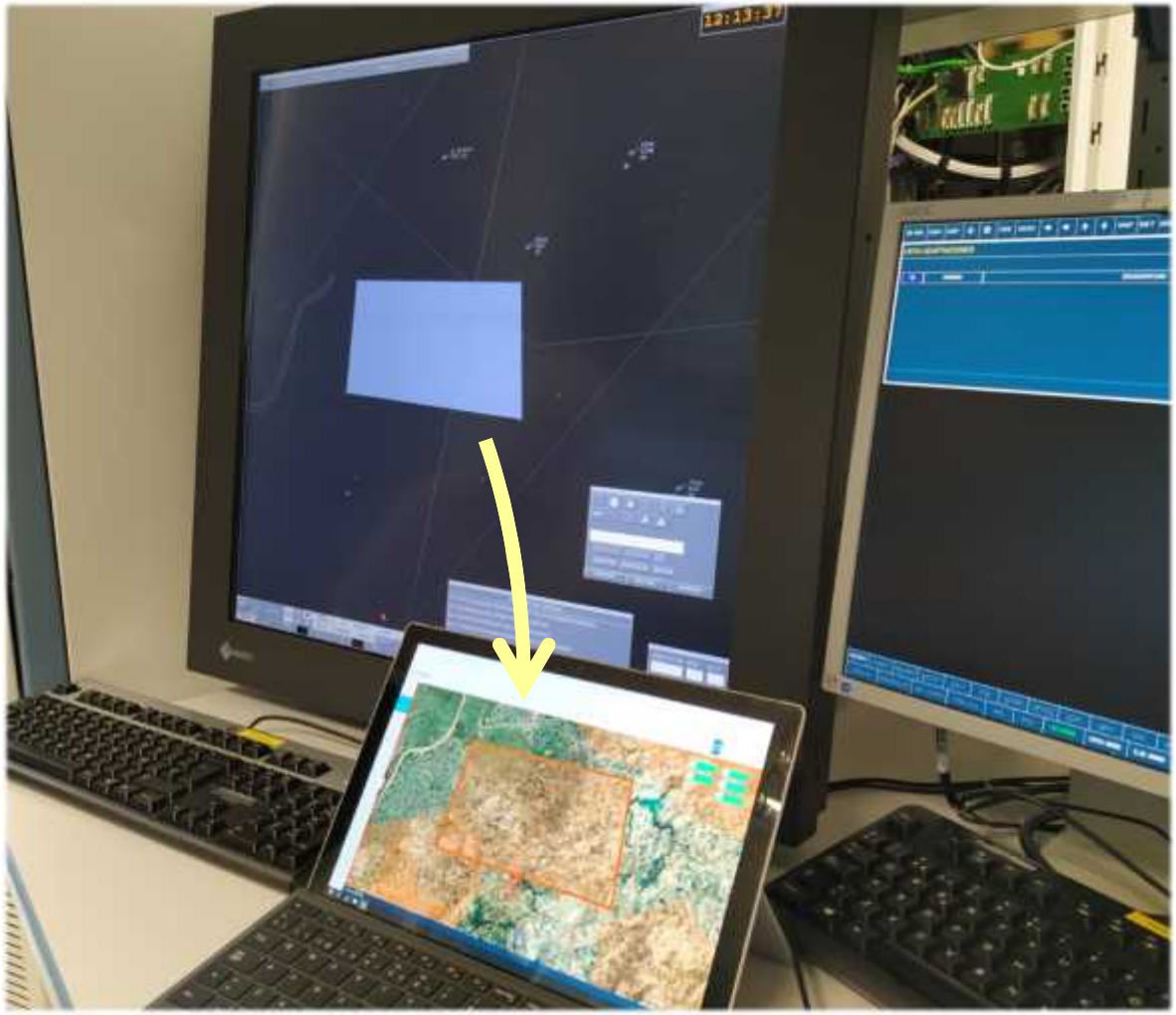
Procedural Interface ATC : ATC Approval





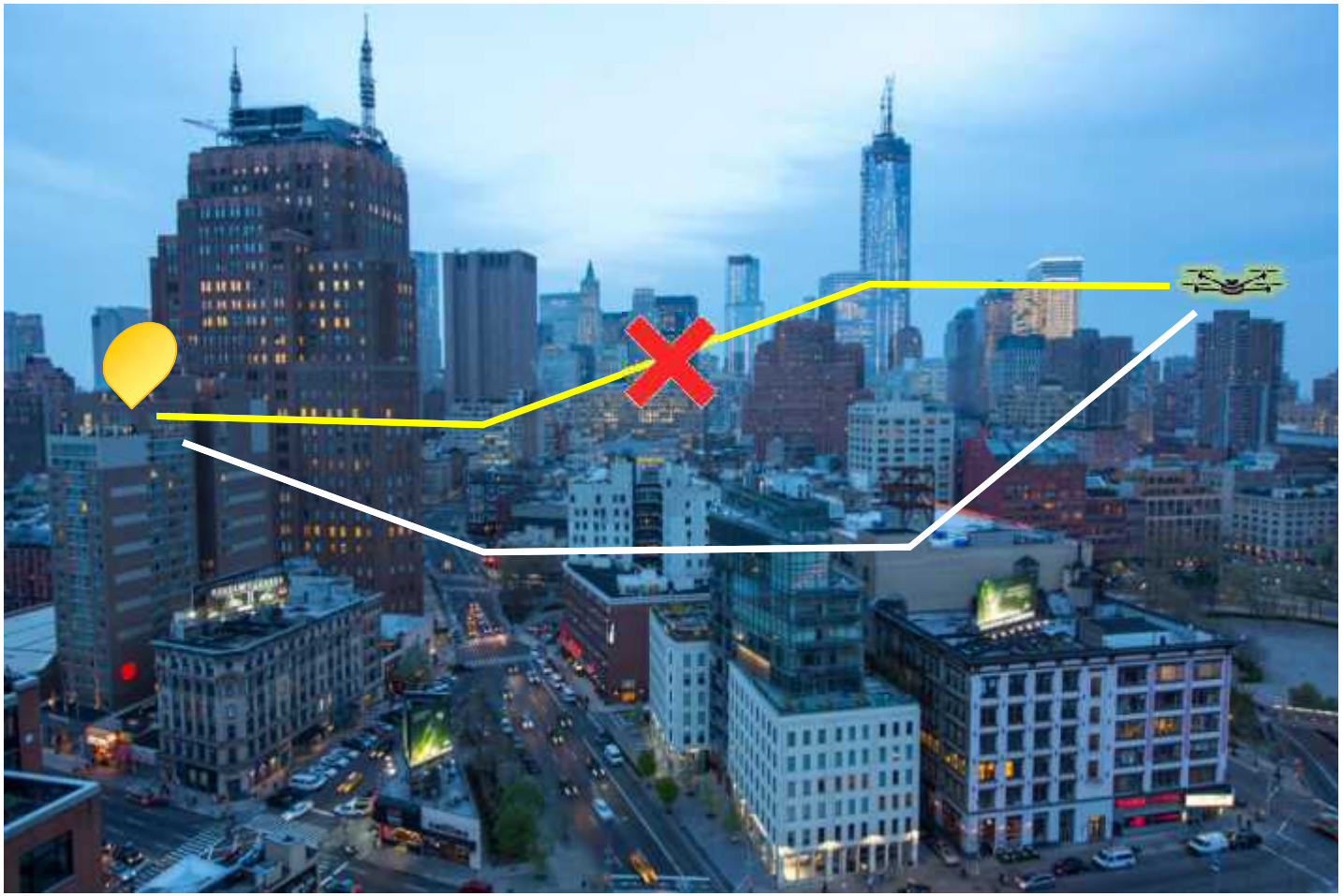
Colaborative interface ATC (1/2): Traffic Information

Colaborative interface ATC (2/2): Geofence Creation



U-space & Smart City Interaction

Strategic Deconfliction

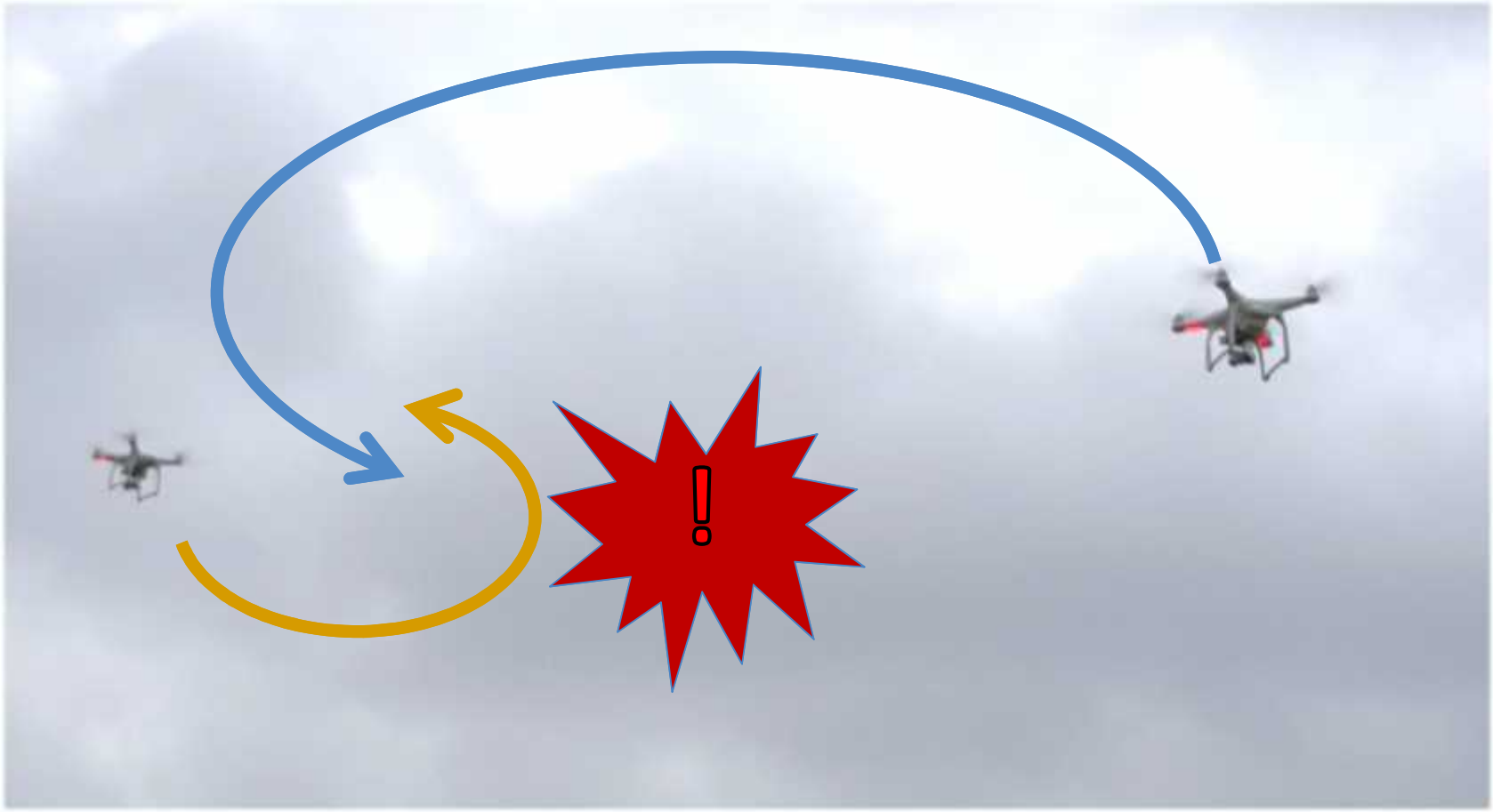


Strategic Deconfliction

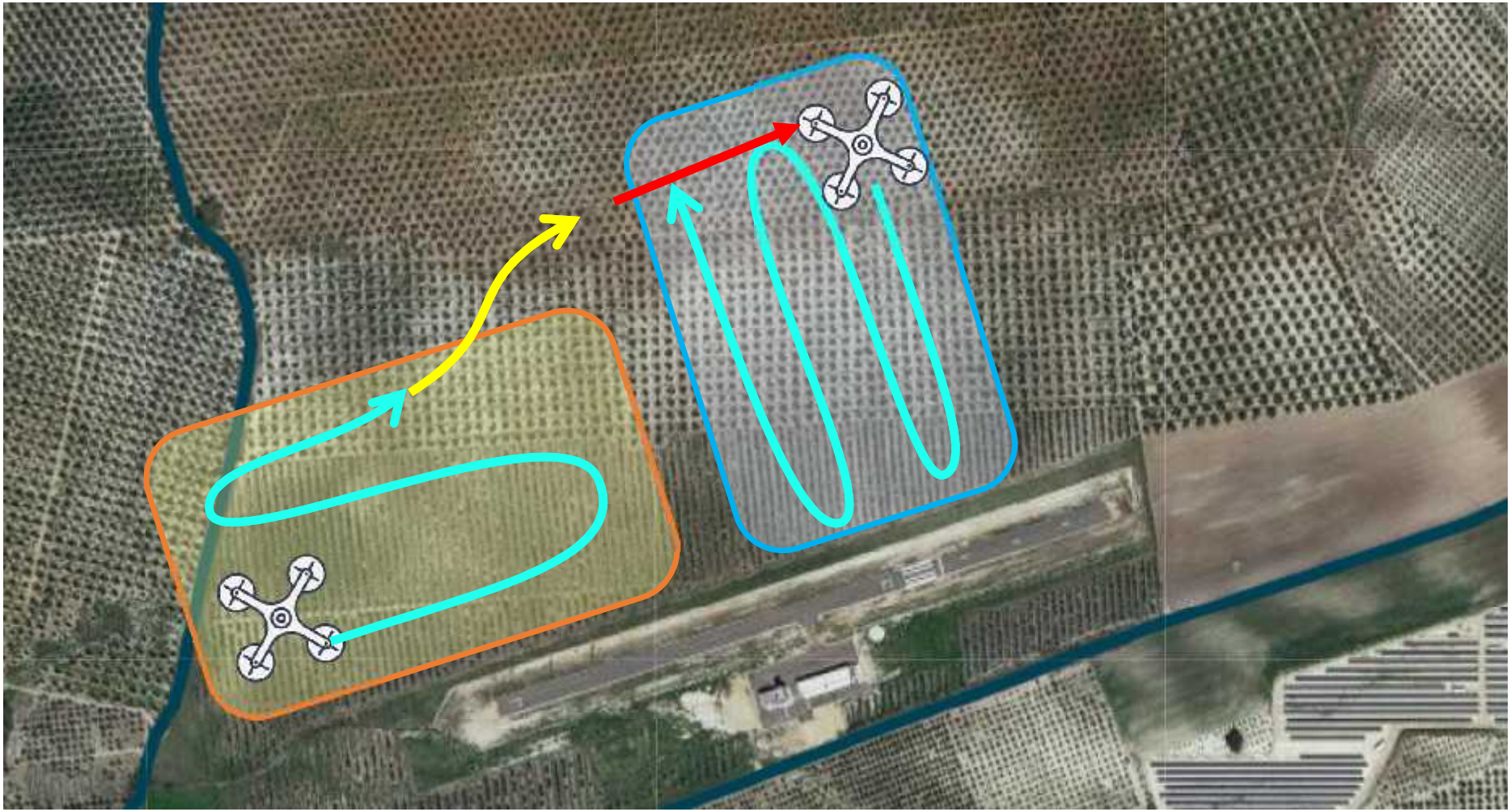
Strategic Deconfliction

E-identification

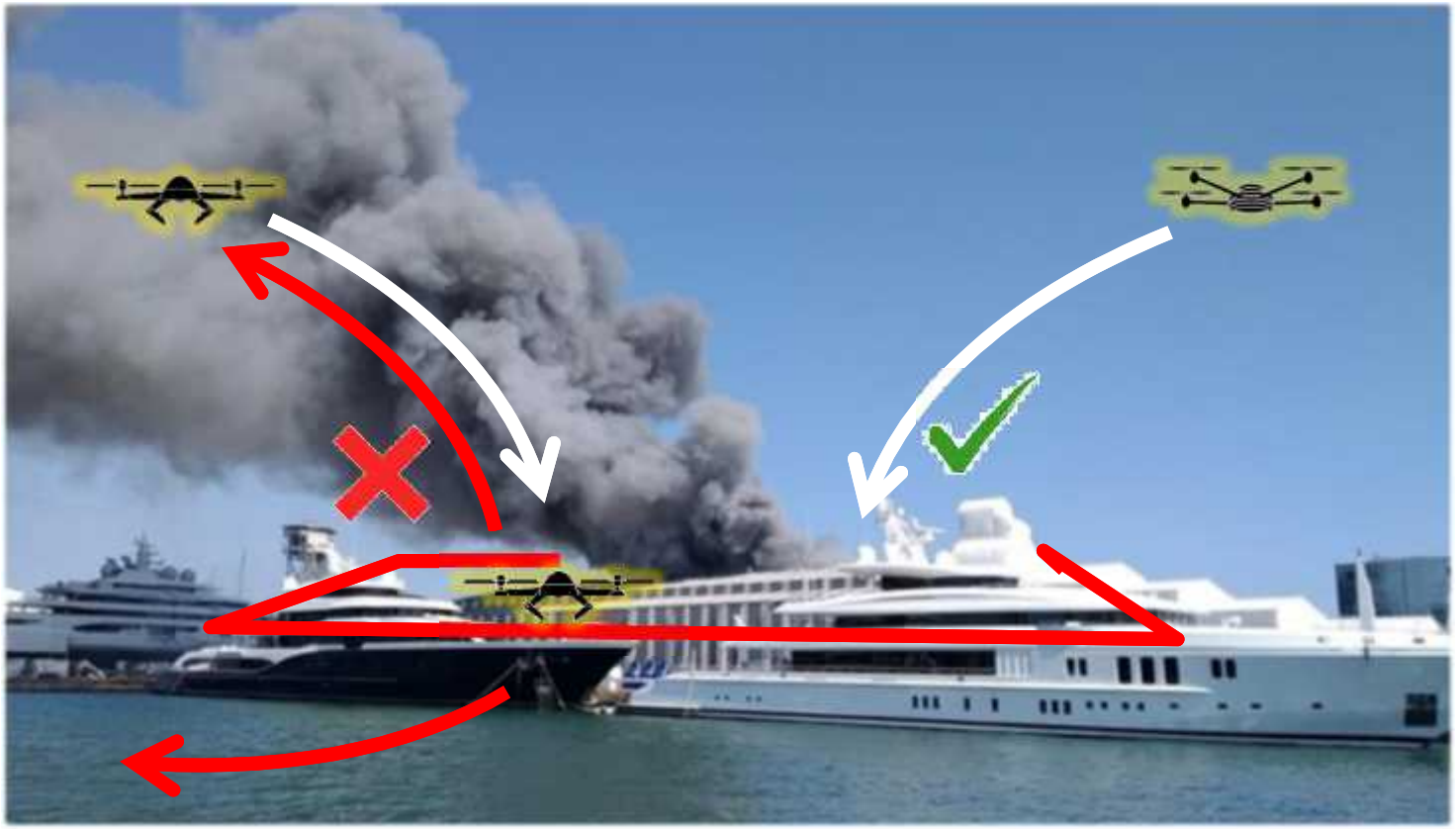
Tactical Deconfliction (U3)



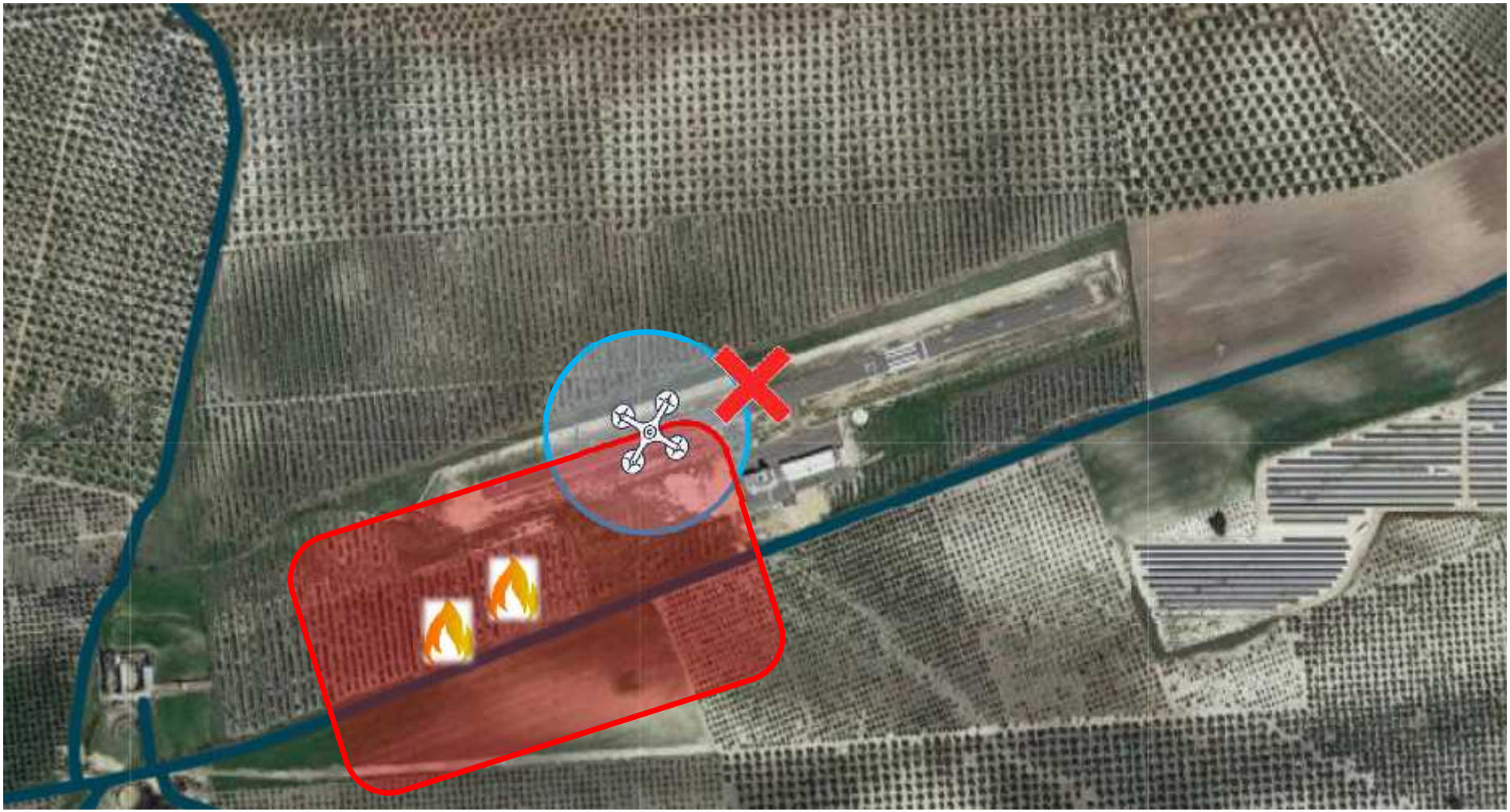
Trial #1: Tactical Deconfliction



Tactical Geofencing & Emergency Delivery



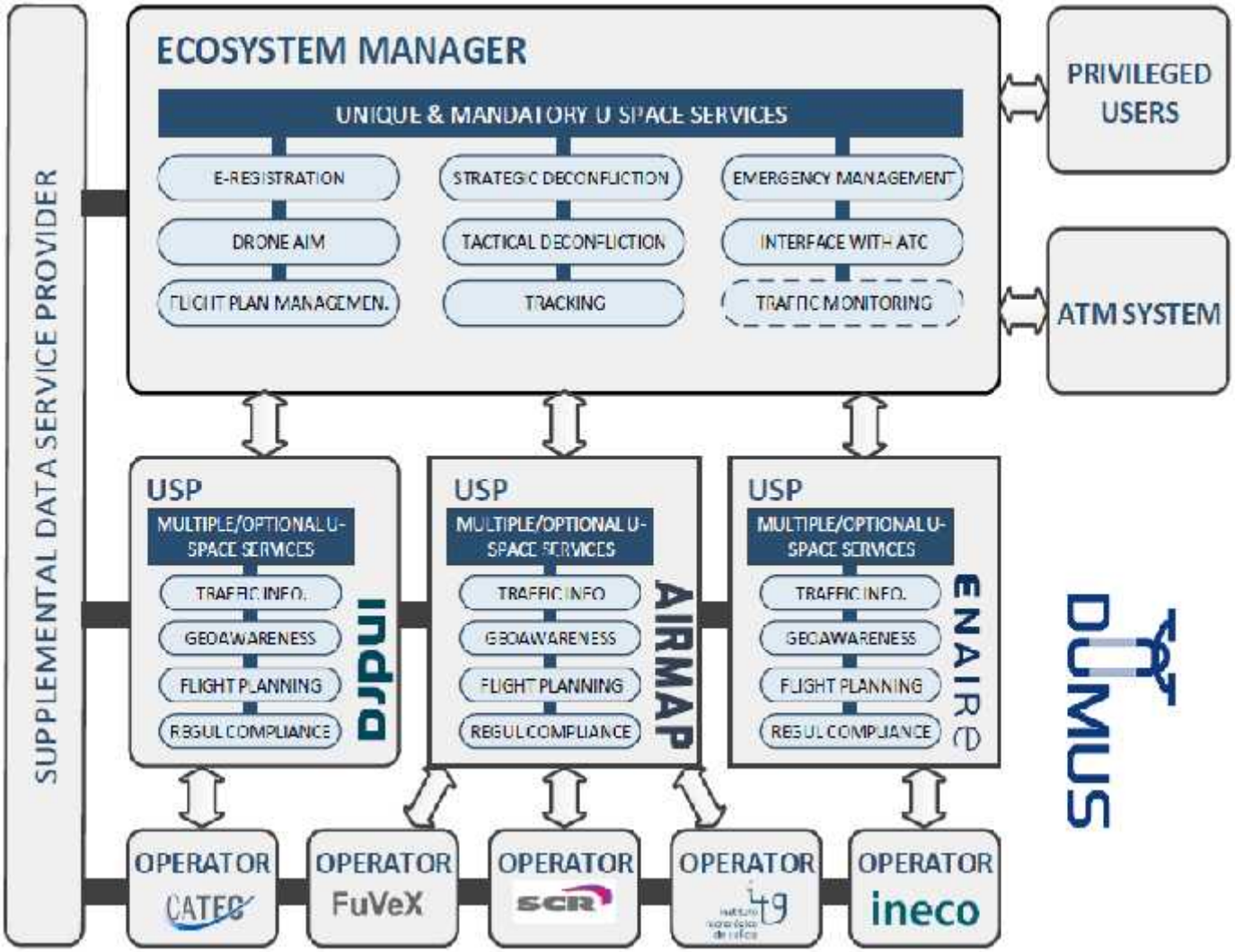
Trial #1: Tactical Geofencing



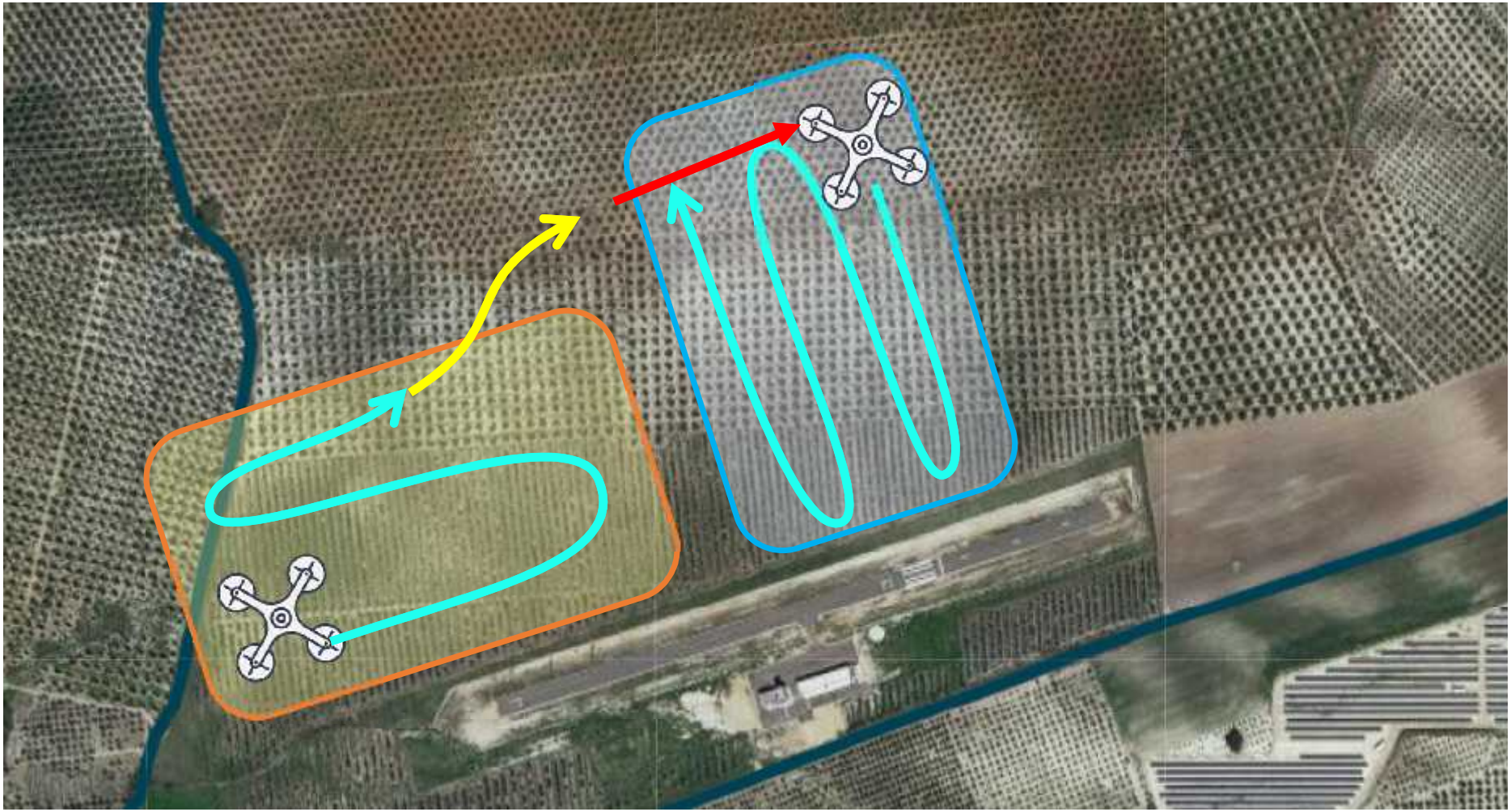
Trial #1: Emergency Delivery


TRIAL #1
LET'S GO!
Tactical
Deconfliction &
Emergency
Operation

Trial #1: General Picture



Trial #1: Tactical Deconfliction



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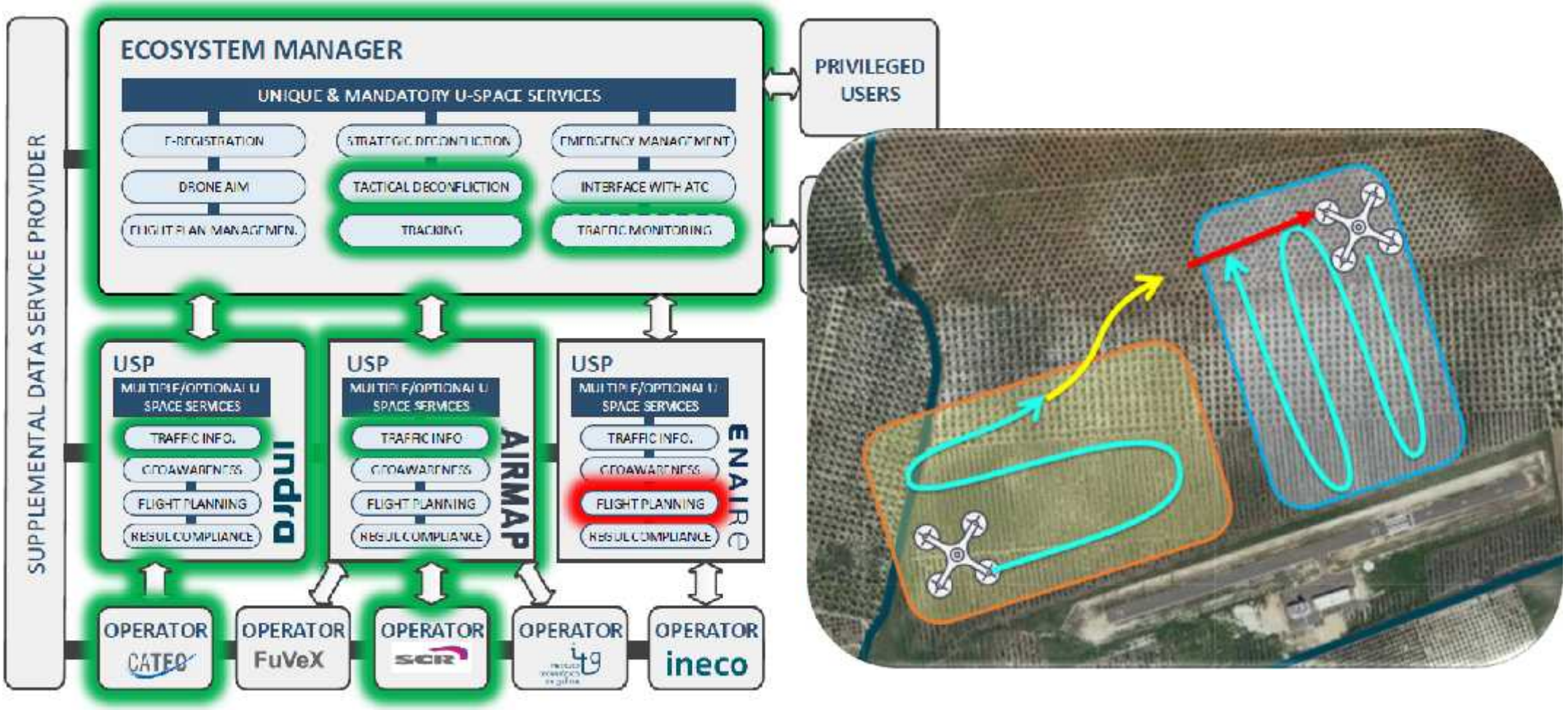

SUPPLEMENTAL DATA SERVICE PROVIDER

ECOSYSTEM MANAGER

UNIQUE & MANDATORY U-SPACE SERVICES

- E-REGISTRATION
- DRONE AIM
- FLIGHT PLAN MANAGEMEN.
- STRATEGIC DECONFLICTION
- TACTICAL DECONFLICTION
- TRACKING
- EMERGENCY MANAGEMENT
- INTERFACE WITH ATC
- TRAFFIC MONITORING

PRIVILEGED USERS

ATM SYSTEM

USP

MULTIPLE/OPTIONAL U-SPACE SERVICES

- TRAFFIC INFO.
- GEOAWARENESS
- FLIGHT PLANNING
- REGUL COMPLIANCE

indra

USP

MULTIPLE/OPTIONAL U-SPACE SERVICES

- TRAFFIC INFO
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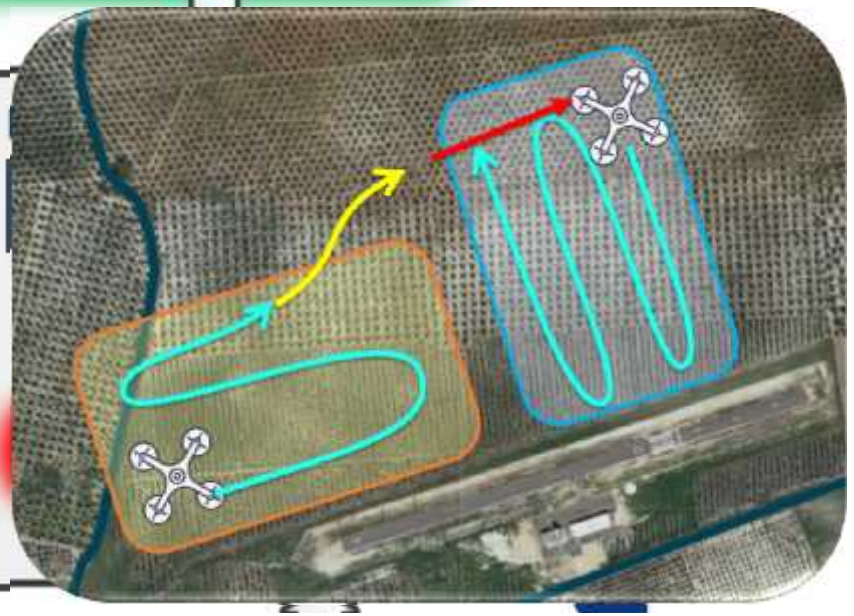
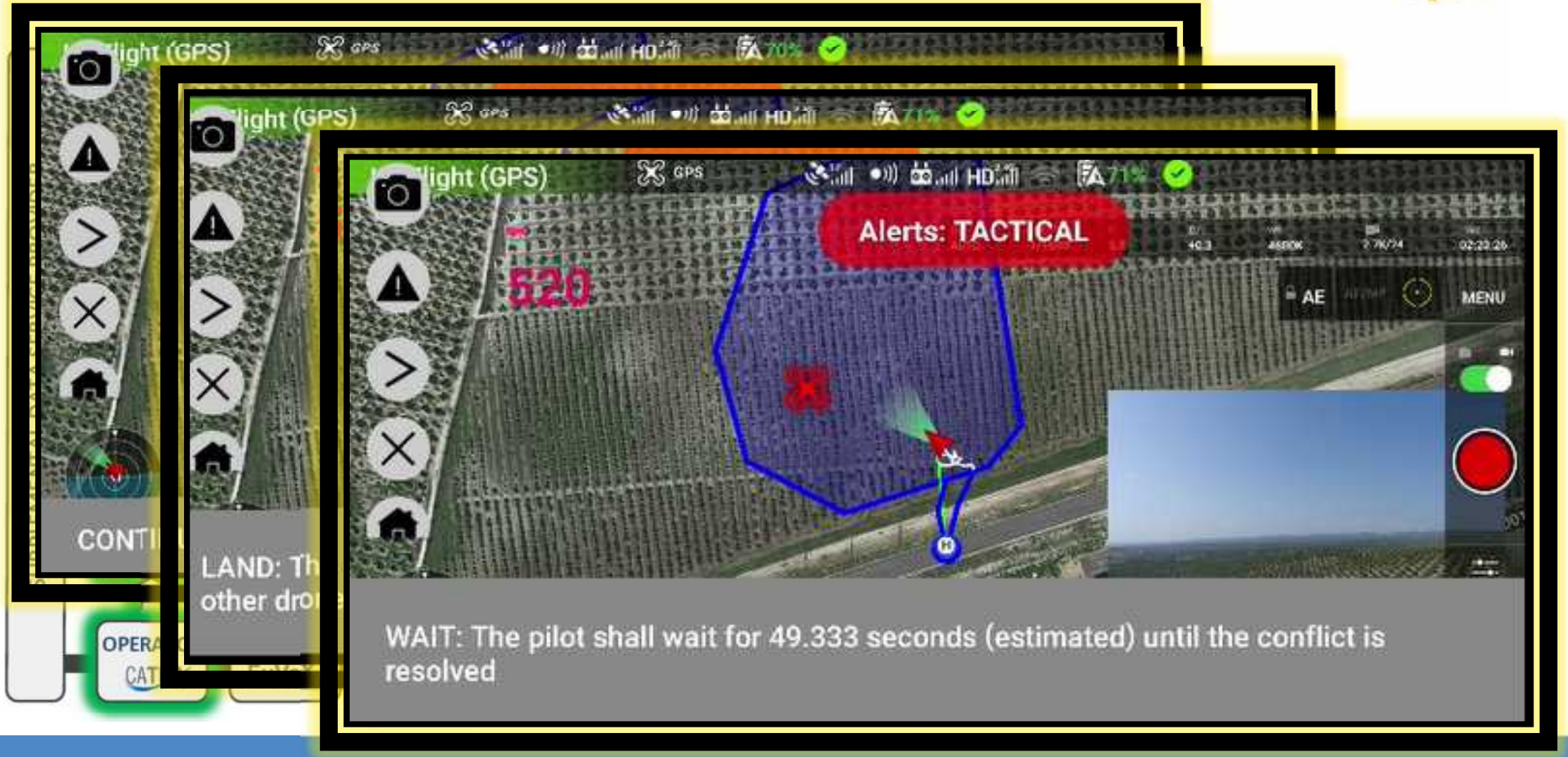
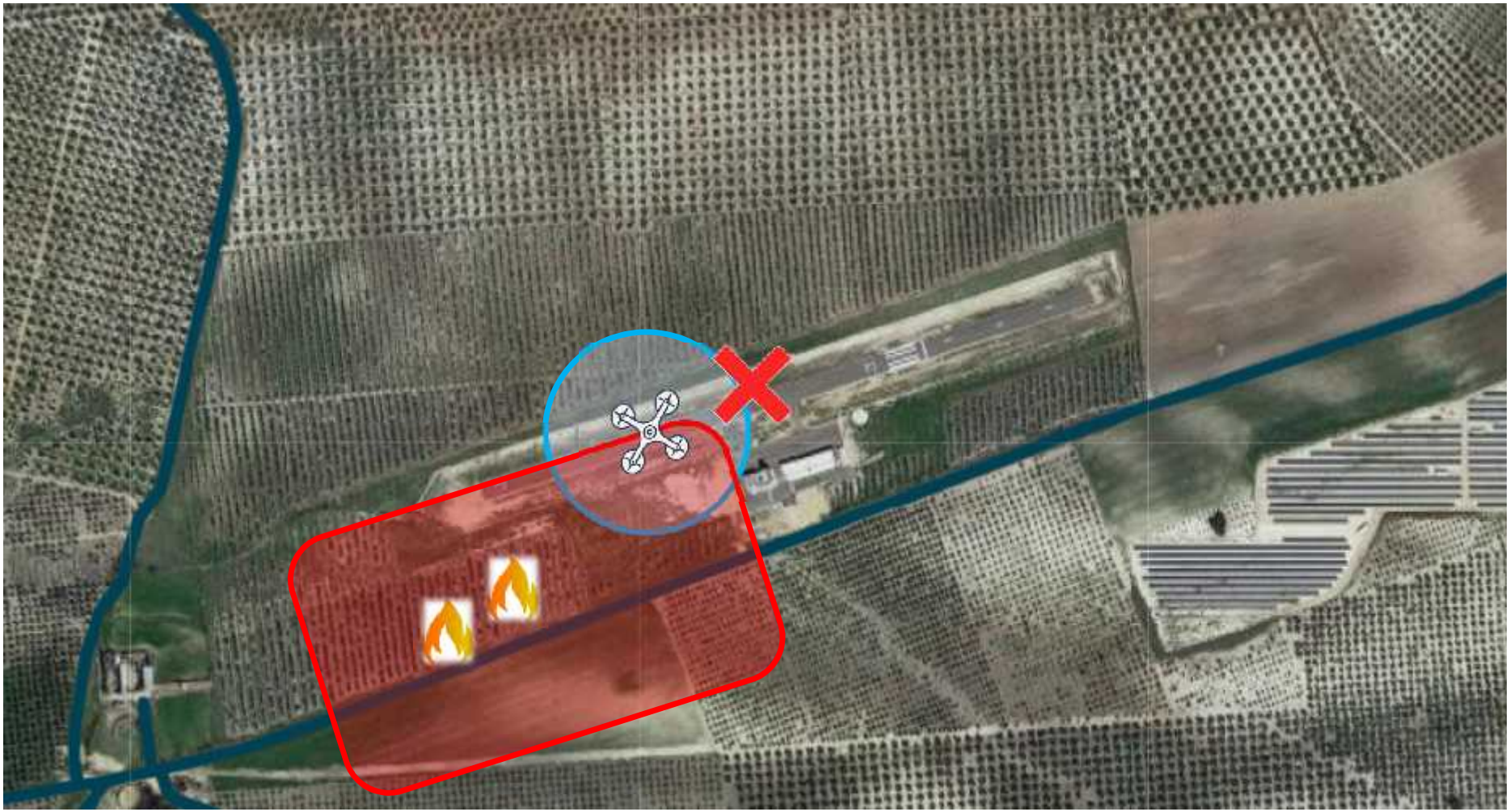
AIRMAP



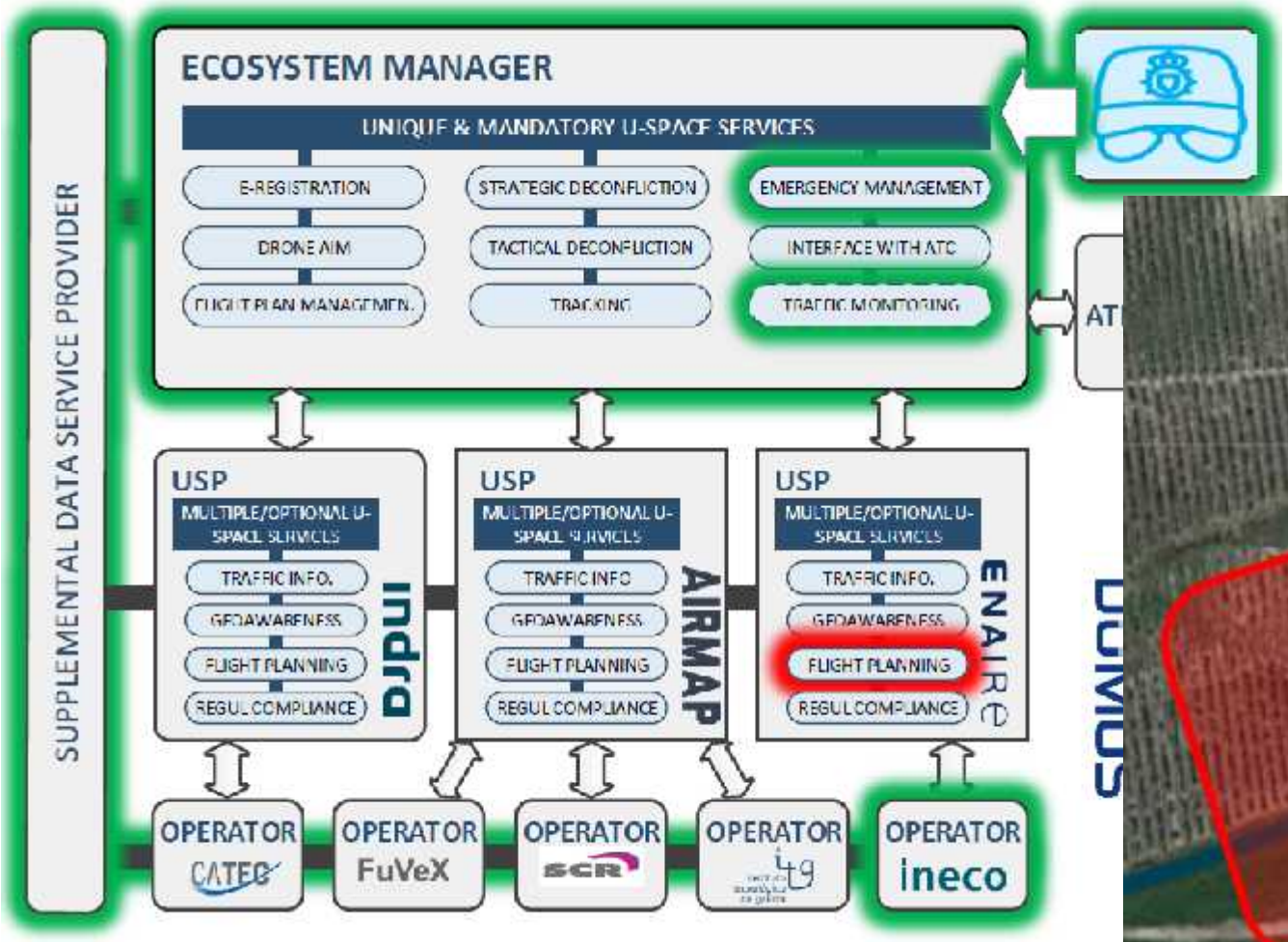
Trial #1: Tactical Deconfliction



Trial #1: Tactical Geofencing



Trial #1: Emergency Area



Trial #1: Emergency Delivery

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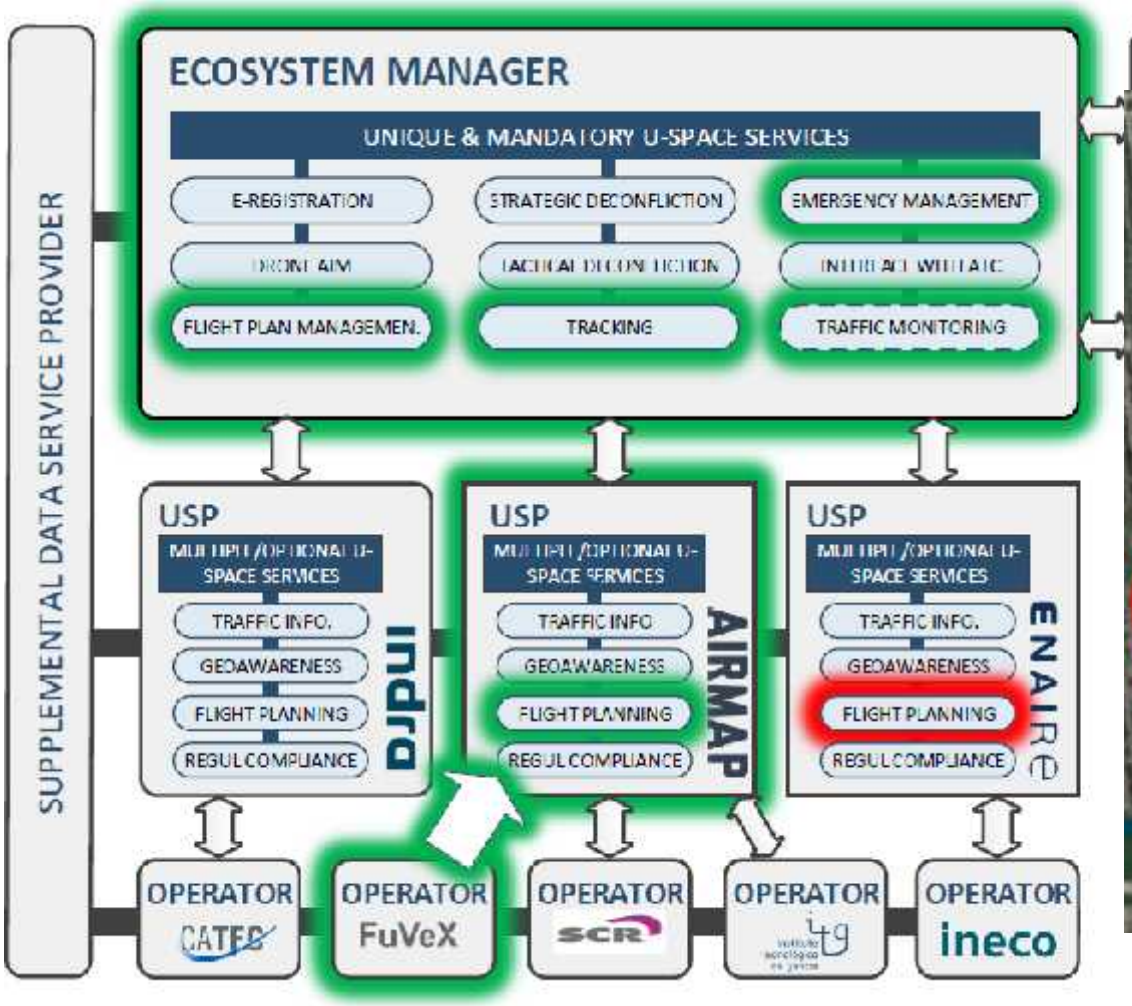

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indra

USP

MULTIPLE/OPTIONAL U-SPACE SERVICES

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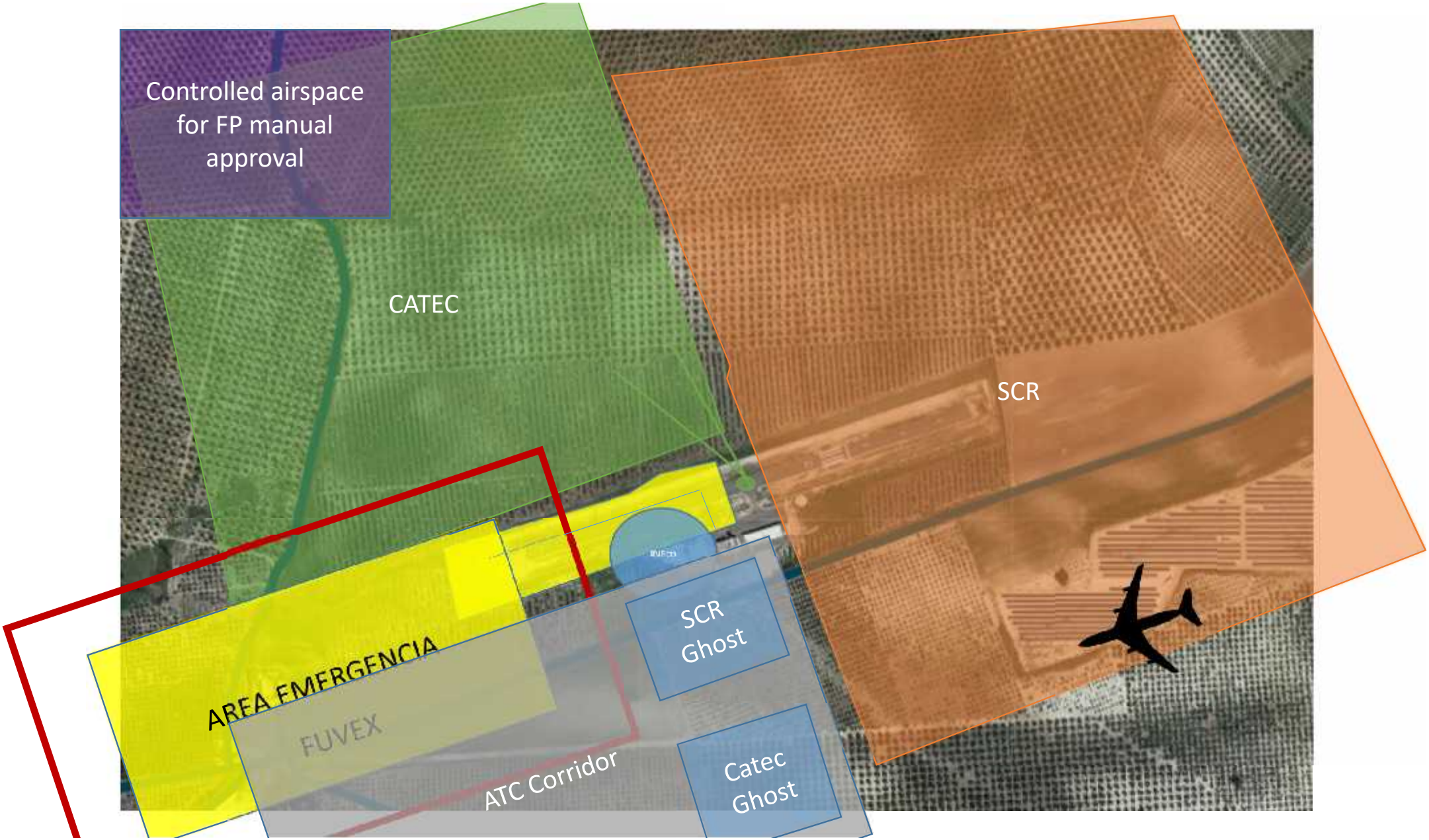
AIRMAP

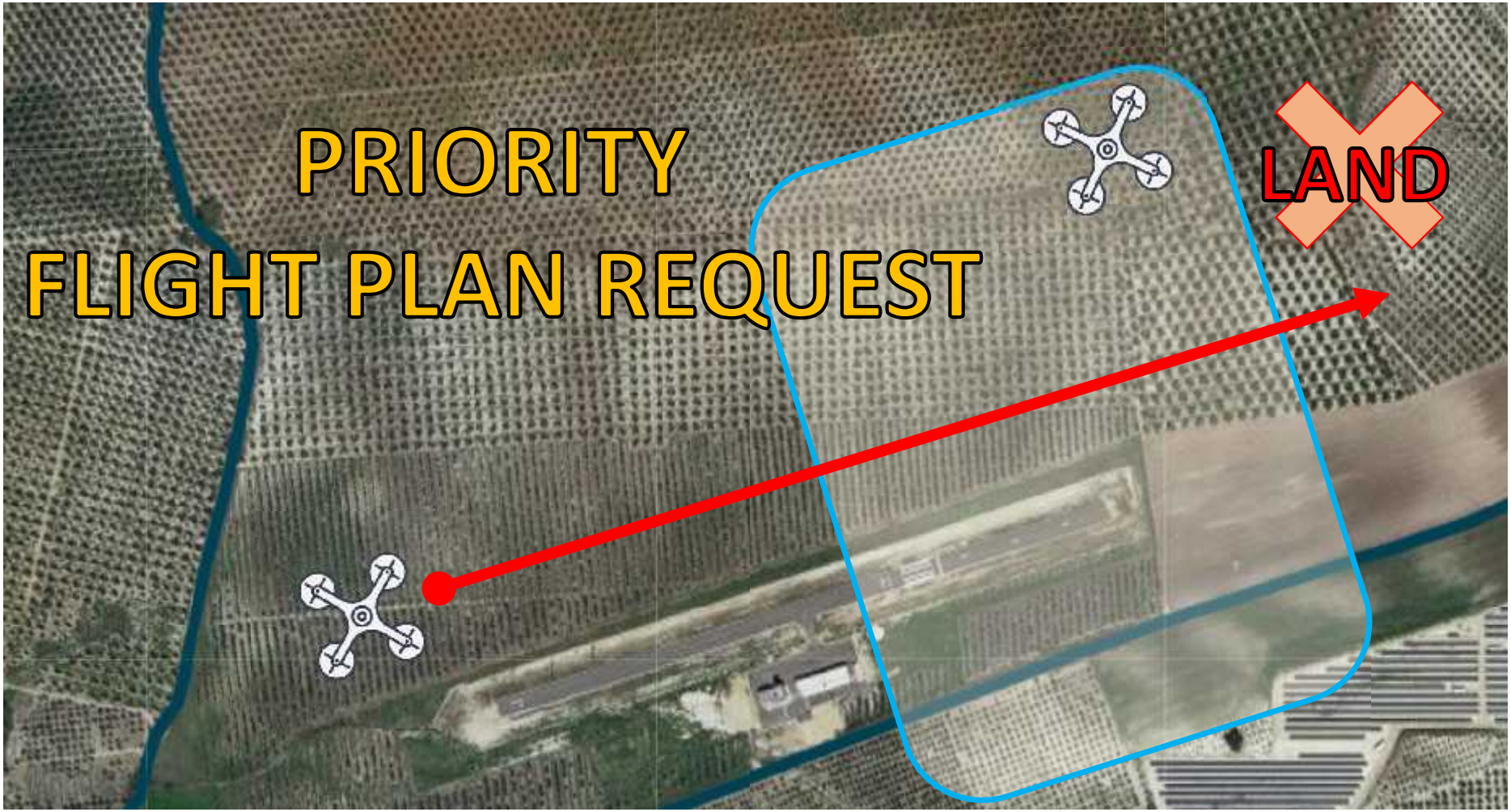
TRIAL #2

ATM-UTM Interface & Surveillance

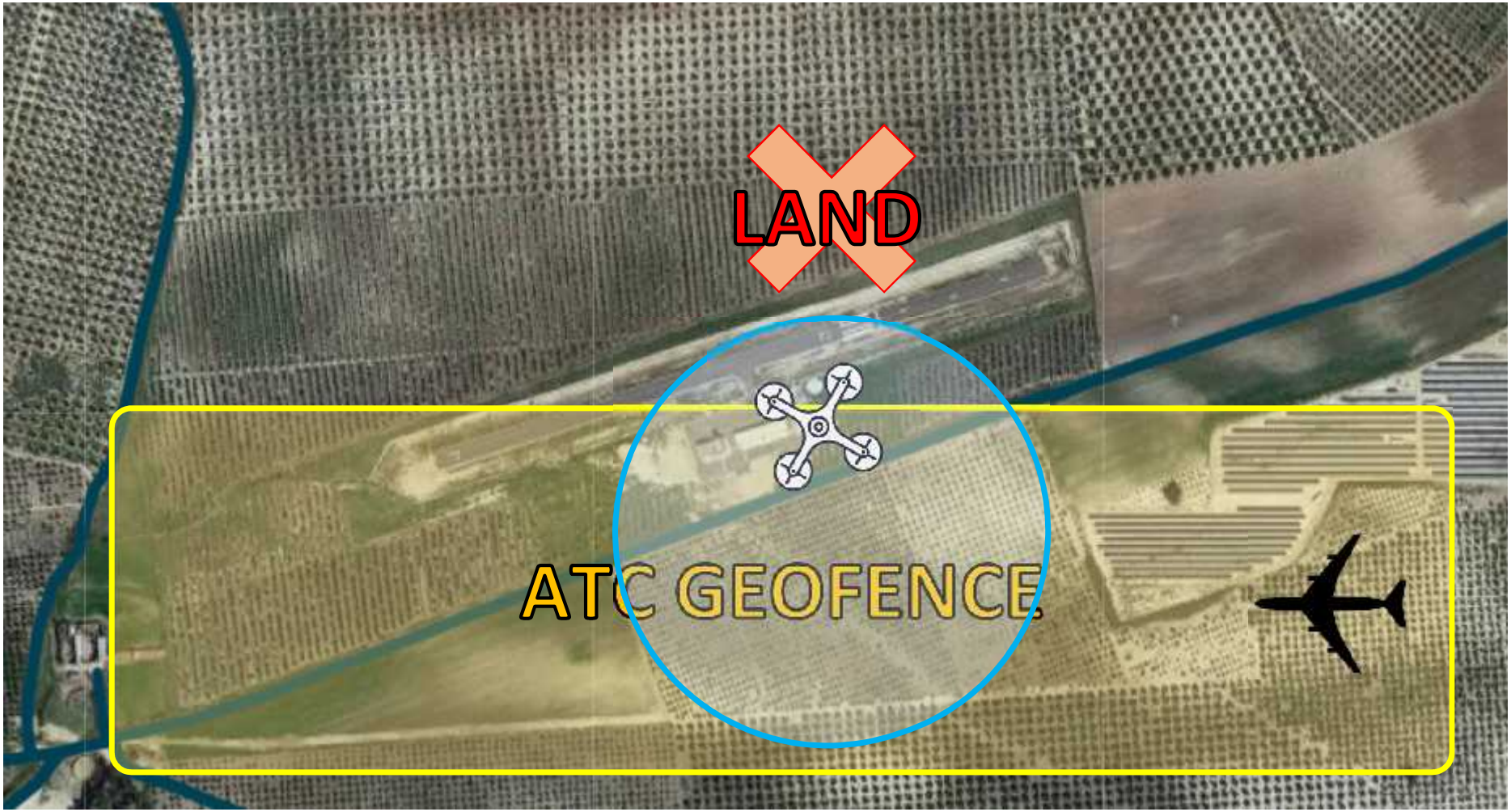

Controlled airspace for FP manual approval
CATEC
SCR
AREA EMERGENCIA
FUVEX
ATC Corridor
SCR Ghost
Catec Ghost

Trial #2: Strategic Deconfliction

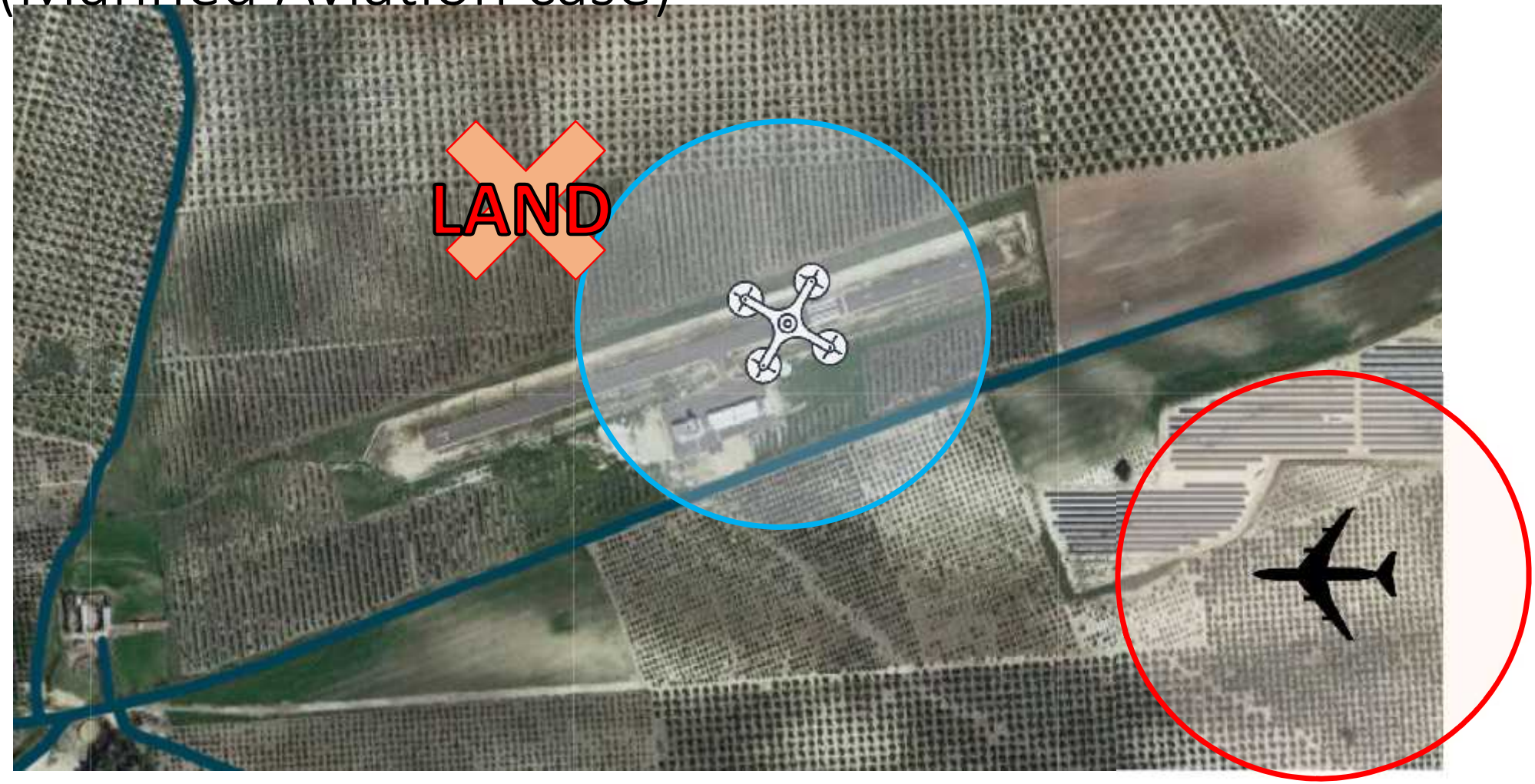
Trial #2: Priority Flight Plan (Flight plan management)

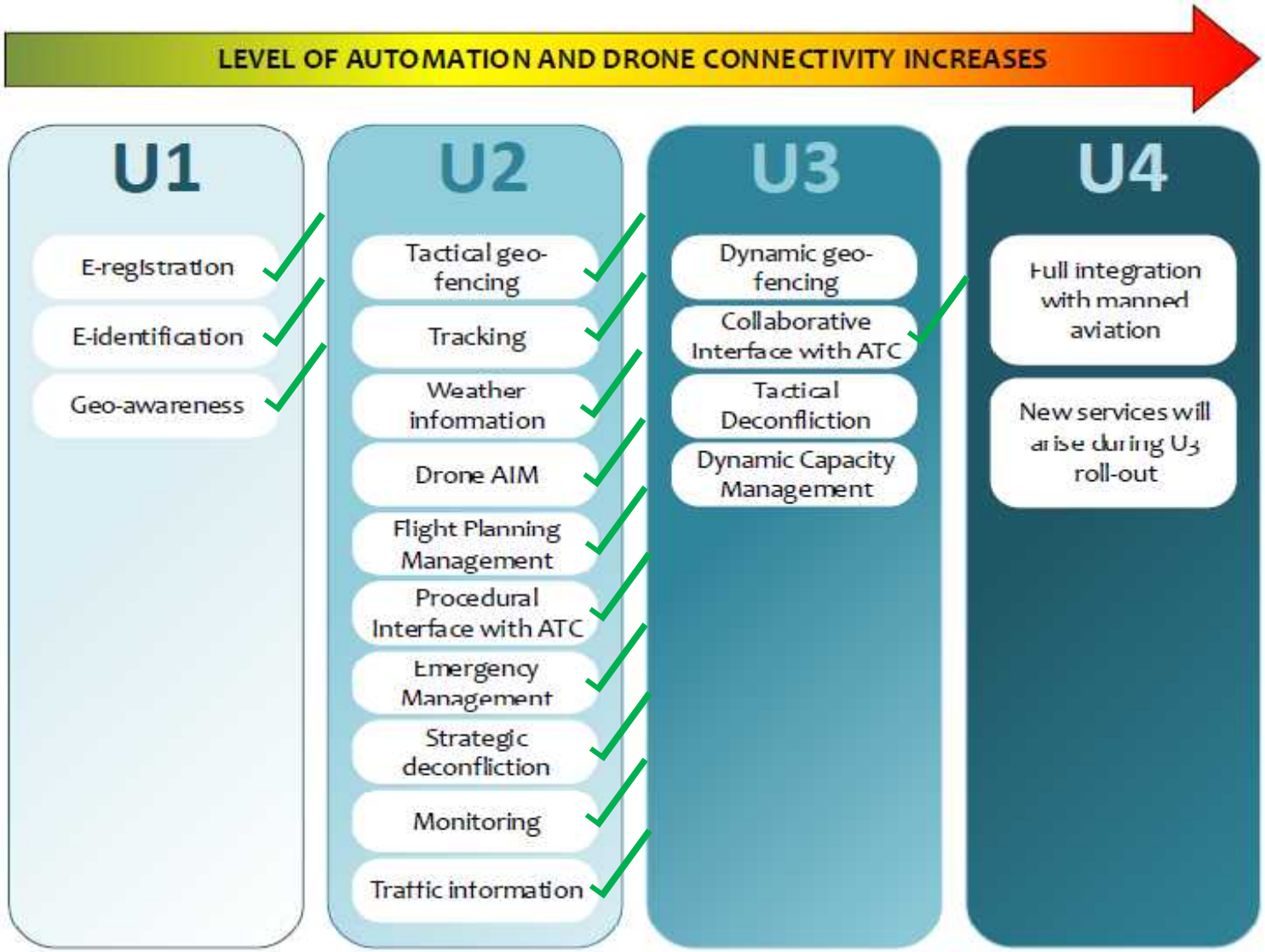


Trial #2: Collaborative ATC



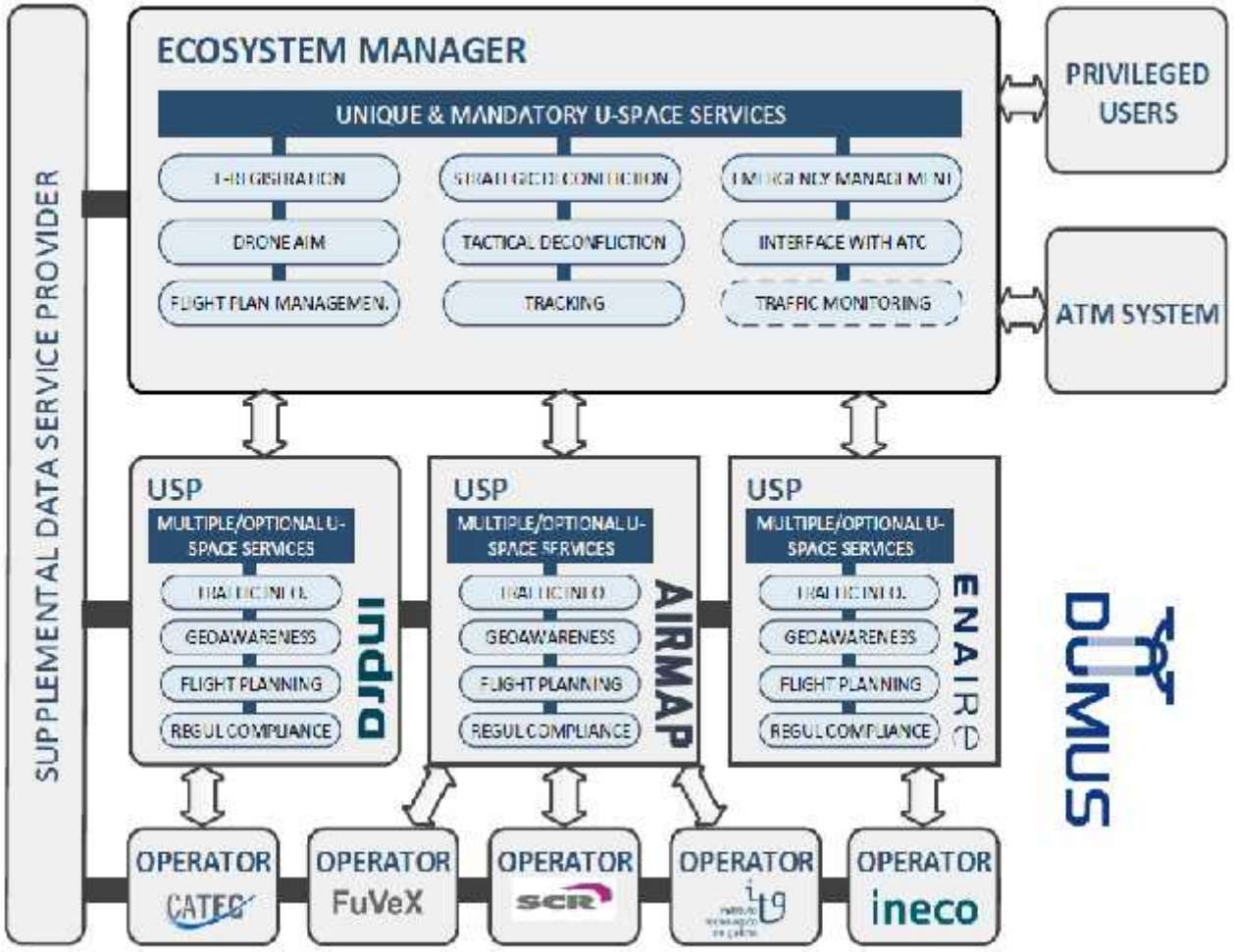
Trial #2: Emergency Management (Manned Aviation case)

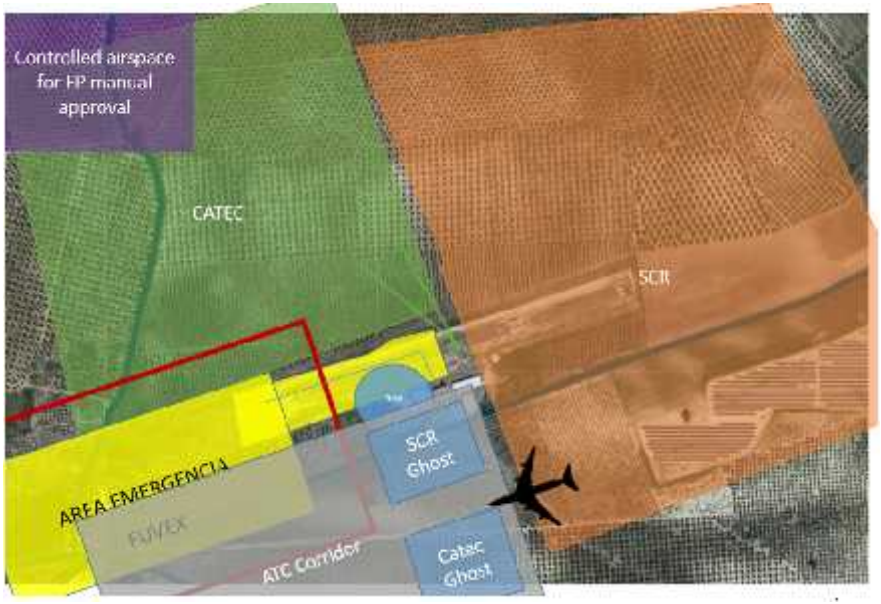



LEVEL OF AUTOMATION AND DRONE CONNECTIVITY INCREASES
U1
E-registration
E-identification
Geo-awareness
U2
Tactical geo-fencing
Tracking
Weather information
Drone AIM
Flight Planning Management
Procedural Interface with ATC
Emergency Management
Strategic deconfliction
Monitoring
Traffic information
U3
Dynamic geo-fencing
Collaborative Interface with ATC
Tactical Deconfliction
Dynamic Capacity Management
U4
Full integration with manned aviation
New services will arise during U3 roll-out

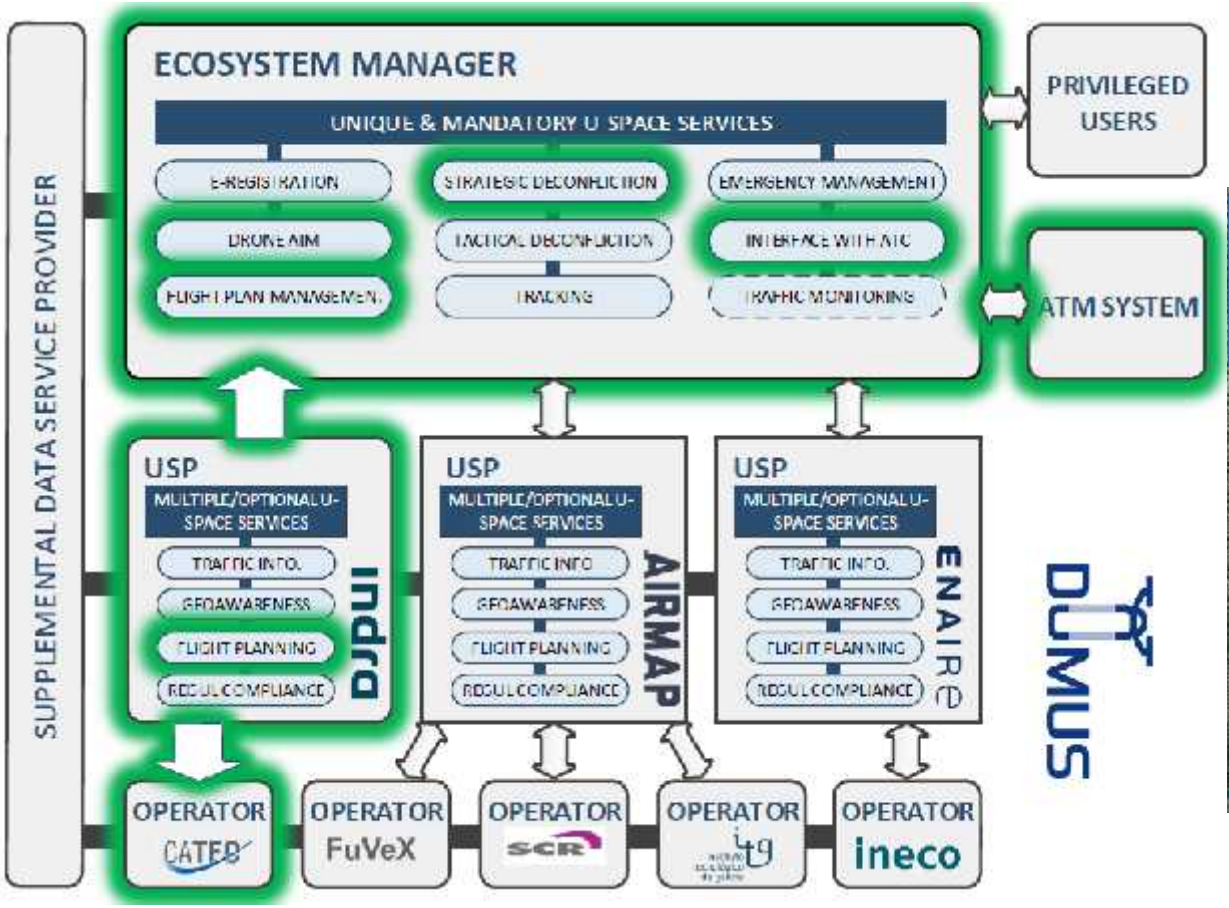

TRIAL #2
LET'S GO!
ATM-UTM
Interface
&
Surveillance

Trial #2: General Picture

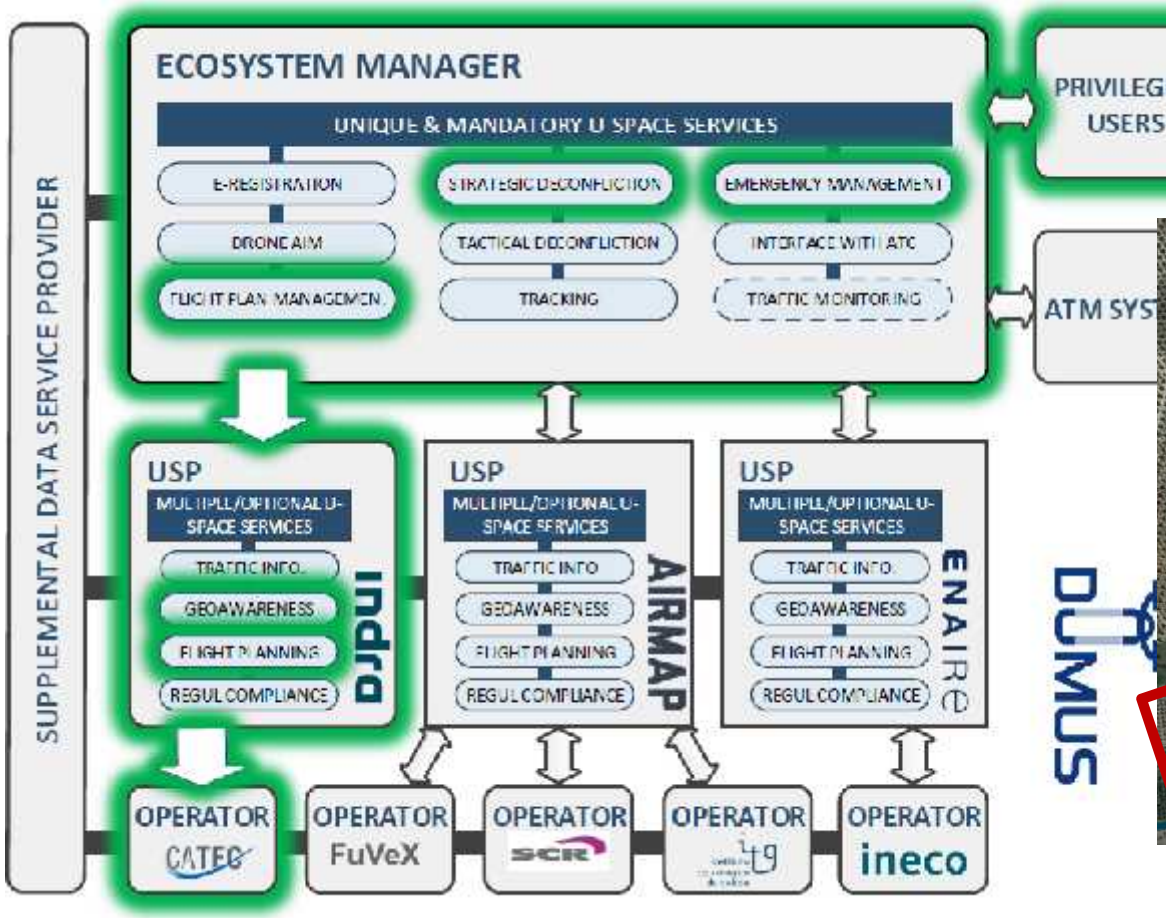




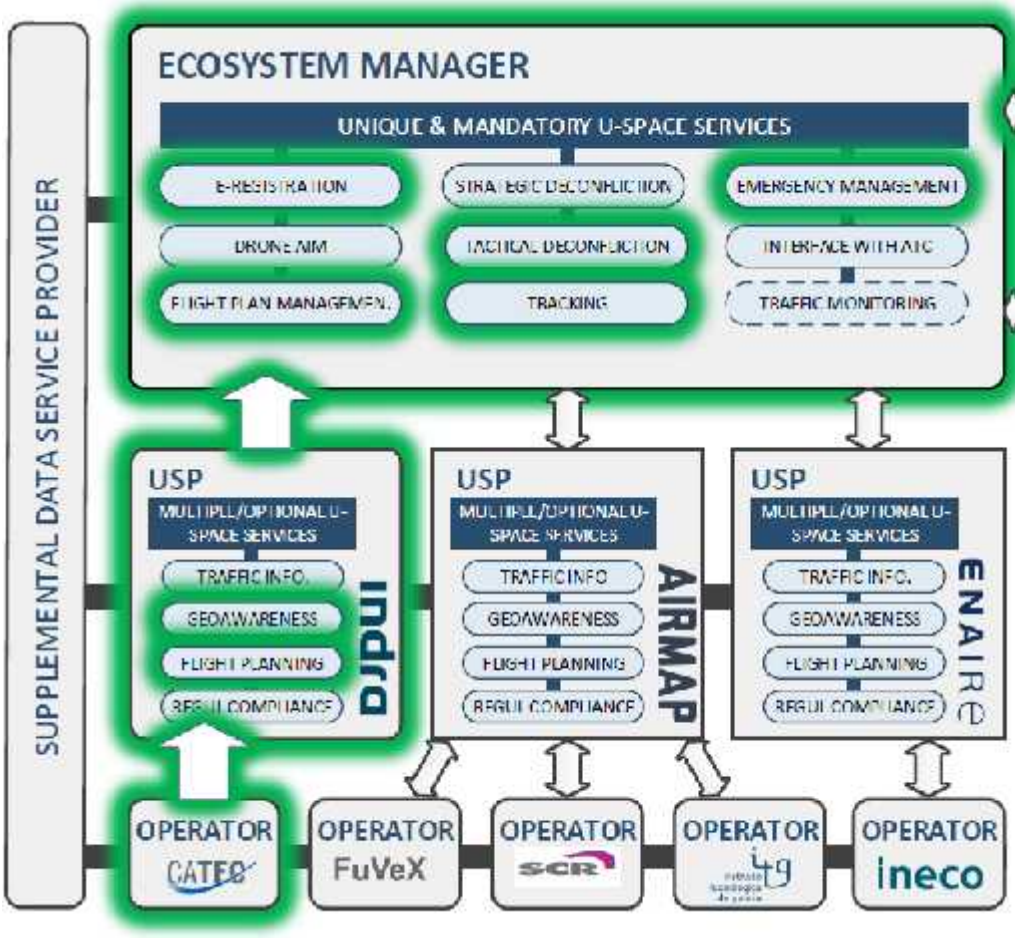
Trial #2: Controlled Airspace Flight Approval (#4)

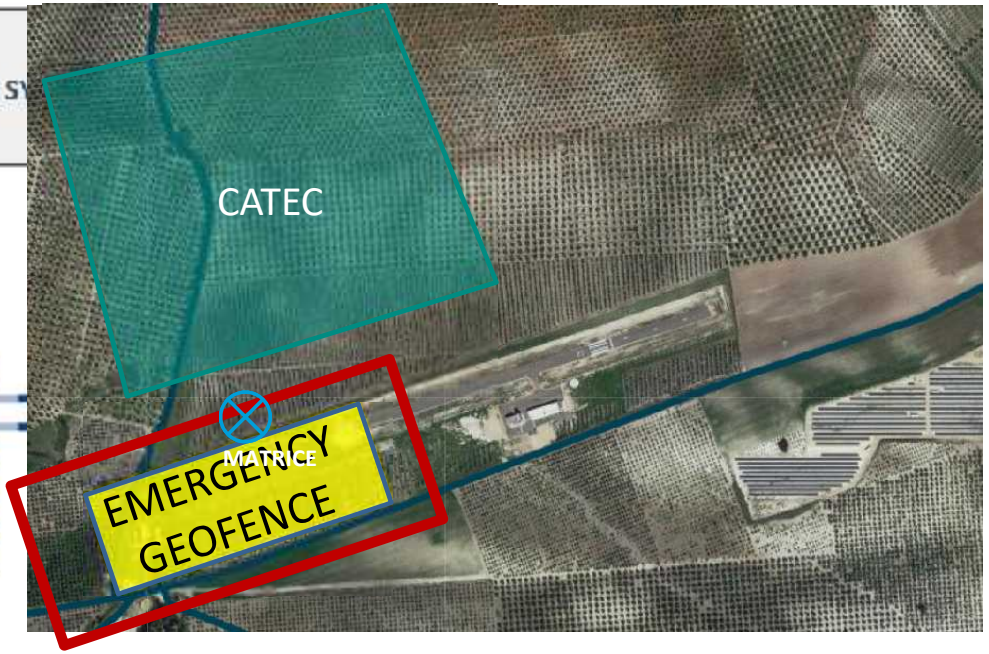


Trial #2: Tactical Geofencing & Strategic Deconfliction (#9, #10)

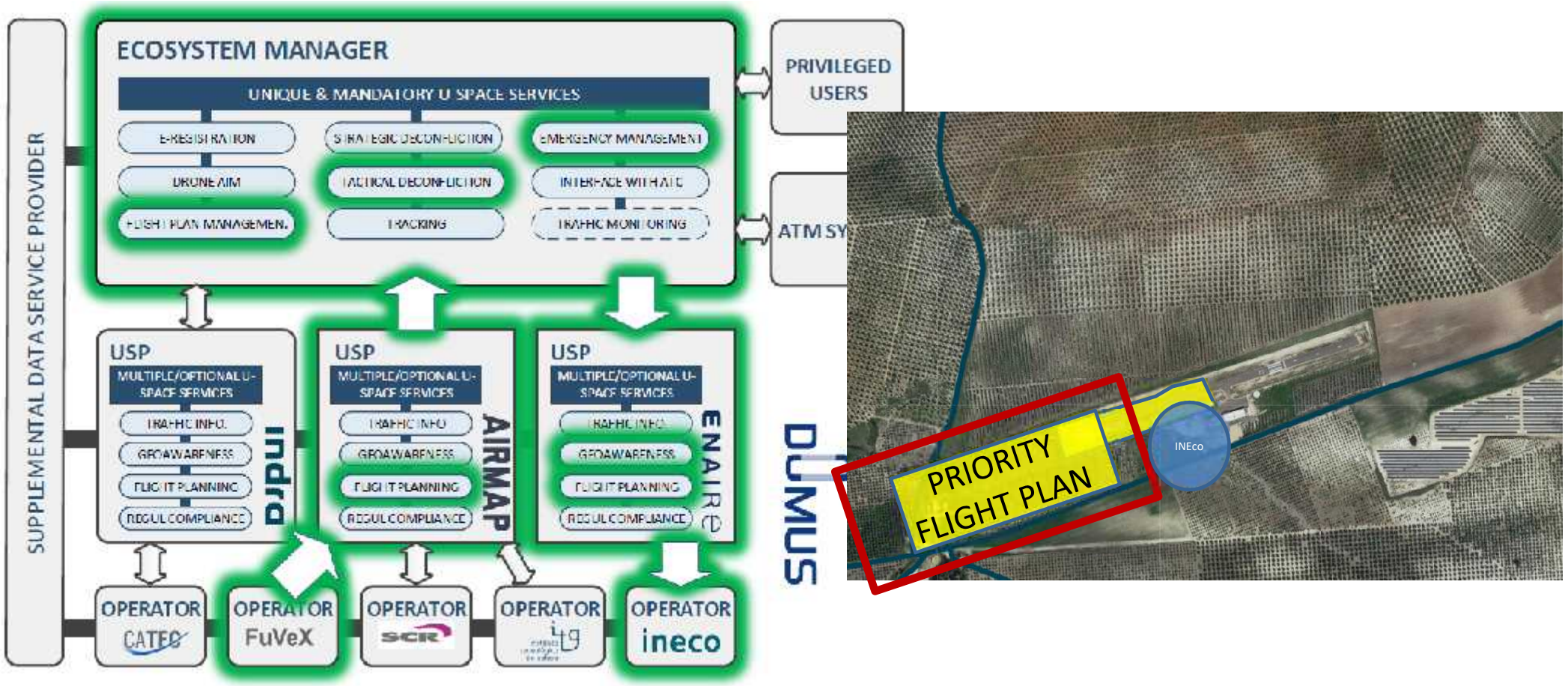


Trial #2: Geofence Alert (#11, #12)

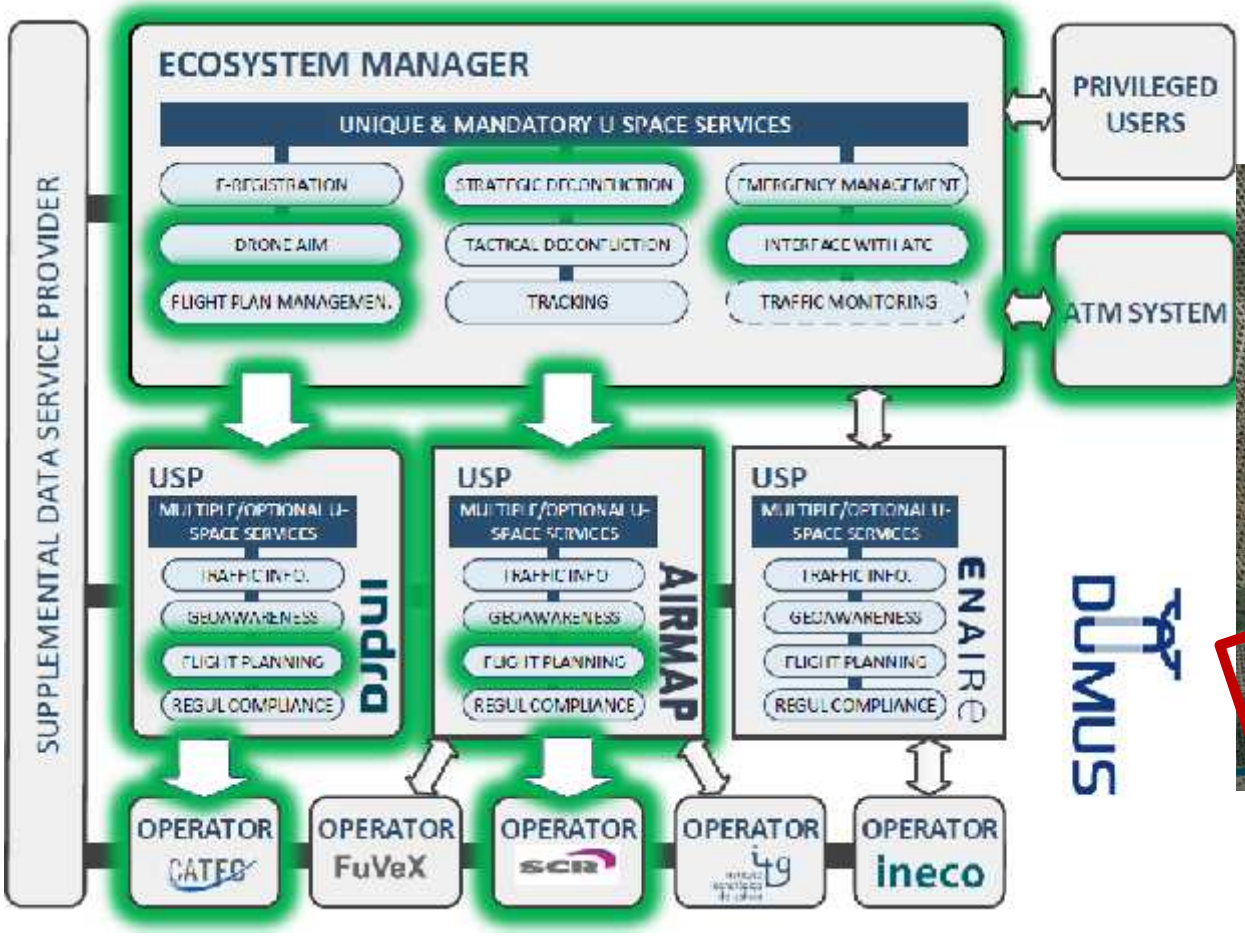


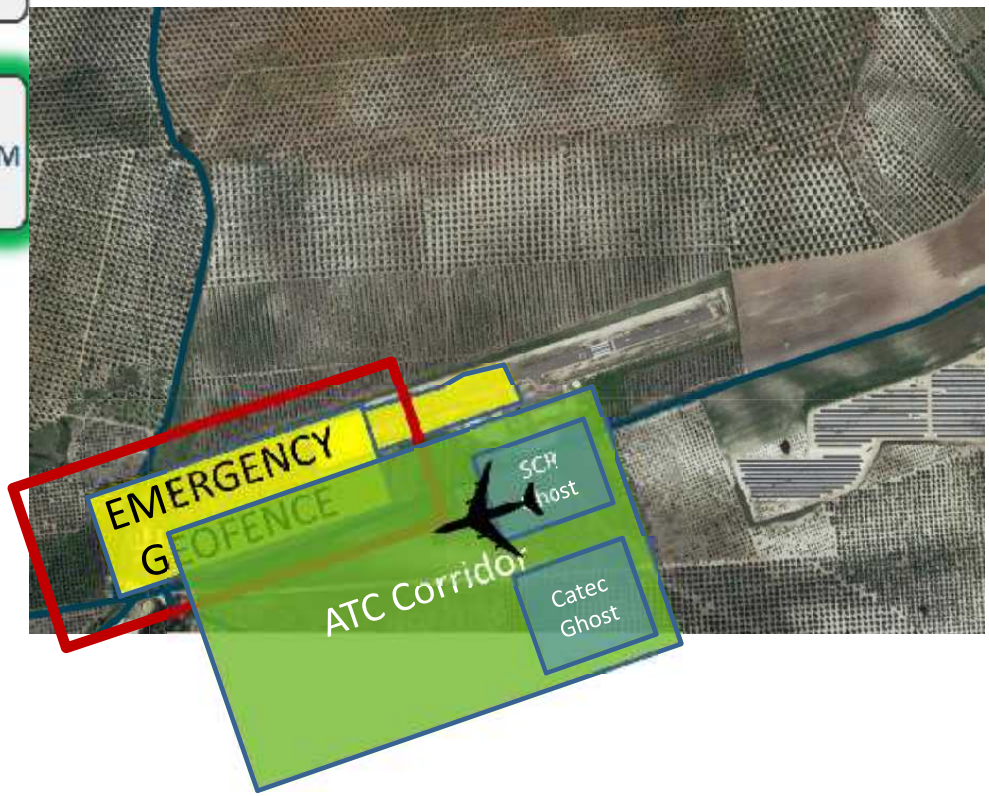


Trial #2: Priority Flight Plan (#15)

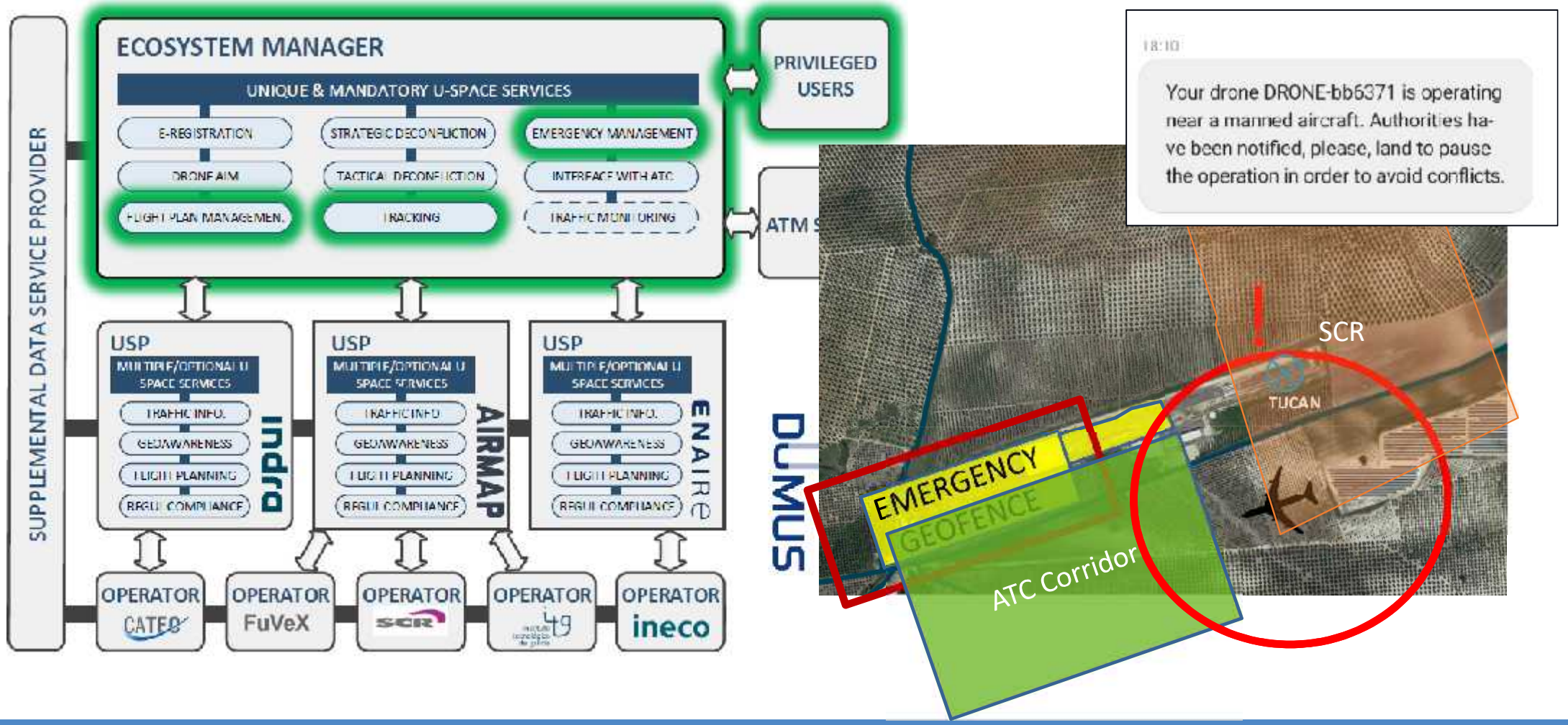


Trial #2: ATC Corridor (#18)

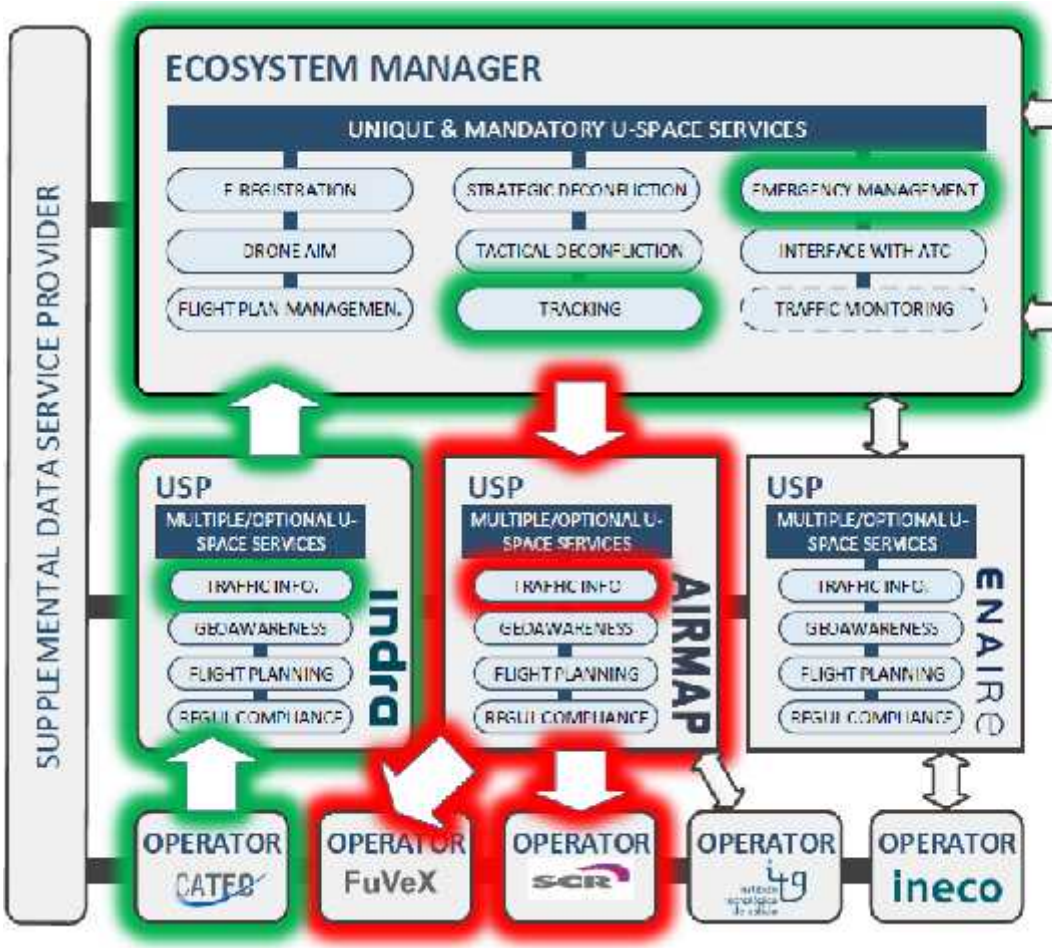


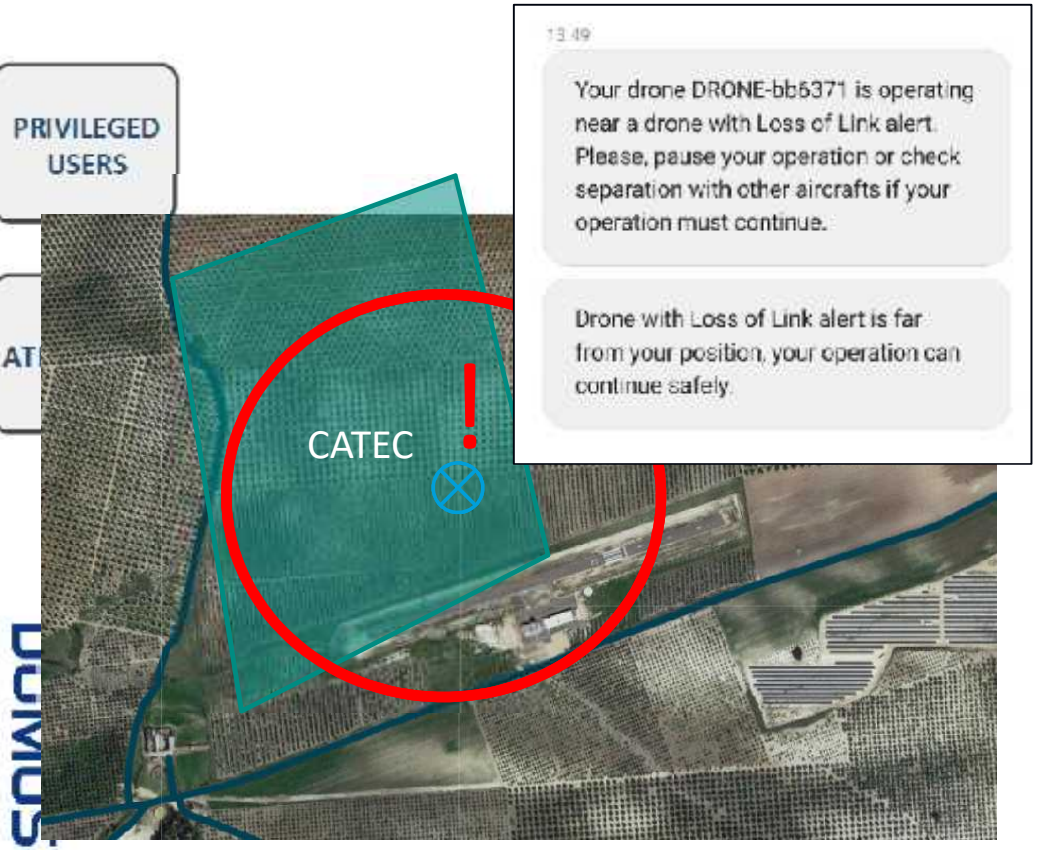


Trial #2: Manned Aircraft Geofencing (#19)



Trial #2: Loss of Link Alert (#22, #23)



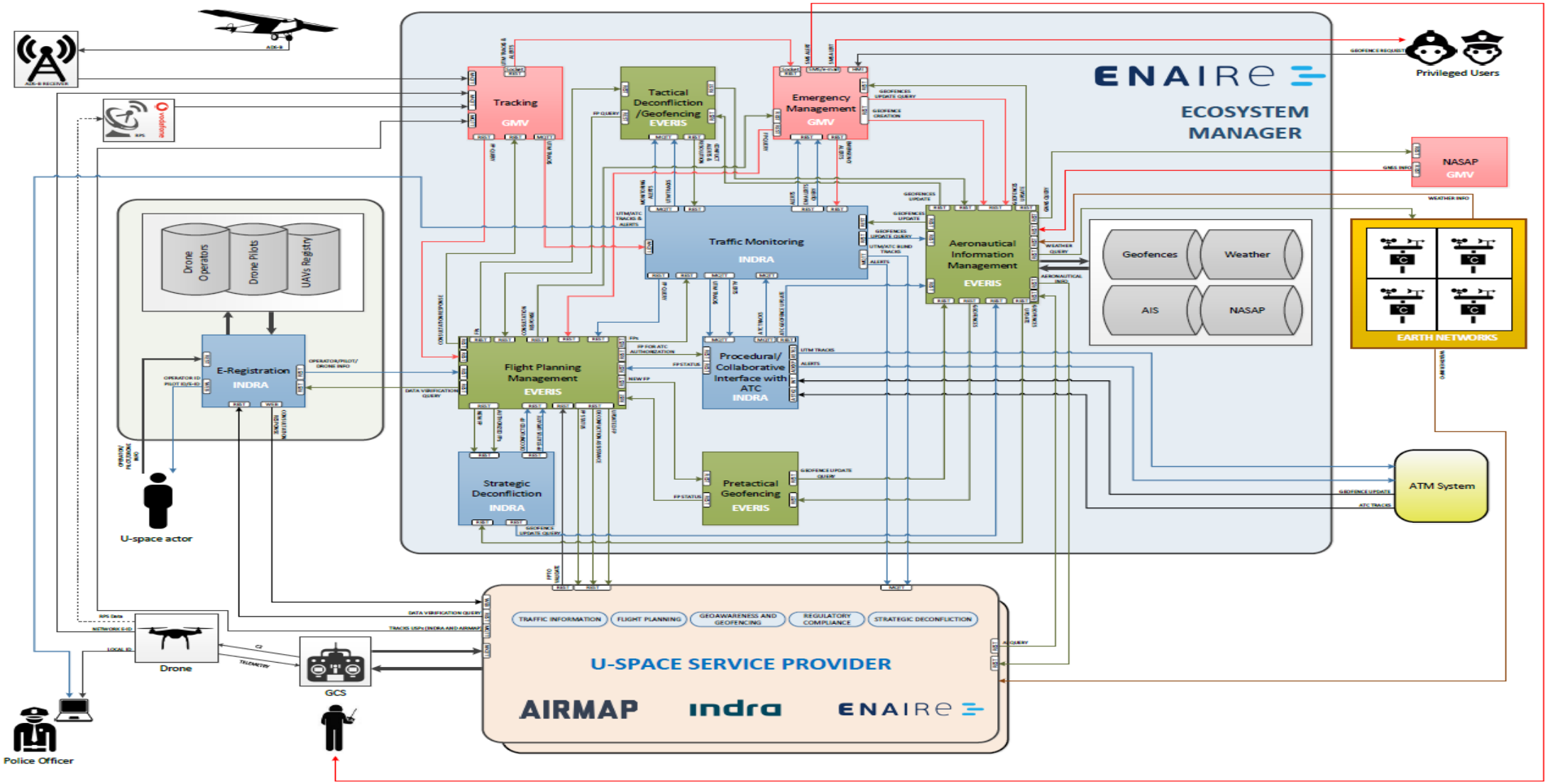


DOMUS Architecture

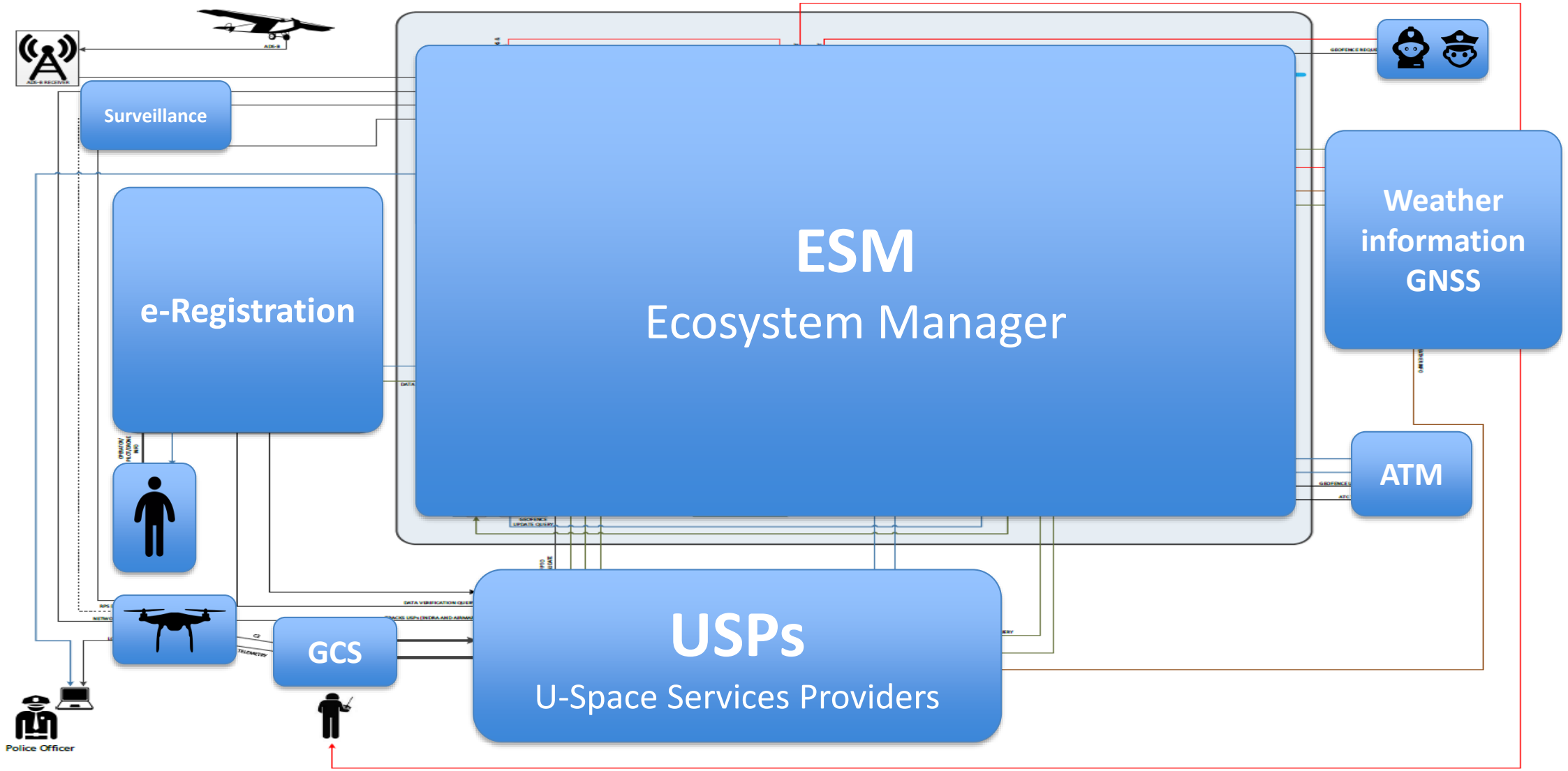
Objectives

- Allow multiple U-space Service Providers (USPs).
- Provide deconfliction, strategic and tactical (U3).
- Common aeronautical and operational information.
- Modular, Open, Interoperable

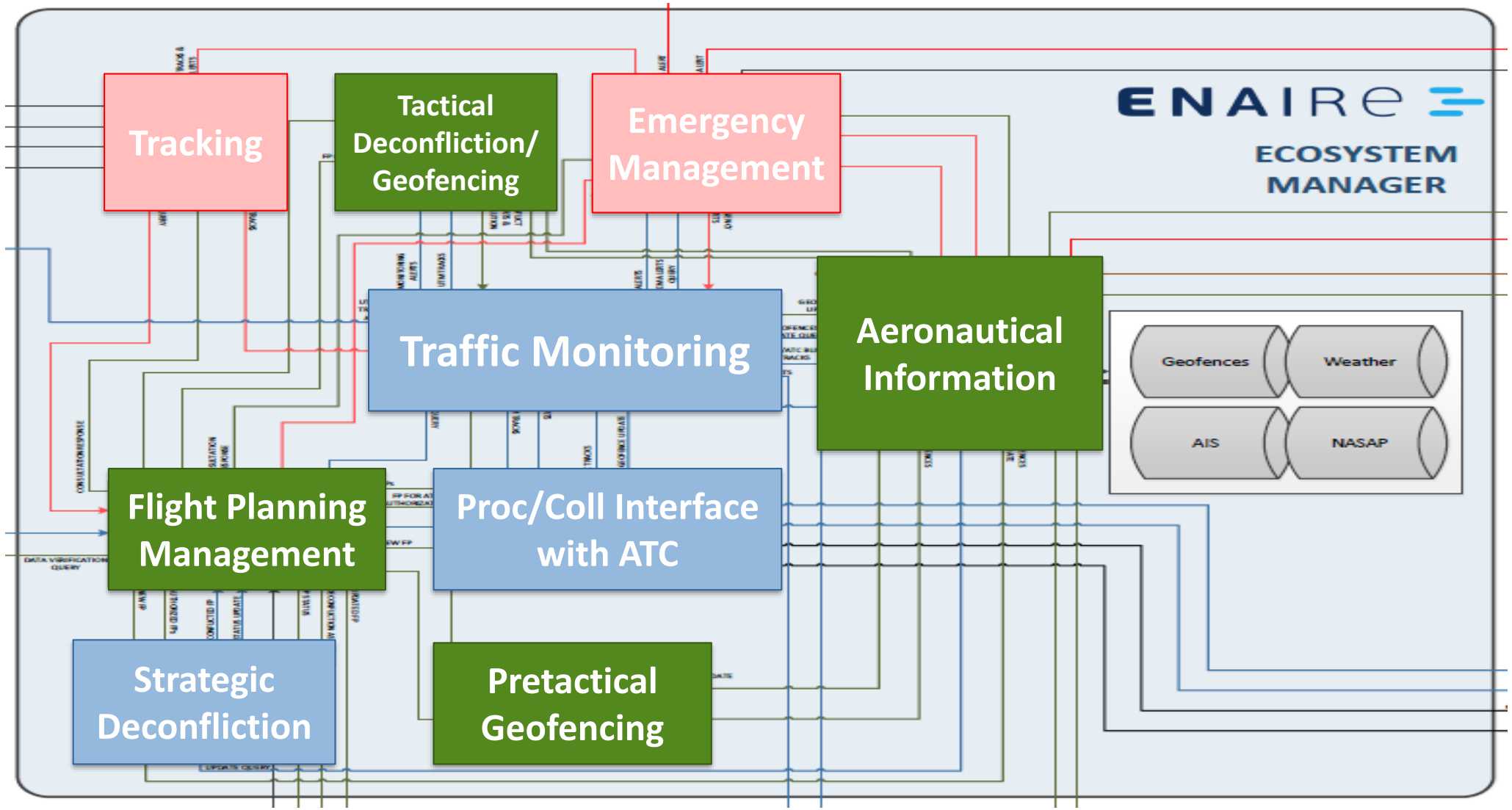
DOMUS Architecture



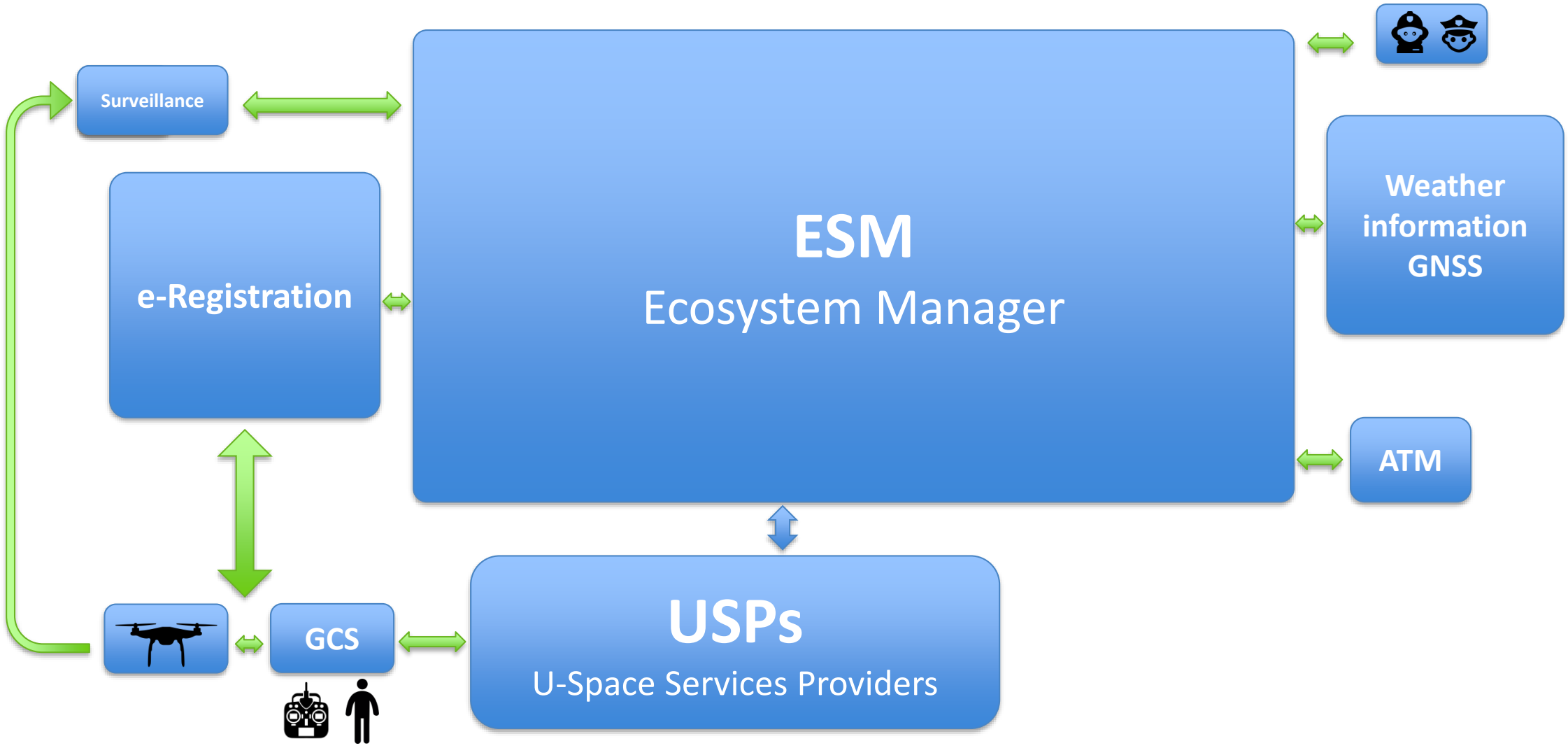
DOMUS Architecture



DOMUS Architecture

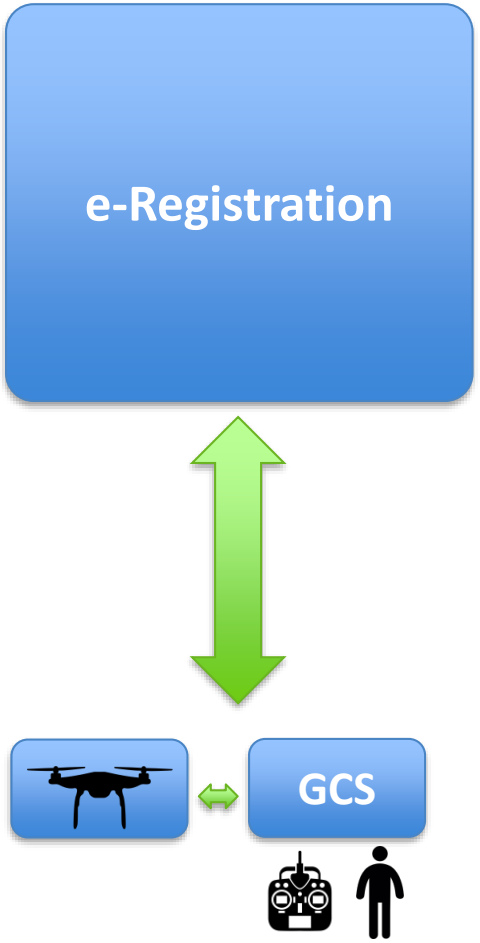


DOMUS Architecture



DOMUS Architecture

Stage 0 – e-Registration



1 → Operator fills in the formulary.

2 → Data is stored in the databases.

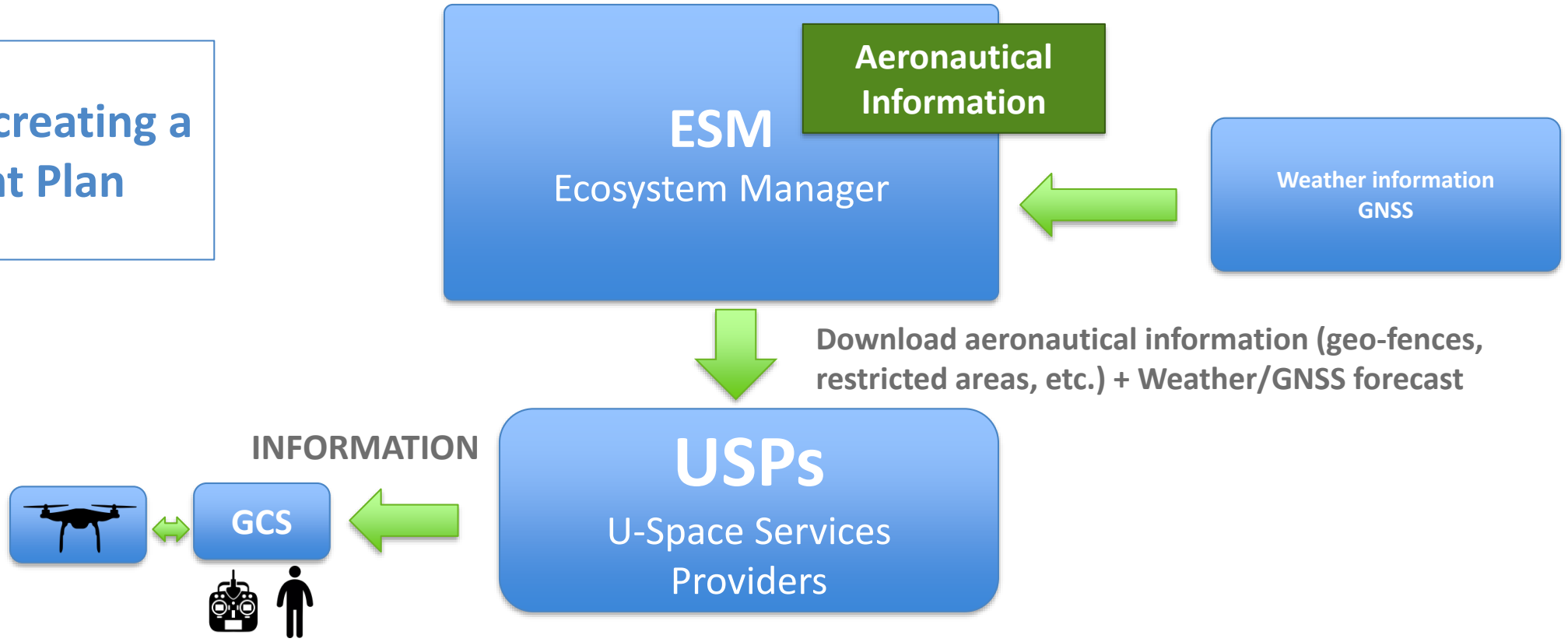
3 → Operator introduces the identifications in the USP, which confirms them with e-Registration.

4 → FPM confirms the data introduced is correct and receives the information required for FPs.

DOMUS Architecture

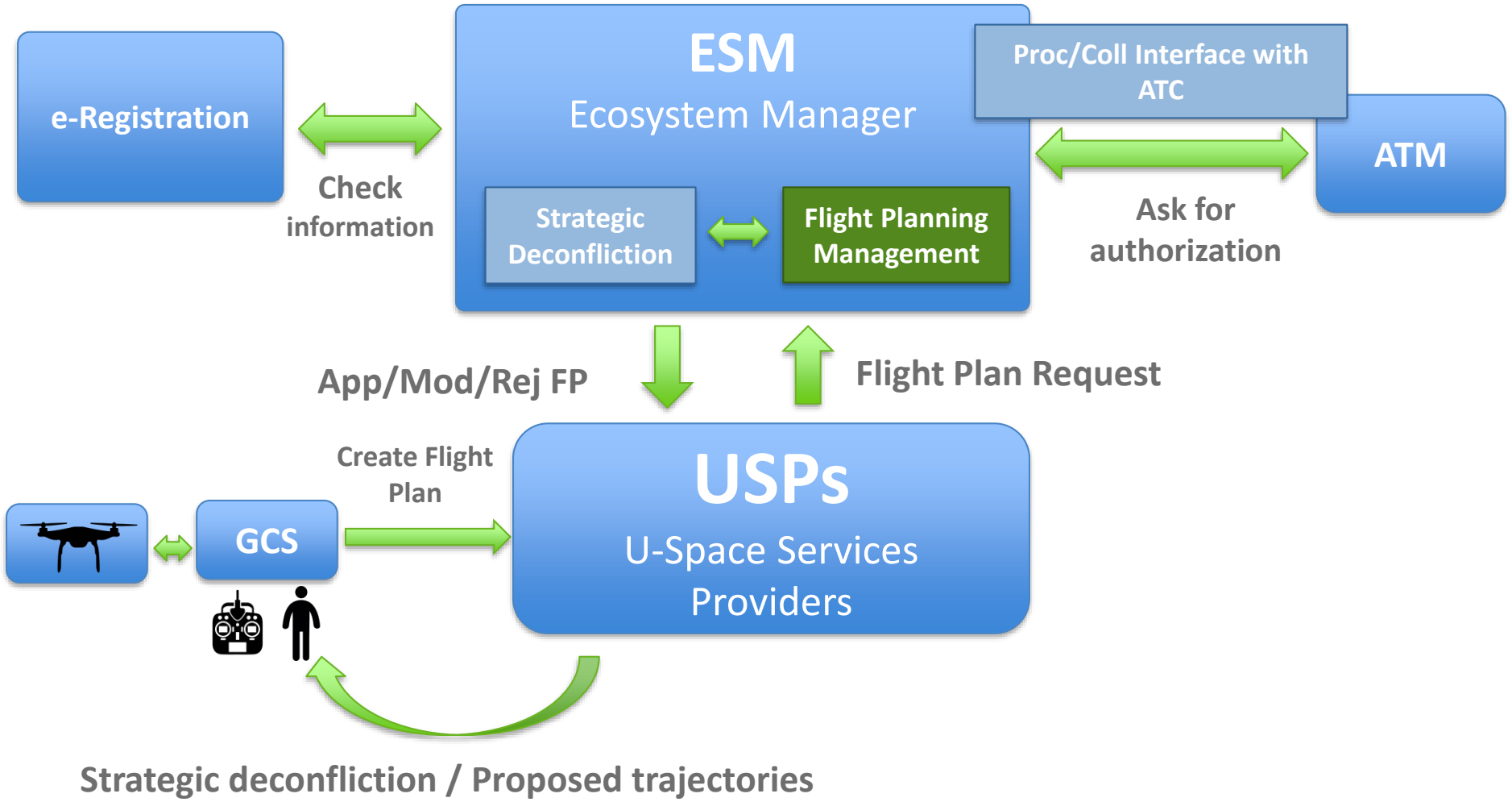
Stage 1 – Flight Plan Request and Approval

Before creating a Flight Plan



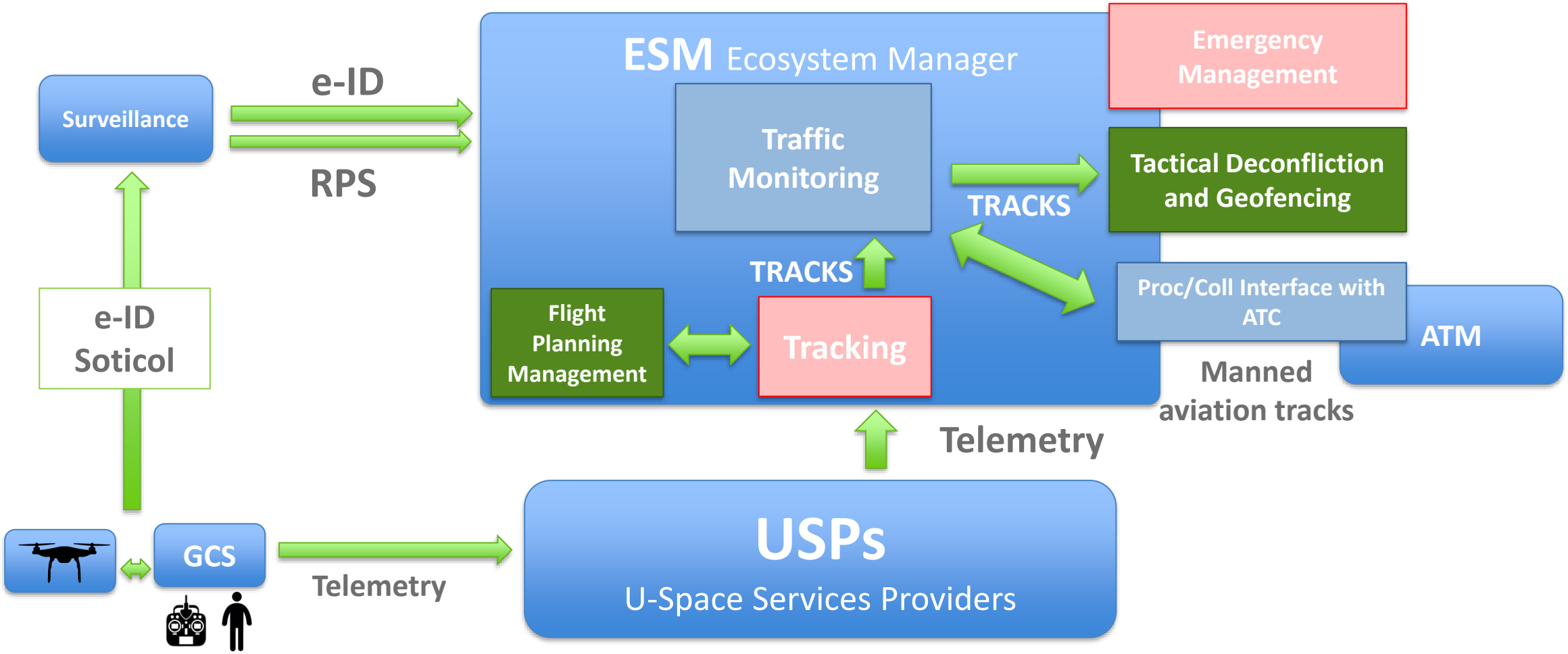
DOMUS Architecture

Stage 1 – Flight Plan Request and Approval



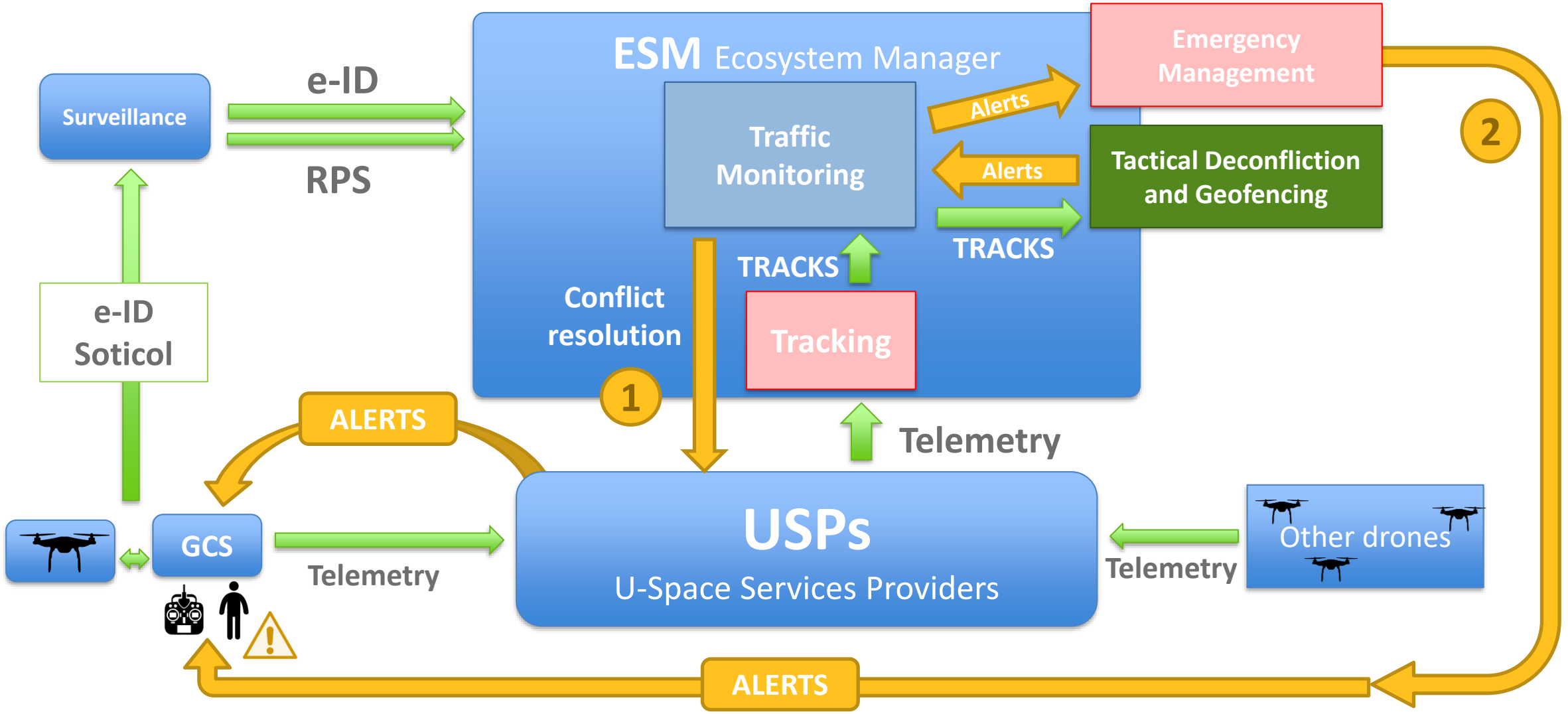
DOMUS Architecture

Stage 2 – Real Time Traffic Monitoring



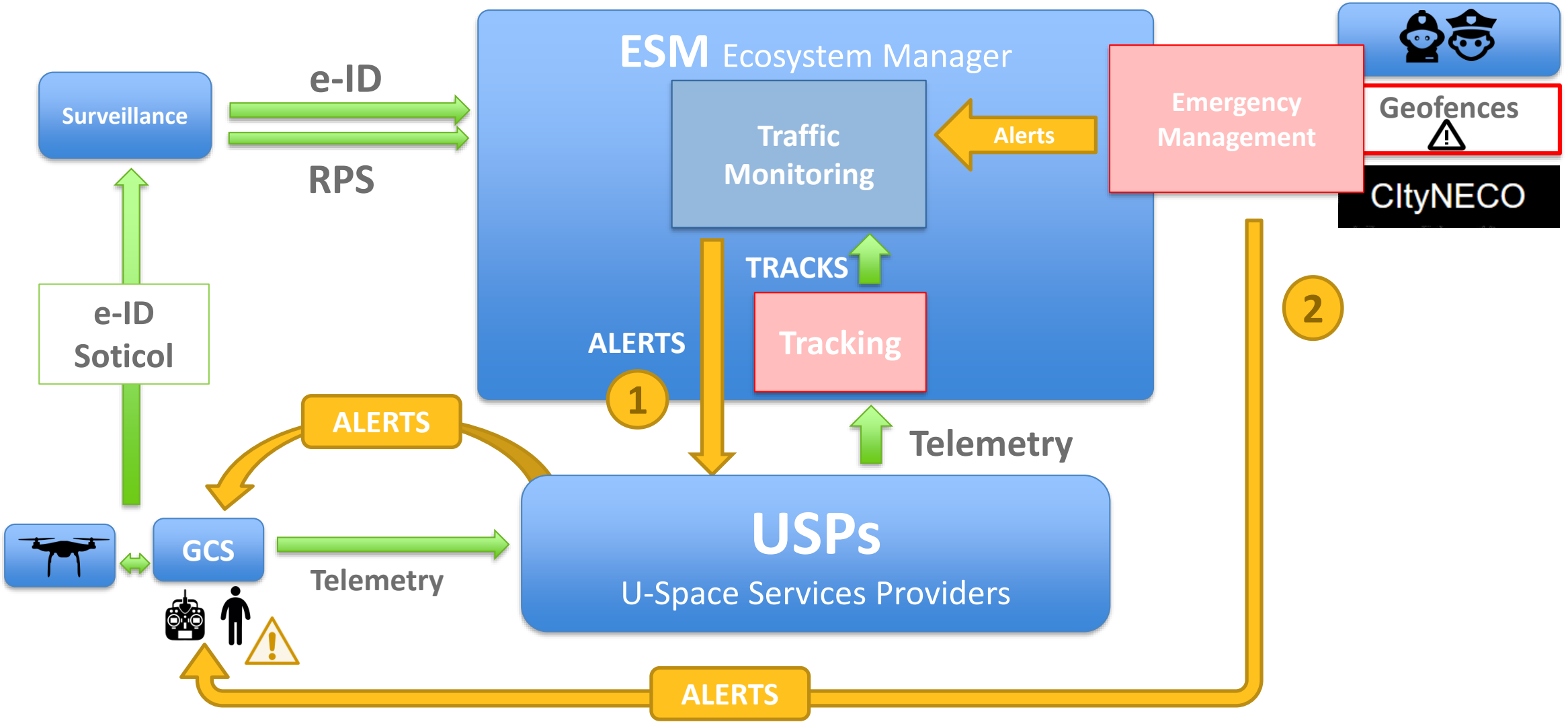
DOMUS Architecture

Stage 2 – Real Time Traffic Monitoring. Deconfliction



DOMUS Architecture

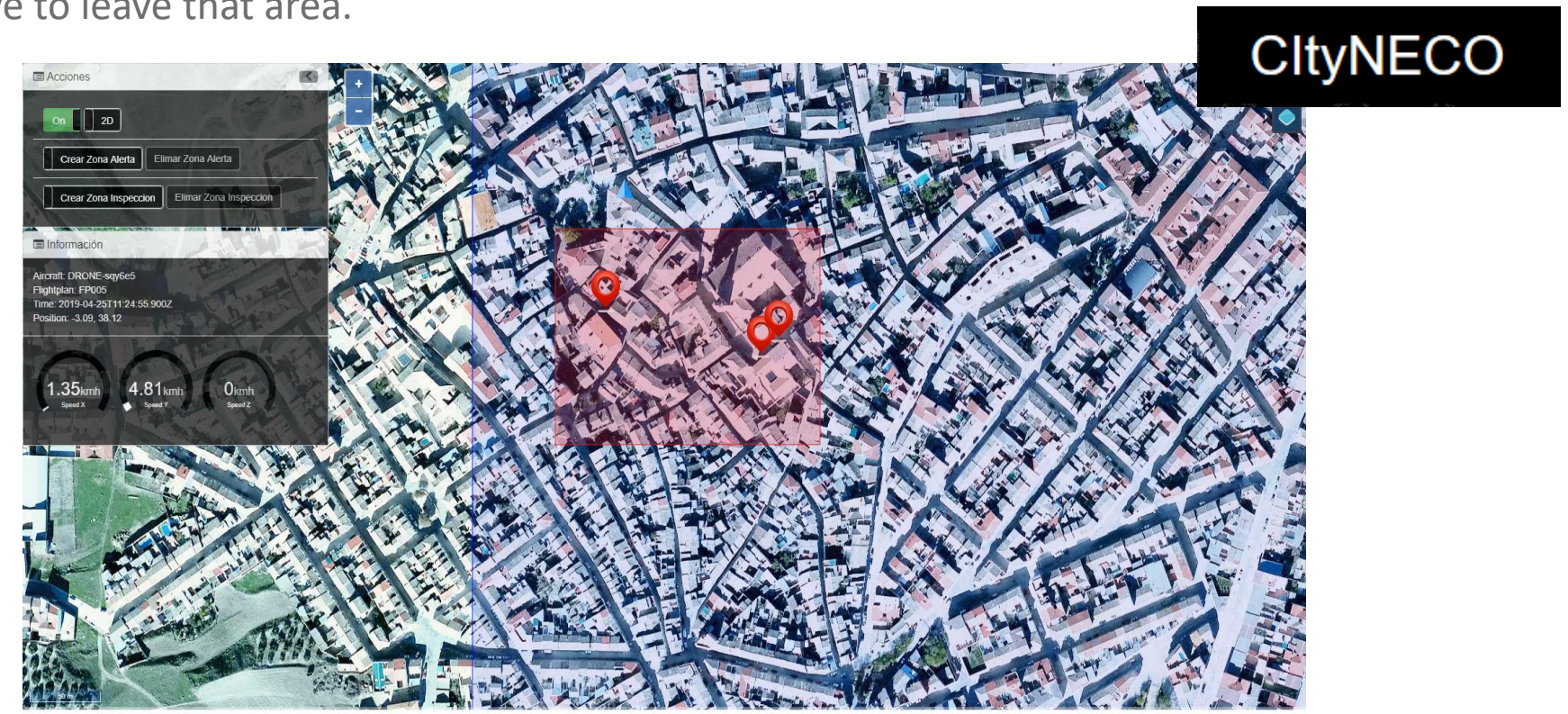
Stage 2 – Real Time Traffic Monitoring. Emergency



DOMUS Architecture

Smart City Interaction: Cityneco

1. Cityneco will connect to the ESM to define monitoring areas and receive tracks of the drones operating in them.
2. Cityneco will use a drone to get video streaming of pedestrian flows in a city.
   - If drones are flying over sensitive areas, Cityneco will provide alerts to the ESM to inform the operators that they have to leave that area.



Surveillance Data: E-ID & RPS

SESAR JOINT UNDERTAKING

Founding Members

EUROPEAN UNION EUROCONTROL

DOMUS Architecture

Dongle specifications

Self-powered (2 hours)

Modem LTE Cat 3 B20

Communication:

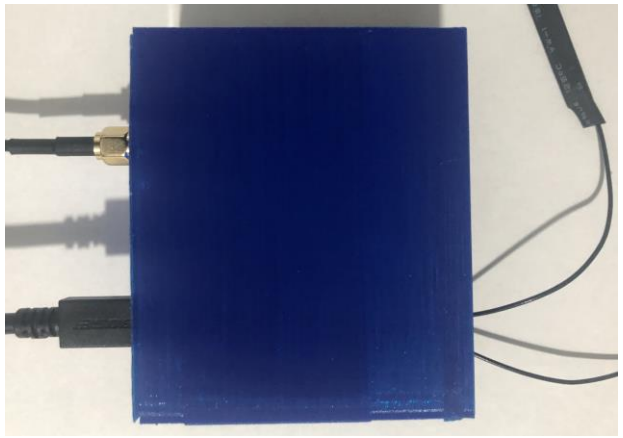
- TCP/IP
- Local radio (2.4 GHz) based on CSS > 1,5 km

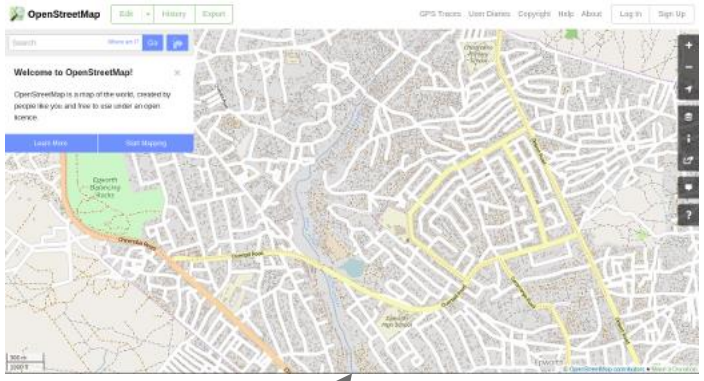
Information provided:

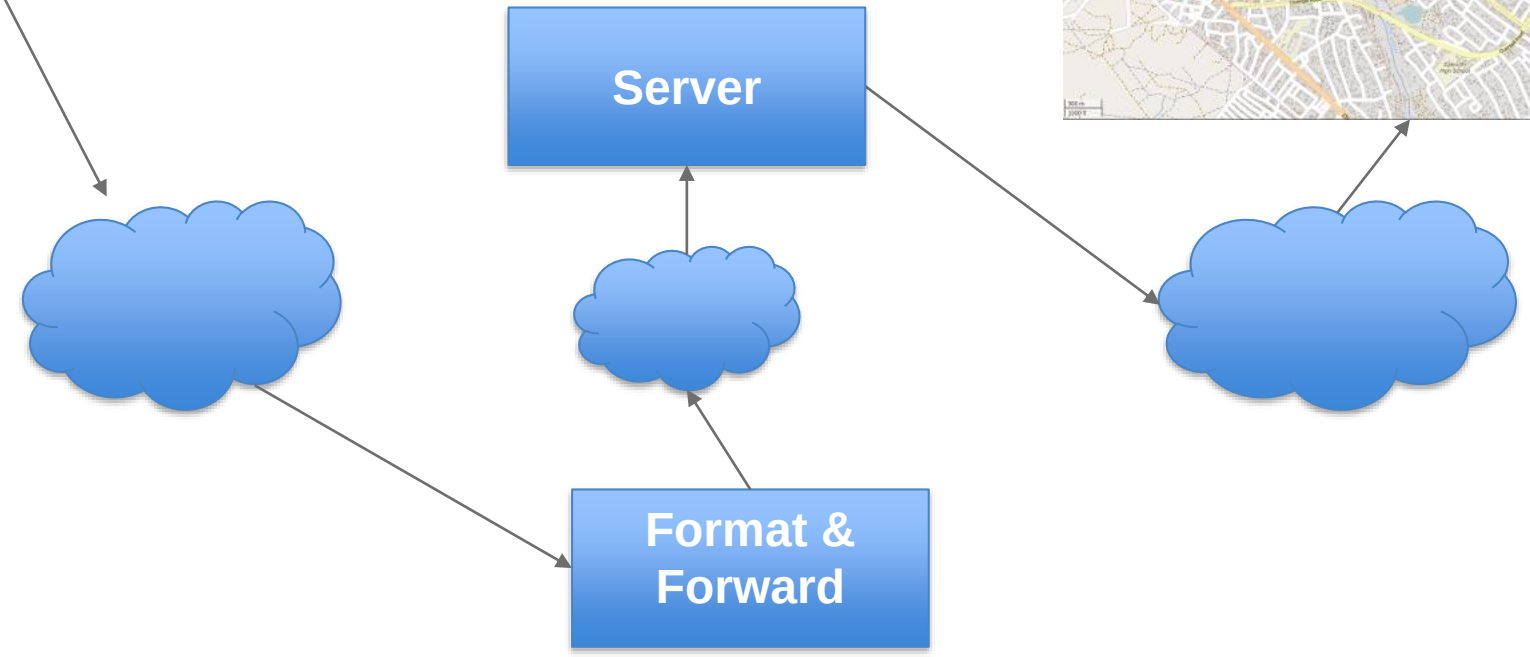
- Dongle_ID, IMSI, IMEI
- GPS data
- Serving cell: CellID, EARFCN, PCID, RSRP
- Neighbour cells: EARFCN, PCID, RSRP

DOMUS Architecture

Test scenario







DOMUS Architecture

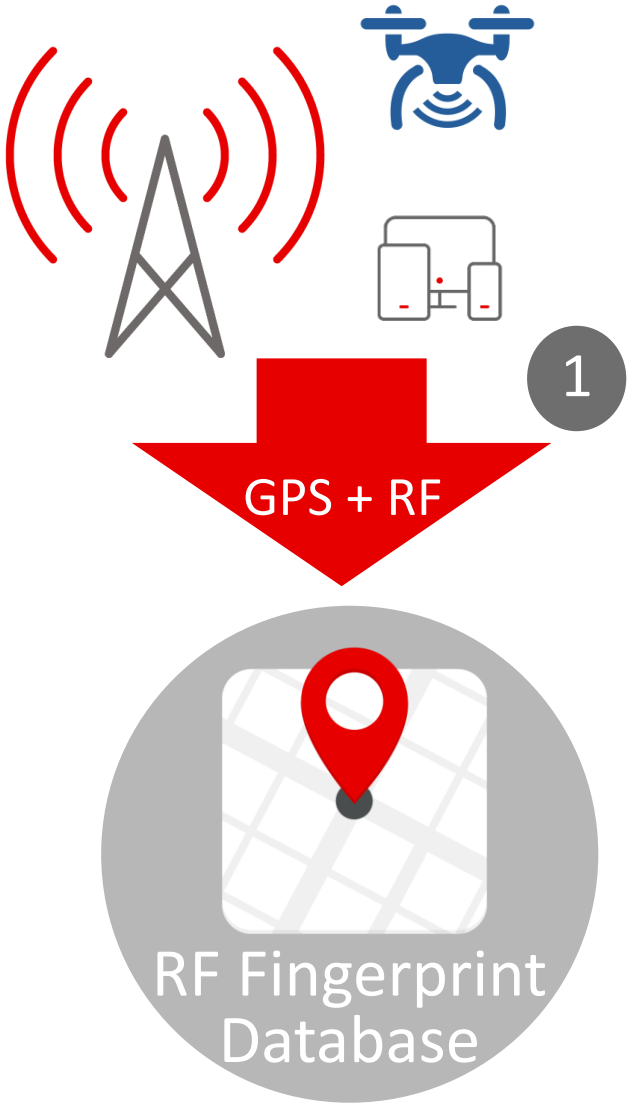
What is RPS?

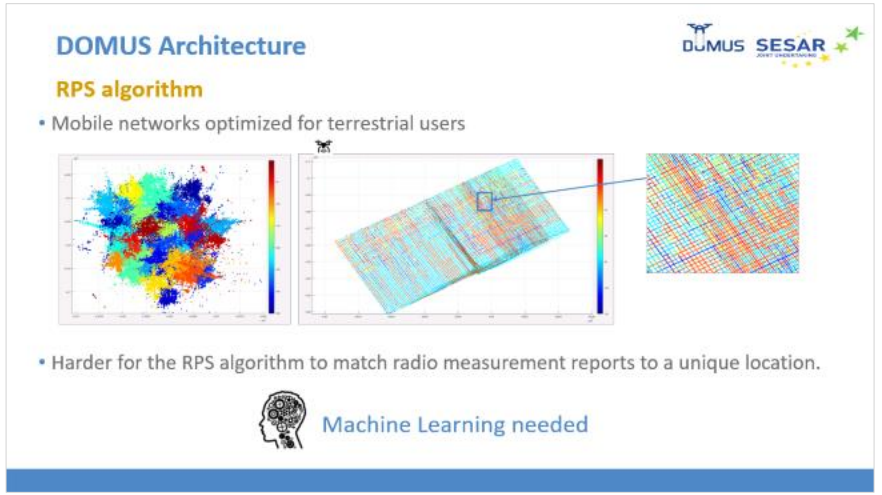
- Localization tool based on **Fingerprinting** and **Machine Learning** developed by Vodafone
- Real-time position estimation and similar accuracy to GPS in urban environments
- A non-hackable alternative to GPS
- It works outdoors and indoors
- It allows mass location of devices

Drones

DOMUS Architecture

RPS: How it works

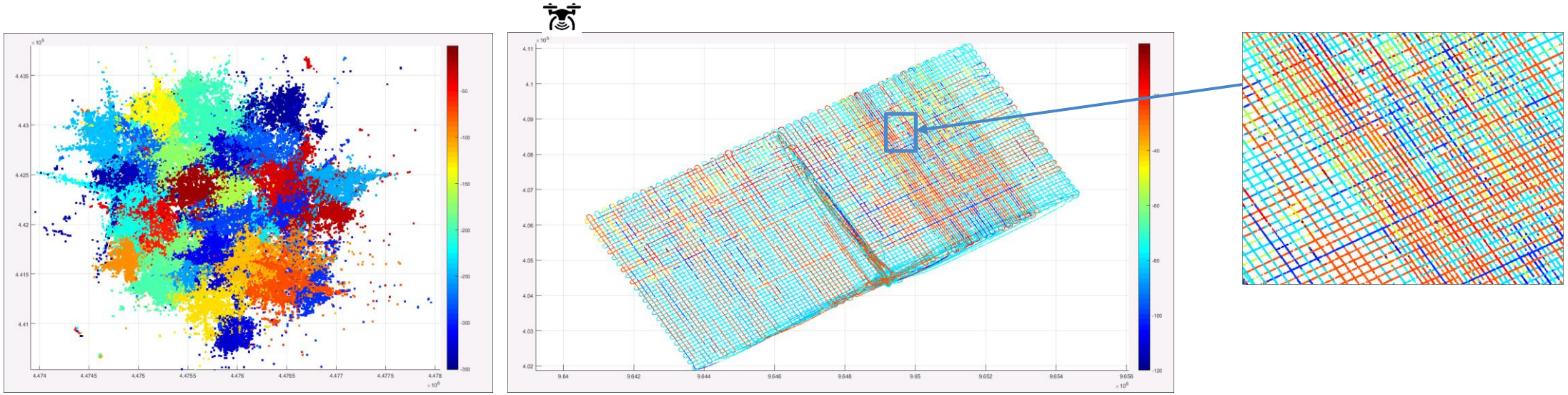




DOMUS Architecture

RPS algorithm

- Mobile networks optimized for terrestrial users

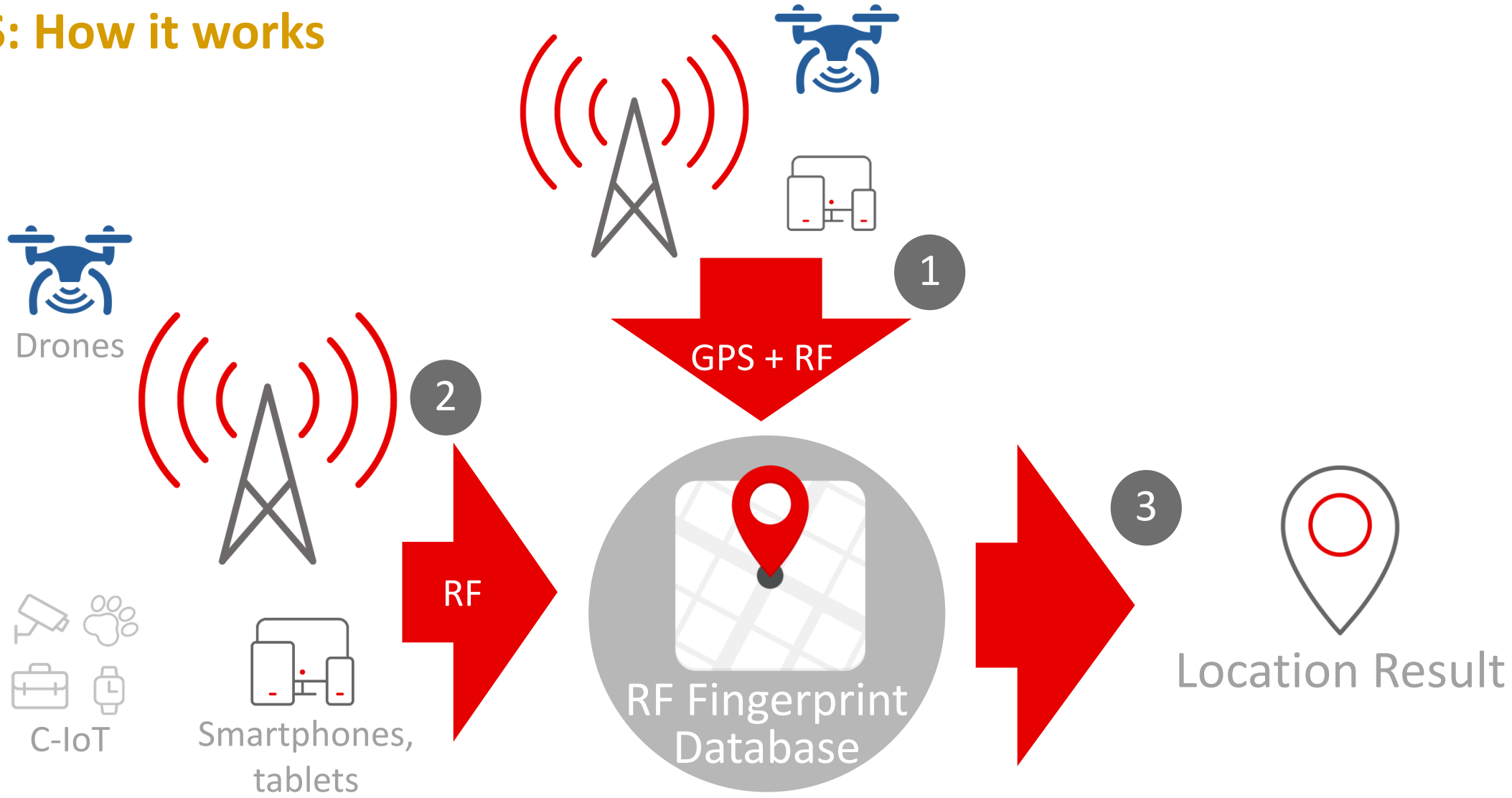


- Harder for the RPS algorithm to match radio measurement reports to a unique location.

Machine Learning needed

DOMUS Architecture

RPS: How it works



SESAR U-space demonstration Project DOMUS

(Demonstration Of Multiple U-space Suppliers)

GMV Contribution to DOMUS

Open Day Demonstration

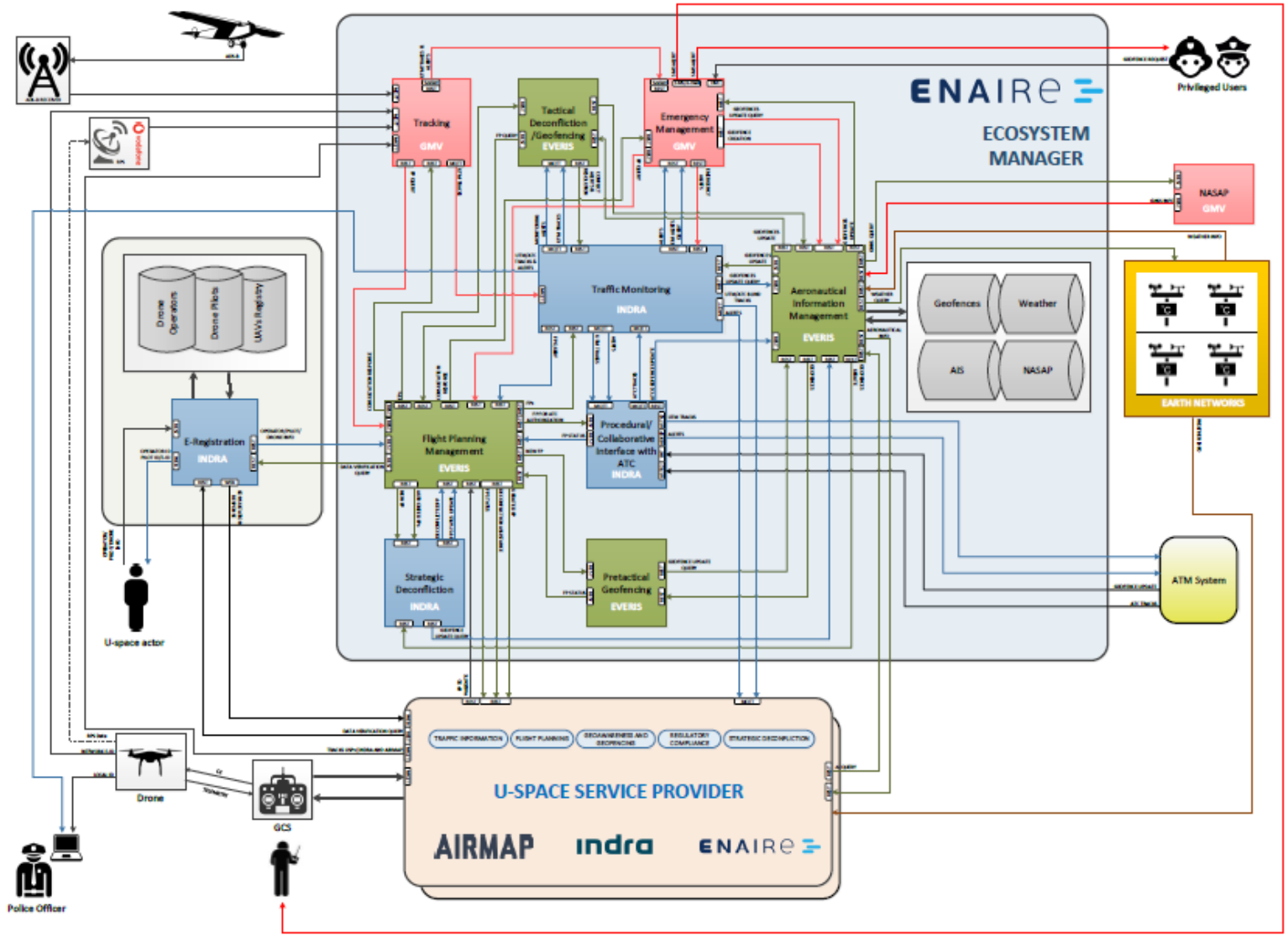
17th of September 2019

SESAR JOINT UNDERTAKING

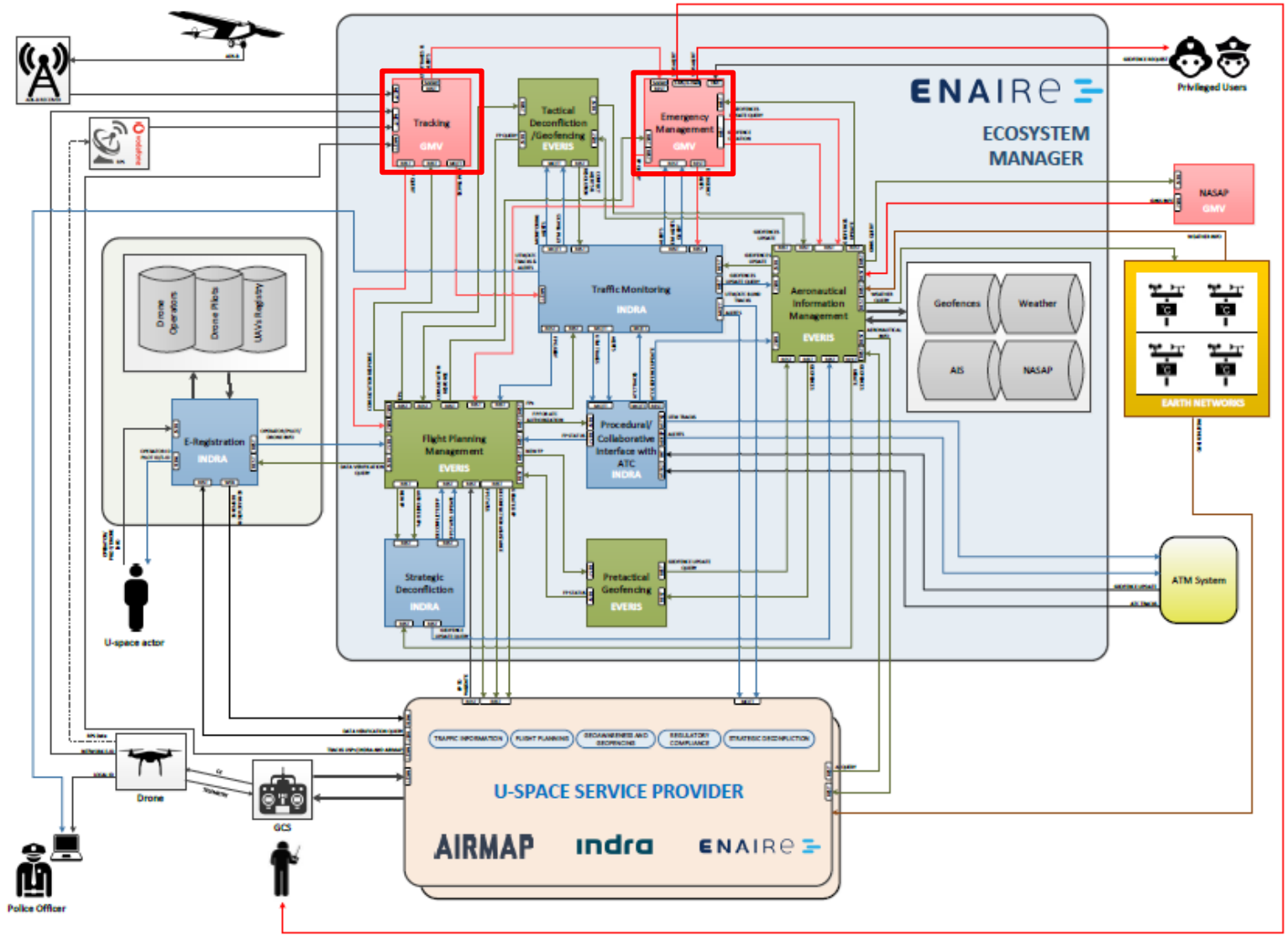
Founding Members

EUROPEAN UNION EUROCONTROL

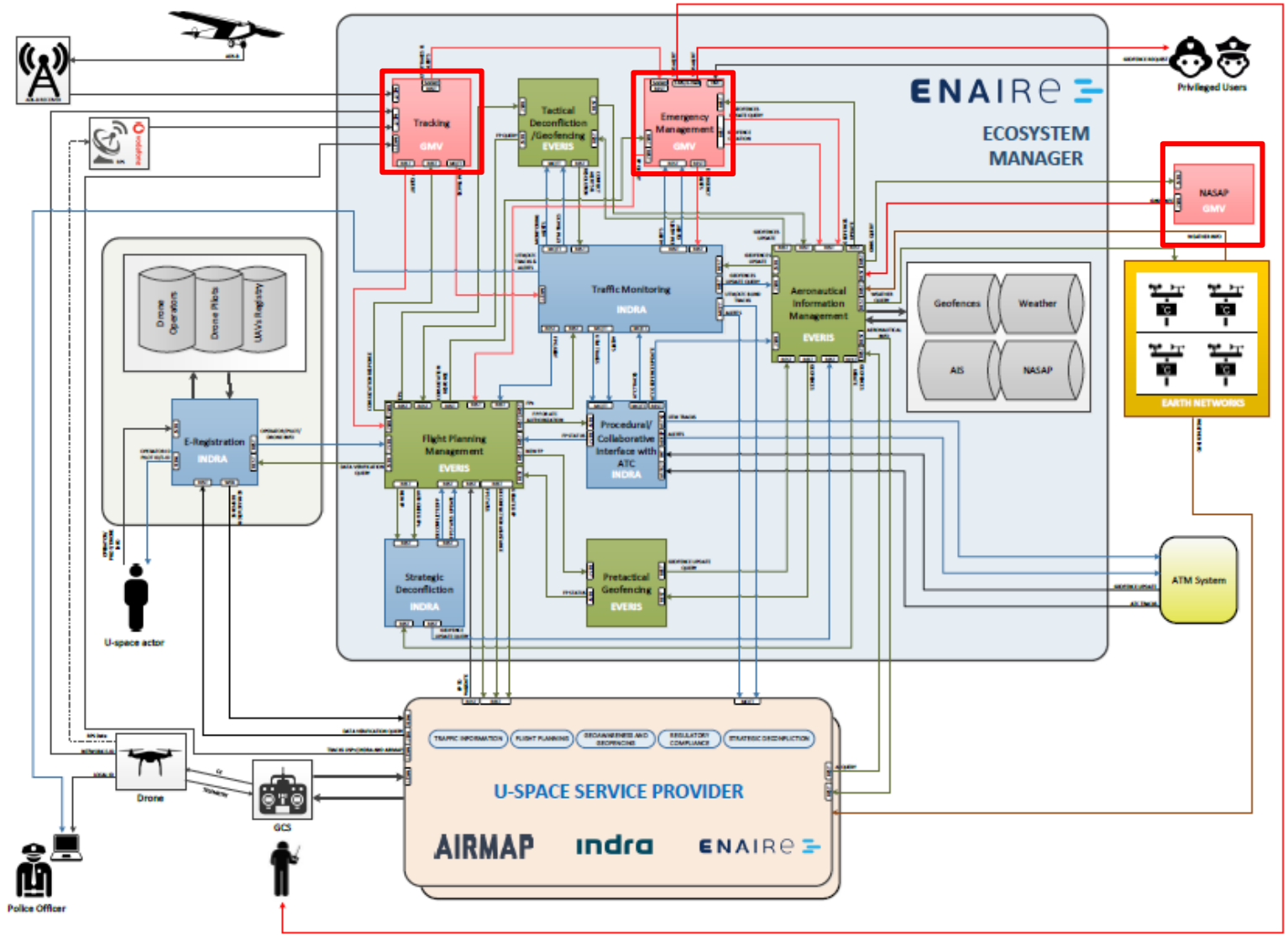
INTRODUCTION



INTRODUCTION

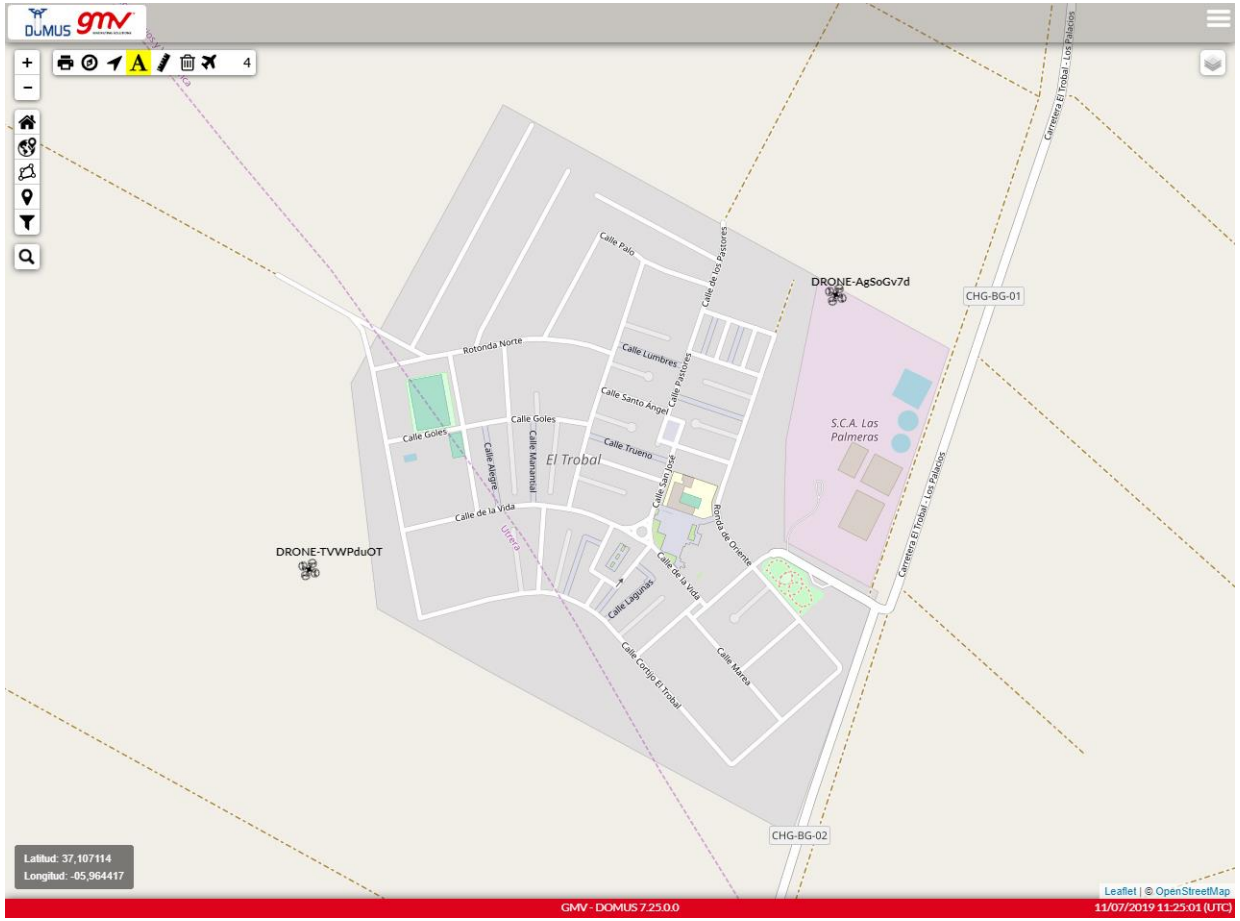


INTRODUCTION



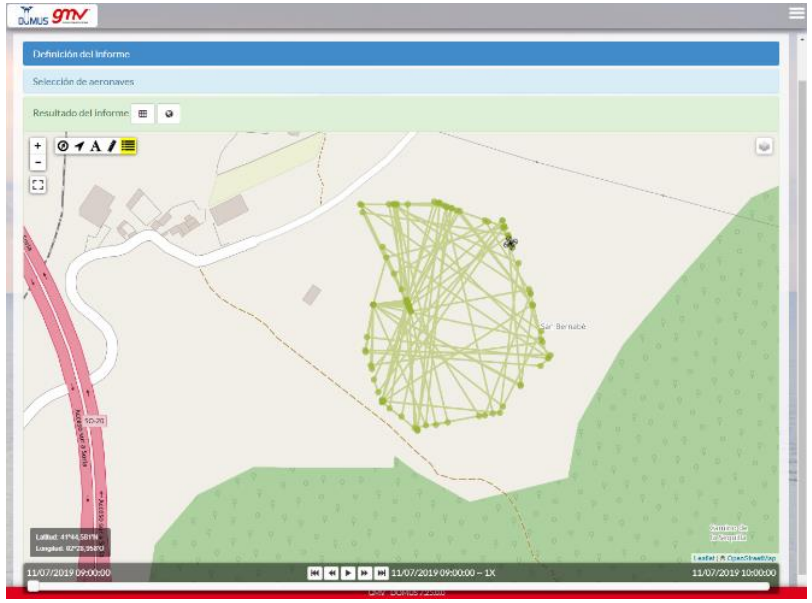
TRACKING SERVICE

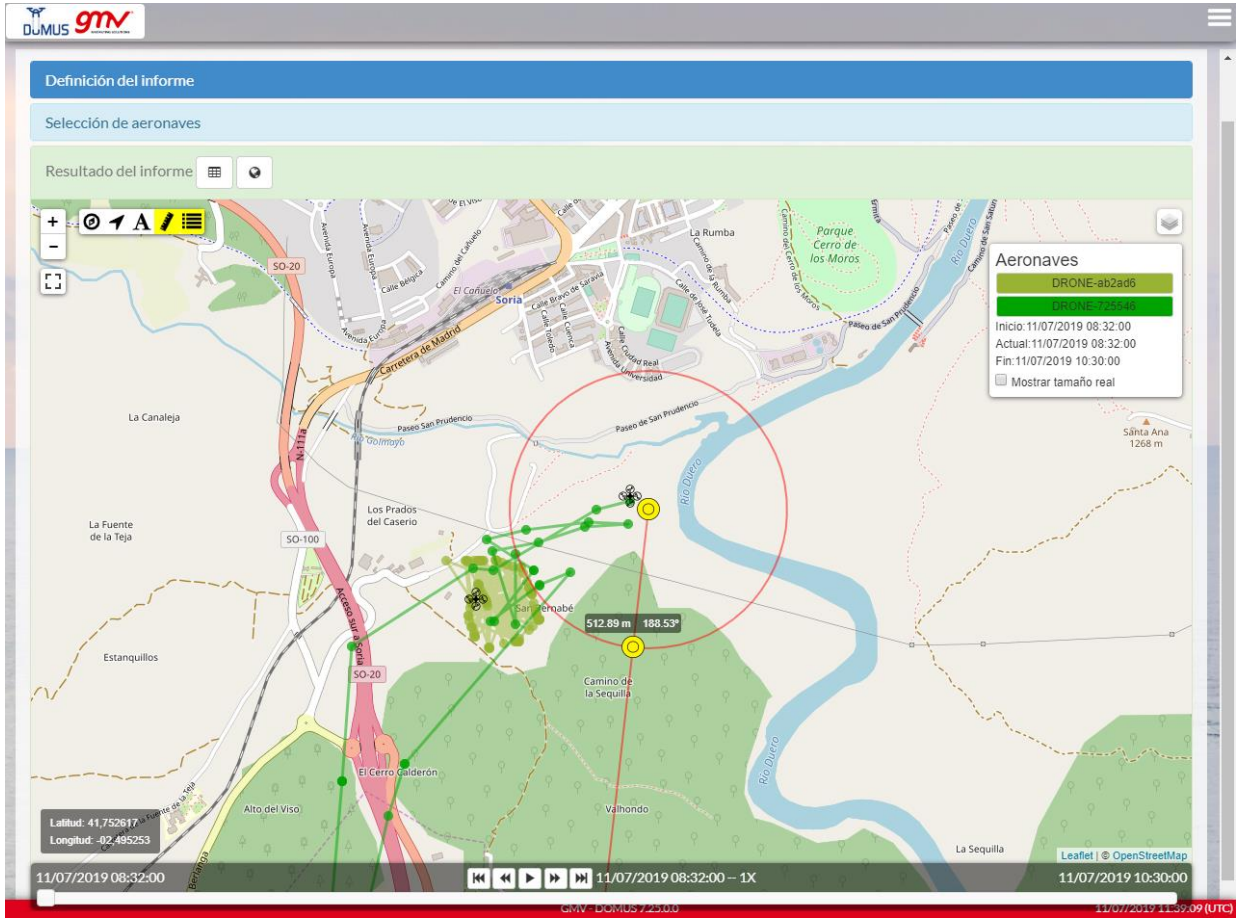
- Management of different track sensors from drones (RPS, e-Identification, Drone Telemetry)
- Management of ADS-B data from manned aircraft
- Track data fusion algorithm
- Management of drone alerts reported by the operators through the telemetry
- Checking flight plan data for the drone tracks
- Interface with Smart City



TRACKING SERVICE

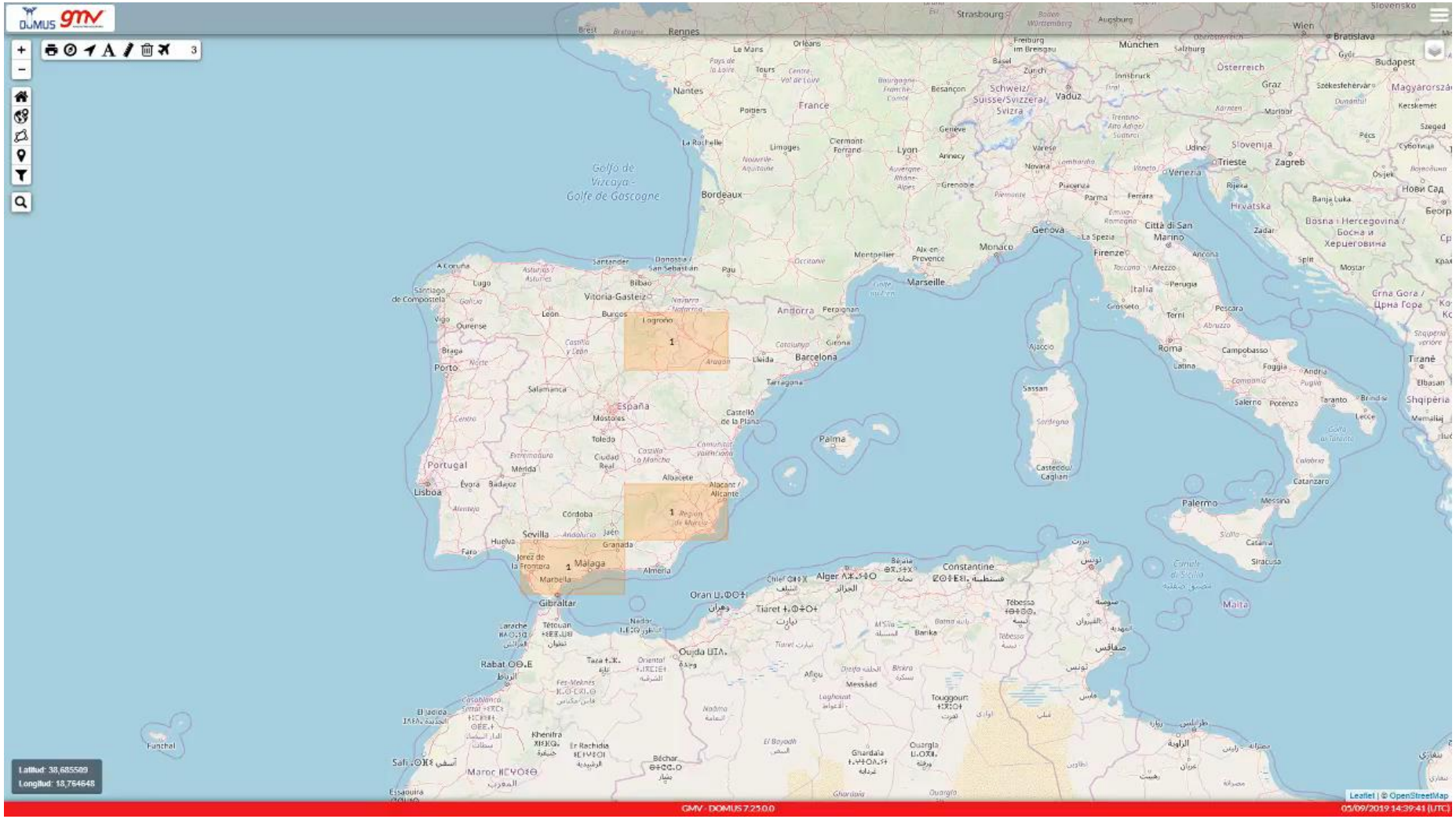
- Data recording and management of drone tracking database
- Geographic Information System (GIS) to explode the historical drone tracking data
- Generation of historical position reports for trajectory analysis (e.g. incidents investigation)





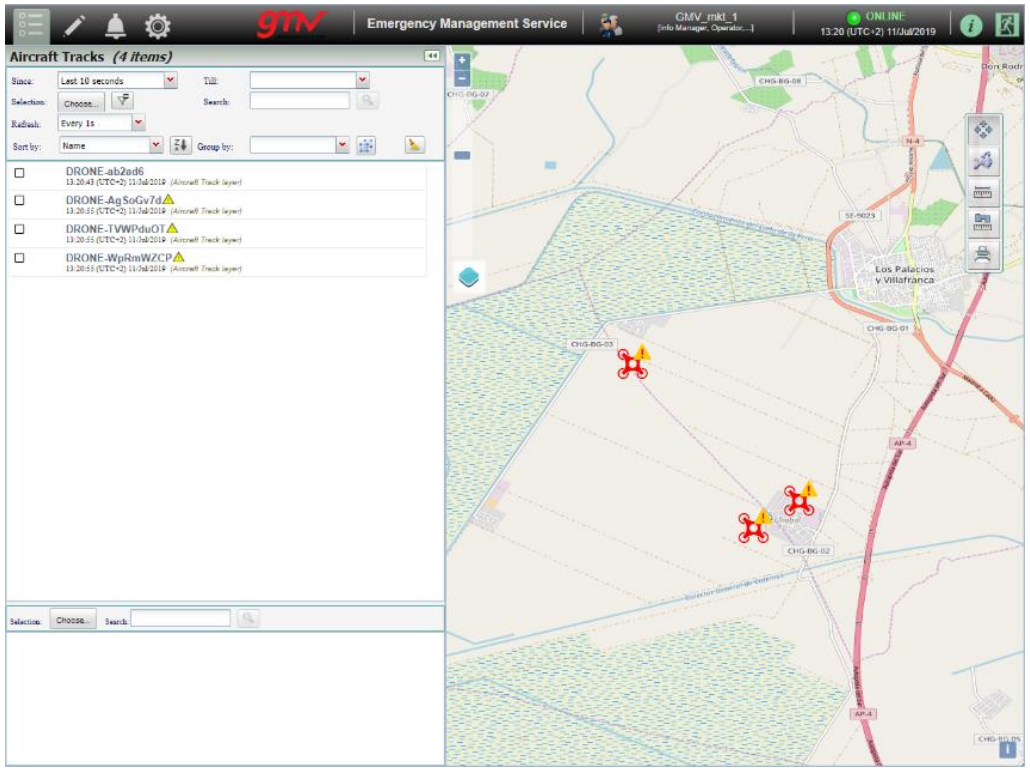
TRACKING SERVICE

- ***Incident/Accident Investigation***



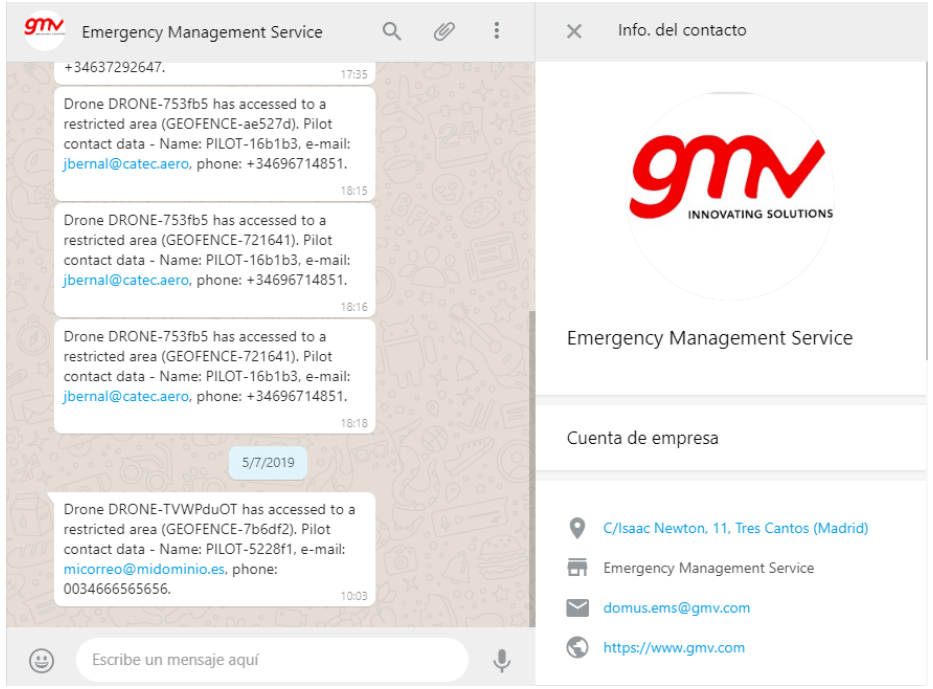
EMERGENCY MANAGEMENT SERVICE

- Management of an alerts database (operator alerts, flight plan nonconformities, emergency geo-fences approaches...)
- Definition of emergency and security geo-fences (e.g. traffic collision, wildfire, security zone…)



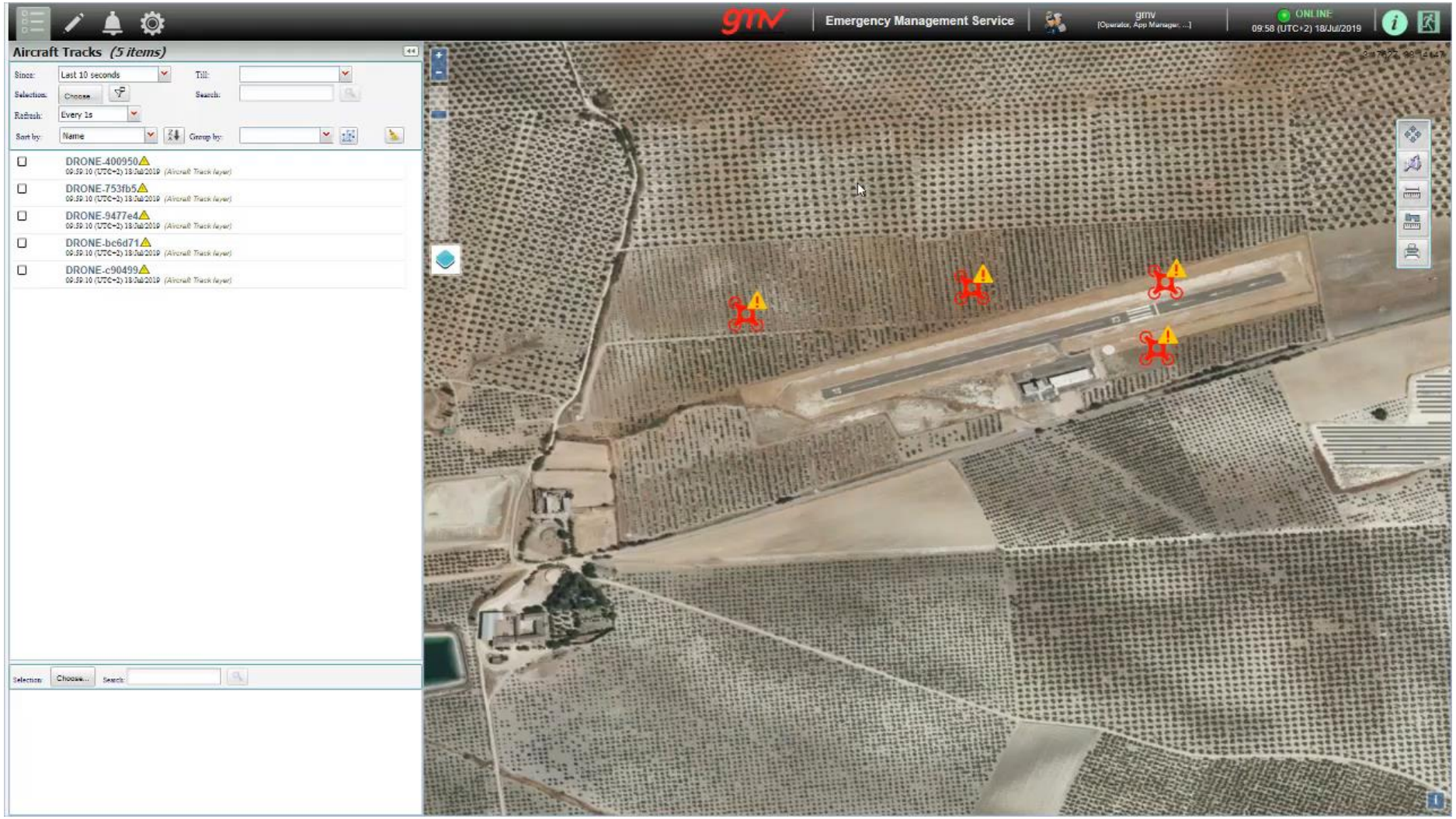
EMERGENCY MANAGEMENT SERVICE

- Notifications to drone operators affected by certain Emergency Alerts
- Monitoring drone traffic in restricted emergency areas and generating notifications to Authorities
- Geographic Information System (GIS) to manage the alerts data and the emergency actions
- Interface with Local Authorities (Smart City) and Firefighting Services



EMERGENCY MANAGEMENT SERVICE

- ***Emergency Geofences and Authorities Notifications***

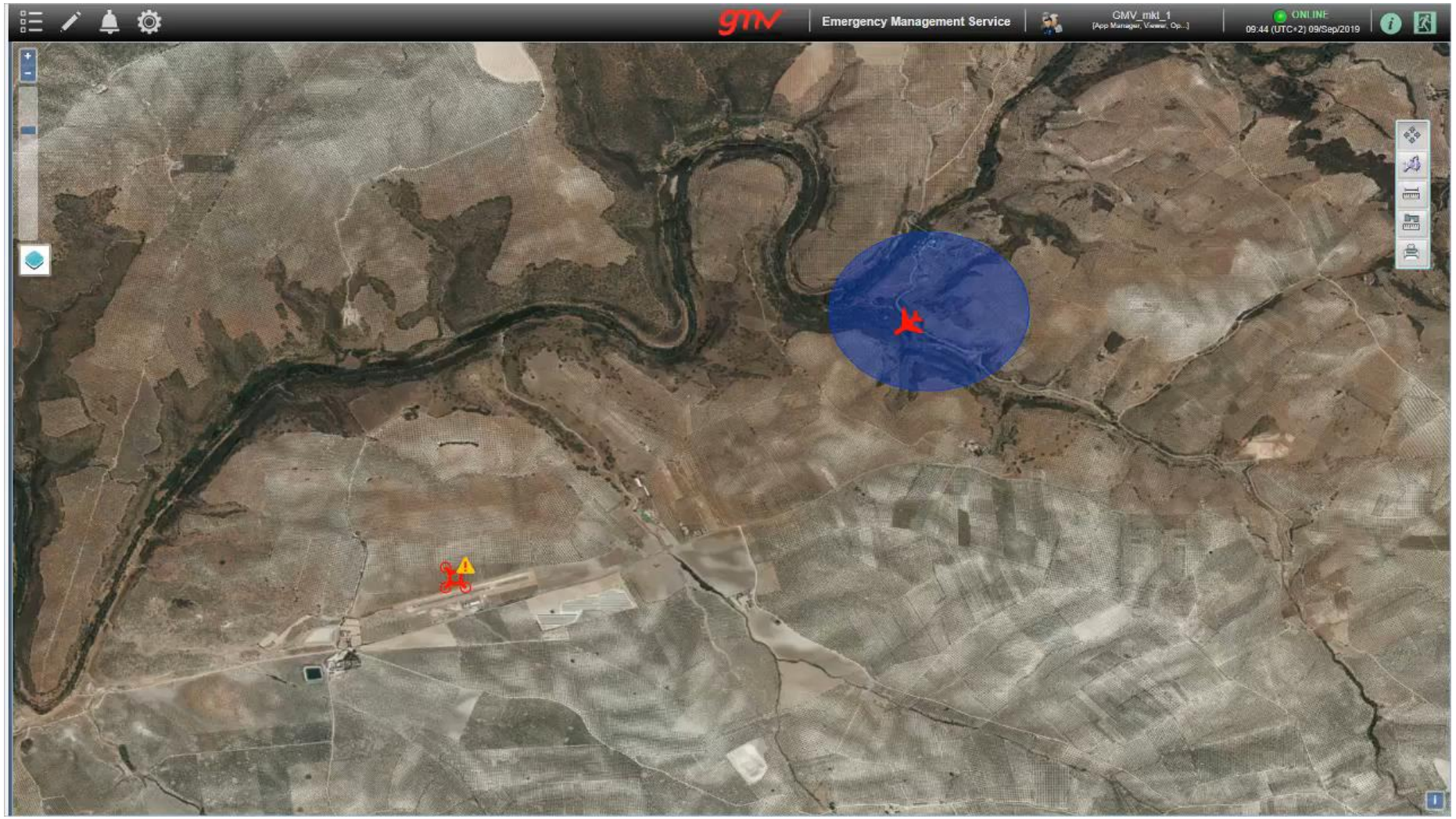


EMERGENCY MANAGEMENT SERVICE

- ***Automatic Protections for Emergency situations (LoL alert)***

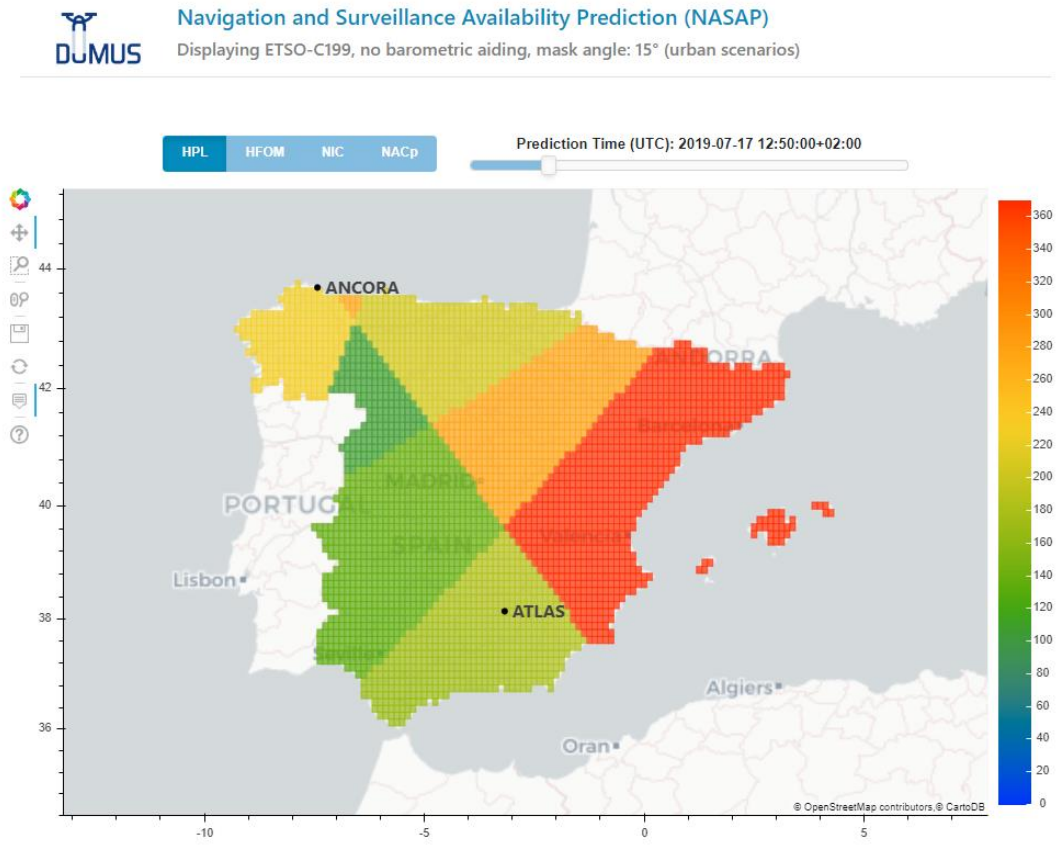
EMERGENCY MANAGEMENT SERVICE

- ***Automatic Protections for Emergency situations (VLL aircraft)***



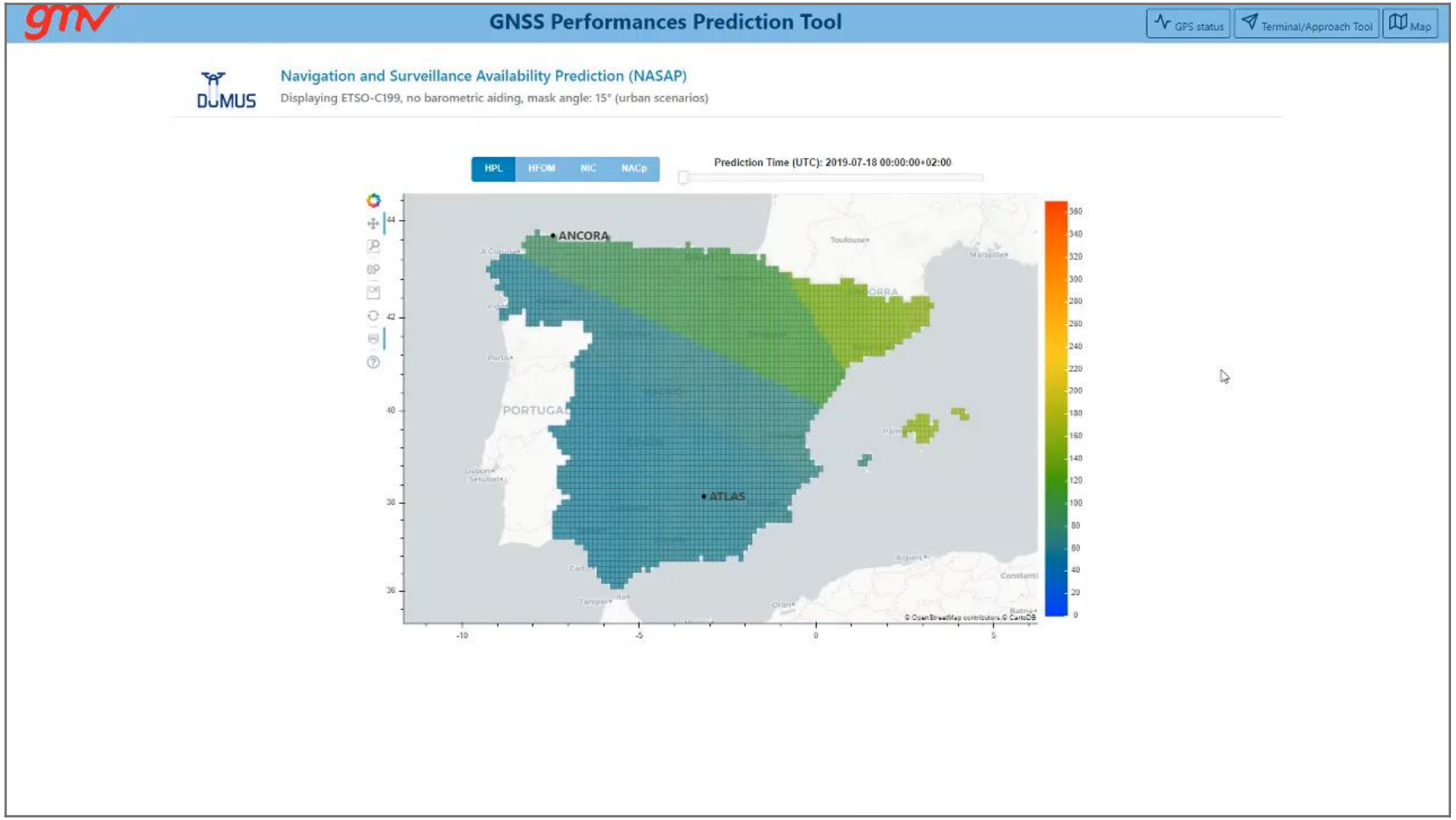
NAVIGATION AND SURVEILLANCE AVAILABILITY PREDICTION SERVICE

- Prediction of the achievable navigation and surveillance performances (accuracy, integrity) in a service area over a given time horizon (e.g. 24 h)
- Determination of the corresponding predicted navigation and surveillance service levels (e.g. based on NACp and NIC quality indicators)
- Based on RAIM algorithm defined in ETSO-C199 standard, and adapted to urban scenarios.
- Fully developed REST API with JWT secure communication, currently used by the Drone AIM service.



NAVIGATION AND SURVEILLANCE AVAILABILITY PREDICTION SERVICE

- ***NASAP Graphical User Interface***



Thank you very much
for your attention!

Indra Ecosystem Manager Services & Indra USP

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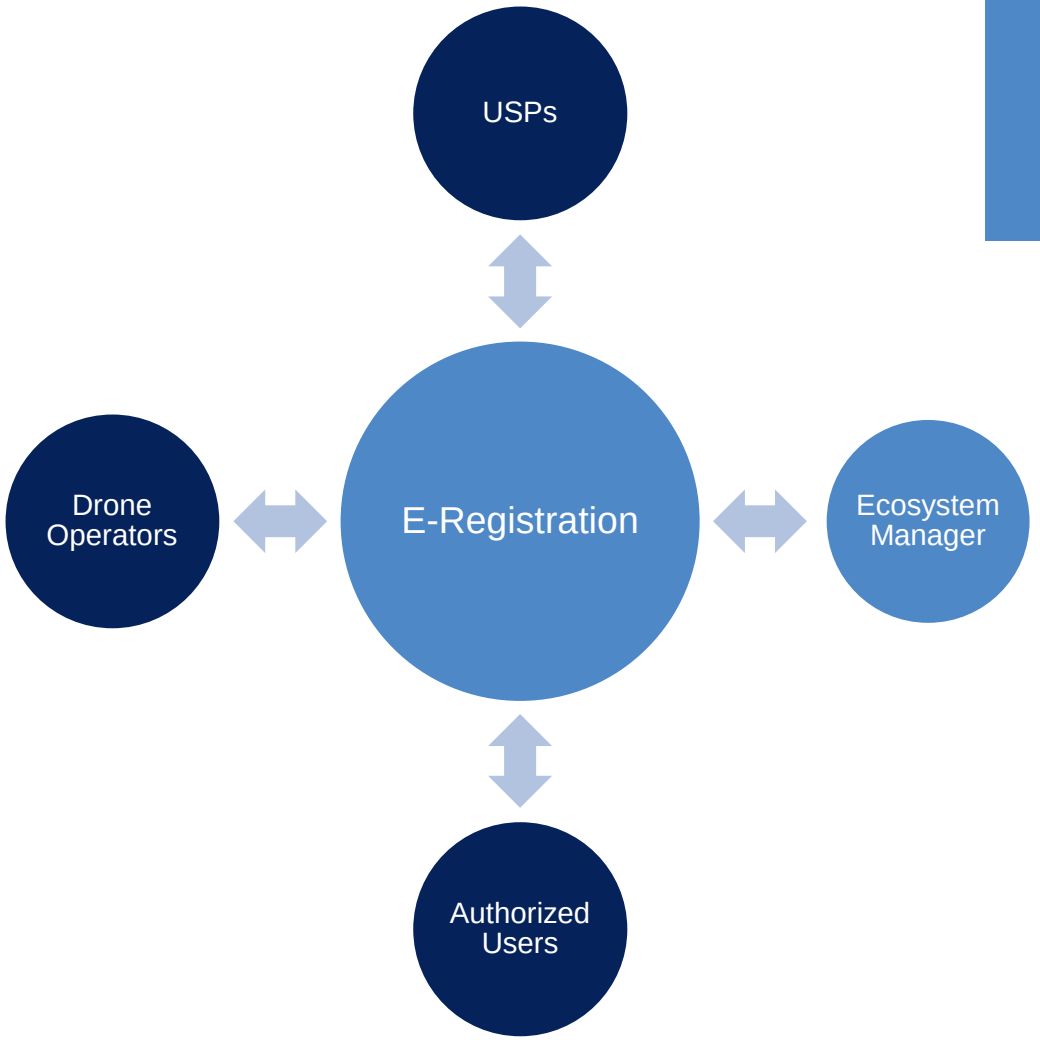
EUROCONTROL

e-Registration

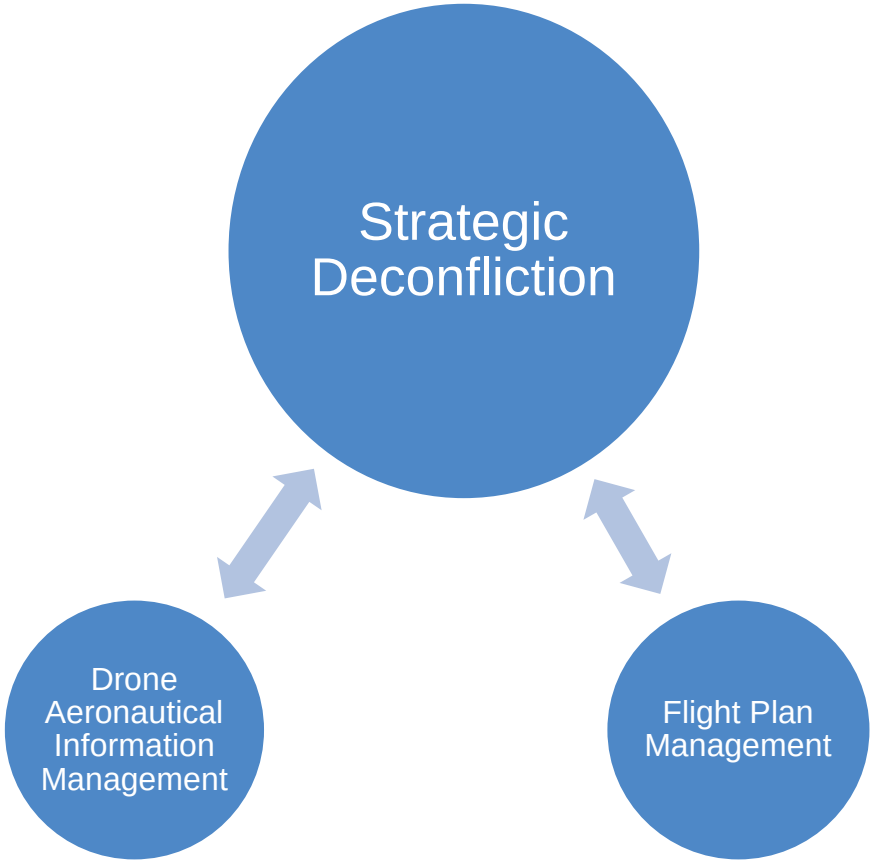


e-registration service provides to operators the capabilities to **registry** their selves, their pilots and their drones, and maintains the registry database that can be **interoperated witihin U-space environment**

Main functions

- USP integrable & web interface for operator, pilot and drone registry
- Generation of unique identifiers for each Operator, Pilot and Drone; relationships maintenance
- Information database to be consulted by specific Ecosystem Manager Services, U-Space actors and USPs, with different access levels depending on the users role
- In addition to identity information, empower advanced U-space services (pilot licenses, operator LUCs, drone specs, etc…)

ESM - Strategic Deconfliction



Strategic Deconfliction compares a new flight plan with every planned or active flight plan and when a **conflict is detected**, it **computes several alternative FPs** and offers them to the USPs as deconflicted FPs

Main functions

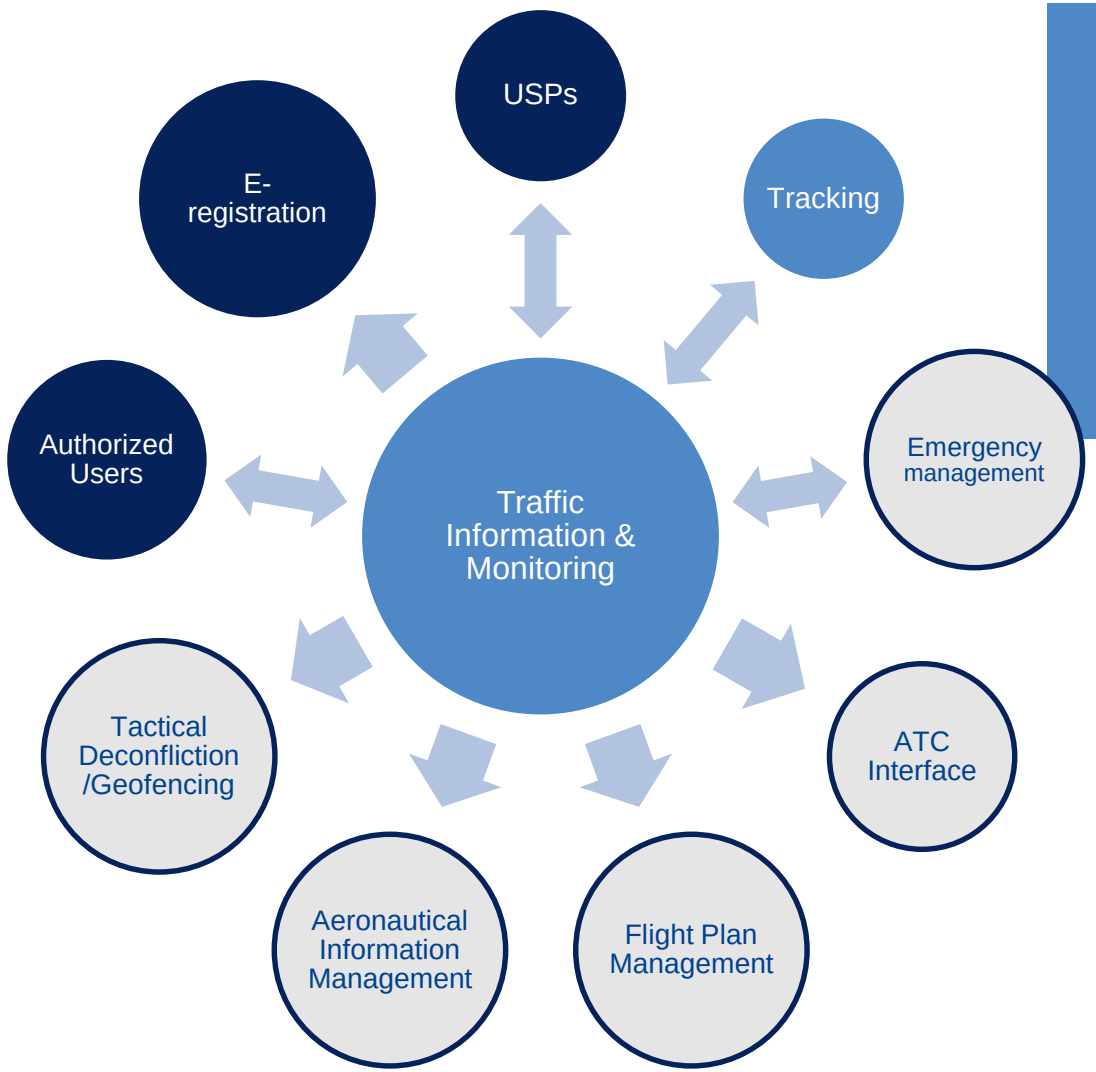
- It can deliver SD service both from USP and ESM
- Receives a new FP from FPM and compares it with the previously approved flight plans detecting conflicts considering its priorities and airspace structure
- If a conflict is detected, SD computes several alternative FPs. Alternative solutions may provide variations on time, route, altitude or volume
- The solutions are sent to the USPs and operator, who may choose any provide alternative or modifiy its original flight plan, keeping privacy on operations

ESM - Strategic Deconfliction

- Evaluates every flight plan when submitted or when relevant changes occur in the ATM/UTM environment
- Assesses regulatory compliance and detects conflicts between Flight Plans and airspace structures (4D)
- Calculates “minimum cost” alternatives considering available airspace, airspace structure and geofences, ground and altitude data, mission parameters (i.e. drone endurance) and airspace rules, among others
- Provides the operator with NON-MANDATORY alternatives, that the operator can modify to shape its flight plan to its necessities

- Strategic Deconfliction service can be delivered both from:
  - the USP using a “discovery service” provided by a FIMS / CIS / ESM
  - the FIMS / CIS / ESM, allowing less mature USPs or big integrated operators to provide the service to its users.

ESM - Traffic Information & Monit.

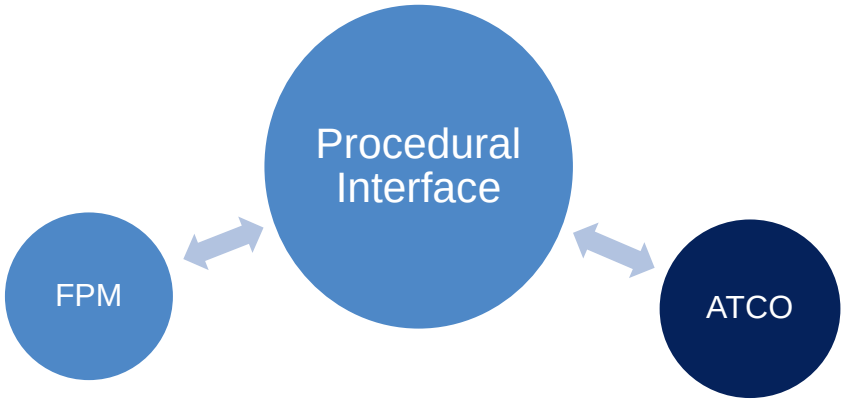


Provides U-space actors with the global **situational awareness** by integrating all tactic and stategic information. In addition it provides Monitoring cabilities and calculates several alarms and alerts. It distributes all the information to USPs and authorized actors

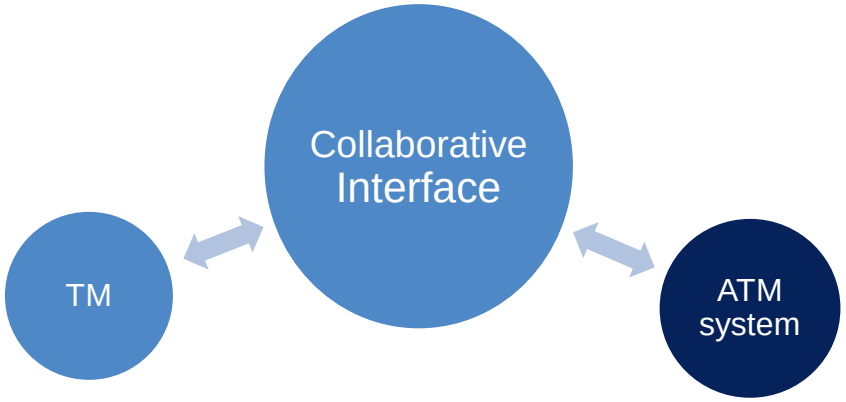
Main functions

- Geospatial view with relevant information, including live tracks and associated FPs, registry information, alerts and alarms, geo-awareness, etc…
- Centralices the information and shares it with the rest of ESM Services & connected USPs
- Computes conformance alerts (lateral, vertical, time), no flight plan alert and geofence invasion alerts

ESM - ATC Interface



Procedural Interface provides ATC with a tool to **visualize, approve and revoke drone FPs** in controlled airspace



Collaborative Interface exchanges tactical information between ATM & UTM, **increasing situational awareness for ATCo** and providing **management tools in the CWP**

Functionalities deployed for Domus Project:

ATM->UTM info:

- Aviation tracks
- Geofences

UTM->ATM info:

- Drone tracks
- Alerts

UTM Connect (Indra USP)

UTM Connect **provides drone operators with connectivity to U-space environment** and tools for flight planning (including strategic deconfliction), geoawareness and registration.

UTM Connect delivers U-space services to the drone and pilot

Main functions

- Flight planning:
  - Linear, polygonal or mixed flight plans
  - FP database to review or reuse old flight plans
  - User friendly graphical interface
  - FP deconfliction against geofences
- Access to registry information and modifications.
- Geoawareness:
  - Geofence information
  - Weather data
  - NASAP information
- Flight monitoring: operator can monitor all its flights and also thrid party drones are shown as blind tracks.
- GCS:
  - Preflight checks
  - Automatic FP loading from UTM Connect website
  - Automatic flight mode
  - Display of alerts (also audible alerts depending on severity). SMS alerts.
  - Display of nearby blind tracks

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SESAR U-space demonstration
Project DOMUS
(Demonstration Of Multiple U-space Suppliers)

Everis components

Domus Open Day

17th of September 2019

SESAR JOINT UNDERTAKING

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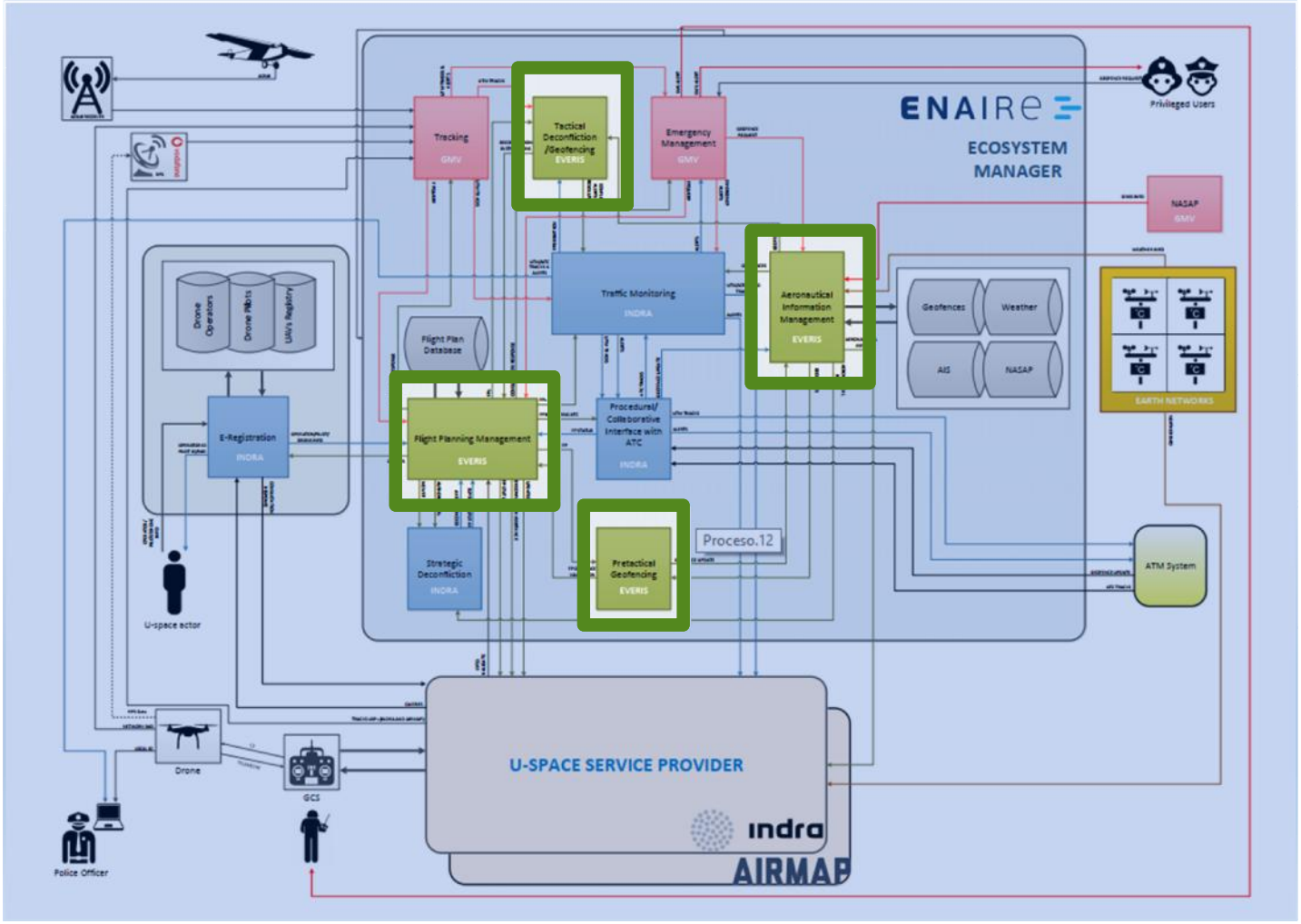
EUROPEAN UNION EUROCONTROL

DISCLAIMER

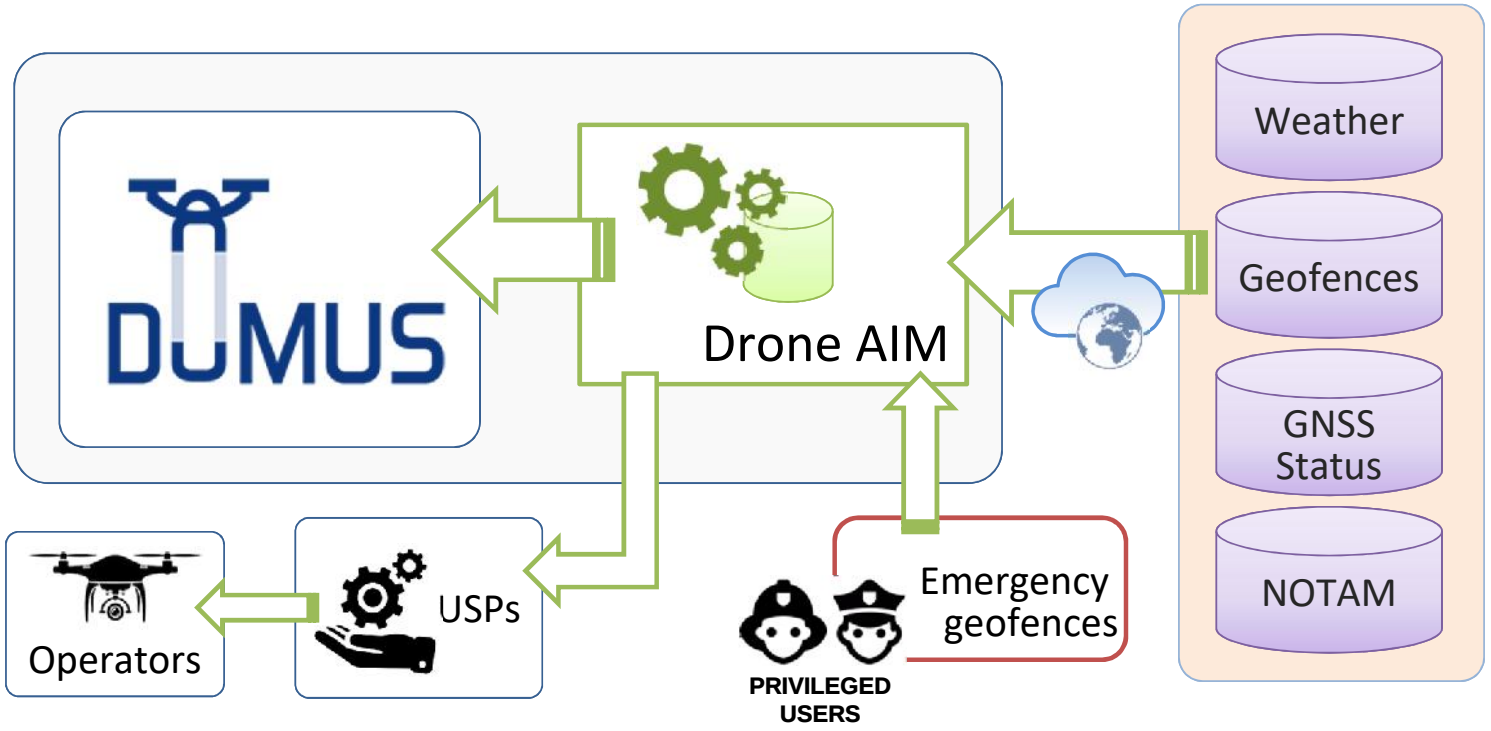
DOMUS ARCHITECTURE – everis components



Drone AIM Service

Purpose

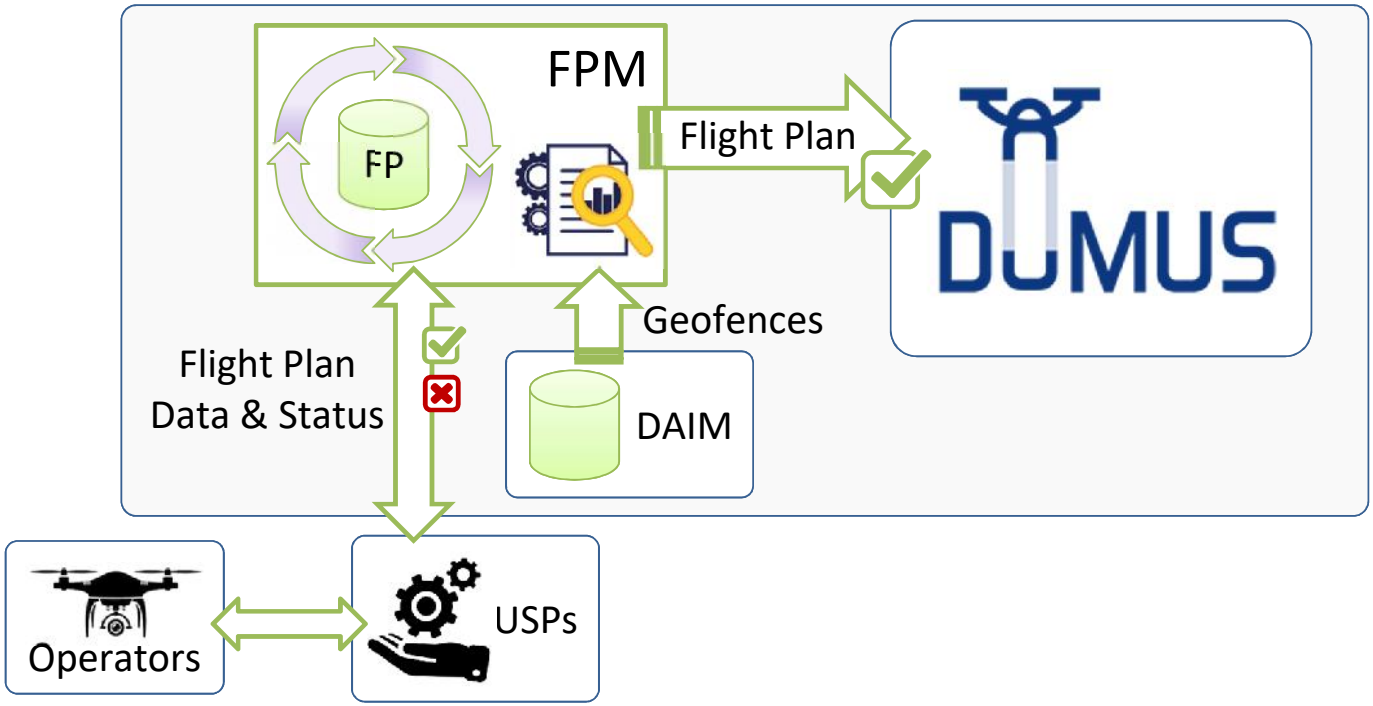
Provides aeronautical information to ecosystem manager, USPs and in turn to drone operator



Flight Planning Management Service

Purpose

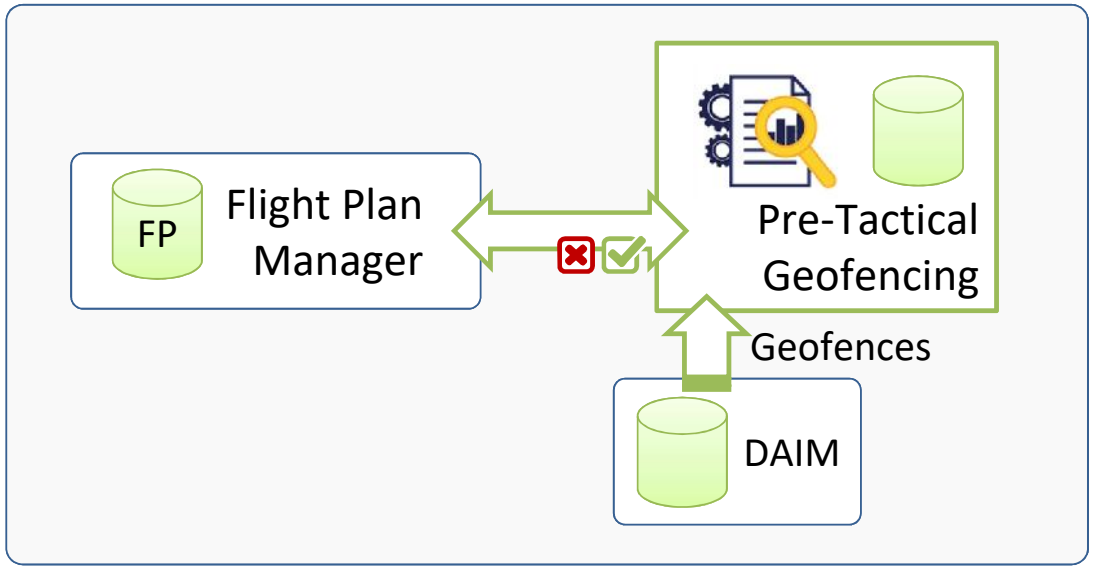
Core of the “pre-flight” part of the Ecosystem Manager, manages the database of Flight plans handling their approval or denial.



Pre-Tactical Geofencing Service

Purpose

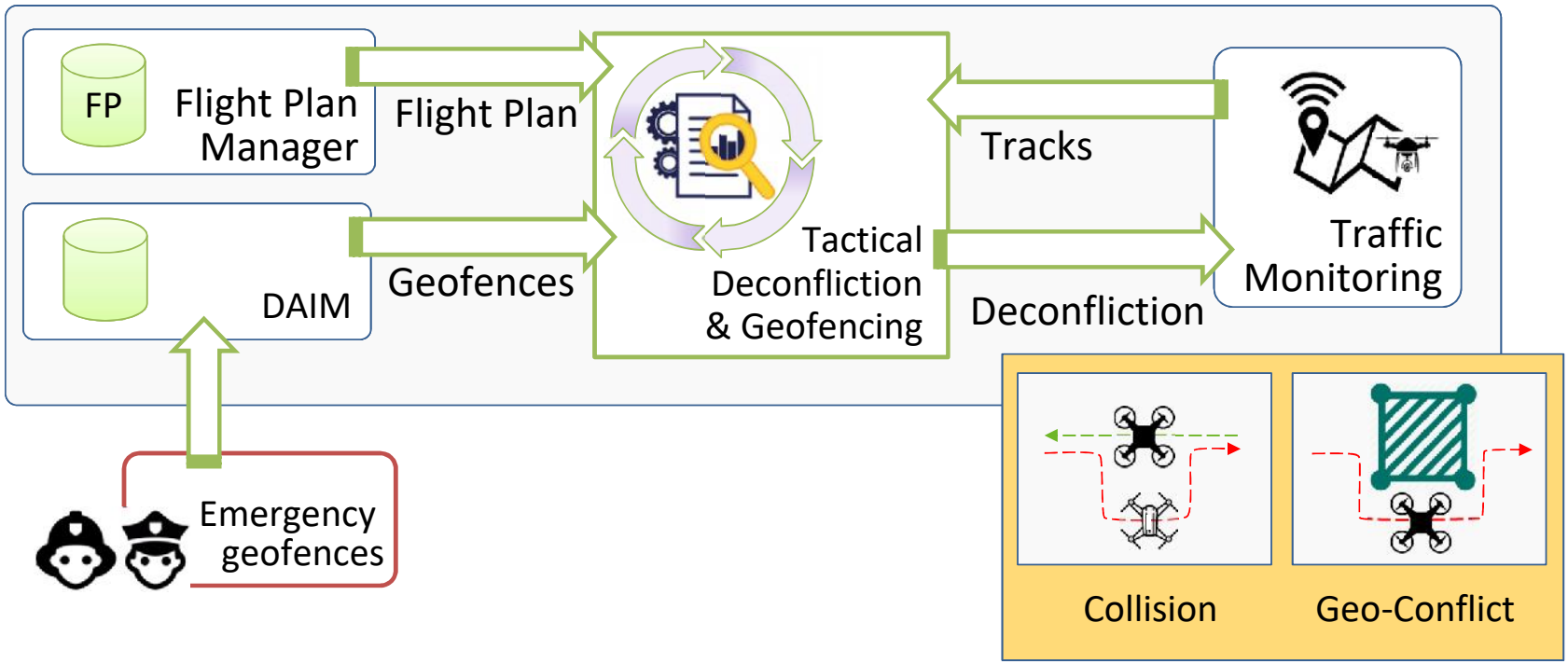
Performs the validation of Flight plans against the geofencing restrictions during the pre-flight phase.



Tactical Deconfliction & Geofencing Service

Purpose

Performs continuous predictions to check if a drone may suffer a collision during flight and to prevent conflicts with emergency geofences



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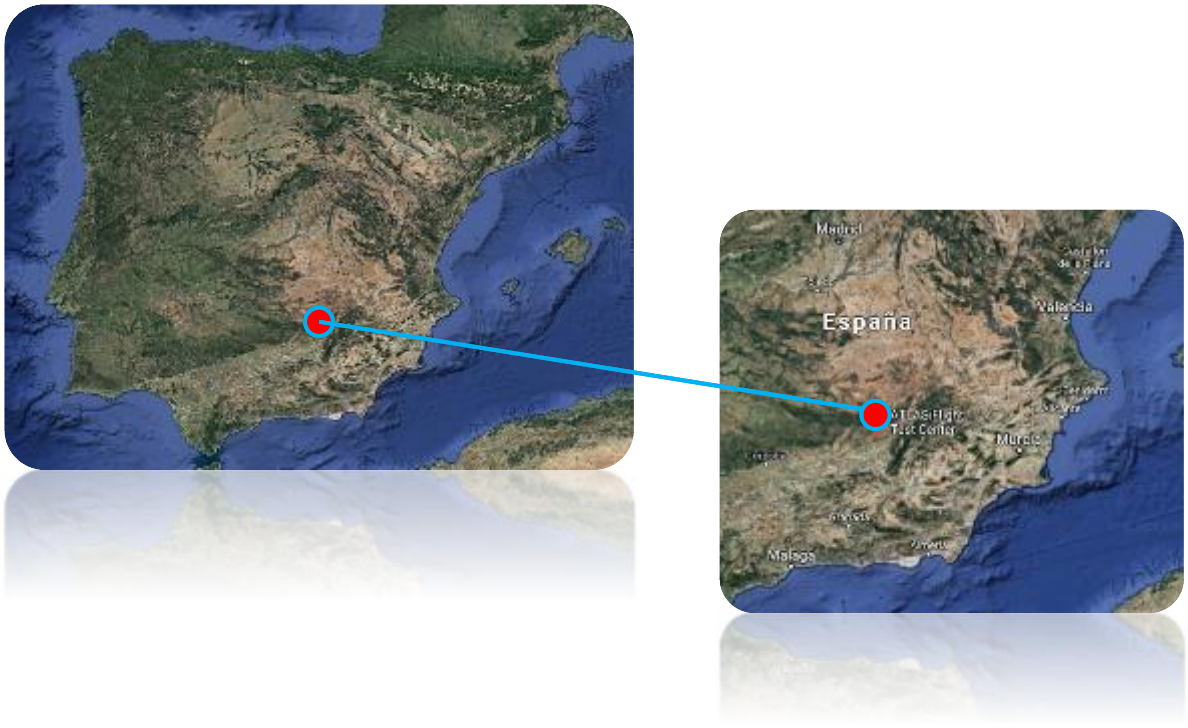
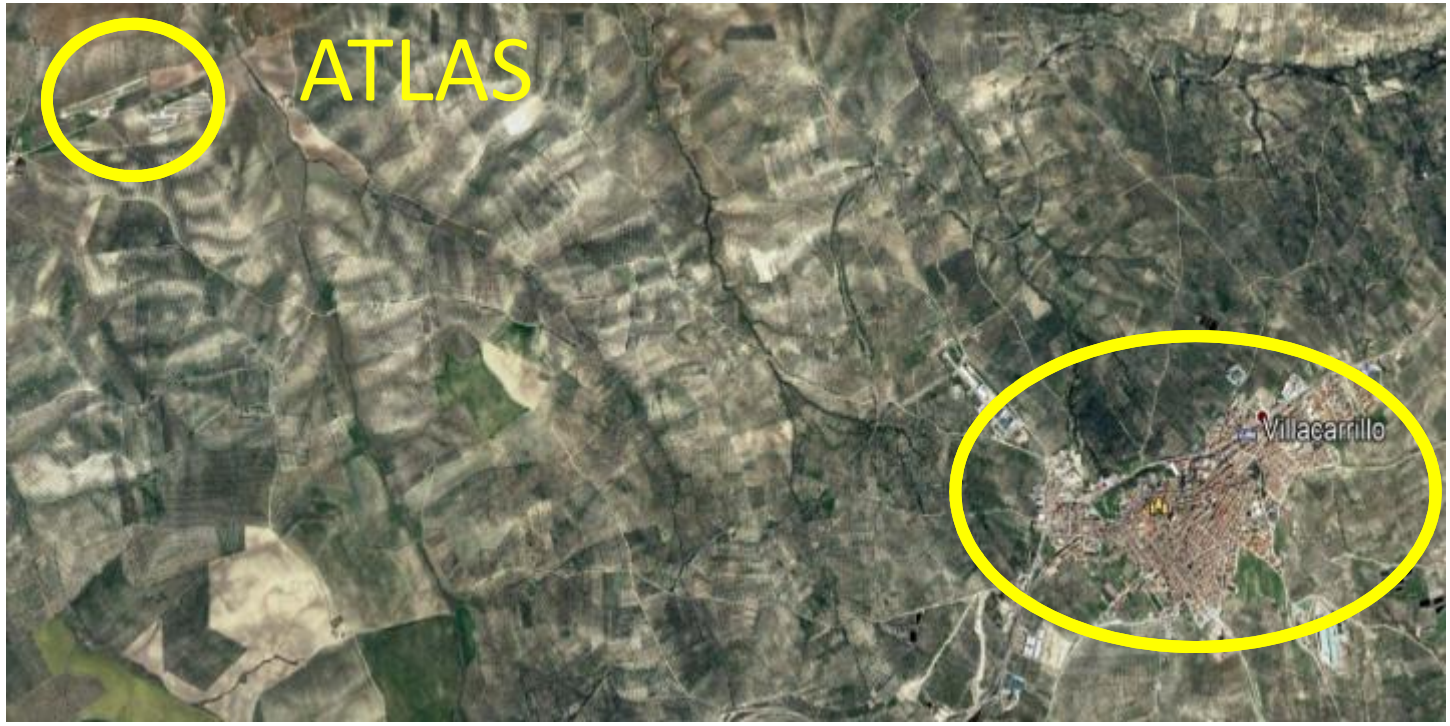
URBAN SCENARIO
VILLACARRILLO USE CASE (TRIAL 3)



VILLACARRILLO



VILLACARRILLO

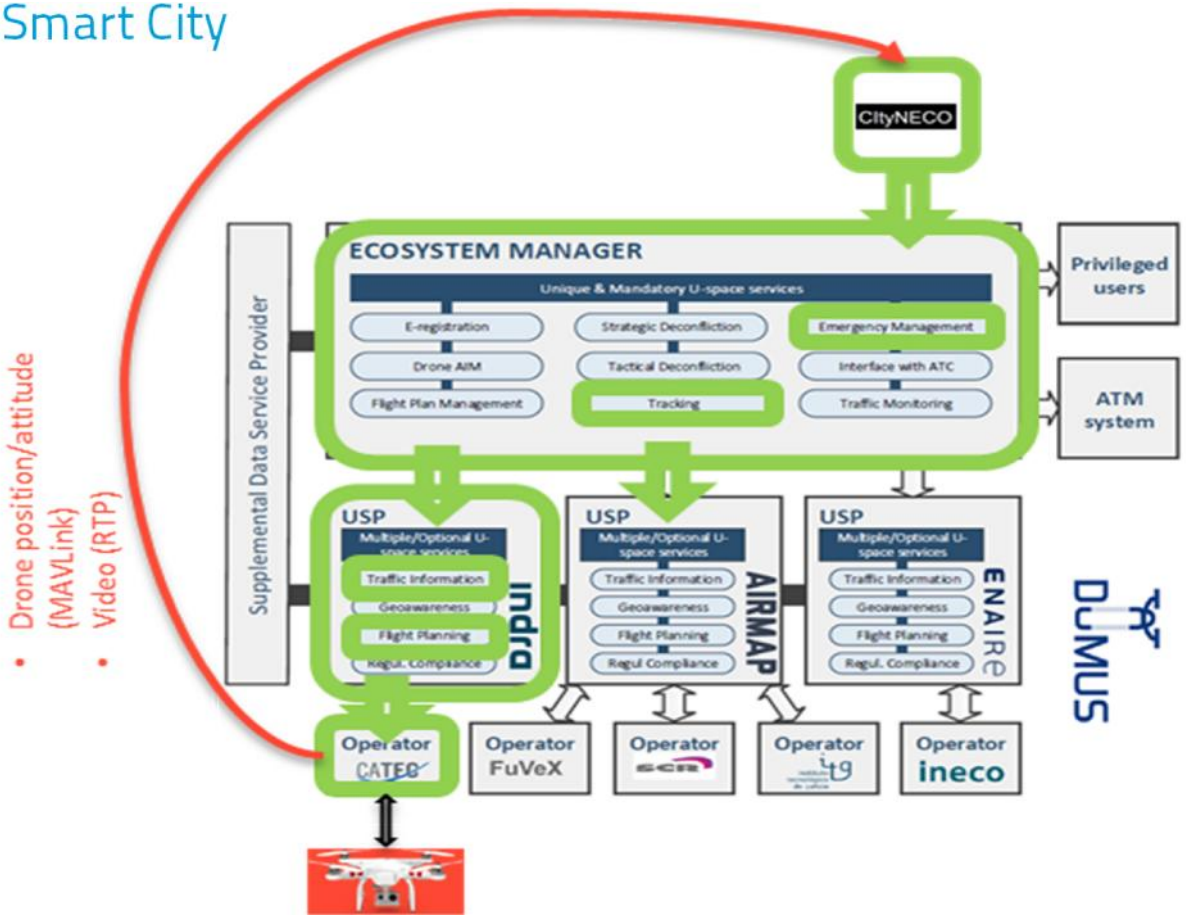
VILLACARRILLO

Plaza Juan XXIII

VILLACARRILLO USE CASE (B.2)

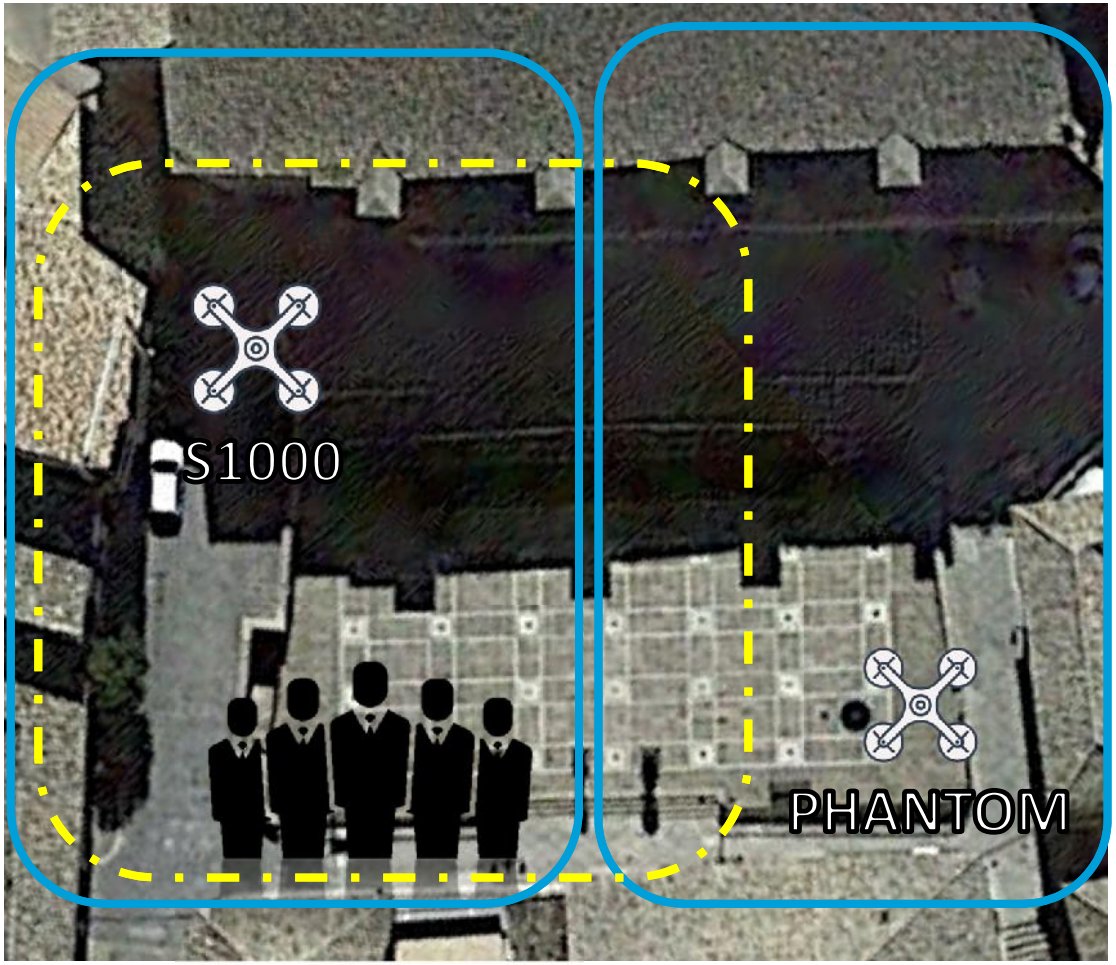
Drone - TYPE	Drone OPERATOR	OPERATION CHARACTERISTICS	Type of Flight	Specific model???
MC1 - Specific	CATEC	Inspection task with DAA	VLOS	PHANTOM
MC2 - Open	CATEC	Filming task	VLOS	S1000

Trial #3: Smart City



1 - FP submission

Vehicle alert



DOMUS Demonstration Findings Summary

DOMUS main technical findings

- The DOMUS federated architecture supported by a Ecosystem Manager or CIS Provider with different USSPs system interconnected to the Ecosystem Manager platform DOES WORK!
- Current technology is shown not only to be viable but also facilitates a rapid deployment of U-Space services
- U-space is a SoL service - High engineering needed behind the safety critical Ecosystem Manager Platform – not a video game but not either a bank system
- Successful to bring into U3 functionalities (Tactical De-confliction & Collaborative ATC)
- Room for improvement: time constraint brought into solutions need be yet further evolved
- Budget constraints to allow specialized USPs connected

DOMUS main technical findings

- As for the **Ecosystem Manager single platform** :
  - certification of the Ecosystem Manager over its high complexity platform makes much lesser laborious certification processes down the stream for USPs, diminishing the NSAs workloads.
  - Guarantee performance as a SoL service
  - single platform to support main functionalities makes gains in simplicity facilitating escalation and access
  - guarantees a safe, secure and efficient U-Space deployment as a single point of truth but also privacy and secrecy, being the proper interface with army and pólice
  - guarantees an only single point of access and interface with ATM
  - helps out simpler USP access to market
  - high modularity is challenging but brings flexibility but also resilience and robustness to support interconnected USPs systems
  - Additionally, as for **interstate services**, needless to say, this architecture will also facilitates easier set up by connecting Nationals ecosystem manager systems each other.

DOMUS main technical findings

- As for the **enabled 'unlimited' number of U-Space Services Providers**
  - Neutral designated Ecosystem Manager guarantees plug and play concept
  - USPs do not need to negotiate among them or negotiate in a unfavourable conditions or be driven for a particular USP technology but just get connected to the Ecosystem Manager Platform.
  - USP access to the market is fostered as for less complex and costly USPs systems and, this way, also the creation of a USP competitive market in the benefit of the users
  - US Provider can play user rather than technology wise and sell the service
  - more investment is left to the USP in the differentiation and specialization of services to offer better and most suited added value solutions to the users
  - less effort for USP certification which do away with costly processes and access barriers thereof
  - USPs are safe and efficiently kept interconected each other through the Ecosystem Manager Platform for the critical functions

DOMUS societal findings

- Societal benefits identified out of the DOMUS Federated Architecture

  - Guarantee the the SoL nature of the service DOMUS/CORUS architecture does, by gathering such a set of essential functions, not prevent at all but ensures the existence of such a competitive market.

  - No multi-plicated investment in costly infrastructure impacting on the drone services affordability

  - Privacy and secrecy and guaranteed by the State designated Ecosystem Manager

DOMUS CONCLUSION

The CORUS Based DOMUS Federated Architecture is recomended to be acknowledged by the U-space regulation as a valid solution for National U-space deployment

Thank you very much
for your attention!