sesar
JOINT UNDERTAKING

TINDAIR Project
FINAL WORKSHOP

Toulouse, *France, December 15th*, 2022

EUROPEAN PARTNERSHIP

Co-funded by
the European Union

Agenda

Agenda

14:00	Introduction – Overall presentation of the project
14:10	WP2 Communication Dissemination by AV (10’)
14:20	WP3 Conops and use cases by Cira (VIDEO 15’)
14:35	WP4 and 5 Safety, security and human factors by Issnova (REMOTE 15’)
14:50	WP6 Uspace concept design by Inov’ATM (20’)
15:10	WP7 demonstrations by Skybirsdsview (20’)
15:30	WP8 analysis of results by Onera (5’)
15:35	Presentation of recommendations (10’)
15:45	Questions & Answers

TINDAIR WORKSHOP
Overal presentation

Sophie ALTHABEGOITY – Innov'ATM

TOULOUSE, 15 DECEMBER 2022

EUROPEAN PARTNERSHIP

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CONSORTIUM

Innovative companies

INNOVATM

AIRBUS

Collins Aerospace

PildoLabs move smart

SkyBirdsView

Skyports

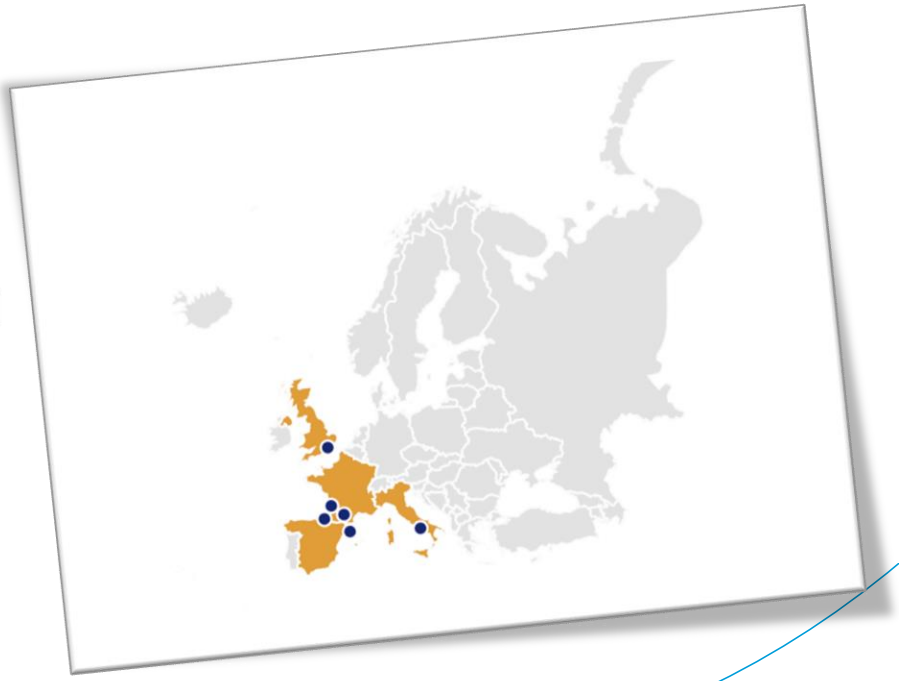
Research institutes

CIRA Italian Aerospace Research Centre

ISSNOVA Institute for Sustainable Society and Innovation

ONERA THE FRENCH AEROSPACE LAB

tecnalia MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE



A Competitiveness Cluster

aerospace valley

A pioneering Very Large-scale Demonstration project

Objectives

- **Develop a strategic and tactical deconfliction service** for the resolution unexpected conflict
- Provide the infrastructure and capabilities to **enable a set of U-space Services** including conflict resolution;
- Use **a secure datalink** compliant with standards in development by EUROCAE and RTCA;
- Allow its usage in **different types** of unmanned and manned platforms

Related tasks

- **Assessment on safety and security**
- **Assessment on social acceptance**

4 use cases

Exercise 1
Autonomous drones flight management within the same navigation corridor (medical + goods delivery)

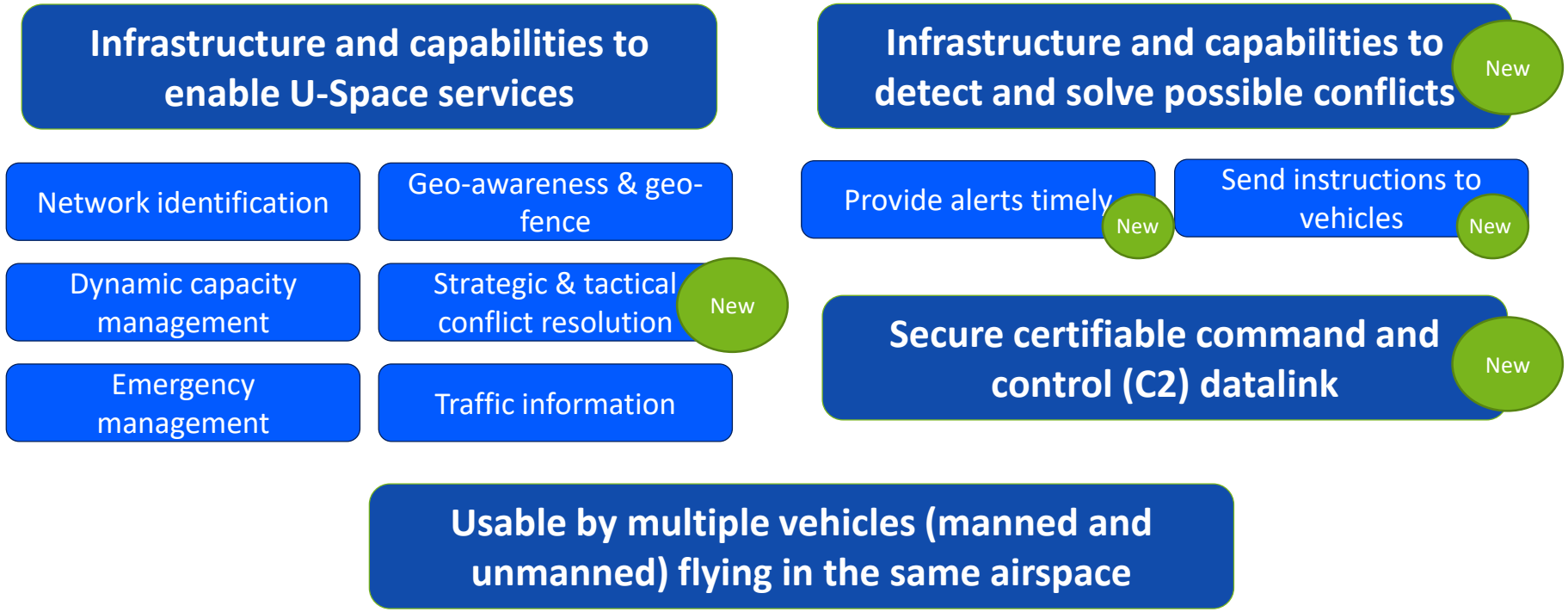
Exercise 2
Autonomous drones + eVTOL flight management: goods delivery + eVTOL with simulated passenger.

Exercise 3
Autonomous drones + eVTOL + helicopter flight management: goods delivery, eVTOL air taxi and a manned medical transport helicopter

Exercise 4
Deconfliction action involving an emergency landing.

Project services

The main objective of TINDAiR system is to provide the required **infrastructure** and **capabilities** to conduct **strategic and tactical conflict resolution** in the UAM environment, while providing **new reliable means of communication**.



Technical solution description "©2022 PildoLabs. All rights reserved. Licensed to the SESAR Joint Undertaking under conditions."

Project Workpackages

Work Package 1
Coordination, Project Management, Governance

Work Package 2
Communication, dissemination and Collaboration

Work Package 3
ConOps, Uses Cases and Requirements definition

Work Package 4
Solution Safety and Security Assessment

Work Package 5
Human Factors and Social Acceptance Assessment

Work Package 6
U-space concept design, architecture, integration and V&V activities

Work Package 7
Execution and UAM demonstrations

Work Package 8
Analysis of the results and recommendations

Project key informations

Key Deliverables

- DEMO Plan – Safety assessment Plan – Security Assessment Plan
- DEMO Report - Safety assessment Report – Security Assessment Report
- Human factor assessment plan and report – Communication and Dissemination activities

Key Ideas

- **Message 1** : Through the SESAR JU3 innovation pipeline, the TINDAIR project has generated, explored and tested an innovative method for the safe integration of UAM aircraft into controled airspaces thanks to the deconfliction service provided.
- **Message 2** : The demonstrations conducted by the TINDAIR project proved the technical and practical feasibility of safely integrating the AI-based tactical deconfliction service module into the U-Space system
- **Message 3** : The TINDAIR project has validated the solution with experts from the UAM and ATM community.
- **Message 4** : The TINDAIR consortium of industrial experts has approached other similar projects and UAM experts in order to cross-fertilize research and positive communication on research on the topic of UAM in Europe.
- **Message 5** : The TINDAIR project wants to show that the social acceptance of this new traffic and Urban areas is possible while ensuring the safety and respecting the privacy of people and property.

Key Audience

- **European citizens**
- Cities – smart cities
- Standardization institutions
- U-space providers
- Drone Clusters
- ANSP
- EASA

WP2: Communication, Dissemination and Collaboration

Morgane HEBERT VERNHES / Céline BIZIEAU – Aerospace Valley

TINDAIR Project Final Workshop, December 15th 2022

EUROPEAN PARTNERSHIP

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Timing

- The overall WP2 duration is of **23 months**, from **M1 to M23**.

- WP2 is structured in 3 tasks:
  - Task 2.1 **PEDR and communication tools** (M1-M23)
  - Task 2.2 **Workshops** (M6-M23)
  - Task 2.3 **Scientific and technical communication, Events participation** (M6-M23)

- WP2 deliverables:
  - D 2.1 **PEDR and communication tools** (M3)
  - D 2.2 **Website** (M3)
  - D 2.3 **Communication tools** (M3)
  - D 2.4 **Video** (M18)
  - D 2.5 **Dissemination and Communication Report** (M23)

Objectives of communication and dissemination activities

- **Raising awareness about solutions for tactical conflict resolution**
  Towards the UAM Community (Drone Industry, ANSPs, standardisation agencies etc.)
- **Promoting the feasibility and safety of Urban Air Mobility**
  Towards EU authorities, regional and local authorities
- **Working on the social acceptance of this new transportation system**
  Towards the general public

Communication tools

Task 2.1 PEDR and communication tools (M1-M23)

Leader: *Aerospace Valley* | Contributors: *all partners*

PEDR

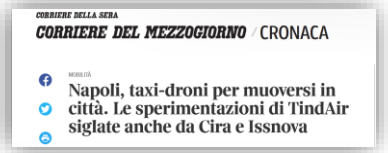
- Validation of the PEDR D2.1

Communication tools

- 2 press releases
- Leaflet D2.3
- Flagship images
- Roll-up D2.3
- Presentations Booklets Flyers
- Video D 2.4

Social Networks & Website

- Linkedin D2.3 — 880 followers
- Twitter D2.3 — 280 followers
- Website D2.2 — 2615 pages seen International visibility (64 countries)
- Pages on partners & SESAR websites

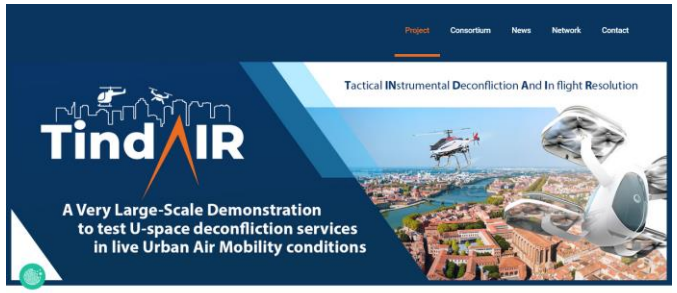

CORRIERE DELLA SERA
CORRIERE DEL MEZZOGIORNO / CRONACA
Napoli, taxi-droni per muoversi in città. Le sperimentazioni di TindAir siglate anche da Cira e Issnova


Les Echos
Innov'ATM intègre les drones dans l'espace aérien


L'USINEDIGITALE
TindAIR, un projet pour faire cohabiter drones et taxis volants avec les aéronefs traditionnels


UNMANNED AIRSPACE
SESAR research partners launch TindAIR programme to demonstrate strategic and tactical conflict detection and resolution

Website



Project

As the demand for the use of uncrewed air vehicles (UAV) in urban settings grows, so does the need to ensure the unlimited, unrestricted and safe cohabitation of all airspace users in our skies. To address this challenge, a group of innovative companies and research laboratories from France, Italy, Spain and the United Kingdom, coordinated by InnovATM under the aegis of the SESAR Joint Undertaking, have teamed up to launch TindAIR, a series of very large-scale demonstrations on urban air mobility, with a focus on tactical deconfliction.

4	2	11	4
Large-scale demonstrations	Year Project 2021-2022	Companies & research institutes	European Countries

An Urban Air Mobility project

What is Urban Air Mobility? It can be defined as the transportation of people and goods by air within individual cities or from locations outside a city inside the city area. This new mode of transportation is expected to become a reality in Europe in 3 to 5 years according to the European Aviation Security Agency (EASA). Shifting a part of the city transportation flow from ground to air will help to reduce greenhouse gases, as well as improving time of travel. It will also represent a tremendous opportunity for business as the European share of the UAM market is expected to be around 4.2 bn € by 2030 (Mc Kinsey report for EASA- 2021 – Report on social acceptance of UAM).

Before lift-off, this new transportation system needs to be integrated safely into the skies, alongside existing crewed aviation and air traffic control. To tackle this issue, the research and innovation programme SESAR Joint Undertaking is pooling Europe's resources and expertise to develop new operational concepts, on the safe and secure integration of drones. This set of services, called U-Space, relies on a high level of digitalisation and automation of functions, and on specific procedures designed to support safe, efficient and secure access to airspace for large numbers of drones. It is in this context that the TindAIR project was launched.

EU Drone Days: presentation of EU Drone Strategy 2.0

December 2, 2022

TindAIR team was happy and proud to be present at the EU Drone Days event held in Brussels on 29-30 November.



The European Commission presented the Drone Strategy 2.0 entitled :

« A Drone Strategy 2.0 for a Smart and Sustainable Unmanned Aircraft Eco-System in Europe. »

This important initiative aims at driving the development of new sustainable drone services and transport solutions throughout Europe. The Drone Strategy 2.0 is guided by a 2030 vision for the use of drones in the lives of Europeans. It addresses the numerous services that drones can provide, including **Innovative Air Mobility** services (IAM), i.e. air taxis, but also **defence aspects** with the importance of synergies between the civil and defence drone industries, and **security aspects** with the concern of threats by non-cooperative drones.

You will find the EU Drone Strategy 2.0 here.

What's more the TindAIR team had the pleasure and honour to present our project to Andreas Boschen, SESAR Executive Director and Jan-Christoph Oetjen, Member of the European Parliament.

Stéphane Bascobert, President of InnovATM, wrote : « It was an honor to present the great achievements of the Tindair project that will unlock the potential growth of the UAM in Europe. The encouraging first results give us confidence that we can safely integrate the drone traffic within the manned aviation traffic. »

Thanks again to Andreas Boschen and Jan-Christoph Oetjen for their support and their interest in our topics. We are very

Social networks

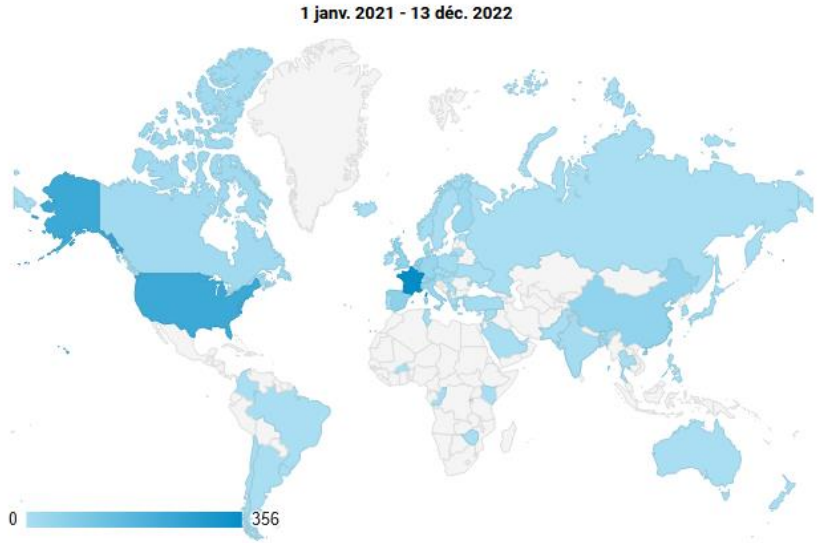
More articles

EU Drone Days: presentation of EU Drone Strategy 2.0

TindAIR team was happy and proud to be present at the EU Drone Days event held in Brussels on 29-30 November. The European Commission presented

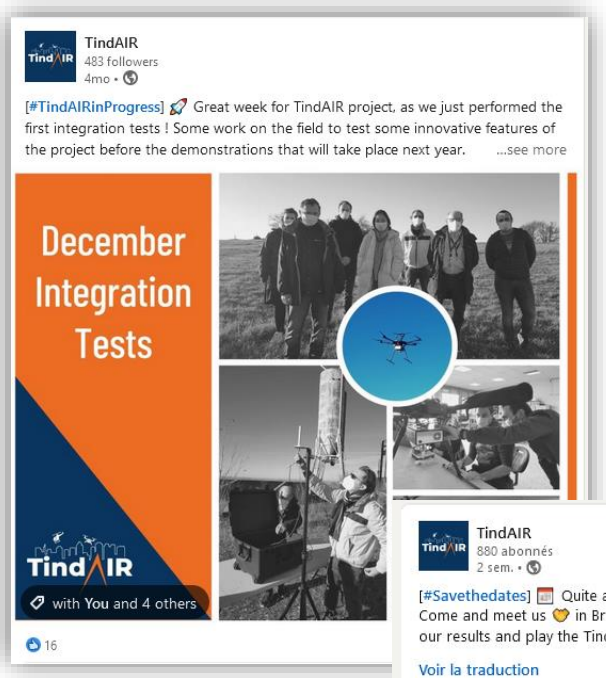
Read More >

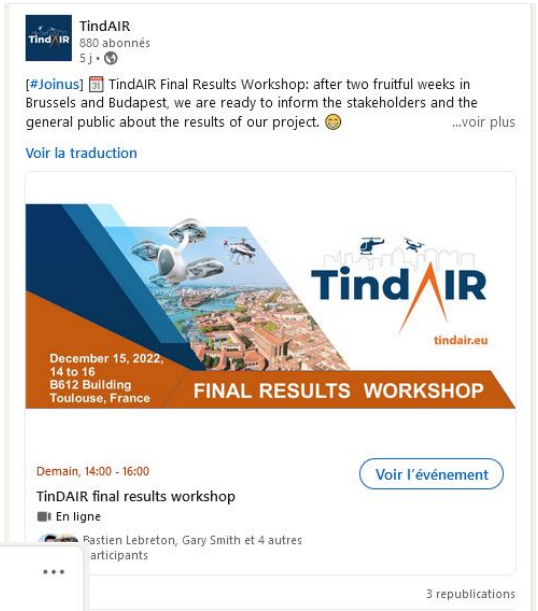
- 2615 pages seen since 2021
- Visitors from 64 countries
- 11 publications on the website including 6 articles

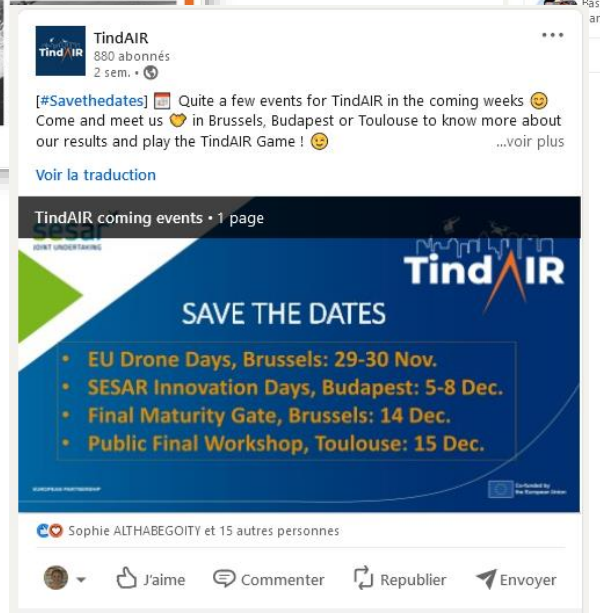


Geographical repartition of TindAIR website users

Social networks







Congresses and international events

Task 2.3 Scientific and technical communication, Events participation (M6-M23)

- Leader: *Aerospace Valley* | Contributor: *all partners*

Events Participation

CURPAS

- Around 600 visitors
- 170 participants onsite and online at the conference

UAV Show

- 2500 visitors
- 70 participants at the conference
- 200 visitors on partners booths

Aerospace Tech Week

- 5000 visitors
- 80 participants at the conference

World ATM Congress

- 6000 visitors
- 160 participants at the 2 conferences

Aero Forum

- 747 views on Youtube

Mobility Solution Shows

- 500 visitors
- 20 participants at the workshop

Congresses and international events

More events…

Amsterdam Drone week

- more than 1500 industry leaders
- More than 15 official meetings

Go Mobility Forum

- Tecnalia participated in a round table
- Around 150 participants at the round table

Nordic Edge

- Session on UAM organised by Polis Network
- 40 participants at TindAIR presentation

ITS Congress

- 3000 visitors
- 20 participants at the session on UAM about Sesar's VLD

World ATM congress

- 6000 visitors
- Participation of Tecnalia at a round table

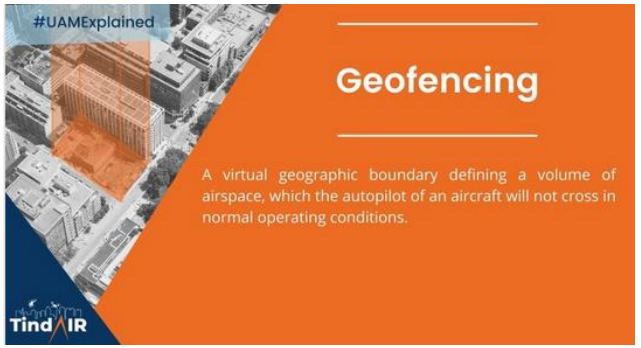
EU Drone Days

- 450 participants
- 50 visitors on TindAIR booth

Article accepted to Transport Research Arena Lisbon 2022

Collaboration activities

- Creation of TindAIR Circle
- Collaboration with the Urban Air Mobility network
  - UAM Explained
  - U-space demonstrators network
  - Sibling projects
  - Joint participation in events : UAV show, ITS
- Participation in standardisation groups :
  - WG 105 from EUROCAE
  - ASD STAN
  - BNAE working groups



Milestones & Deliverables

- No milestone linked to WP2 implementation

Deliverables associated to WP2						
#	Description	Lead beneficiary	Type	Dissemination level	Month	
D2.1	PEDR	AV	Report	CO	3	On time
D2.2	TINDAiR website	AV	Website	PU	3	On time
D2.3	Communication Tools	AV	Other	PU	3	Delivered Month 4
D2.4	Video of the Project	AV	Other	PU	18	Delivered Sept 27th
D2.5	Dissemination and Communication Report	AV	Report	PU	23	End of Dec

Next actions

Final dissemination report

Final results workshop

Aerospace Valley Drone Day

Final press release

Social networks releases

Final website publications

- Final Demo report
- Social Acceptance report
- Article on Final workshop
- Presentation from the final workshop

WP3: ConOps, Uses Cases and Requirement definition

Vittorio DI VITO, CIRA, WP3 Leader

TINDAIR Final Workshop, December 15th 2022

Toulouse and WebEx

EUROPEAN PARTNERSHIP

Co-funded by the European Union

Description of work

Objectives

- Review and refinement of the overall U-space Concept of Operations (ConOps) with respect to the specific Urban Air Mobility (UAM) operations peculiarities.
- Definition of the UAM operational scenarios representing the specific use cases to be demonstrated in the TINDAiR project.
- Review and refinement of the U-space requirements with respect to the specific UAM operations considered, in the project with particular emphasis on the U-space operational requirements affecting the demonstration of the TINDAiR considered use cases.
- Definition of the objectives that the demo activities carried out in TINDAiR aim to achieve and of the performance metrics that are intended to be used in the project in order to assess the indicated objectives.

Work organization

- The WP3 activities have been broken down into 4 tasks:
    - Task 3.1 – U-Space ConOps refinement with respect to UAM operations
    - Task 3.2 – UAM operational scenario and use cases definition
    - Task 3.3 – U-Space requirements refinement with respect to UAM operations
    - Task 3.4 – Demo objectives and performance metrics definition

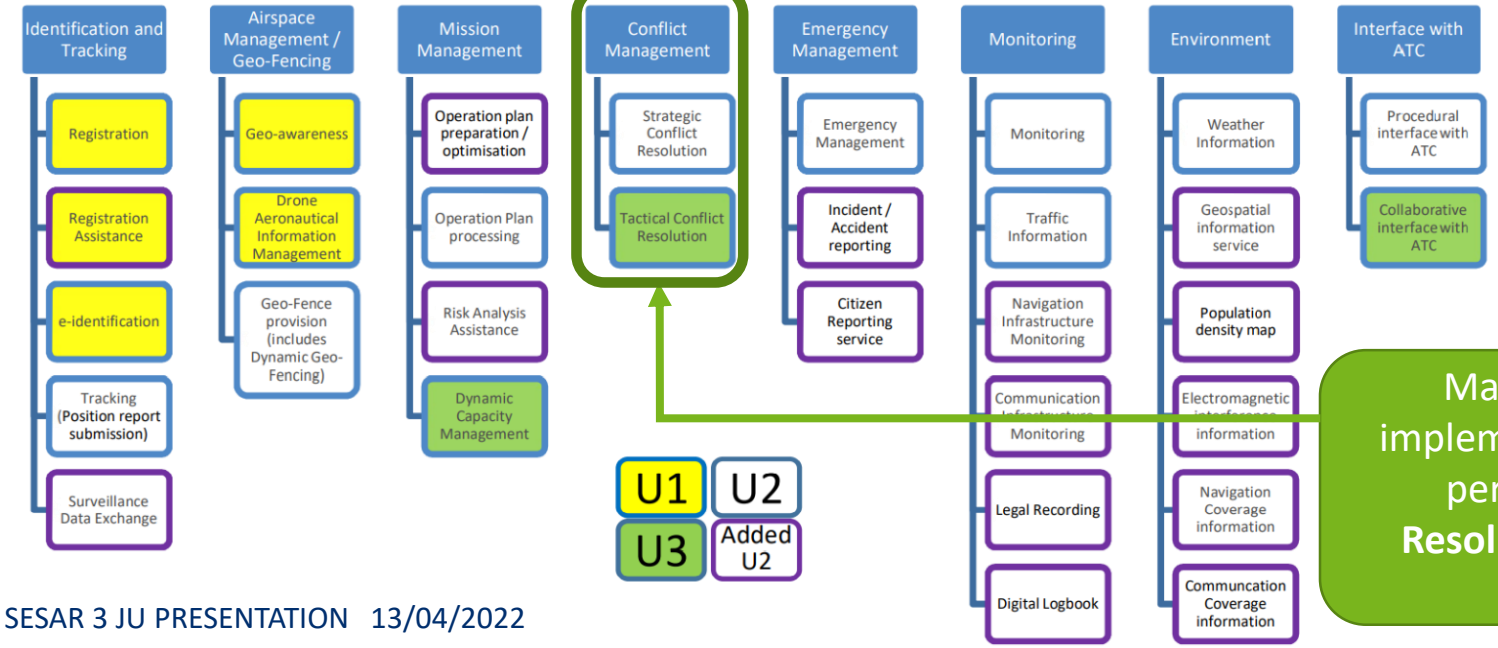
U-Space Concept & Services (1 of 2)

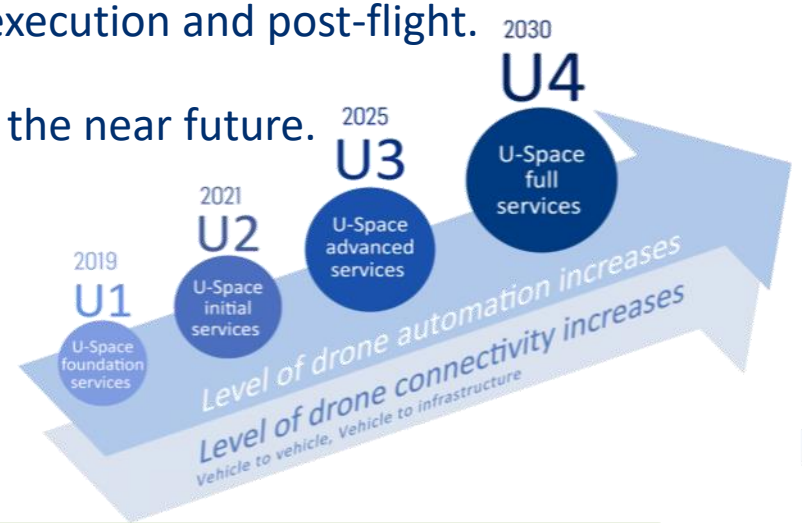
- **CORUS Project**
  - It is a SESAR2020 Exploratory Research project (2017-2019)
  - It developed a comprehensive set of Concept of Operations for U-Space

- U-Space addresses Very-Low-Level (VLL) Operations and envisages the phased introduction of services and procedures in support of safe drone operations.

- U-Space services address all of the drone flight phases, from pre-flight to execution and post-flight.

- Some U-Space services are already in use, while others will be activated in the near future.

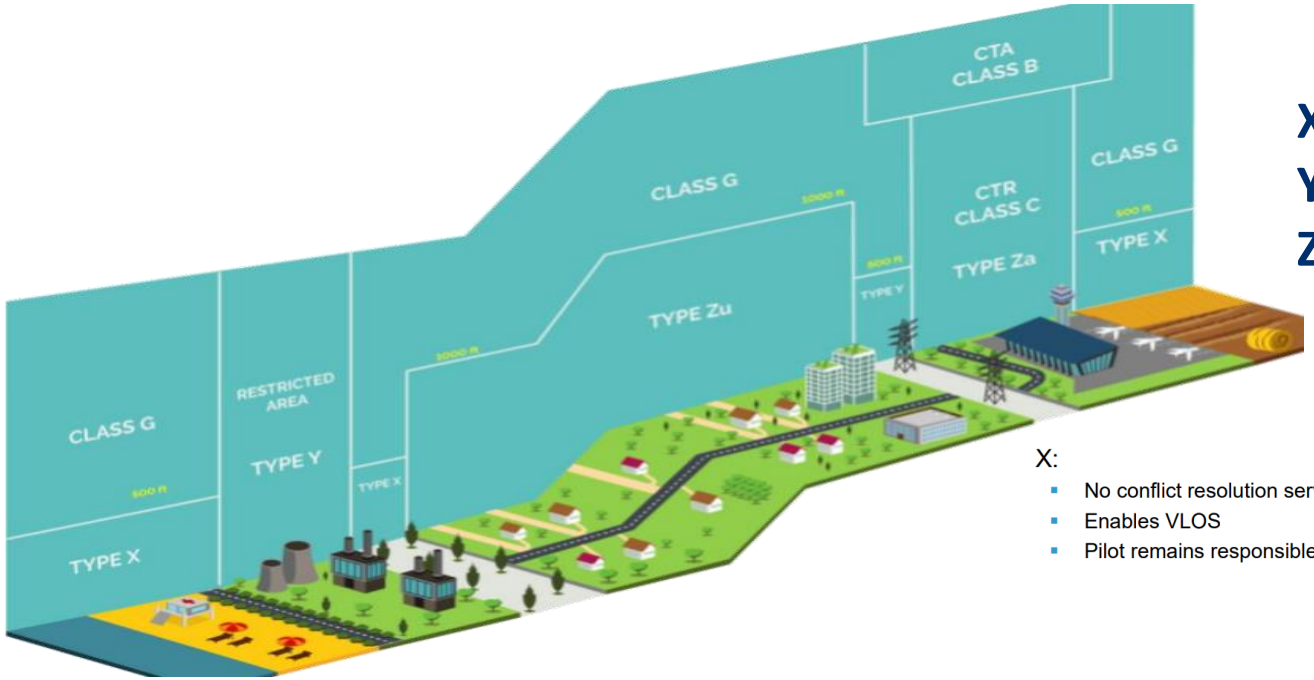




Main **TINDAIR** contribution to U-Space implementation is the proposal of possible U3 perspective service of **Tactical Conflict Resolution** (in addition to **Strategic Conflict Resolution**).

U-Space Concept & Services (2 of 2)

- The CORUS ConOps introduce also a classification of the VLL airspace into three types of volumes → X, Y and Z.
- These airspaces are characterized by different access requirements and by different U-Space services offered



X – Low risk
Y – Higher risk
Z – Highest Risk

Increasing level of airspace complexity
Increasing number of access requirements
Increasing number of U-Space services provided

X:
- No conflict resolution service
- Enables VLOS
- Pilot remains responsible to remain well clear

Y:
- Approved flight plan required
- Conflict resolution before take off
- Usually:
  - Position reporting required
  - Information given to pilot during flight
    - Conformance & Geo-awareness
    - Warnings & Traffic information

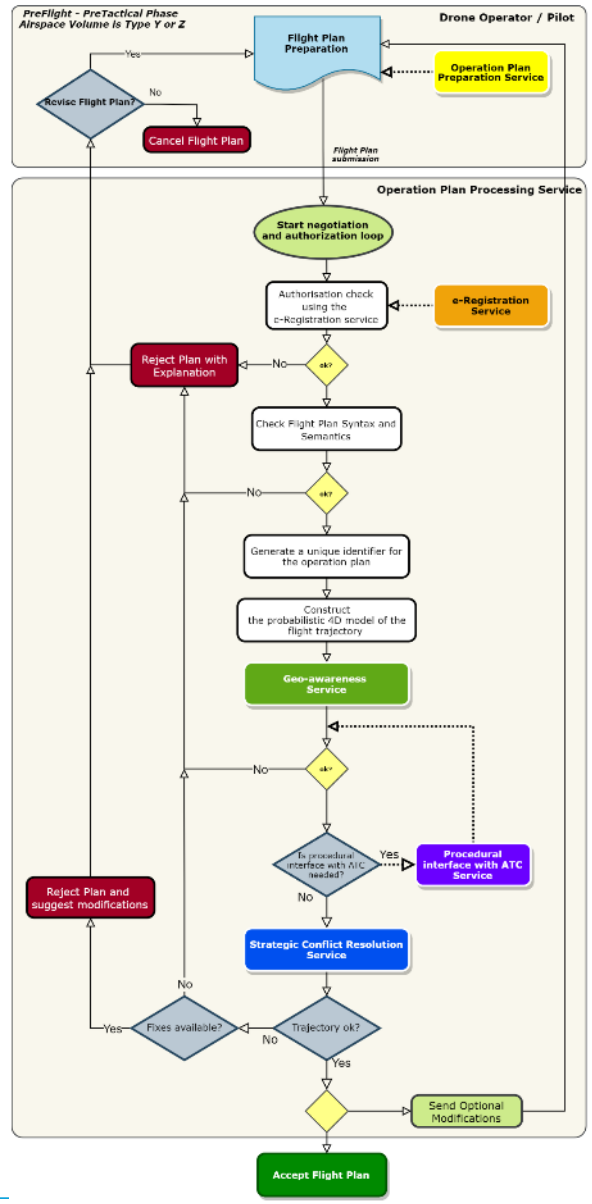
Z:
- Conflict resolution before flight **and** in flight
- Requires tracking
  - Separation minima in function of system performance
- Za
  - ATC controlled airspace, e.g. airport
  - U-space provides
    - Situational awareness to ATC
    - Communication tools
    - Standard ways of working
- Zu
  - U-space (software) provides conflict resolution during flight, from the ground

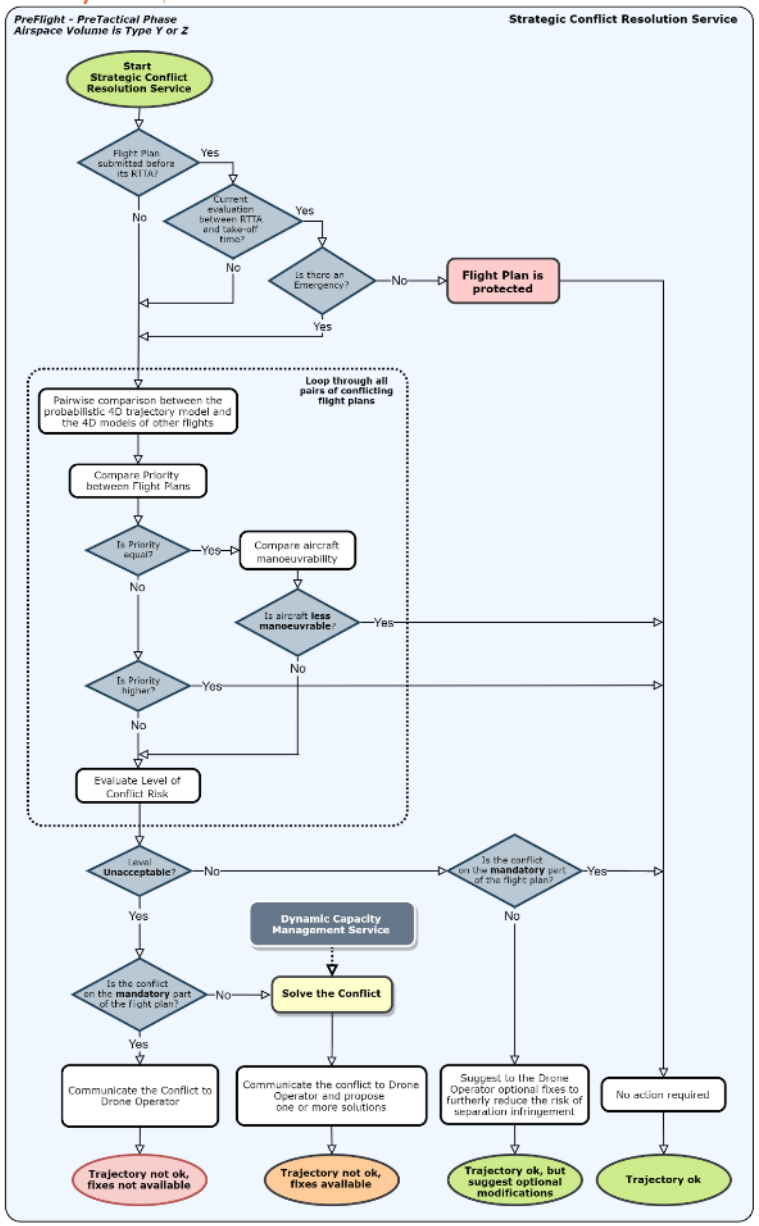
For instance, **Tactical Conflict Management** is offered only for operations that take place in Z-Type Volumes

TINDAIR proposed U3 perspective service of **Tactical Conflict Resolution** allows supporting deconfliction in complex airspace environments (Z-Type Volumes).

U-Space Concept of the Strategic Conflict Resolution

- Mandatory in Y and Z types of airspace volumes.
- Triggered once the drone operator or drone pilot submits a flight plan to the **Operation Planning Processing Service**. Applicable to pre-flight pre-tactical phase.
- Linked U-space services:
  - **Geo-awareness Service**, to check for geo-fences and other environment constraints (weather, terrain or other restrictions);
  - **Dynamic Capacity Management Service**, if the airspace density is an issue;
  - **Procedural Interface with ATC Service**, if the flight has a significant probability to interfere with ATS airspaces.

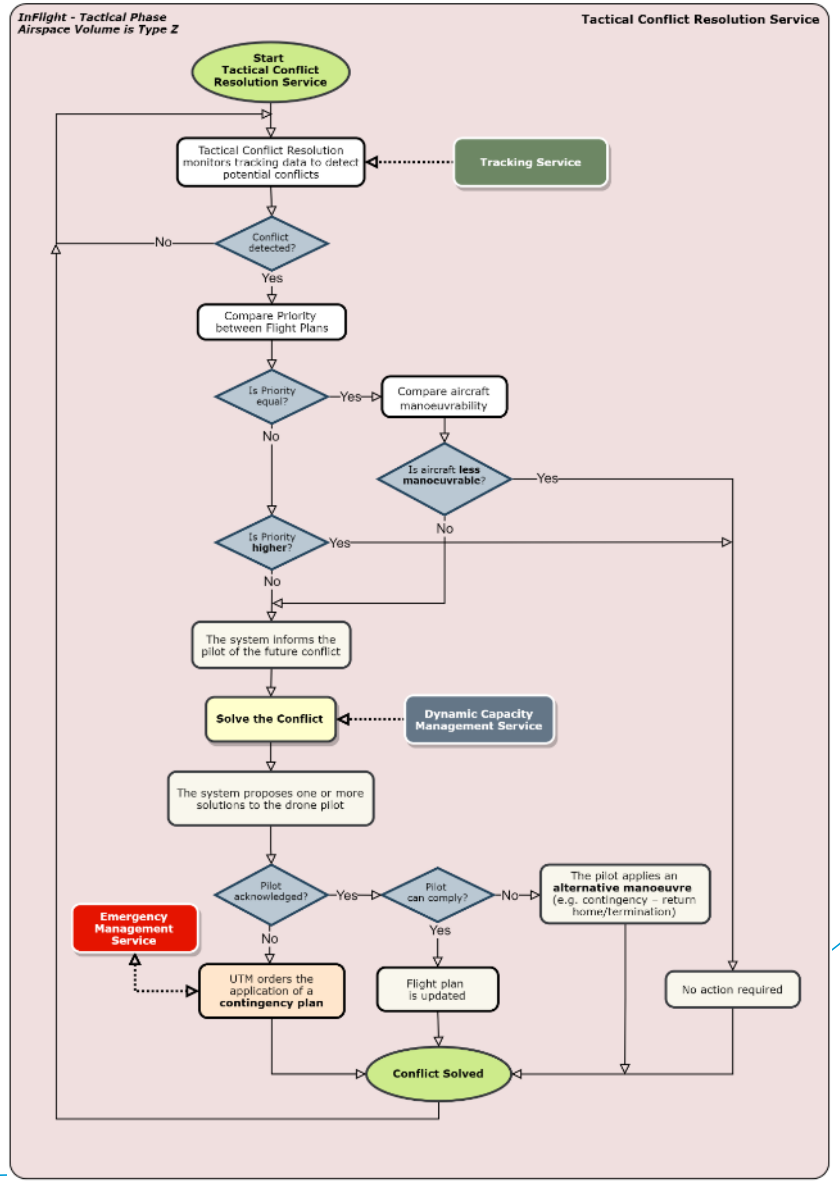




U-Space Concept of the Tactical Conflict Resolution

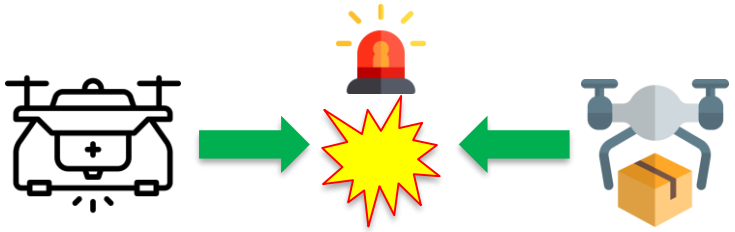
- Mandatory in Z type of airspace volumes.
- This service processes the drone tracks generated within the **Tracking Service** and allows to:
  - detect potential separation infringements;
  - determine conflict resolution solutions.

- Linked U-Space services:
  - **Dynamic Capacity Management Service**, if the airspace density is an issue while solving the conflict;
  - **Emergency Management Service**, if the flight is in off-nominal conditions and a contingency plan is applied.



UAM Operational scenarios and use cases (1of5)

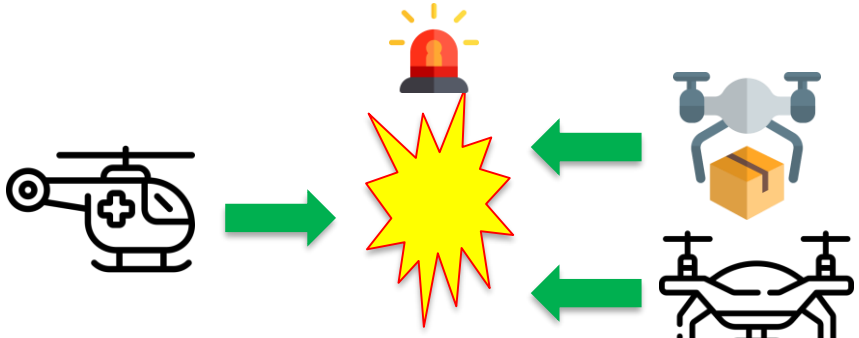
Use Case 1



Use Case 2

eVTOL

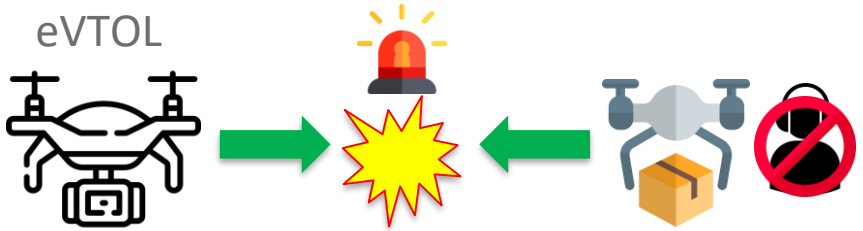
Use Case 3



eVTOL

Use Case 4

eVTOL



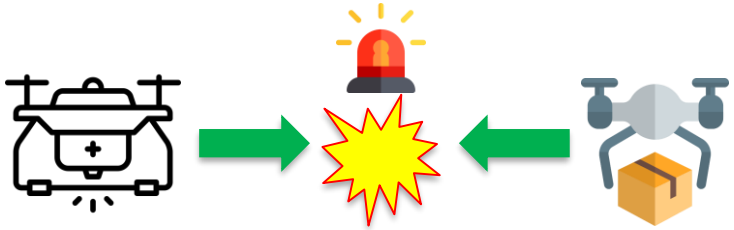
Communication failure

RTH procedure

TINDAIR considered four specific Use Cases involving occurrence of conflict conditions at tactical level during the flight, with the need of provision of Tactical Conflict Resolution service by the TINDAIR proposed system (more details in the next slides).

UAM Operational scenarios and use cases (2of5)

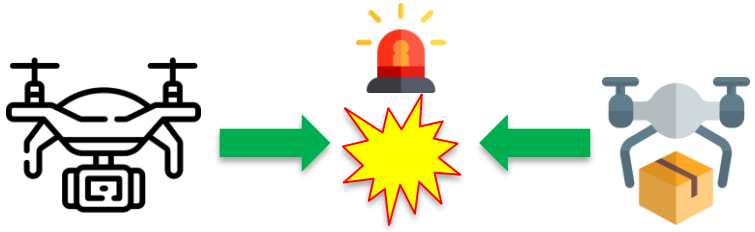
Use Case 1



Identifier	EXE-VLD-TINDAIR-001
Title	Autonomous drones flight management
Description	Medical link between a specialized clinic and a delivery point located at 11 km. They are to organize a deconfliction management between two Drones on similar trajectories (imposed air corridor).
Demonstration Technique	Live trial
KPA/TA Addressed	Predictability, Human Performance, Airspace capacity
Number of flights	2
Demonstration Coordinator	ONERA
Demonstration Platform	TINDAIR
Demonstration Location	Toulouse area

UAM Operational scenarios and use cases (3of5)

Use Case 2

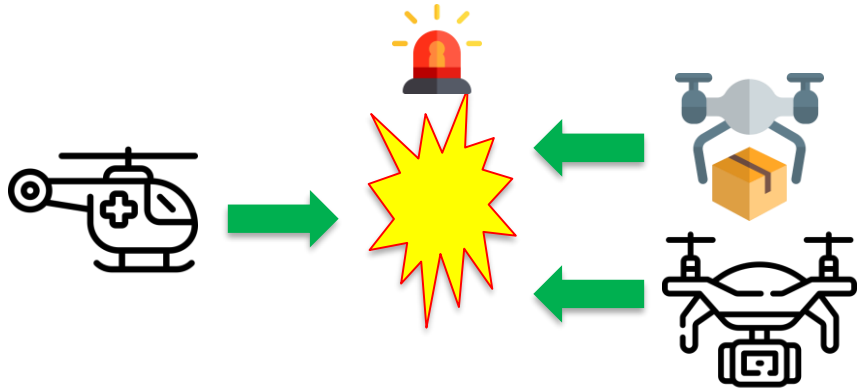


eVTOL

Identifier	EXE-VLD-TINDAIR-002
Title	Autonomous drones + eVTOL flight management
Description	Flight in a segregated area with the use of an E-VTOL + Drone. Mixed traffic with one merchandise delivery with autonomous drone and a simulated one-person transportation with eVTOL.
Demonstration Technique	Live trial
KPA/TA Addressed	Predictability, Human Performance, Airspace capacity, Safety
Number of flights	2
Demonstration Coordinator	TECNALIA
Demonstration Platform	TINDAIR
Demonstration Location	Bordeaux area

UAM Operational scenarios and use cases (4of5)

Use Case 3

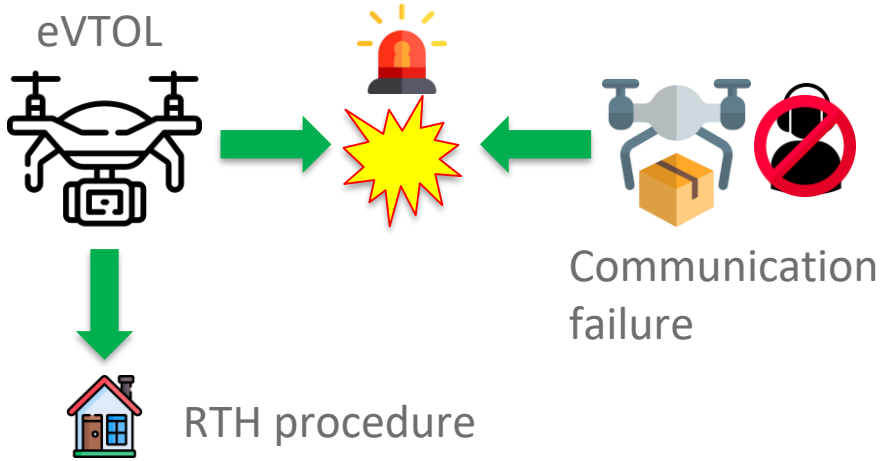


eVTOL

Identifier	EXE-VLD-TINDAIR-003
Title	Autonomous drones + eVTOL + Helicopter flight management
Description	Light in a segregated area with the use of a Helicopter+ E-VTOL + Drone. Mixed traffic (general aviation and UAV) including one merchandise delivery with autonomous drone, simulated one-person transportation with eVTOL and one emergency medical transport with helicopter
Demonstration Technique	Live trial
KPA/TA Addressed	Predictability, Human Performance, Airspace capacity, Safety
Number of flights	3
Demonstration Coordinator	SKYBIRDSVIEW
Demonstration Platform	TINDAIR
Demonstration Location	Bordeaux area : Souges military base

UAM Operational scenarios and use cases (5of5)

Use Case 4



Identifier	EXE-VLD-TINDAIR-004
Title	Emergency landing
Description	Flight in a segregated area with the use of Drones. The purpose of this scenario is to assess a deconfliction action involving an emergency landing.
Demonstration Technique	Live trial
KPA/TA Addressed	Predictability, Human Performance, Airspace capacity, Safety
Number of flights	2
Demonstration Coordinator	SKYPORTS
Demonstration Platform	TINDAIR
Demonstration Location	Toulouse ONERA area

U-Space Requirements from CORUS

- CORUS project has developed a set of **high-level requirements** for each service and for different flight phases.

- Task 3.3 identified and refined the applicable requirements for the services that are included in the TINDAIR demonstration, namely: **Strategic Conflict Resolution (SCR)** and **Tactical Conflict Resolution (TCR)** in the framework of UAM.

The applicable requirements were defined considering the following categories:

- **Functional** (FUN) – referring to the main function that SCR and TCR are expected to provide;
- **Performance** (PER) – referring to the proprieties such as safety, security, accuracy, reliability, integrity that that SCR and TCR are expected to provide (for each specific functionality);
- **Interface** (INT) – referring to the interfaces that SCR and TCR are expected to consider (for each specific functionality).

Refined U-Space Requirements for TINDAIR

- **The refined requirements have been collected in tables in the D3.1.**
- Each requirement is characterized by a unique **Identifier** of the type REQ-*CAT-YYY-XXX,* built according to the following rules:
  - *CAT* represents one of the three categories (Functional, Performance, Interface)
  - *YYY* represents a progressive number from 001 to 999
  - *XXX* represents a progressive number from 001 to 999 within the numbering of YYY requirement. It aims to trace an interdependence.
- The fields **Title**, **Type**, **Service/Capability**, **Category**, **Environment type** and **Status** are filled according to CORUS indications.
- The field **Link to CORUS** reports the identifier of the linked CORUS requirement from which the current requirement is derived.
- The fields **Description** and **Additional Information** report the description of the requirement and possible further specifications.

Identifier	Title	Type	Service /Capability	Category	Environment type	Status	Link to CORUS
REQ-FUN-001	Flight Plan Definition	Capability	Operations Management	Functional	All	Defined	3.3.1.1
Description: (…)							
Additional Information: (…)							

Demo objectives and performance metrics definition

- Tacking into account the SESAR Requirements and V&V Guidelines, **high-level objectives** have been defined for each SESAR solutions addressed by VLD (e-Identification, Geo-awareness, Strategic conflict resolution, Tactical conflict resolution, Tracking, Monitoring, Traffic information, Emergency management).
- For each objective, it has been defined a **set of success criteria** to be validated in order to established that the objective has been achieved.
- A **set of assumptions** has been identified, which define the conditions for carrying out the demonstrations and assessing the achievement of the objectives.
- The defined objectives, success criteria and assumptions have unique identifiers whose structure is constructed in such a way it eases the traceability and their links.
- Example:

Identifier	OBJ-VLD-TINDAIR-001
Objective	Demonstrate the strategic deconfliction when an operation plan is created or updated in such a way it causes a conflict with another existing operation plan
Title	Strategic deconfliction objective
Category	Operation feasibility
Key environment conditions	Nominal conditions
TRL Phase	TRL7

Identifier	Success Criterion
CRT-VLD-TINDAIR-001-001	100 % of such action result in a strategic conflict alert raised by the system
CRT-VLD-TINDAIR-001-002	Every time a proposed strategic conflict resolution is applied, the resulting strategic air situation does not contain conflict anymore
CRT-VLD-TINDAIR-001-003	No geo-awareness is infringed after applying a proposed strategic conflict resolution

Refined objectives and performance metrics for each demonstration

- For each demonstration exercise, further details on objectives are provided in order to:
  - define which objectives are applicable for this exercise;
  - if these objectives require further refinement;
  - how far the initial objective is covered by the exercise;
  - refinement on objective success criteria for this exercise, if necessary;
  - unique identifier for a given exercise and a given objective (resp. success criterion).
- Example:

Identifier	EX1-OBJ-VLD-TINDAIR-001
Objective	Demonstrate the strategic deconfliction when an operation plan is created or updated in such a way it causes a conflict with another existing operation plan along the same air corridor
Title	Strategic deconfliction objective
Category	Operation feasibility
Key environment conditions	Nominal conditions, Traffic sample 2025, Hub Airport with complex layout, Regional Airport
V Phase	V1

Identifier	Demonstration Exercise 1 Success criteria	Coverage and comments on the coverage of Demonstration objectives (as in section 4.4)
CRT-VLD-TINDAIR -001-001	EX1- CRT-VLD-TINDAIR-001-001: as soon as the second flight plan is edited, the system detects the conflict with the first flight at strategic level and rise an alert	Partially covered: only the situation of conflict along the same air corridor is demonstrated here
CRT-VLD-TINDAIR -001-002	EX1- CRT-VLD-TINDAIR-001-002: when the proposed strategic conflict resolution is applied, the two flight plans are not conflicting anymore	
CRT-VLD-TINDAIR -001-003	EX1- CRT-VLD-TINDAIR-001-003: No geo-awareness is infringed after applying the proposed strategic conflict resolution	

D3.1 Demo Plan

Table of Contents

WP4: Solution Safety and Security Assessment

Vittorio Sangermano - ISSNOVA

TINDAIR Final Workshop, December 15th 2022

EUROPEAN PARTNERSHIP

Co-funded by the European Union

WP Structure

- The overall WP4 duration is of 18 months, from M6 to M23

- WP4 is structured in 4 tasks.

Task 4.1 Safety assessment planning (M6-M12)

Task 4.2 Security assessment Planning (M6-M12)

Task 4.3 Safety Assessment Reporting (M13-M23)

Task 4.4 Security assessment Reporting (M13-M23)

Work achieved

Task 4.1 Safety assessment planning M6-M12

Leader: ISSNOVA | Contributor: ALL WP contributors

Description of the work achieved in this task

- Safety Assessment Plan to evaluate that all the safety measures are in place.
- Proper Safety Assessment to be performed (Hazards identification, worst credible event and mitigation of the hazards) considering the most suitable methodology for each use case (i.e. SORA assessment was used for all the use cases).
- Safety objectives from Demo plan added to the safety assessment plan. Additional safety objectives coming from SORA assessment have to be achieved to maintain safety during the demonstration activities.

Planning of the project safety assurance activities

Definition of applicable Assessment methodologies

Definition of safety objectives to met to maintain safety during demonstration activities

Work achieved

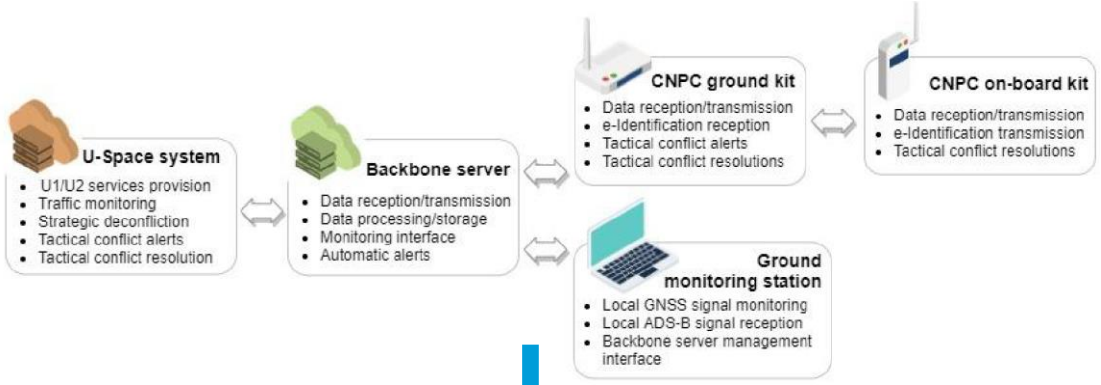
Task 4.2 Security assessment Planning M6-M12
Leader: APSYS | Contributor: ALL WP contributors

Description of the work achieved in this task

- Security Assessment has been established proposing security risk assessment methodology.
- Risk assessment followed SecRAM risk assessment methodology. Security context have been initiated in the Security plan.
- Security risk assessment used FENCE Tool provided by Apsys (which is fully compliant with SecRam Methodology) to deliver preliminary risk assessment results as expected.
- Identification of primary assets and supporting assets.
- Definition of (cyber-)impact, vulnerability and threat assessment.

Work achieved

Task 4.2 Security assessment Planning M6-M12



Primary Asset Identification

Id	Type	Primary Asset	Description
PA#01	Service	U1 service provision	Collection of available U1 services.
PA#02	Service	U2 service provision	Collection of available U2 services.
PA#03	Service	Traffic monitoring	This service provides the drone pilot or operator with traffic information and warnings about other flights – manned or unmanned – that may be of interest to the drone pilot. It is the presentation of the "air situation".
PA#04	Service	Strategic de-confliction	This service is to plan before flight operations of a strategy that does not conflict with other users. […]
PA#05	Service	Tactical conflict resolution	The process of resolving conflicts that occur during the flight by changing the flight while it happens. […]
PA#06	Information	Tactical conflict alerts	Alert information about the occurring of tactical conflicts.
PA#07	Information	Tactical conflict commands	Instructions or advisory information for tactical de-confliction
PA#08	Service	U-space information distribution	Information distribution between the U-space system and other building blocks, simplifying the data transmission.
PA#09	Information	Automatic alerts and warnings	Alerts and warnings based on message data.
PA#10	Service	OWL	Cloud-service intended for automatic assessment and reporting of GNSS Signal-In-Space and Navigation Performances.
PA#11	Information	GNSS signals	GNSS signals.
PA#12	Information	ADS-B signals	ADS-B signals.
PA#13	Information	Data reception/transmission	Data reception/transmission.

Supporting Asset Identification

Id	Type	Supporting Asset	Description	Related Primary Asset
SA#01	Component	U-space system	This component provides to the UAS users the required infrastructure to access U-Space services.	PA#01, PA#02, PA#03, PA#04, PA#05, PA#06, PA#07
SA#01.01	Subcomponent	UAS C2 Platform	This platform will be used as C2 platform to display collaborative U-space user to be tracked and coordinated.	PA#03
SA#01.02	Subcomponent	U-space platform	This corresponds to Drone Keeper, an integrated drone U-space solution, focused on the safe guidance, facilitation, and interaction with drones.	PA#04, PA#05, PA#06, PA#07

…

Work achieved

Task 4.3 Safety assessment reporting M13-M23
Leader: ISSNOVA | Contributor: ALL WP contributors

Description of the work achieved in this task:

3 Safety Objectives were identified in the D4.1 Safety assessment plan:

- Demonstrate the system capability to monitor flights
- Demonstrate the tactical deconfliction when a flight has deviated from its operation plan leading to one or several conflicts
- Demonstrate the emergency management when the communication of an aircraft is lost

Safety objective results were gathered during the execution of the four demonstration activities.

Provision of safety evidences to ensure that the level of safety was maintained during the execution of the demonstration activities

Work achieved

Demonstration Objective	Identifier	Category	Demonstration Objective description	Demonstration Success criteria	Demonstration Success criteria description
Monitoring objective	OBJ-VLD-TINDAIR-005	Safety	Demonstrate the system capability to monitor flights	CRT-VLD-TINDAIR-005-001	100% of aircraft tracked by the system is associated to an operation plan.
				CRT-VLD-TINDAIR-005-002	Each time a flight deviates from its operation plan, the system raises an alert.
Tactical deconfliction objective	OBJ-VLD-TINDAIR-006	Safety	Demonstrate the tactical deconfliction when a flight has deviated from its operation plan leading to one or several conflicts	CRT-VLD-TINDAIR-006-001	100% of separation infringement are detected by the system
				CRT-VLD-TINDAIR-006-002	Every time a proposed tactical conflict resolution is applied, the resulting air situation does not contain conflict anymore
				CRT-VLD-TINDAIR-006-003	No geo-awareness is infringed after every tactical conflict resolution
Emergency management objective	OBJ-VLD-TINDAIR-008	Safety	Demonstrate the emergency management when the communication of an aircraft is lost	CRT-VLD-TINDAIR-008-001	100% of loss of connection during more than 10 seconds, an emergency alert is raised by the system
				CRT-VLD-TINDAIR-008-002	As soon as an emergency alert is raised, the system sends emergency landing orders to all aircraft close to the lost flight in the few next seconds

Work achieved

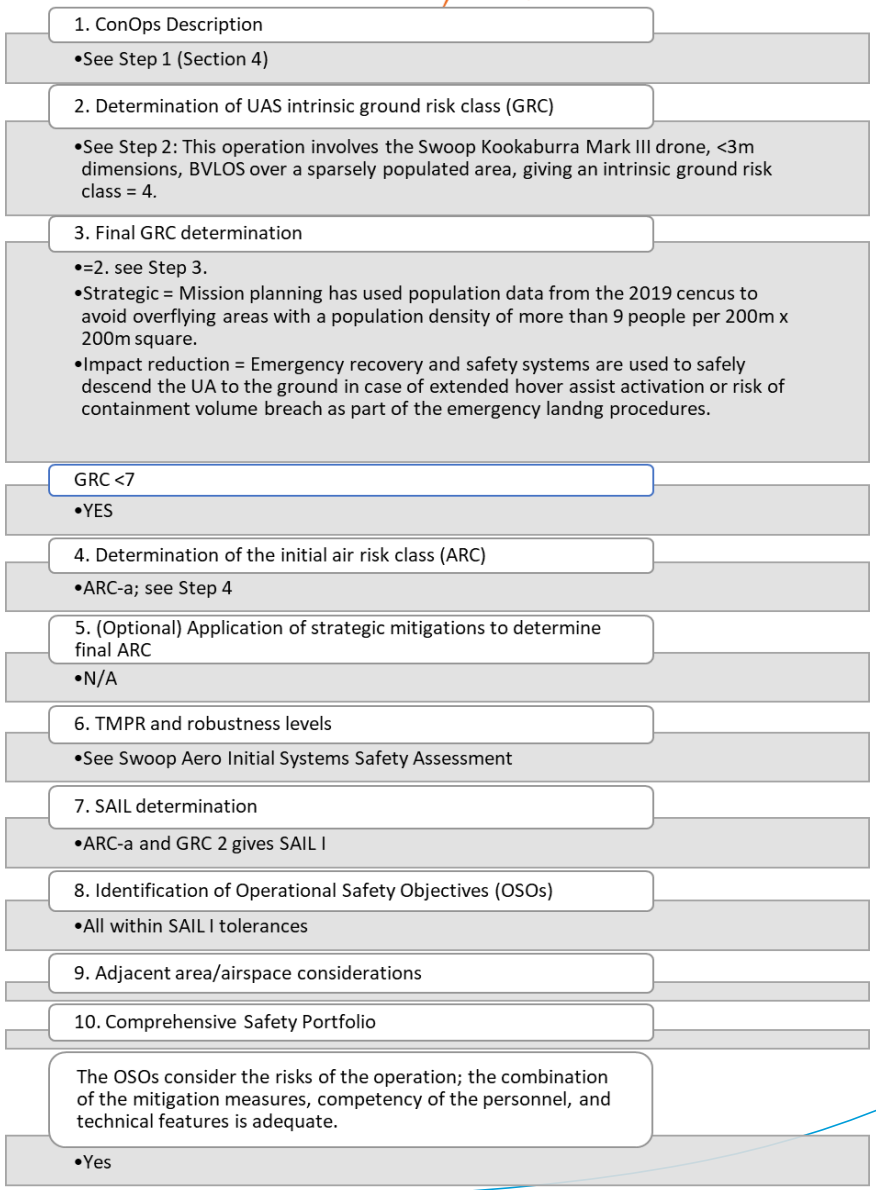
Summary of Safety Results

Demonstration Objective	Demonstration Success criteria description	Summary of results
Monitoring objective	100% of aircraft tracked by the system is associated to an operation plan.	In all the scenarios, the aircraft were correctly displayed on the HMI of both USSP supervisor and drone pilots. The scenario 3, due to telemetry issue, one flight was simulated. However, as soon as the flight plan was uploaded, the system associated the flight plan to the aircraft.
	Each time a flight deviates from its operation plan, the system raises an alert.	The system raised an alert as soon as an aircraft exceed from its operation plan. (e.g. higher altitude, time slot, etc.)
Tactical deconfliction objective	100% of separation infringement are detected by the system	The trajectory prediction to detect possible conflicts was done over the next 2 minutes in all the exercises. However, the separation infringement were always detected by the system
	Every time a proposed tactical conflict resolution is applied, the resulting air situation does not contain conflict anymore	Even if some exerices were executed with simulated aircraft, after the execution of a tactical conflict resolution order no more conflict were detected
	No geo-awareness is infringed after every tactical conflict resolution	After every tactical conflict resolution order the aircraft never exceed their operational volume in all the scenarios.
Emergency management objective	100% of loss of connection during more than 10 seconds, an emergency alert is raised by the system	The system correctly raised an alert during the execution of scenario 4 and the alternate exercise of the scenario 1
	As soon as an emergency alert is raised, the system sends emergency landing orders to all aircraft close to the lost flight in the few next seconds	The system correctly send the emergency landing order to all the aircrafr involved. In addition, the USSP supervisor in the scenario 4 had to select one spot for landing aircraft.

Work achieved

Task 4.3 Safety assessment reporting M13-M23
Leader: ISSNOVA | Contributor: ALL WP contributors

SORA Assessment executed for all the scenarios and provided in the Appendix A of the D4.3 – Safety Assessment Report



WP5: Human Factors and Social Acceptance Assessment

Gabriella Duca - ISSNOVA

Final workshop, December 15th 2022

EUROPEAN PARTNERSHIP

Co-funded by the European Union

Description of work - overview

Objectives

- To set up and execute HF investigation, relying on data available from Pilots and USSPs supervisors involvement in the flight demo campaign, with an iterative approach
- To involve stakeholders in order to elicit their needs, perspectives, and priorities about the proposed use cases, allowing to early detect concerns and barriers to the successful deployment of envisaged use cases
- Involving Human Factors and Stakeholders, this WP has the final objective to build a clear framework of technical, environmental, regulatory and social issues relevant for the UAM future implementation and full deployment.

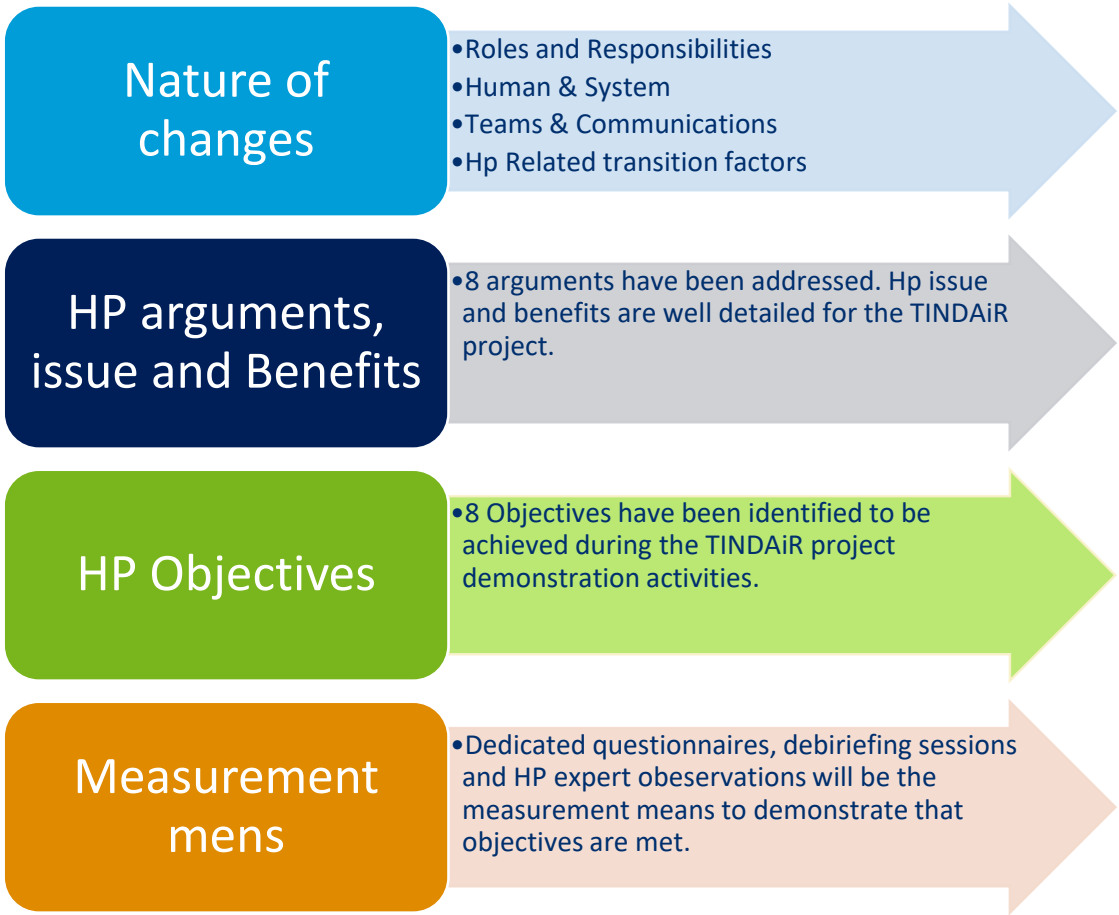
Work organization

- The WP5 activities are broken down into 4 tasks:
    - Task 5.1 - Human Factors assessment planning (M6-M12)
    - Task 5.2 - Social acceptance assessment Planning (M7-M9)
    - Task 5.3 - Human Factors Assessment Reporting (M13-M23)
    - Task 5.4 - Social acceptance assessment Execution and Reporting (M10-M23)

Description of work - Task 5.1

Task 5.1 - Human Factors assessment planning M6-M12

- Leader: ISSNOVA | Contributor: ALL WP contributors
- Description of the work achieved in this task
  - The task defined HP aspects related to TINDAiR project. In particular, the task defined the nature of the changes to be considered in the TINDAiR project.
  - The task identified HP arguments, Issues and benefit related to the TINDAiR Use Cases.
  - The task identified HP objectives to be achieved in demo activities.
  - The task defined the characteristics of data gathering tools to be used in Task 5.3 - Human Factors Assessment Reporting (questionnaires, debrief discussion and HP expert observation)
  - Reference to the SESAR HP log and guidance material



Description of work - Task 5.1

Task 5.1 - Human Factors assessment planning M6-M12

Arg.	HP assessment Obj. ID	HP validation objective
Arg. 1.1.2: The description of roles & responsibilities covers all tasks to be performed by a human actor.	OBJ-VLD-TINDAIR-HPAP-001	To demonstrate that the roles and responsibilities of each actor involved in the demonstrations are clear and cover all the tasks
Arg. 1.2.5: Operating methods can be followed in an accurate, efficient and timely manner.	OBJ-VLD-TINDAIR-HPAP-002	To demonstrate that operating methods can be followed in an accurate, efficient and timely manner with no negative impact on HP and acceptable limits of potential errors
Arg. 1.3.3: Level of workload within acceptable limits ('acceptable limits' to be defined with regard to the tool used for the assessment).	OBJ-VLD-TINDAIR-HPAP-003	To demonstrate that the level of workload for drone pilots are within acceptable levels
Arg. 1.3.4: Level of trust experienced as sufficient by the end user.	OBJ-VLD-TINDAIR-HPAP-004	To demonstrate that level of trust in the deconfliction system by drone pilots is sufficient
Arg. 1.3.5.: Level of situational awareness within acceptable limits ('acceptable limits' to be defined with regard to the tool used for the assessment).	OBJ-VLD-TINDAIR-HPAP-005	To demonstrate that the level of situational awareness remains within acceptable levels for drone pilots
Arg. 2.2.1: Information accuracy experienced as sufficient by the end user.	OBJ-VLD-TINDAIR-HPAP-006	To demonstrate that the TINDAiR system provides the drone pilots with complete information
Arg. 2.3.1: End user is able to perform the task in a timely and error free manner.	OBJ-VLD-TINDAIR-HPAP-007	To demonstrate that the drone pilots is able to perform the task in time and with and without errors
Arg. 2.3.4: Alarm and alerts are consistent with design standards or regulations (e.g. false alerts or missed detections are minimised and can be recovered from).	OBJ-VLD-TINDAIR-HPAP-008	To demonstrate that the alarm and alerts provided by the TINDAiR system are clearly meaningful and understandable by drone pilots and USSP supervisor

Description of work - Task 5.3

Task 5.3 - Human Factors Assessment Reporting (M13-M23)

Demonstration activities

City:..... Date:.....

Pilot Post Run Questionnaire (PRQ)

Run n. __ of the day

DIRECTIONS

Please, for each sentence check the box that represents at the best your opinion.

All comments are very appreciated, please feel free to express your thoughts and opinions in the open questions section.

Demonstration Activities

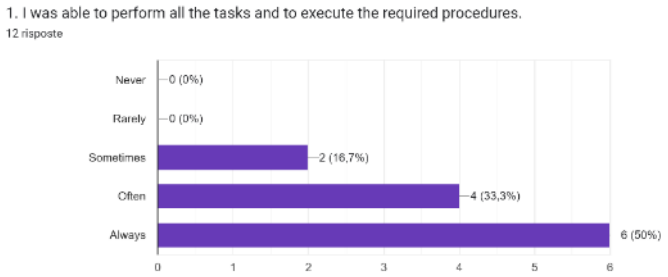
City:..... Date:.....

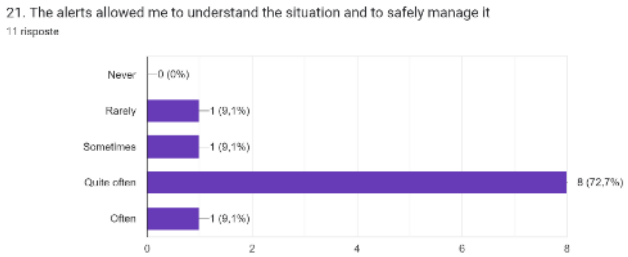
USSP Post Exercise Questionnaire (PEQ)

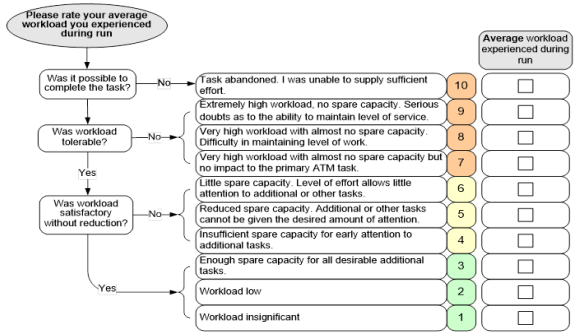
DIRECTIONS

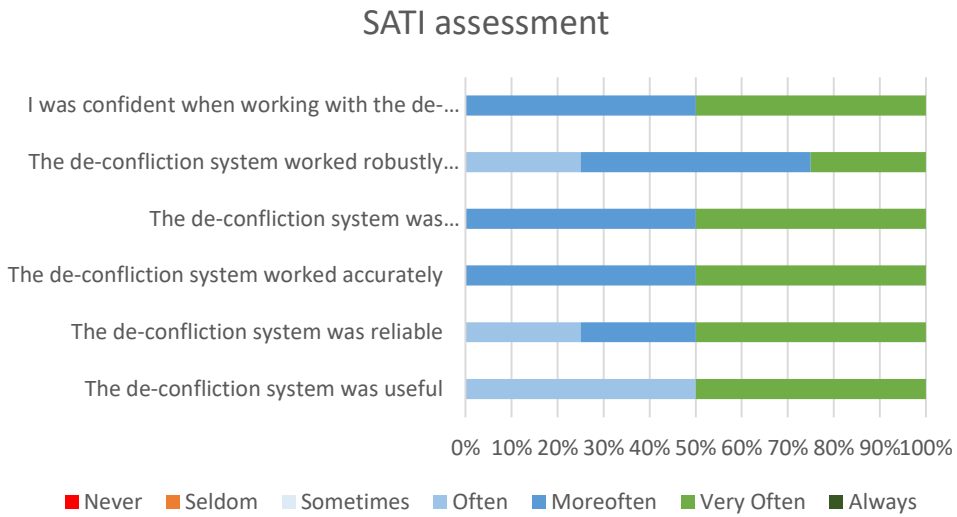
Please, for each sentence check the box that represents at the best your opinion.

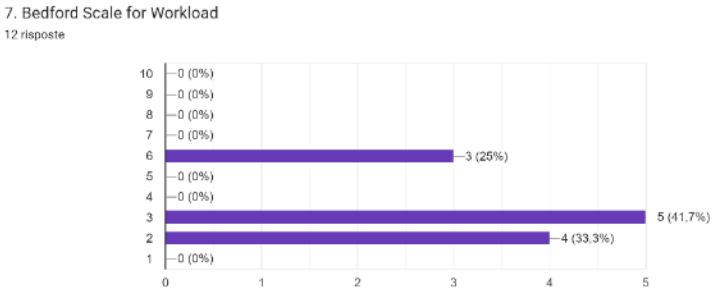
All comments are very appreciated, please feel free to express your thoughts and opinions in the open questions section.











Description of work - Task 5.3

Task 5.3 - Human Factors Assessment Reporting (M13-M23)

Summary of Results:

- Mostly positive results for all the objectives;
- Workload and Situational Awareness maintained within a satisfactory level;
- TINDAiR system provides all the information required in time and accurate;
- USSP Supervisor provided very positive results regarding the trust in the tactical de-confliction system;

Comments from the scenarios:

- Workload high due to monitoring of trajectories and drone status – drone pilot is able to face one order from the USSP, no room for any other task;
- The conflict detection is always “loading”: the pilot is disturbed from a continuous detection of conflict;
- The alerts are disturbing: they should have different colors. Emergency, contingency, resolution order are showed with the same color

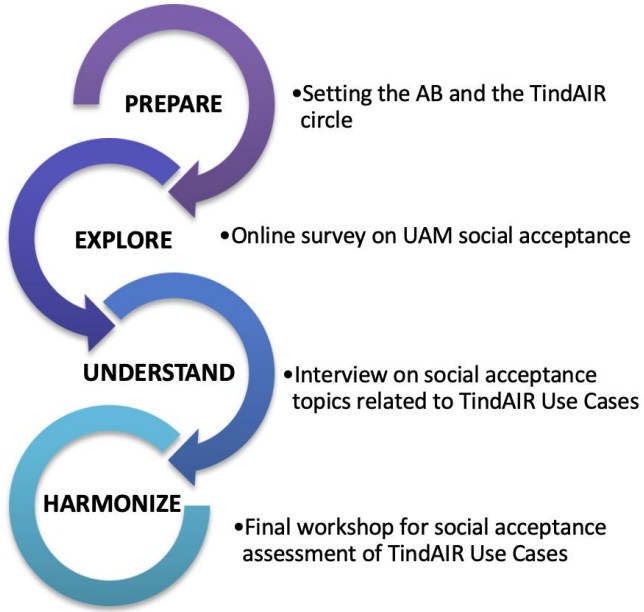
Description of work - Task 5.2

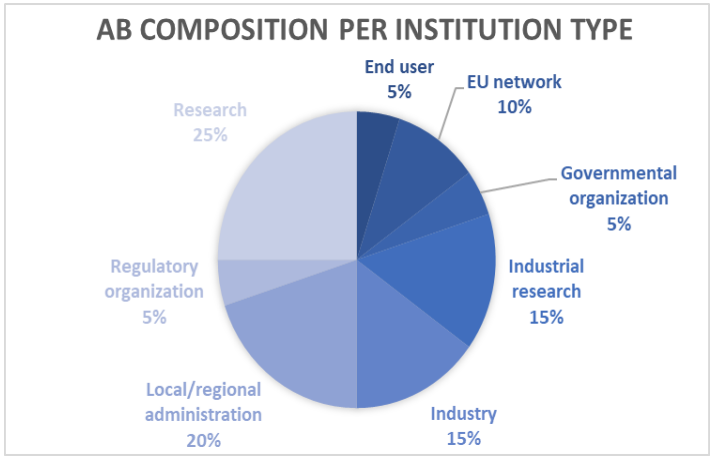
Task 5.2 - Social acceptance assessment Planning M7-M9

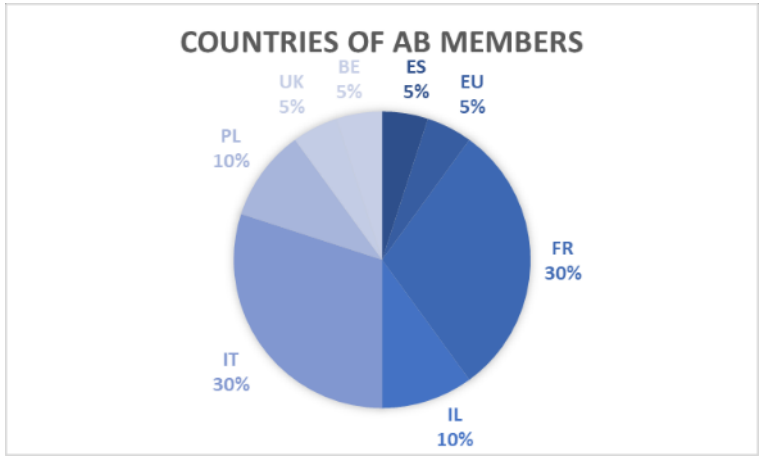
- Leader: ISSNOVA | Contributor: ALL WP contributors

- Description of the work achieved in this task:
  - ✓ Social Acceptance Assessment Plan has been finalised and shared. It contains:
    - ➢ the composition of the project's Advisory Board (AB): 21 experts
    - ➢ the rationale and methodology of the consultation of the AB and of the

      TINDAiR Circle







Description of work (5 of 5)

Task 5.2 - Social acceptance assessment Planning M7-M9

On line survey

- 27 questions formulated in order to be understandable by a technical audience not necessarily with aeronautical background and by general public
- A four ranks Likert scale will be used in order to avoid neutral answers
- The online survey was anonymous, was active February-May 2022 and collected information from 42 respondents from AB and TindAIR circle

Interviews

- 8 interviews to selected AB members
- 15 questions, focused on discussing the social implications of UAM from the most relevant online survey responses with a focus on TindAIR use cases

Workshop

- Held on line on November 8th 2022
- 21 registered participants from FR, IT, ES, PT, CZ, PL from AB and TindAIR circle
- Discussion on TindAIR Use Cases
  - Controversial points VS clear points
  - Advantaged groups VS disadvantaged groups
  - Feasibility VS problematic use of resources

Description of work – Task 5.4

Task 5.2 - Social acceptance assessment Planning M7-M9

Key results

- There is a strong need to provide for the inclusion of UAM in urban planning with integration not only in Sustainable Urban Mobility Plans (SUMPS) but also with the issuance of specific regulations for the use of land, city sky, buildings and existing infrastructure by UAM. This planning should be supported by citizen communication and involvement actions.
- It is noted that there are at least four conditions for social acceptance of UAM:
  - it should bring direct or indirect benefits not only to UAM direct end users
  - it should be used for emergency and disaster management, in monitoring public infrastructure, and in transporting medical items, as starting applications to foster a stepwise approach;
  - it should use energy from renewable sources;
  - It should clearly define certifications and rules in identifying responsibilities in case of accidents;
  - There is concern about the possible implications of the noise levels of drones on public acceptance;
- There are some controversial or non-unanimous opinions on the following aspects related to the deployment of UAMs:
  - A general public distrust of technology (primarily the 5G network) in addition to safety concerns on possible accidents that increases the preference toward a stepwise approach to developing UAM services;
  - It is not clear if accessibility of UAM services and a counterpart in more desirable services for the community is crucial for social acceptance (compensation, equalization criteria and needs not clear)
  - There are concerns that UAM services and infrastructure could negatively impact the environment, create social inequalities, and endanger privacy
  - Passenger transport could be hard to be accepted for large use without pilot on board

WP6: U-space concept design, architecture, integration and V&V activities

PILDO/COLLINS PRESENTATION

TINDAIR Project review Meeting, April 13th 2022

EUROPEAN PARTNERSHIP

Co-funded by the European Union

Description of work

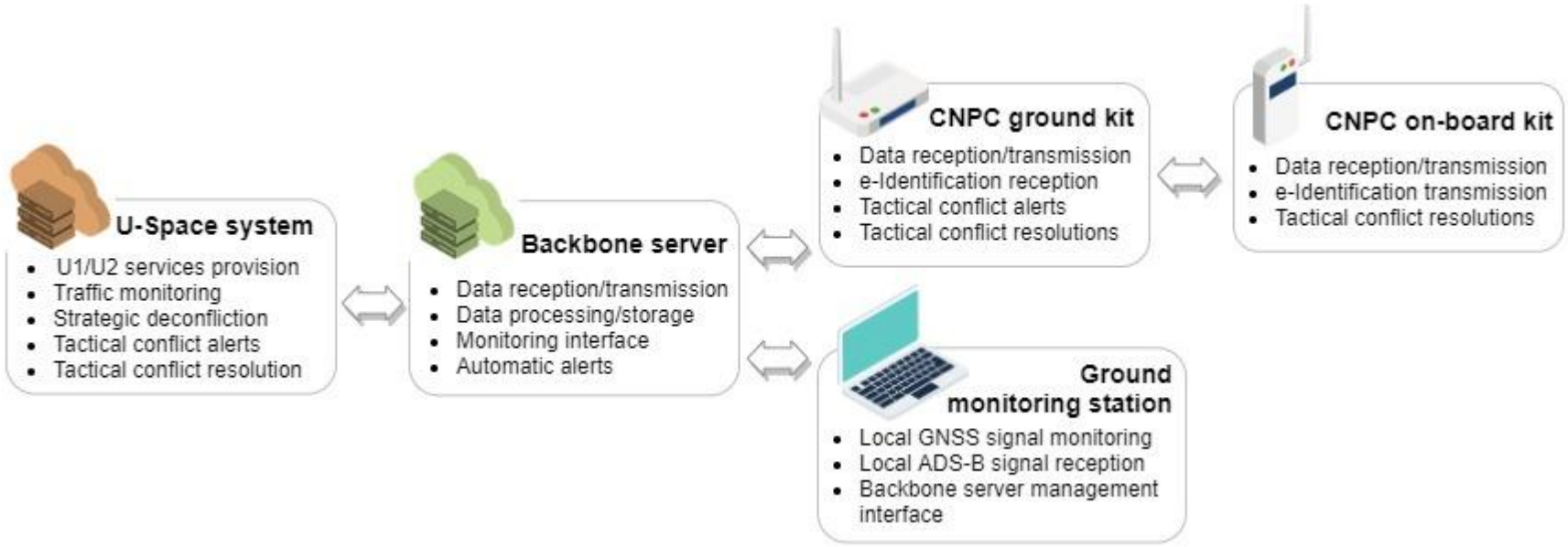
Task 6.1 Design of System Architecture

- Leader: PILDO | Contributor: ALL

- Description of the work achieved in this task:
  - Assessment on the **TINDAIR system objectives**, which can be summarized in:
    - Provide the infrastructure and capabilities to **enable a set of U-space Services**, highlighting **strategic and tactical conflict resolution**;
    - Capabilities to **send deconfliction instructions** to air vehicles;
    - Usage of a **secure datalink** compliant with standards in development by EUROCAE and RTCA; and
    - Allow its usage in different types of unmanned and manned platforms.
  - Assessment on the **TINDAIR system use cases** (expected features and actions to be developed) and **actors** (vehicles characteristics and restrictions on payload volume, weight and power supply).
  - Based on the system objectives, use cases and actors, it has been defined **TINDAIR system technical and functional requirements.**
  - Based on the requirements, **TINDAIR system architecture** has been defined.
  - All the information is gathered in deliverable D6.1.

Description of work

Task 6.1 Design of System Architecture



Description of work

Task 6.2 Interoperability and standardization

- Leader: PILDO | Contributor: ALL

- Description of the work achieved in this task:
  - Assessment on the data exchange format in which TINDAIR system should operate. Following the Global UTM Association (GUTMA) in its Air Traffic Data Protocol, the **JavaScript Object Notation (JSON)** Data Interchange Format has been selected for the payload message bringing together practices from aviation and sensor manufacturers.
  - Network identification data is gathered in 3 different message types, aligned with the **MOPS for UAS Network Identification material** that is being drafted by **EUROCAE**.
  - Other messages have been defined in line with Innov'ATM UTM platform characteristics.
  - All the information is gathered in deliverable D6.1.

Description of work

Task 6.3 Integration of safe and secured command and control datalink

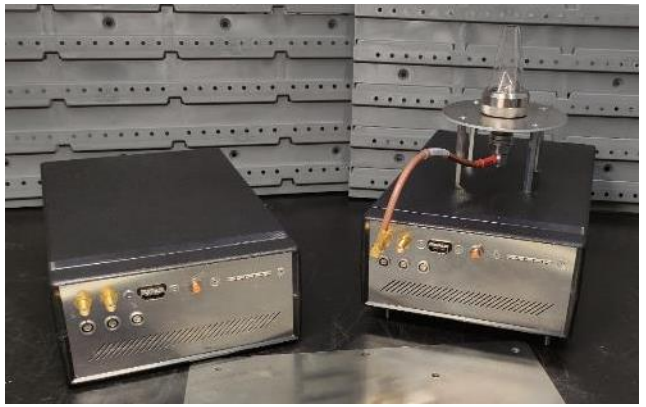
- Leader: PILDO | Contributor: Rockwell Collins France
- Description of the work achieved in this task:
  - Collins provided **Six CNPC-5000E radio systems** together with associated document and support to be integrated in PildoBoxes.
  - PildoLabs provided GNSS, computer, control software and mechanical integration
  - **Two labs** were set up for integration at both Collins and PildoLabs premises.
  - The **CNPC-5000E** is a reliable **line of sight safety link** for exchanging Command and Control Information with unmanned platforms. It has been used as a prototype to validate RTCA DO362 MOPS This has been the radio link used in the design of TINDAIR system.
  - CNPC5000E operates in the **5030-5091MHz UAS C2 safety band**.
  - Define the most efficient approach to **integrate the CNPC-5000E** to the various configurations (air and ground) while meeting the required CONOPs.
  - **Assessment of the scenarios characteristics** in terms of operation distances, visibility limitations, and vehicles' operations.
  - **Selection of the auxiliary parts** required to meet UAVs constraints: RF antenna, RF filter, Power amplifier, RF Switch, GNSS receiver.

Description of work

Task 6.4 Development of prototype (HW&SW) and ops procedures

- Leader: Innov'ATM | Contributor: PILDO & RCF
- Description of the work achieved in this task:
  - **Design and development** of integrated **airborne and ground-based systems** meant to equip manned and unmanned aircraft, and to be used as ground station, based on the TINDAIR system design requirements D6.1:
    - To **receive on-board tactical deconfliction commands** sent by U-Space system; and
    - To **transmit UA's information** to the ground to feed U-Space system for tactical deconfliction detection.
  - Both systems integrates a **CNPC-5000E radio**.
  - Both systems are managed through **CNPC Kit Manager software**.
  - A specific version has been designed to be able to fit within SWOOP payload bay.
  - Two ground antennas versions were selected (Sector and omnidirectional) to accommodate various RF link characteristics and geometries.

Weight	≈ 2kg
Volume	25 x 16 x 7.5 cm
Power input	15 - 30VDC
Consumption	42W (nom), 62W (max)



Description of work

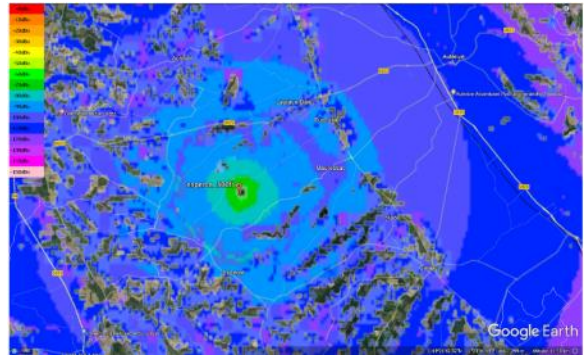
Task 6.4 Development of prototype (HW&SW) and ops procedures

- **Design and development** of a **ground monitoring station**, aimed to monitor GNSS signal degradation on ground, and detect cooperative traffic through ADS-B signals.
- **Design and development of Backbone Server**, a system aimed to centralize the information distribution between the U-Space system and the CNPCs, simplifying the data transmission and allowing an easier integration.
- All the information is gathered in deliverable D6.4.

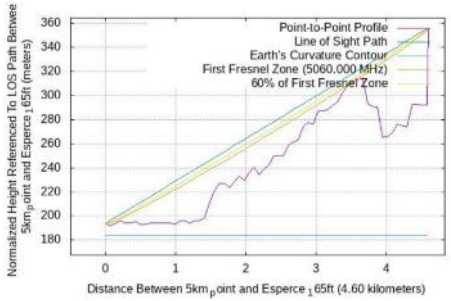
Description of work

Task 6.4 Development of prototype (HW&SW) and ops procedures

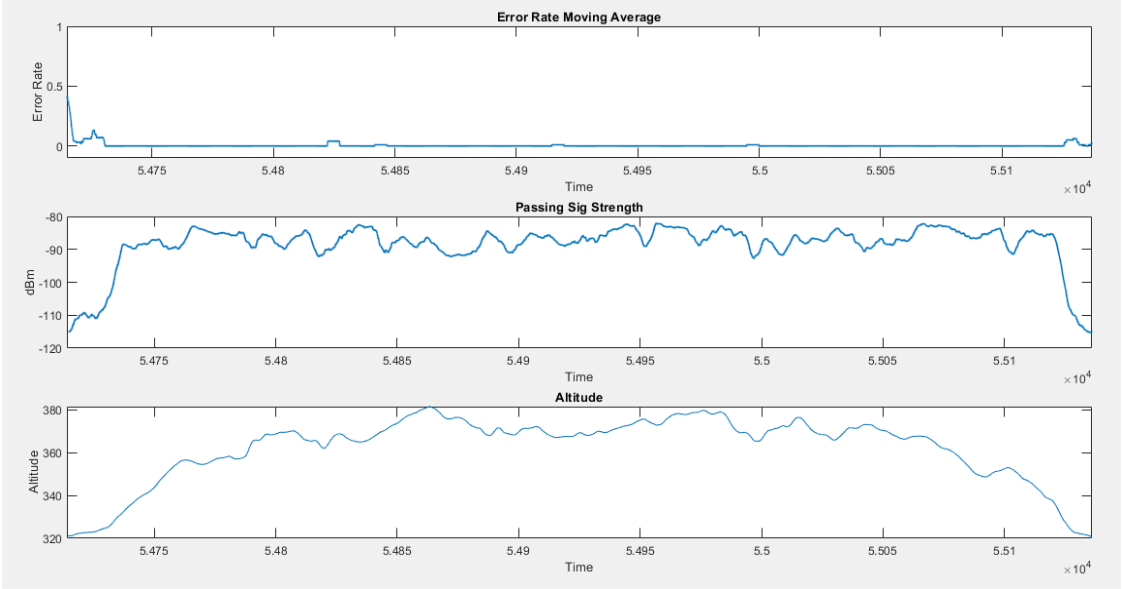
- **Prototypes were integrated at Pildo and RF aspects tested** at RCF to validate the following parameters
  - Sensitivity
  - TX power
  - TX Mask
  - ⇒ Initial prototype met targeted RF performances in the lab
  - ⇒ Issue encountered on Ground station integrated GPS identified and fixed
  - ⇒ Flight test performed with Collins RF test Software
  - ⇒ Initial control SW integration could be performed



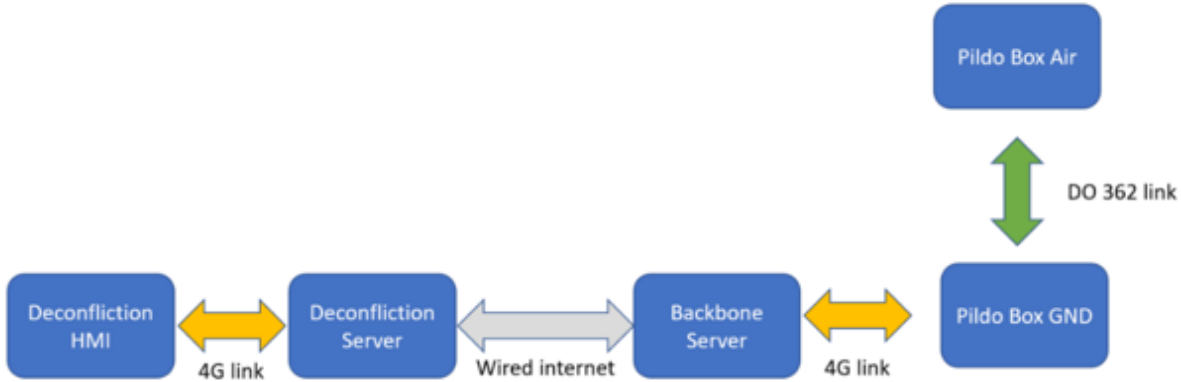
- **Initial Flight tests were performed** in Esperce in December 2021 to validate RF performances
  - Frequency license requested and granted by ARCEP be able to transmit using CNPC waveform in C band.
  - Propagation simulation including terrain characteristics performed to assess expected signal levels
  - Definition mobile ground station measurement points (1km, 5km and 8km)
  - Actual collection of RF performance data on the field
    - Air Pildo Box carried by Matrix600 UAV
    - Custom ground station provide by Collins for RF measurements
  - ⇒ Expected RF performances met and in line with propagation predictions
  - ⇒ Results used to accurately determine scenarios



Performances During Flight tests



- 9 km link achieved with almost no error with UAV flying at low altitude (60m)
- Latency achieved going from Time UA is sending information to information available at deconfliction server using DO362A, 4G and wired link meet operational needs
  - Data sent every second
  - More than 99% of the data received and processed within 2s



WP6: U-space concept design, architecture, integration and V&V activities

INNOV'ATM PRESENTATION

TINDAIR Project Final Workshop, December 15th 2022

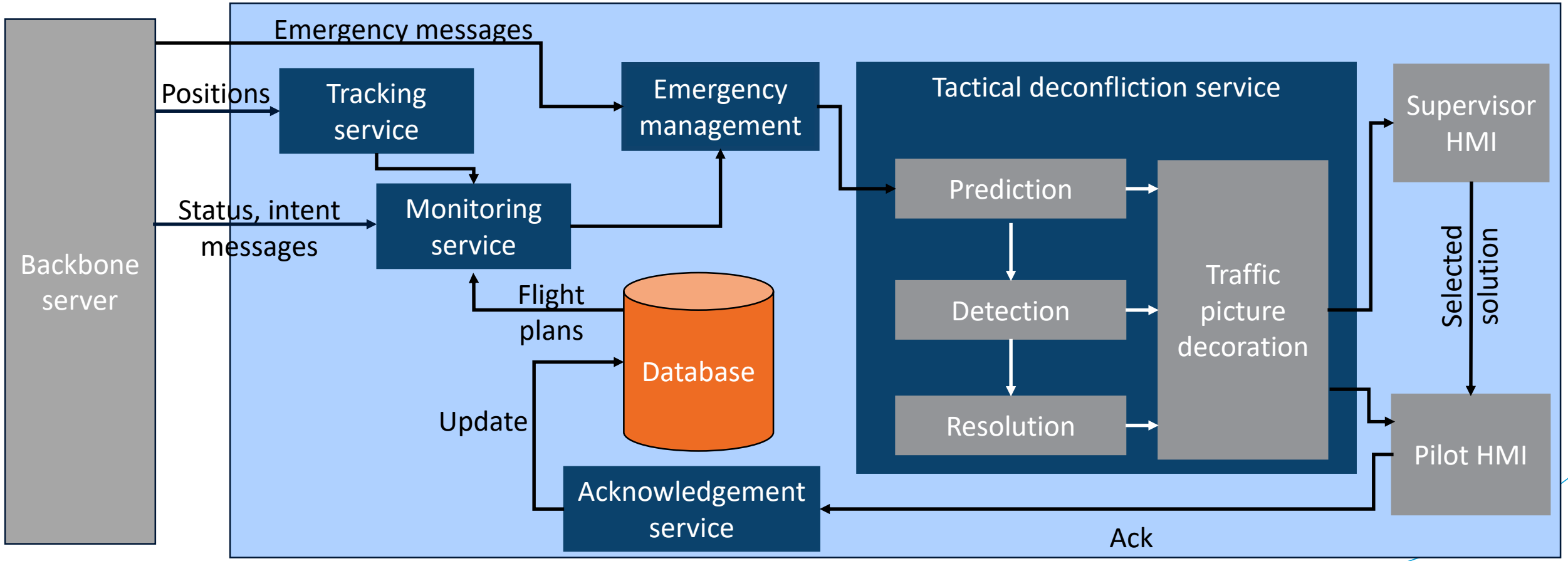
EUROPEAN PARTNERSHIP

Co-funded by the European Union

Description of work

Task 6.4 Development of prototype (HW&SW) and ops procedures

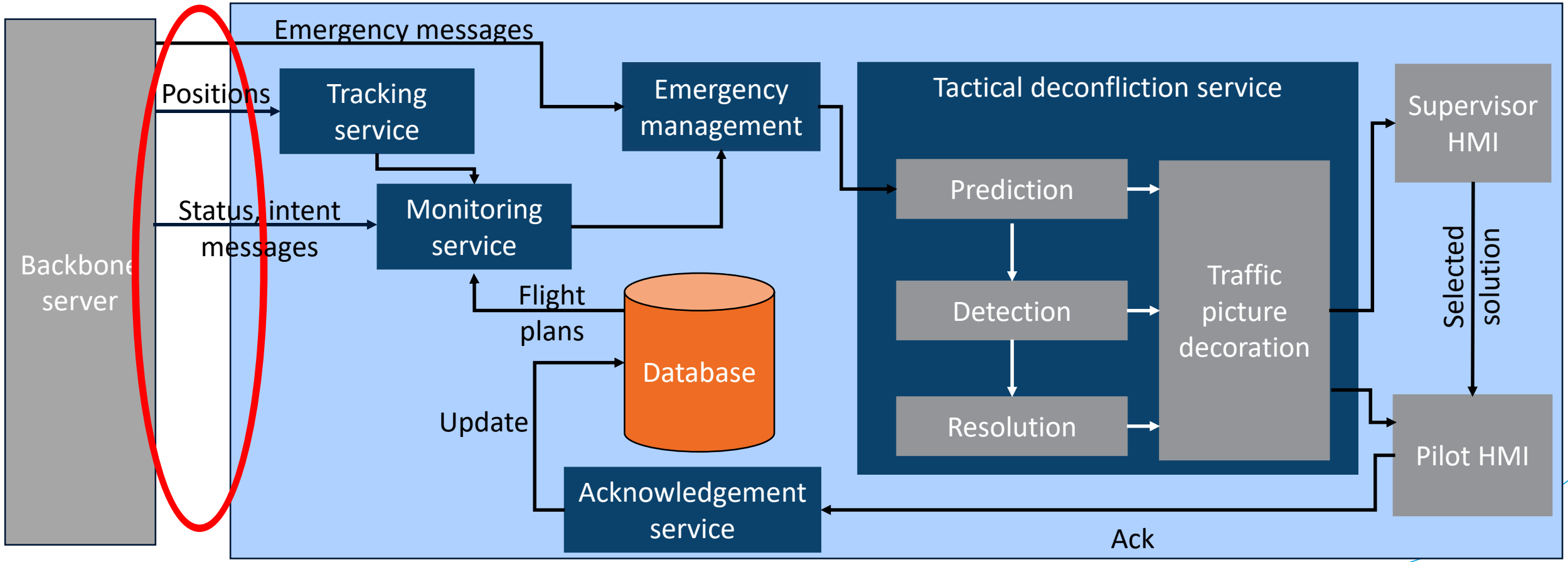
Software Development



Description of work

Task 6.4 Development of prototype (HW&SW) and ops procedures

Interface with Backbone server



Description of work

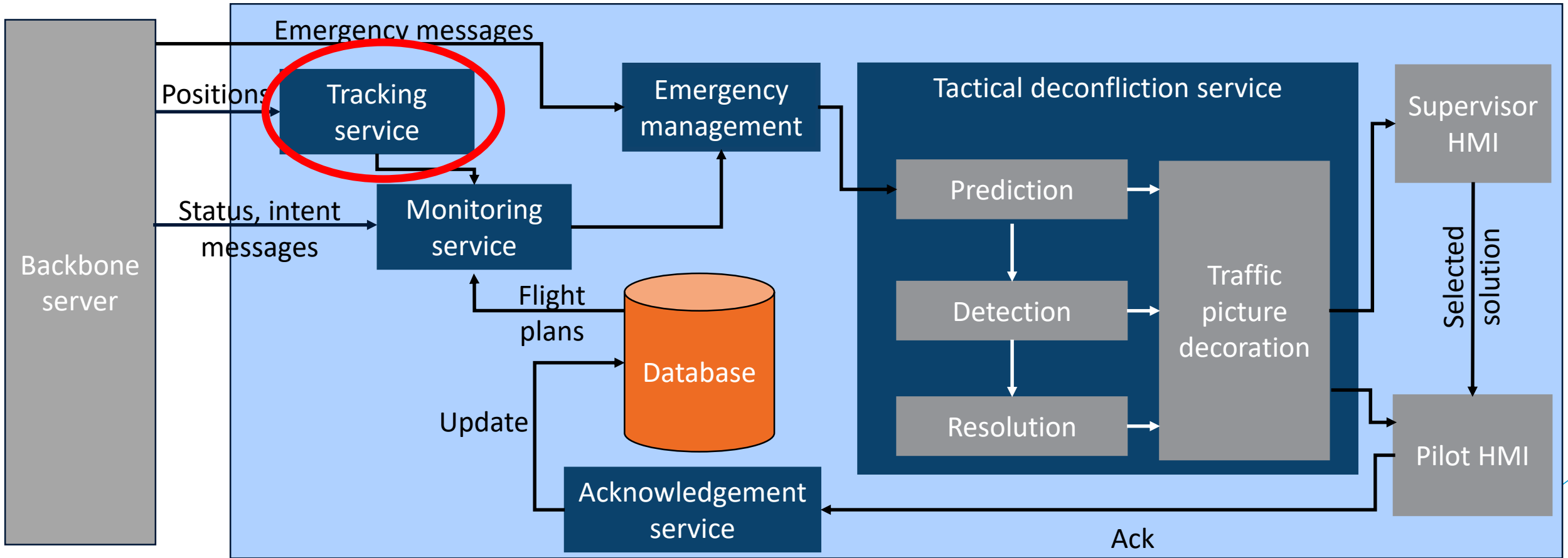
Backbone server interface key points:

- TINDAiR software connects as a client to the Backbone server through MQTT communication protocol
- Secure connection thanks to dedicated credentials
- Subscription to a single topic for each message type:
  - State message (aircraft positions)
  - Status message (additional metadata)
  - Intention message (spatial coordinates to reach)
  - Emergency message
  - Instruction message (flight manoeuvres to apply for conflict avoidance)
  - Acknowledgement message (for instruction reception acknowledgement)
- Saving of every message received from Backbone server into the database

Description of work

Task 6.4 Development of prototype (HW&SW) and ops procedures

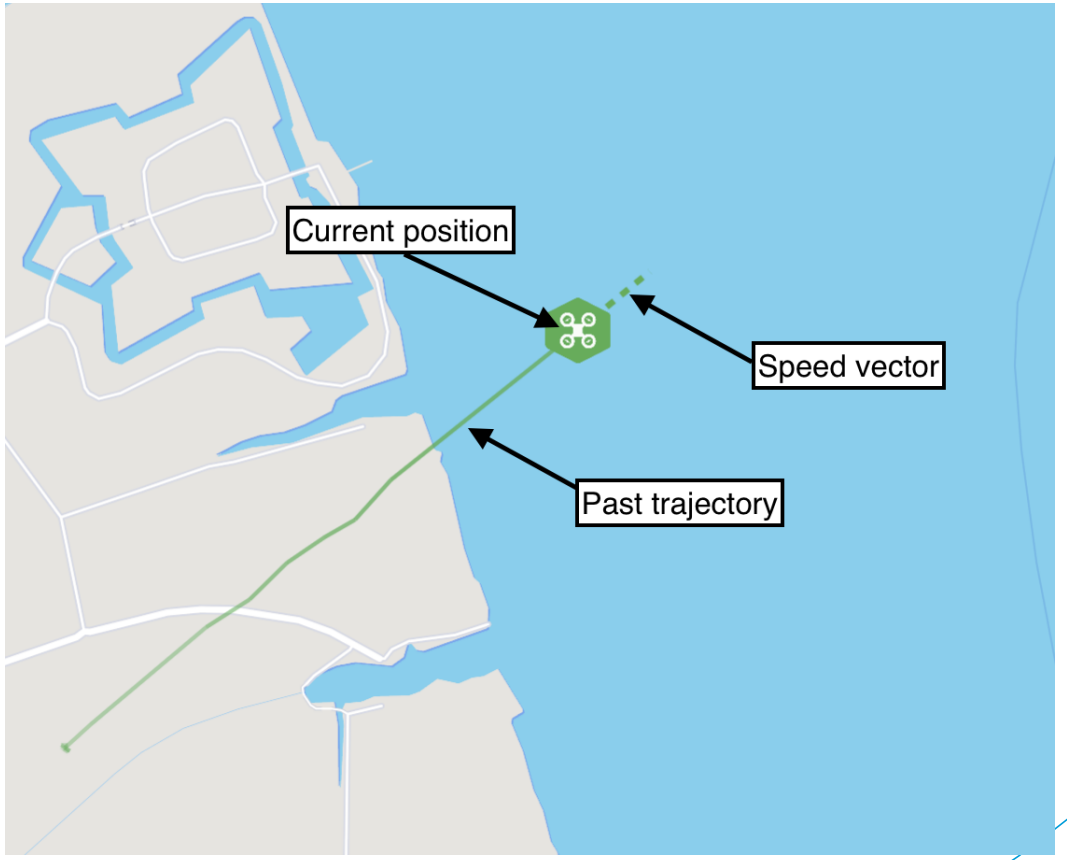
Aircraft tracking



Description of work

Tracking key points:

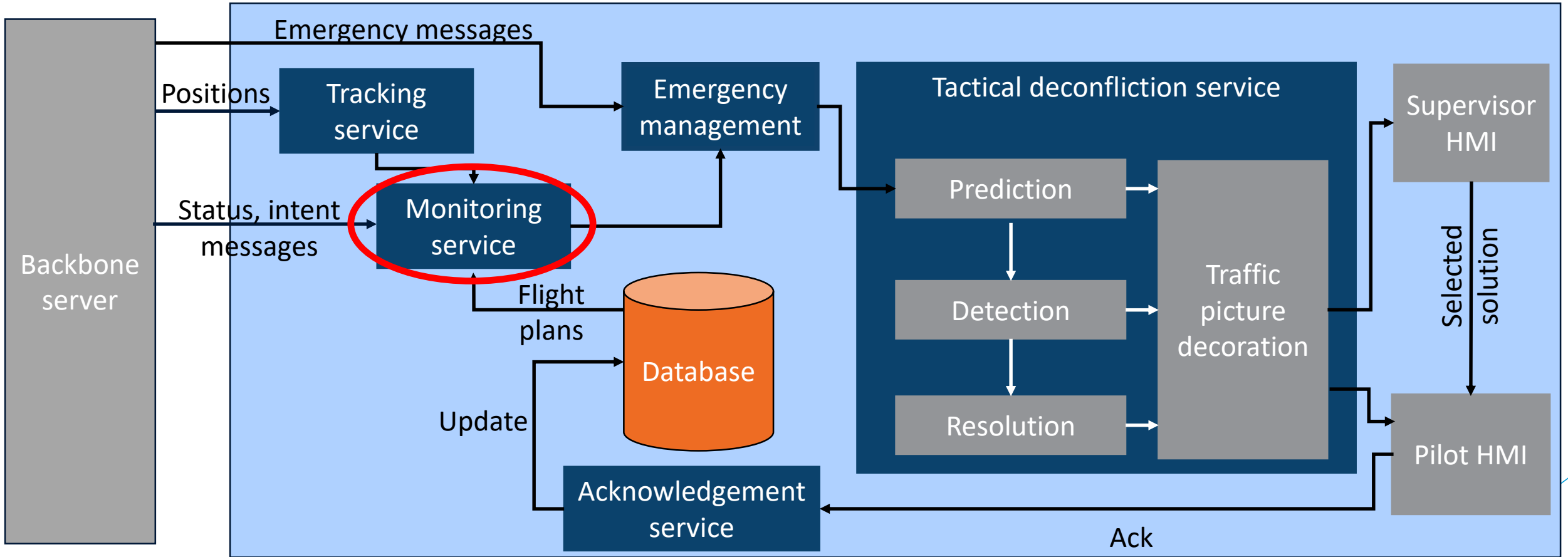
- Consolidation of aircraft positions
  - Groups aircraft positions by CNPC kit identifier
  - Computes for each position the speed vector
- Past trajectories reconstruction
  - Sorts the positions chronologically
  - Trajectory reduction with Douglas-Peucker algorithm
- Production of traffic picture each second



Description of work

Task 6.4 Development of prototype (HW&SW) and ops procedures

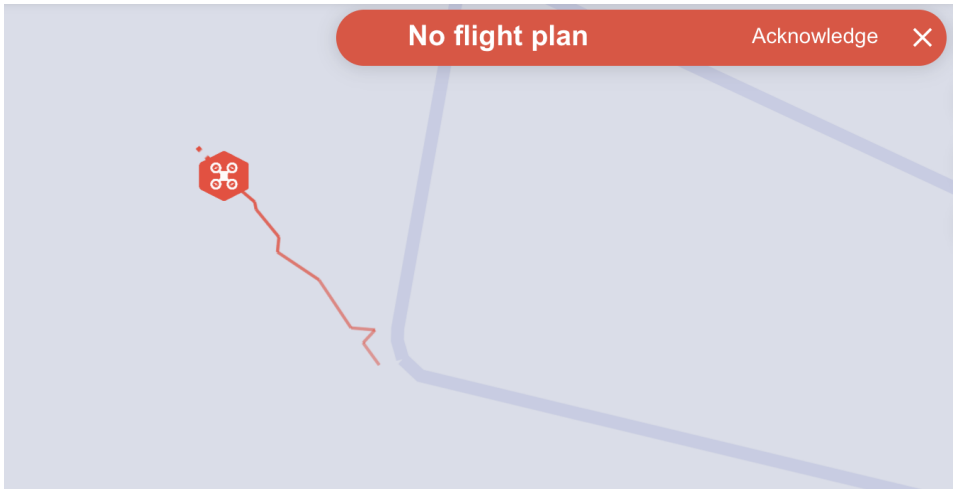
Flight monitoring

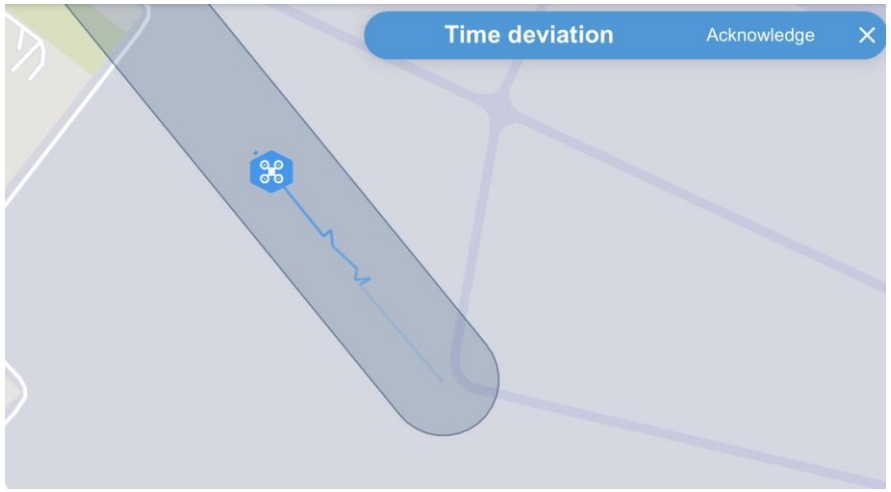


Description of work

Flight monitoring key points:

- Association to flight plan through CNPC kit identifier
- Trajectory analysis to detect flight plan deviation
- Consolidation of status, emergency and intention messages
- Raises alerts in case of:
  - Unknown / unauthorized flight plan
  - Deviation from flight plan (spatial and temporal)
  - Degraded mode
  - Emergency

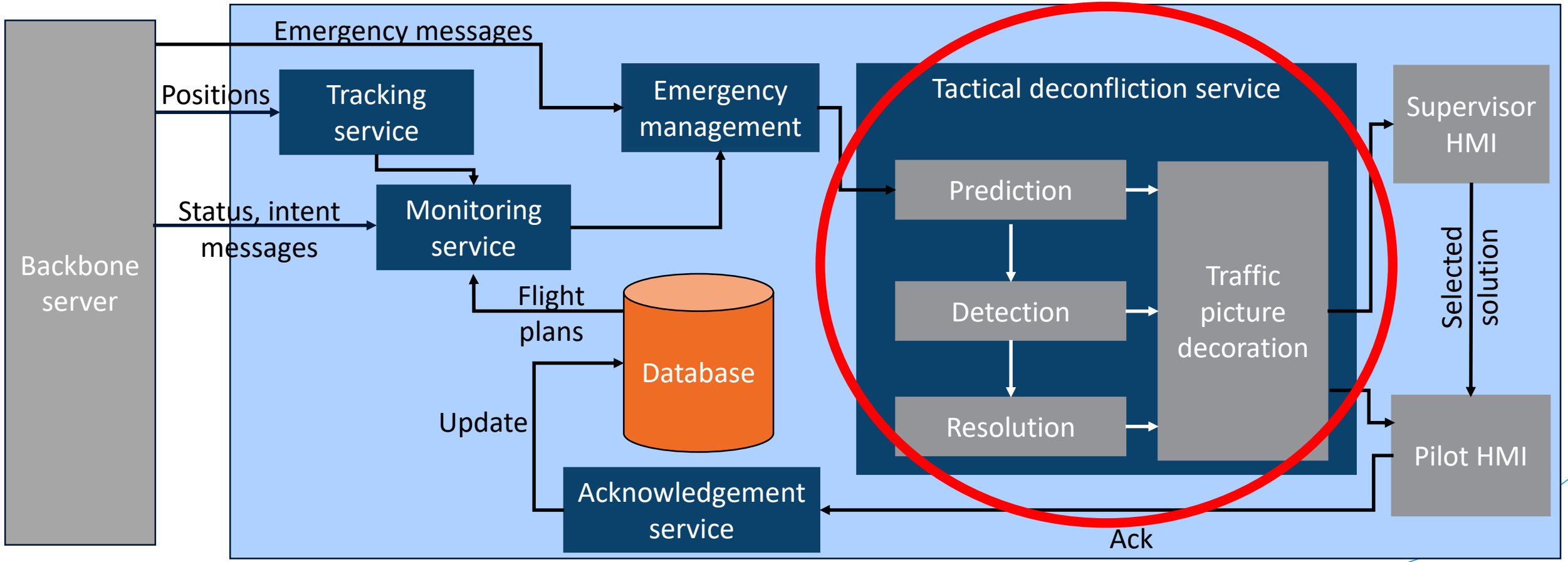




Description of work (5 of 7)

Task 6.4 Development of prototype (HW&SW) and ops procedures

Tactical deconfliction

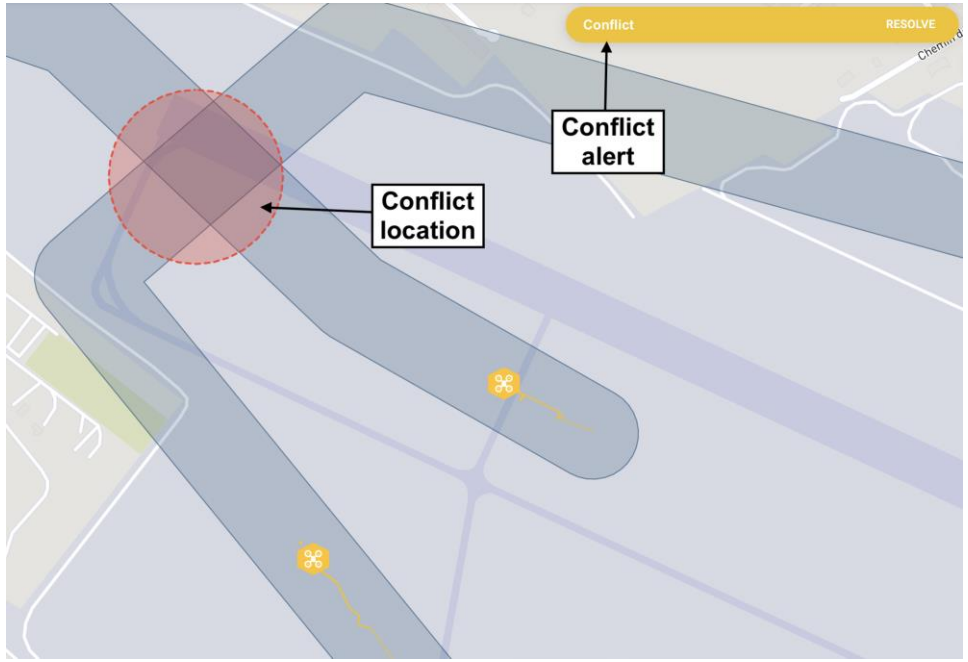


Description of work (5 of 7)

Tactical deconfliction key points:

- Prediction of the trajectories 2 minutes in the future
- Detection of tactical conflict based on estimated trajectories
- Raises an alert in case of conflict detection
- Deconfliction algorithm automatically triggered at conflict detection:
  - Use of genetic algorithm
  - First find trajectories that solve the conflict and then optimise them
  - Propose several solutions with different manoeuvre types
  - Do not propose a solution that generates a conflict

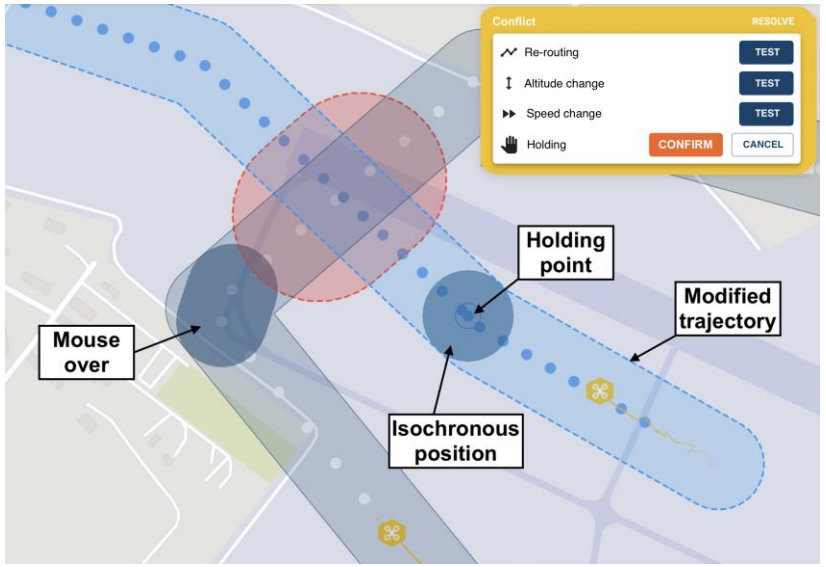
Description of work (5 of 7)

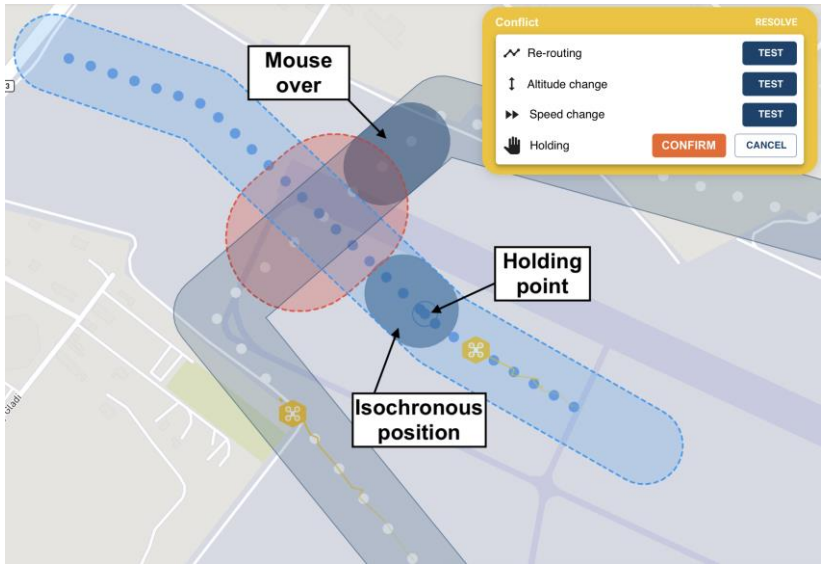


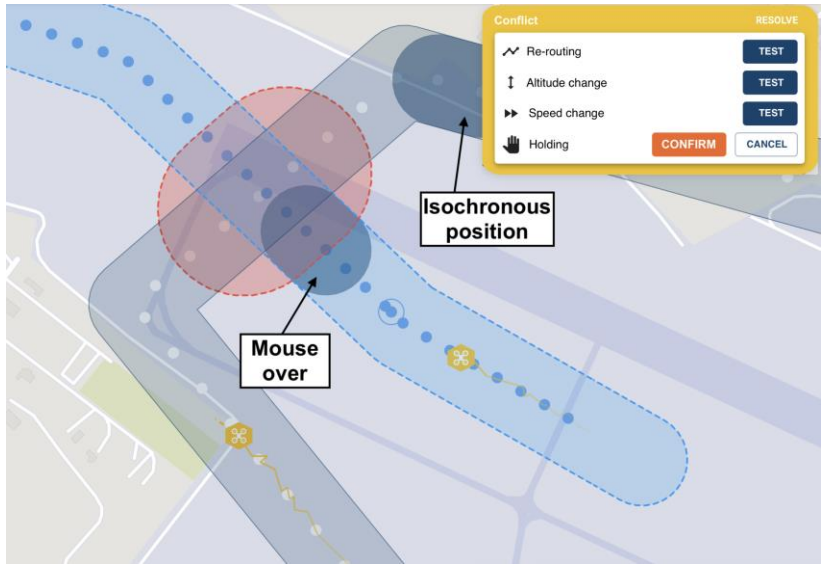
Solution consultation

Description of work

Holding solution analysis



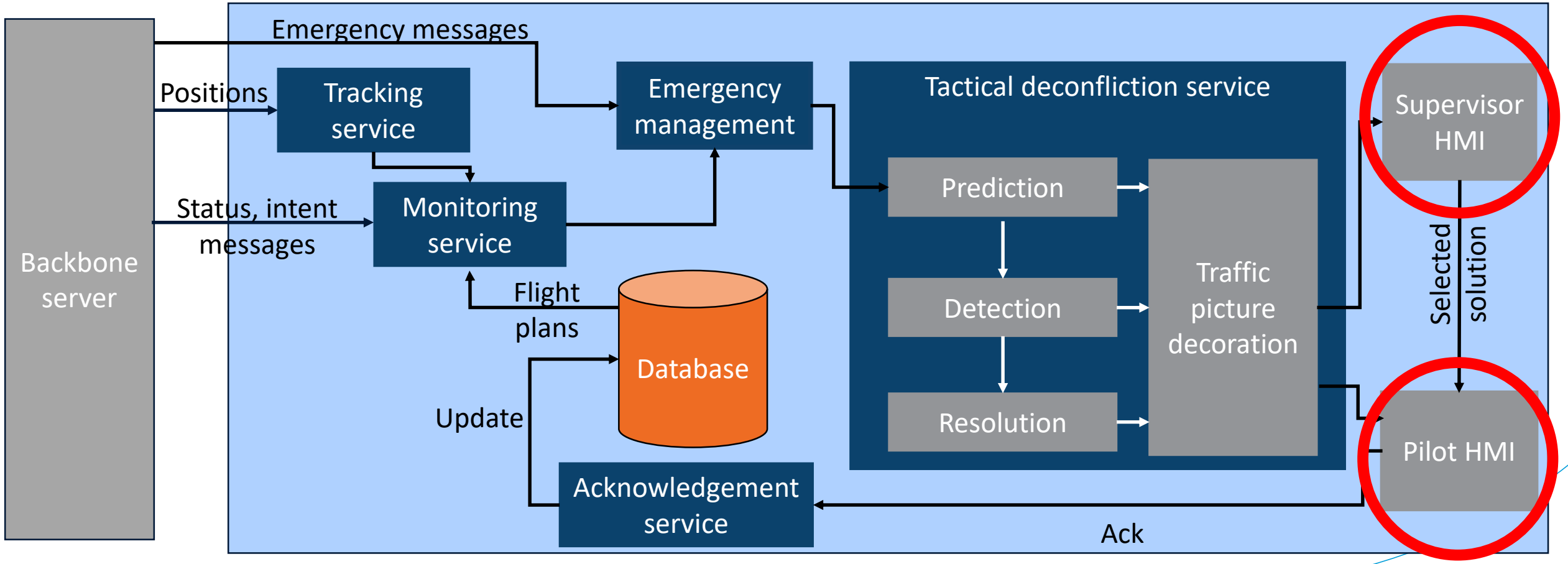




Description of work

Task 6.4 Development of prototype (HW&SW) and ops procedures

Traffic visualisation



Description of work

Supervisor HMI key points:

- Visualization of real time traffic
  - Aircraft trajectories
  - Aircraft state (position, status, …)
  - Known flight plans
- Alert highlighting
  - Flight plan deviation
  - Conflict detection
  - Degraded mode
  - Emergency
- Conflict visualisation
- Conflict avoidance solution analysis and selection

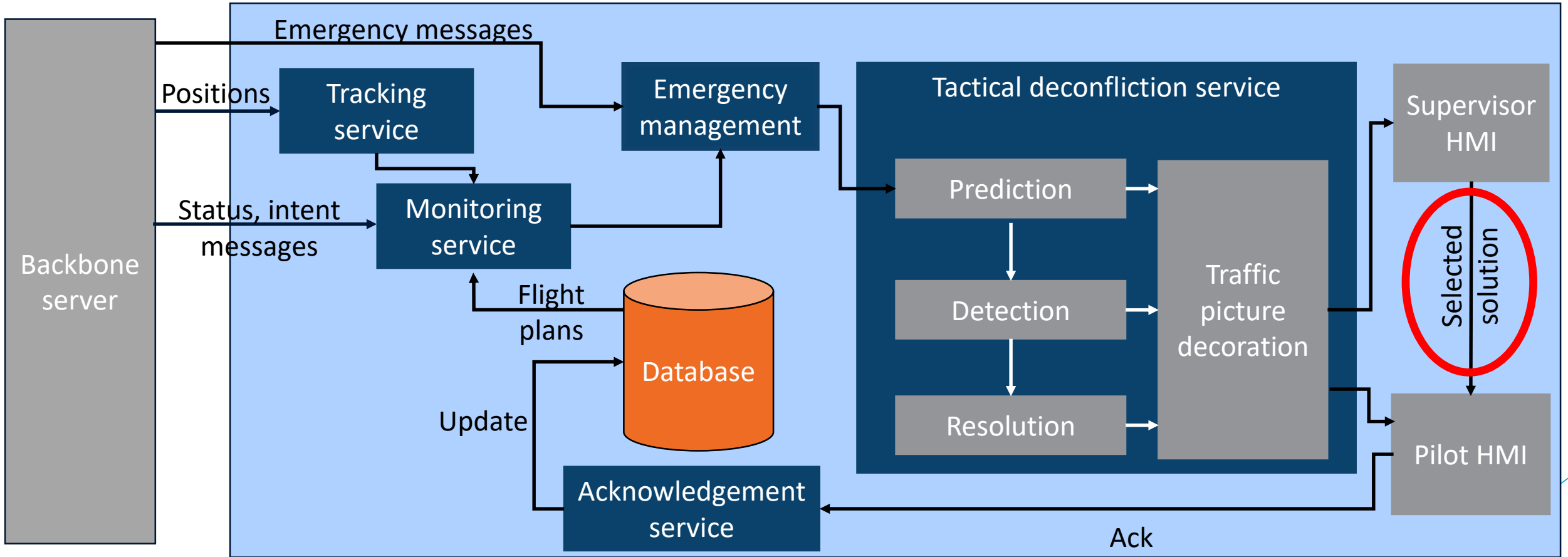
Pilot HMI key points:

- Visualization of real time traffic centred around his/her aircraft
- Additional data related to his/her aircraft
  - Aircraft state (position, status, …)
  - Detailed associated flight plan
- Highlighting of alert related to his/her drone
  - Flight plan deviation
  - Conflict detection
  - Degraded mode
  - Emergency
- Selected conflict solution visualisation
- Conflict solution acknowledgement

Description of work

Task 6.4 Development of prototype (HW&SW) and ops procedures

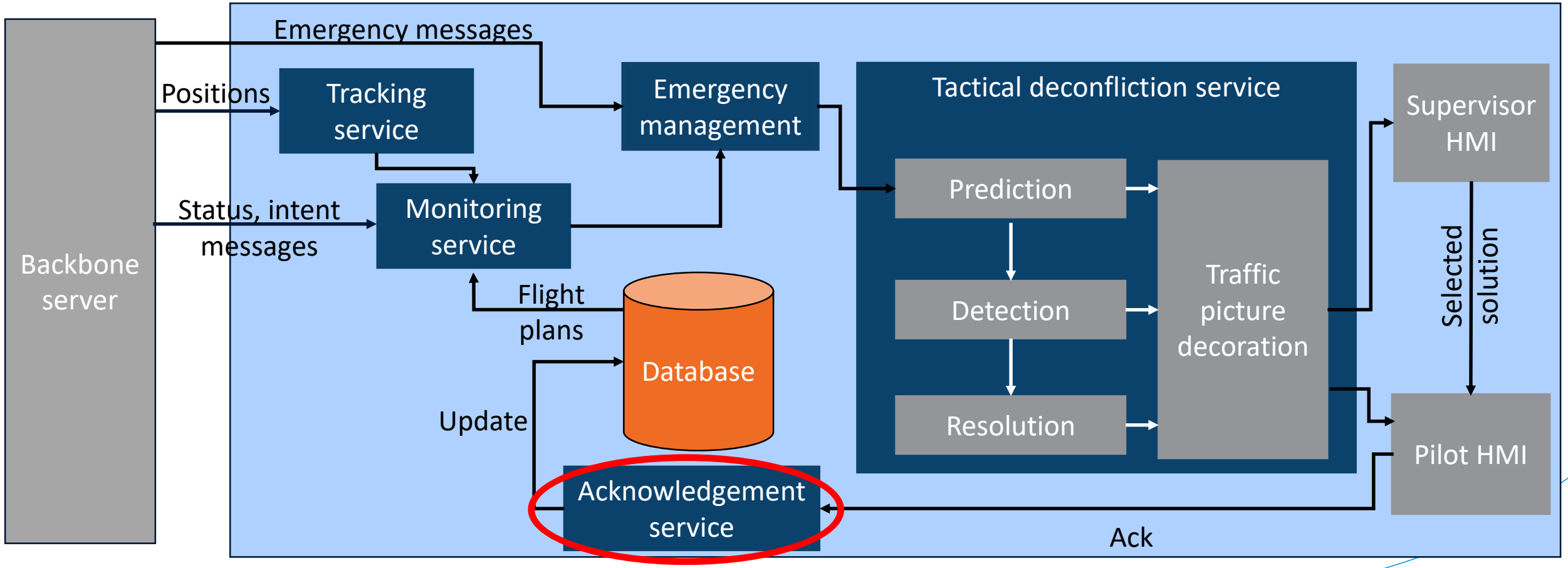
Conflict solution sending



Description of work

Task 6.4 Development of prototype (HW&SW) and ops procedures

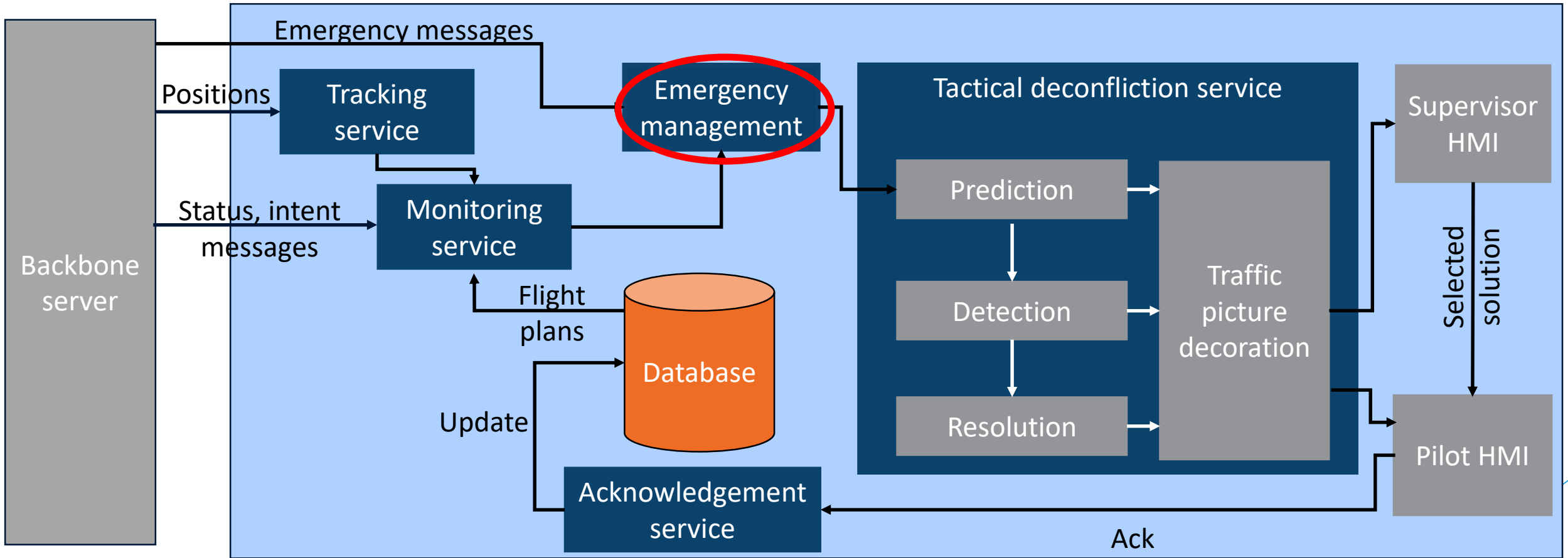
Conflict solution acknowledgement



Description of work

Task 6.4 Development of prototype (HW&SW) and ops procedures

Emergency management



Description of work

Emergency management key points:

- Analyse traffic picture and incoming emergency message to detect emergencies
- Different type of emergency considered
  - Loss of connection
  - Failure on an aircraft
  - No tactical conflict solution found
- Proposed to the supervisor closest and available landing points for the aircraft in distress
- Add landing point selection, emergency landing order automatically sent to the related pilot

WP7: Demonstrations

WP leader: Skybirdsview
Contributors: Skyports, Tecnalia, Skybirdsview, Onera

TINDAIR Project Final Workshop, December 15th 2022

EUROPEAN PARTNERSHIP

Co-funded by the European Union

WP7. Demonstration Exercises

❑ 4 exercises on 4 sites in the south-west of France

- Exercise #1: Skyports
- Exercise #2: Tecnalia
- Exercice #3: SkyBirdsView
- Exercice #4: ONERA

❑ 6 flying platforms


M600

SWOOP


SARAH


VARIO


UMILES


R44

WP7. Demonstration Exercise #1 (Skyports)

- **Objective: detect conflicts** of 2 aircraft in **opposite direction in same corridor** and **resolve** them considering **flight priorities** by suggesting **new route**.

Scenario 1

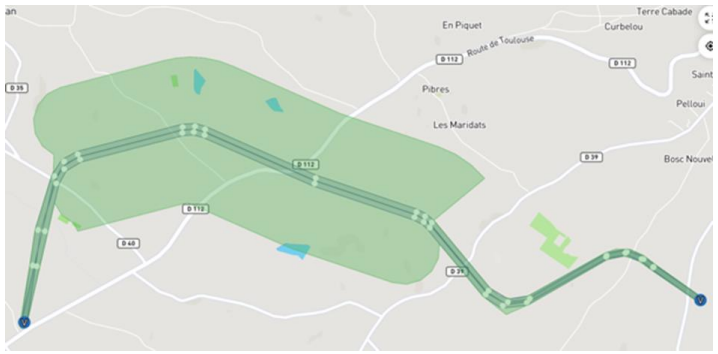
Mission : one warehouse delivery mission and one medical delivery identified as priority aircraft, with flight plan in conflict

Conflict detected and resolve before flight by Strategic Deconfliction : non-priority drone had to change trajectory

Scenario 2

Mission : same mission without strategic conflict but with one drone declaring an emergency during flight

An emergency occurred to one drone, and the system managed it by asking the aircraft to land at the closest landing site



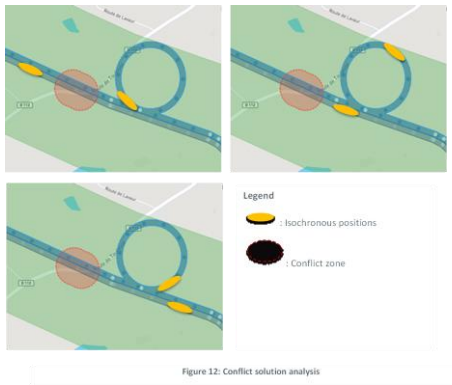
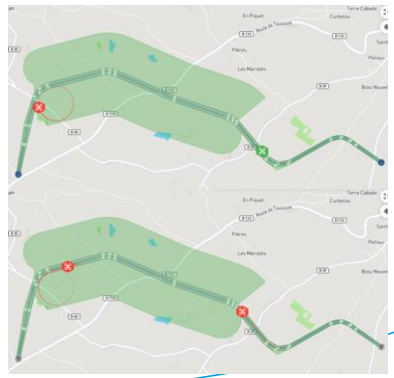


Figure 12: Conflict solution analysis



WP7. Demonstration Exercise #1 (SkyPorts)

Comments on the execution of the demo:

- Strategic deconfliction objective completed : conflicts has been detected and rejected before mission
- Identification and tracking of both aircraft continuously along the whole route
- Non-priority aircraft taken into account in solutions proposed
- Emergency situation well managed by the system

Conclusion

- The aim of this Exercise #01 was to demonstrate conflict detection and resolution by sending solutions considering flight priorities => Achieved

WP7. Demonstration Exercise #2 (Tecnalia)

Two missions executed during each scenario: one delivery mission from an airport to one warehouse and one autonomous e-VTOL drone mission with simulated person transportation from a vertiport to another vertiport.

Scenario 1

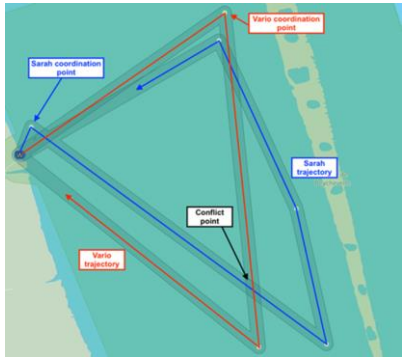
- at Saint-Julien-de-Beychevelle with the **Vario** from ONERA and the **FlyingCam Sarah** from Skybirdview. Sept 15. Fail issues.
- at Esperce with the **Umiles Concept 2** from Tecnalia and the **Matrice 600** from SkybirdView. Sept 26.

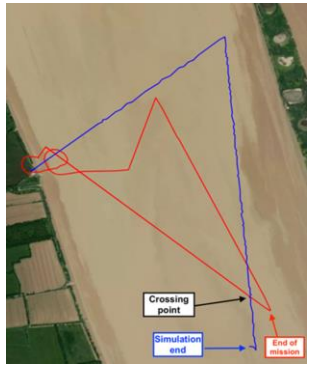


Scenario 2

at Saint-Julien-de-Beychevelle. **Vario** from ONERA and **FlyingCam Sarah** from SkybirdView operated. Sept 15. The **Vario** (taxi flight) replaced by simulation.

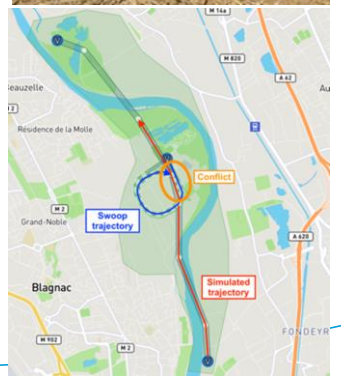






Scenario 3

- at Saint-Julien-de-Beychevelle, the **Sarah** from SkybirdView was operated. Sept 15.
- at Blagnac, one **Swoop** from Skyports was in air and the second flight was performed by a simulation. July 12.



WP7. Demonstration Exercise #2 (Tecnalia)

Comments on the execution of the demo:

- Strategic deconfliction has been resolved for scenario 1 by delaying the taxi flight and for the two other scenarios by changing its cruise altitude
- TINDAIR system can automatically detect a conflict and solve it both strategically and tactically.
- All the scenarios were performed using simulation. At least one real drone flight was carried out per scenario, but no impact on the validity of the results
- In this Exercise #02, despite some encountered contingencies, we have successfully validated the consistency of the flow of actions related to the coordination between the Strategic/Tactical Conflict Resolution Service, the Tracking Service and the Monitoring Service.

Conclusion

- The aim of this Exercise #02 was to demonstrate the capability of the TINDAIR tactical deconfliction system to automatically detect conflicts between two crossing drone trajectories and resolve them considering flight priorities => Achieved

WP7. Demonstration Exercise #3 (SkyBirdsView)

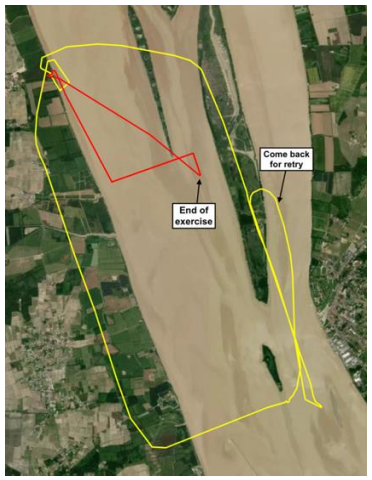
- **Objective:** proving that the TINDAIR system can automatically **detect conflicts** and **resolve** them considering **flight priorities** and **other aircraft** around the conflict.

Scenario 1

Mission : one delivery mission from an airport to one warehouse and one emergency medical transport with a manned helicopter

Sept 14th and 15th : 2 flights at Saint-Julien-Beychevelle with:

- **FlyingCam Sarah** from **SkyBirdsView** (delivery)
- Manned Helicopter **Robinson R44** (medical)

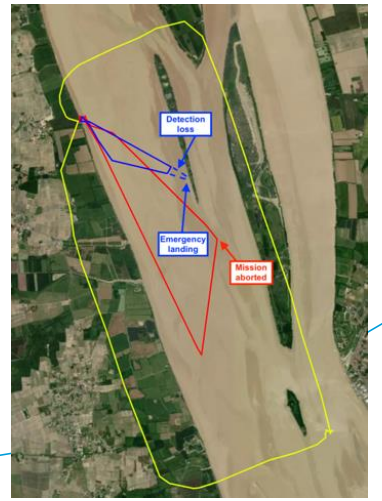


Scenario 2

Mission : same as scenario 1 and in addition one taxi flight.

Sept 15th : 1 flight at Saint-Julien-Beychevelle with:

- **FlyingCam Sarah** from **SkyBirdsView** (delivery)
- **Helicopter Robinson R44** (medical)
- **Vario** from **ONERA** (taxi)



WP7. Demonstration Exercise #3 (SkyBirdsView)

Comments on the execution of the demo:

- 3 flights performed at Saint-Julien-Beychevelle (North West of Bordeaux) in a mixed unmanned/manned environment
- All conflicts were detected in advance (2 minutes) and the TinDAIR solutions provided were validated by the supervisor and pilots
- The Tactical Conflict Resolution Service was able to prioritize manned aircraft over unmanned aircraft on conflict resolution
- Simulation was partially used but without any impact on results

Conclusion

- The aim of this Exercise #03 was to demonstrate the system capability to solve conflicts considering priorities between flights, and the rest of the traffic to avoid the creation of another conflict => Achieved

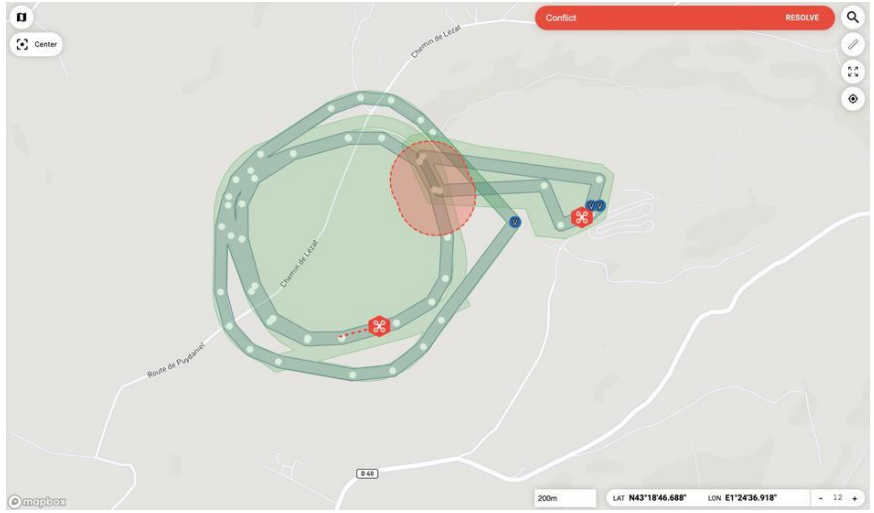
WP7. Demonstration Exercise #4

- **Objective:** automatically detect an **emergency** and to react accordingly.

Scenario 1

- Context: 2 drones - Skyports' Swoop & ONERA's Vario
- Brief: one drone loose the connection with the USSP system while in conflict with the other one. Then the USSP system orders to the other drone to **hold** or to **land**.

Scenario 2

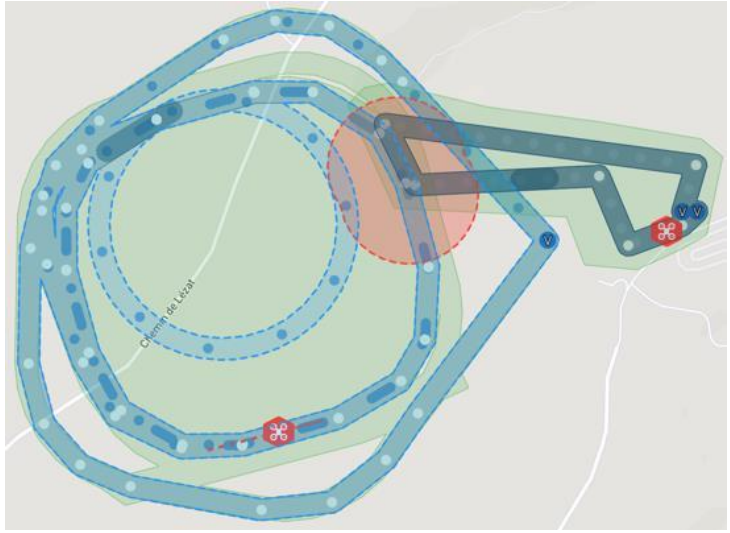


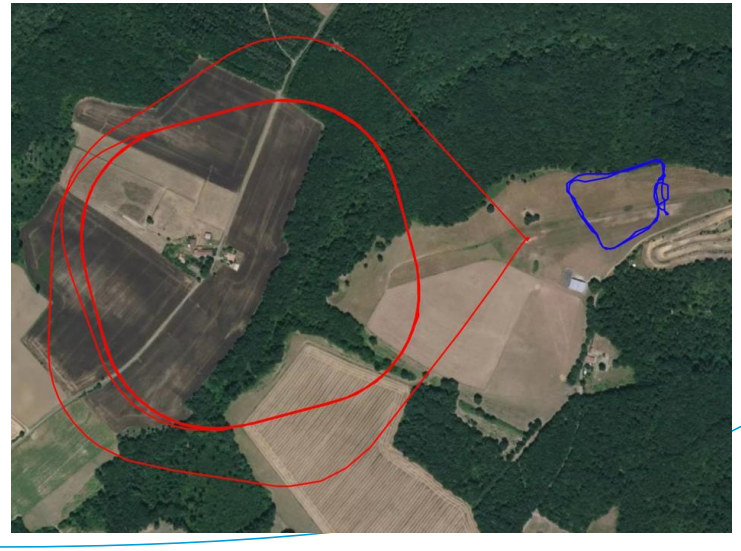
Scenario 3

- Context: 1 drone – ONERA's Vario
- Brief: a drone's system failure occurred which compromise its mission. Then the USSP system provides a safe route to the nearest vertiport.

WP7. Demonstration Exercise #4

- 3 flights performed at Esperce flight space (Toulouse area), on July 2022.
- Emergency successfully detected and handled by the TinDAIR solution and the operators:
  - Scenarios 1&2 both validated with conflict resolution by holding or landing.
  - Scenario 3 not performed but indirectly validated by emergency landing tested in Sc. 1&2
- A RF range of 9 km validated during the third flight





WP8: Analysis of the results and recommendations

WP leader: Onera

TINDAIR Project Final Workshop, December 15th 2022

EUROPEAN PARTNERSHIP

Co-funded by the European Union

Description of Work

- **Objectives:**
  - Analyse the flight data obtained in WP7, and compile the analysis results into the final demonstration report.
  - Validate the proposed U-space CONOPS for UAM operation scenarios and the tactical conflict resolution framework.
  - Present recommendations to SESAR and European civil aviation authorities for
    - Further technology development of U-space services, and
    - Requirements towards safe & secure UAM integration into the ATM airspace.

- **Work organization:**
  - **Task 8.1** – Assessment of demonstration results (Innov'ATM)
  - **Task 8.2** – Identification of business opportunity (Innov'ATM)
  - **Task 8.3** – U-space requirements and CONOPS validation (CIRA)
  - **Task 8.4** – New requirements definitions (Pildo)
  - **Task 8.5** – Recommendations (Pildo)

Timing & Deliverables

- The overall WP8 duration is of 5 months, from M19 to M23.
- Deliverables:
  - D30 (D8.1) Maturity Gate Report → submitted in M23
  - D31 (D8.2) Final Demo Report → submitted in M22, reviewed in M23

	2022					
	Jul M18	Aug M19	Sept M20	Oct M21	Nov M22	Dec M23
Deliverables	WP7 Demos 1 & 4		WP7 Demos 2 & 3	D30 (D8.1)	D31 (D8.2)	Maturity Gate
Task 8.1		Assessment of demonstration results (Innov'ATM)				
Task 8.2		Identification	of business opportunity (Innov'ATM)			
Task 8.3				U-space requirements and CONOPS validation (CIRA)		
Task 8.4				New requirements definitions (Pildo)		
Task 8.5					Recommendations (Pildo)	

T8.1 - Assessment of demonstration results (Innov'ATM)

- Demonstration results have shown the TINDAiR system capability
  - to detect and resolve conflicts at strategic and tactical levels
  - to manage emergencies by the detection of hazardous situations and by ordering suitable emergency landing orders
  - to ensure indispensable services such as Tracking, Network identification, Traffic information, Geo-awareness or Monitoring.

- Major part of the demonstration objectives was validated, the rest was partially validated.

- The consistency of the flow of actions related to the coordination between all the services is validated. The results confirm the technical and practical feasibility of the proposed TINDAiR system.

T8.2 - Identification of business opportunity (Innov'ATM)

- As an extension of the Tindair Solution and in order to develop an economical sustainable U-Space services for Tactical conflict resolution, the following R&D shall be addressed:
  - Integration of U-space services for conflict resolution with on-board DAA
  - Full automatic conflict resolution orders computation

- Better integration UTM/ATM for emergency situation management

T8.3 - U-space requirements and CONOPS validation (CIRA)

- Flight results have shown that the TINDAiR system is compliant with the ConOps flow of operations at least within the limitations of the flight demonstration scenarios.

- Strategic and Tactical De-confliction Services were tested in a relevant environment, and their coordination with other U-space services (Tracking, Emergency Management, Geo-awareness, etc.) was also demonstrated

- Future work:
  - To address more complex scenarios involving the use of other U-space services, considering multiple kinds of aircraft and triggering coordination with ATM.
  - To lay the foundations for the definition of both Operational Improvement (OI) steps and Enablers to facilitate the gradual deployment of the SESAR Solutions addressed in this project.

T8.4 - New requirements definitions (Pildo)

- Identified a set of improvements to be considered as new requirements for upcoming developments:
  - Heat dissipation improvement
  - Power malfunction additional security elements
  - Electromagnetic tests conduction
  - Miniaturization and robustness design
  - Remote management capabilities
  - Visual indicators improved
  - User alerting integration

T8.5 - Recommendations (Pildo)

- Augmentation of robustness and versatility of the TINDAIR system for paving the way towards a fully adaptable solution for all users.

- Consideration of aircraft capabilities in deconfliction measures:
    - In the future, regulation means must take into account the difference between aircraft flight systems. Moreover, the conflict resolution must take into account the UAS capability to execute a deconfliction order (hold, speed/altitude change, re-routing, etc.)

- Standardization of deconfliction procedure among all the pilots, so that the flight systems can integrate standard actions to be allowed to fly in U-Space.

THANK YOU FOR YOUR ATTENTION !

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