

IRINA Workshop Solution 0379

Integration of RPAS in Airspace class A to C

Brussels, 17th February 2026

María del Carmen Jiménez Moleón –SNETs expert

AGENDA DAY 1 SOLUTION 0379

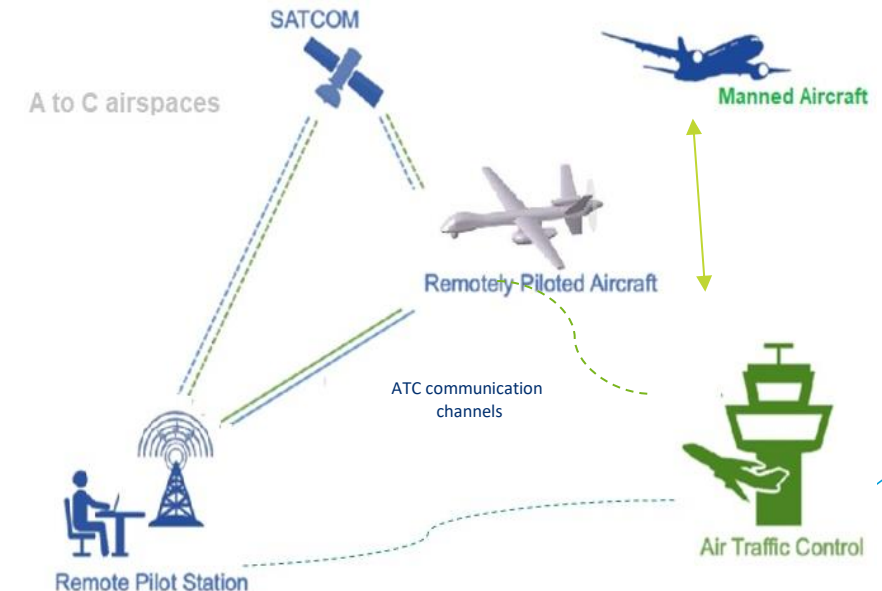
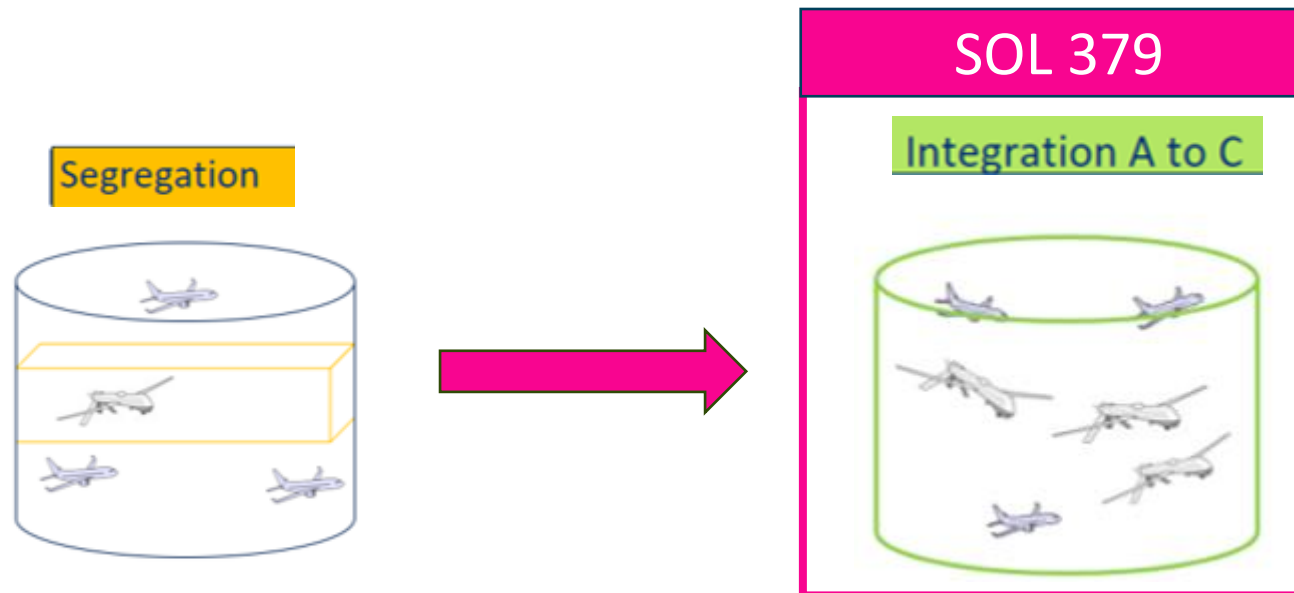
- **IRINA Introduction:** 13:00-13:15
- **Solution 0379 overview** – 13:15-13:30
- **SNETS** – 13:30-13:40
- **ACAS Xu**
 - RTS – 13:40–13:50
 - FTS – 13:50–14:20
 - ACAS Xu FTS general
 - FTS ACAS Xu results
 - FTS ACAS Xu operational acceptability
- **Flight test** – 14:20–14:25
- **EUDAAS** (System, RTS, FTS) – 14:25–15:00
- **Coffe break** – 15:00–15:15
- **Safety** – 15:15–15:35
- **Human Performance** – 15:35–15:55
- **Regulation and Standards** – 15:55–16:05
- **Solution general conclusions and recommendations** – 16:05–16:20
- **Q&A** – 16:20–16:50
- **Wrap-up** – 16:50–17:00

IRINA SOL 0379: What is it about?

Validate the RPAS full integration into the controlled A to C airspaces

- Assess procedures & communications between ATCO and RP
- Improving DAA provision and enhancing ATM infrastructure and services associated
- Improvement of ground-based safety nets to adjust to RPAs particularities (performance, C2L associated delay)
- Key performance areas addressed by this solution are Access and Equity, Safety and Efficiency

SOL379
Maturity:
TRL6



IRINA Operational environment, traffic, CNS



- Airspace classes **A**, **B** and **C** (**ATC provides separation**) ATC is responsible for IFR separation both against IFR and VFR
- **En-route** and **TMA** environment. Medium/Low complexity and density
- **Traffic characteristics**: Same as today (Air-Transport commercial traffic) + RPAS (MALE, TUAV)
- **Missions** Travel without segregation, military missions, surveillance (Specific cases)
- **Performance**: drones perform more slowly than manned aircraft(jets, commercial aviation...)
- **RP-ATC communications and the C2 link**: latency and C2link-loss scenarios

Nominal
Conditions

Non
nominal
conditions

Use Cases

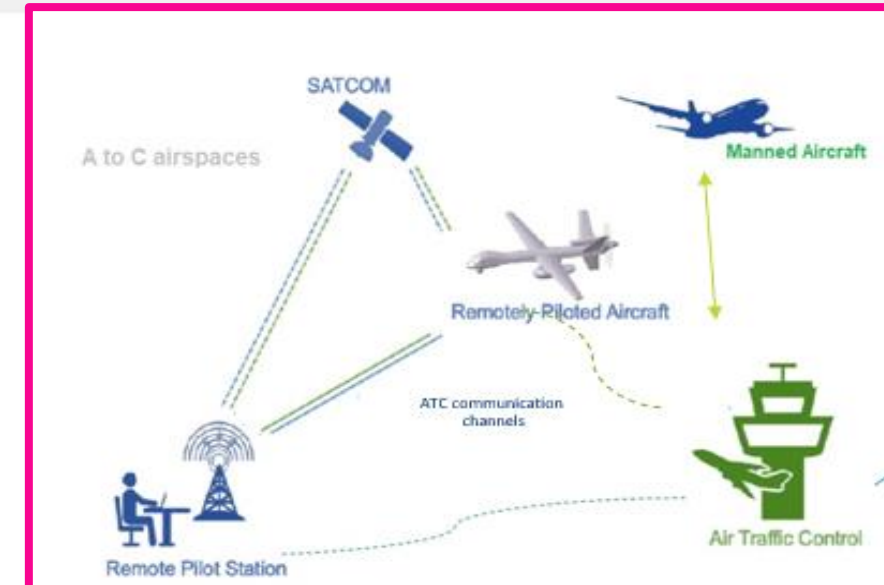
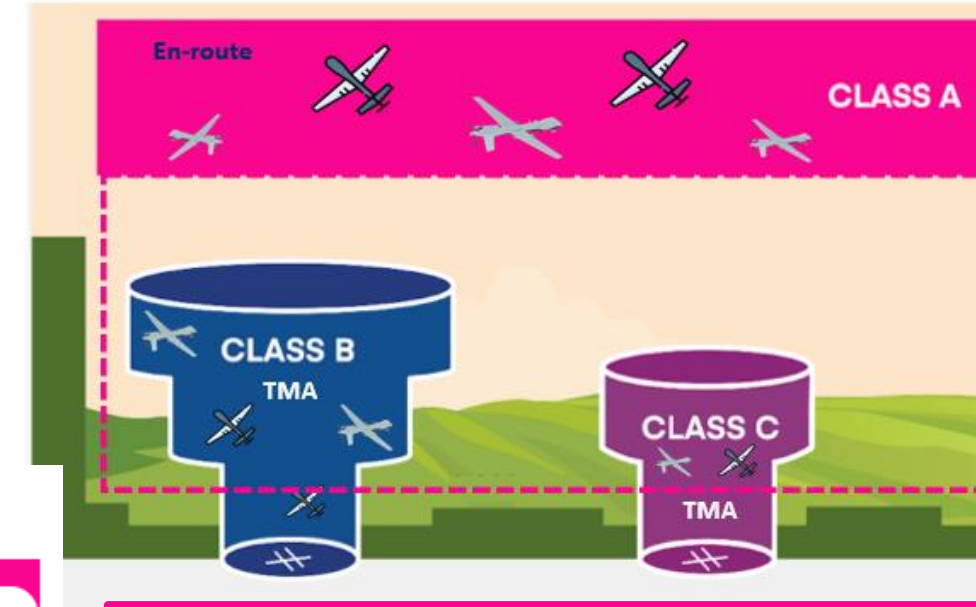
IFR RPAS
Operations
Route

IFR RPAS
Operations
SID, STAR

Ground-based
Safety Net:
STCA, MSAW,
APW

C2 link loss

DAA: CA, and
RWC



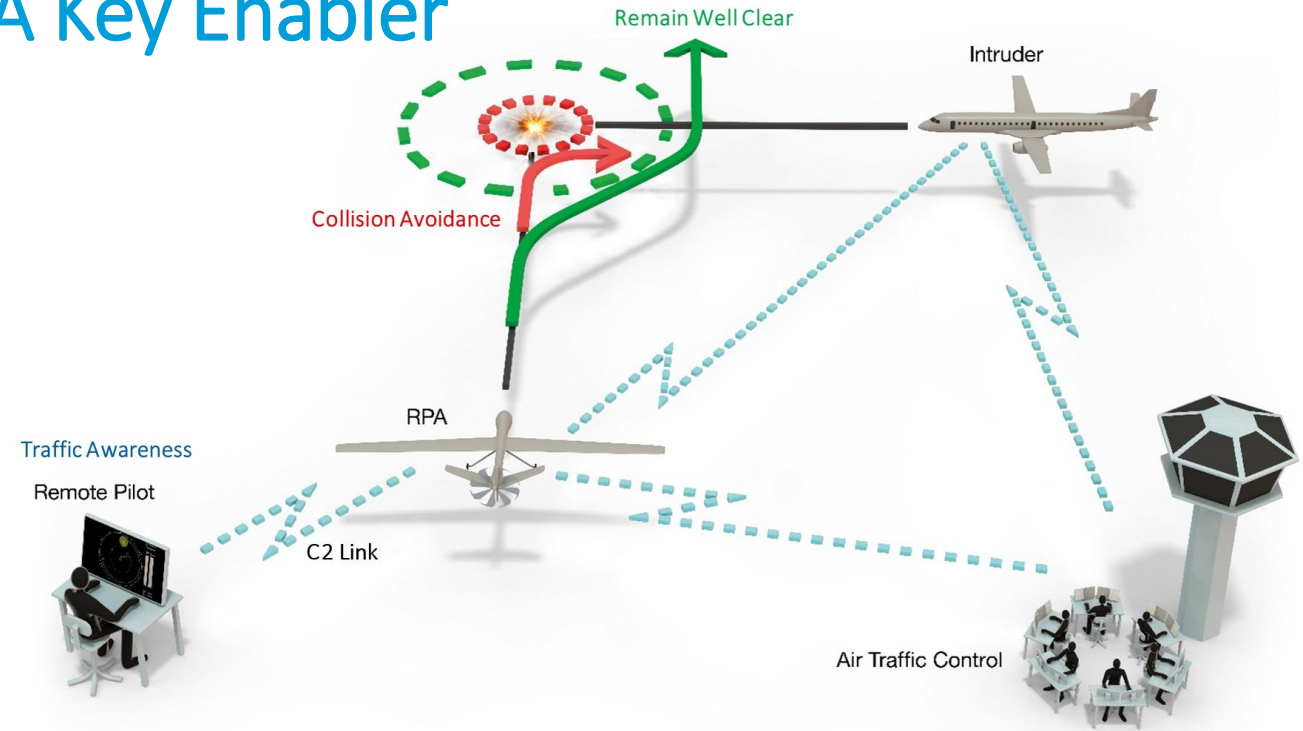
From your perspective, what is the main barrier today to achieving full RPAS integration in controlled Class A–C airspace?

- A. Operational aspects: procedures, controller and pilot training, concept maturity
- B. Technical aspects: C2 link performance, latency, DAA capabilities
- C. Regulatory and certification aspects
- D. Human factors and acceptability: ATCO and RP trust in the concept and tools



IRINA Solution 0379: DAA Key Enabler

- Traffic Awareness
 - "Be informed"
- Remain Well Clear
 - "Don't scare others"
- Collision Avoidance
 - "Don't collide"

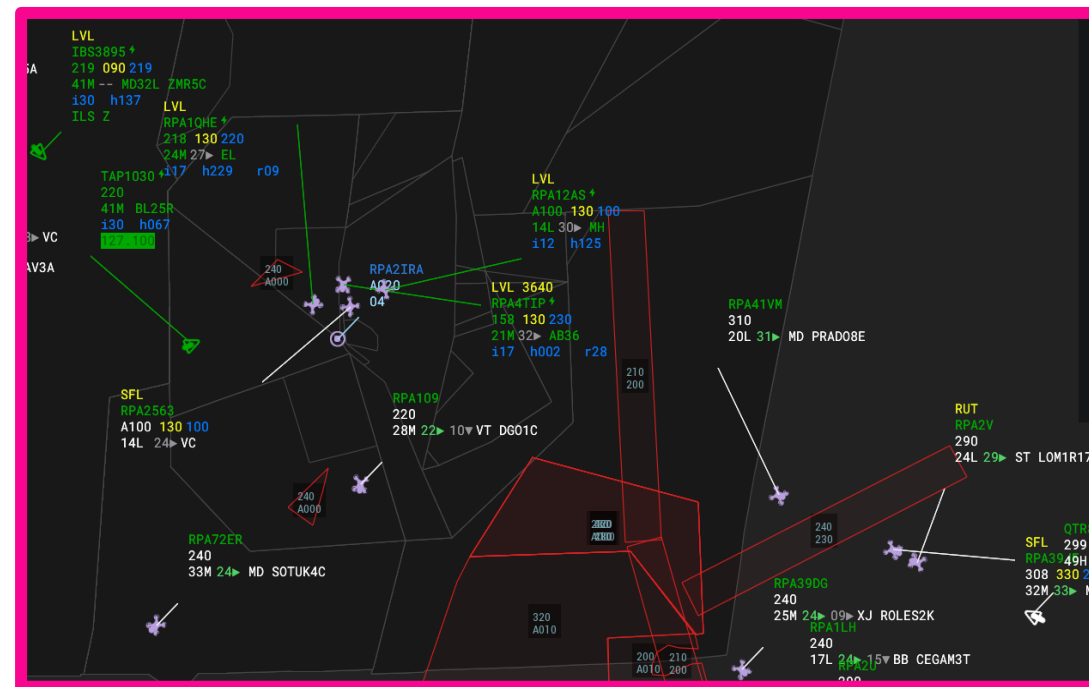


- DAA is a key enabler for integrating RPAS into controlled, as it supports the pilot's responsibility to detect and avoid traffic in an unmanned context.
- Unlike TCAS, DAA Collision Avoidance can generate both vertical and horizontal manoeuvres and is designed to support higher automation levels, including C2 link loss scenarios.

Validation activities covering both DAAs: EUDAAS and the joint USA–European ACAS Xu through dedicated exercises.

IRINA Solution 0379: Enhanced Ground based- SNETS

- ✓ Enhanced Ground-based Safety Nets (SNETs) support RPAS integration by considering specific characteristics such as RPAS performance, C2 Link latency, and ATCO–Remote Pilot interaction.
- ✓ SNETs provide adapted tools for ATCOs to ensure safe separation between manned and unmanned traffic, maintaining acceptable safety levels.
- ✓ Positioned in the third layer of conflict management, SNETs include STCA, APW, and MSAW, adapted to RPAs



IRINA Solution 0379: Validation Exercises

Fast Time Simulation (FTS)

- ✓ 4 FTS Exercises: TVAL.02 (THALES SIX, SAFRAN), TVAL.05 (HISRO), TVAL.07 (DSNA), TVAL.09 (SAAB)

For this EXEs a series of fast-time simulations was performed using the encounter sets generated by Eurocontrol.

Real Time Simulation (RTS)

- ✓ 4 RTS Exercises: TVAL.01 (INDRA), TVAL.03 and TVAL.08 (SAFRAN, DSNA), TVAL.11 (SAAB)

For this EXEs different air traffic scenarios were replicated in real time, allowing ATC to interact as they would in actual operations.

Flight Test (FT)

- ✓ 2 FT Exercise: TVAL.04 (SAFRAN), TVAL.06 (HISRO)

These EXEs consisted of live operational exercises using real RPAS to validate systems under real flight conditions.



Improvement of ground-based safety nets capabilities for RPAS

TVAL.01.0 (EXE001 – SOL0379)
INDRA, ENAIRE, CRIDA-INECO

María del Carmen Jiménez Moleón –SNETs expert

17th February 2026

IRINA TVAL.01.0 (EXE001 - SOL 0379)

Context

- Operating environment: **TMA & En-route**, class A-C
- Multiple RPAS simultaneously flying on the simulation with **IFR traffic**

Scenarios

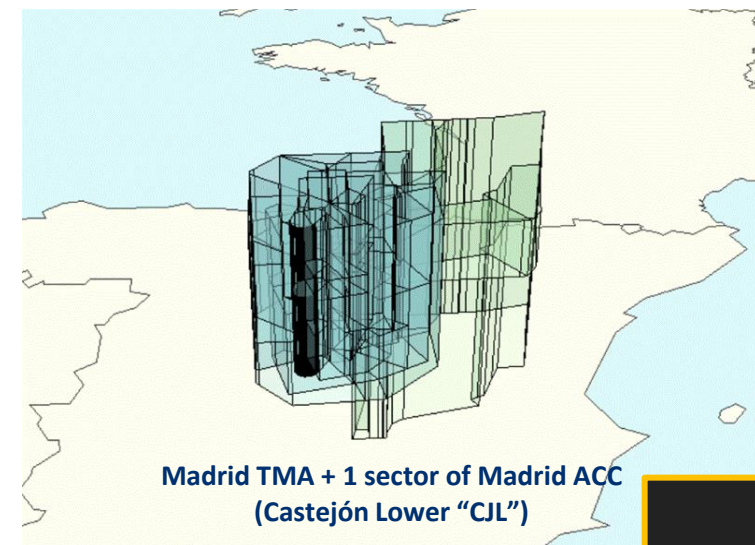
- Nominal situations: RPASs flying SID, En-route and STAR
- Non-nominal situations: C2LL contingency
- Medium density and complexity environment with representative differences between RPAS and manned aviation performance
- Latency 2s + 2s

Assumptions

- Scenarios intentionally designed to create short-term conflicts to test the adapted SNETs system
- Traffic Volume: flight plan data of real air traffic from July 2019
- Sub-operating environment : medium complexity/density
- On-board Equipment for manned aircraft no changes
- Separation Jurisdiction, ATC retains responsibility for separation provision

Actors and Platform

- 2 Executive Controllers for the conflict management testing new SNETs improvements
- 4 Pseudo Remote pilots manipulate flight controls of a remotely-piloted aircraft during flight time and also oversees implementing over the RPAS any instruction issued by ATCOs
- iTEC based simulation platform which integrates the adapted (enhanced) safety nets module and an HMI CWP to support the interaction of the controller with the system and RPAs scenarios +Latency in COM when involving RPAS

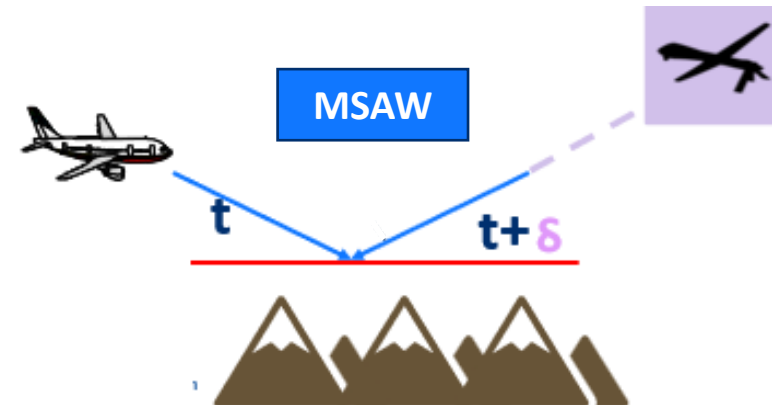
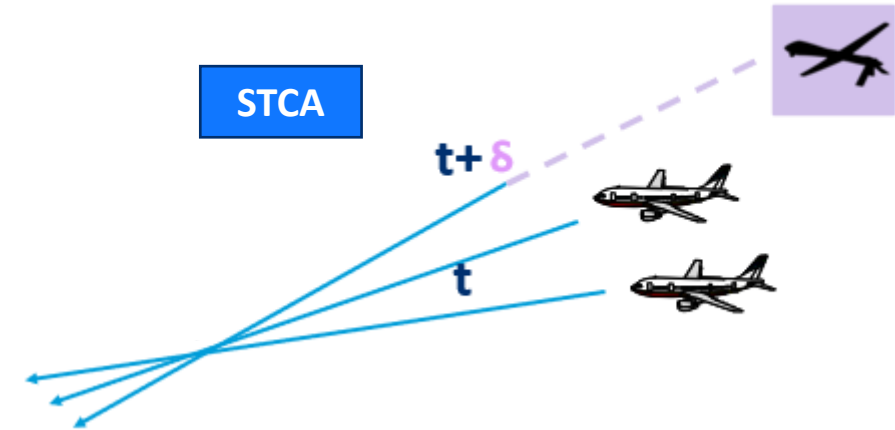


IRINA ENHANCED SNETS, RPAS-Specific Adjustments: TIME DELTAS

- **SNETs will adapt its calculations** when radar data identifies the aircraft as **unmanned (RPAS)**.
- **Alert thresholds** (for both prediction and violation) will be **adjusted** to better suit conflicts involving RPAS.
- **Time-to-conflict parameters** will be **modified** by adding **time deltas** to the current default values

Earlier alerts :Allowing **more margin for conflict resolution** due to RPAS response (delay, limited performance...)

EX : $120 + 40\% t = 120 + 48 = 168s$

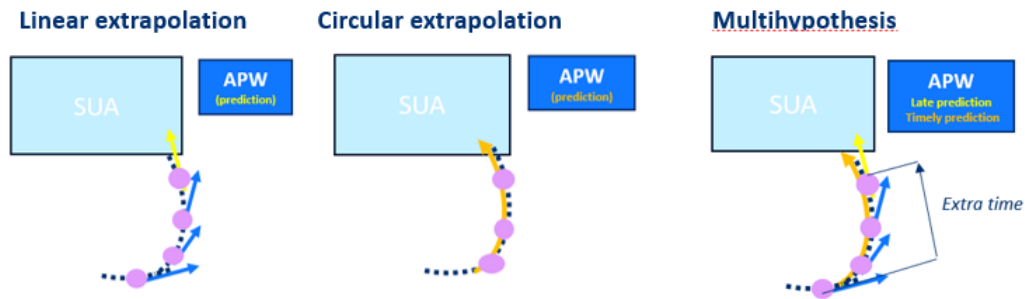


IRINA Enhanced extrapolation calculations

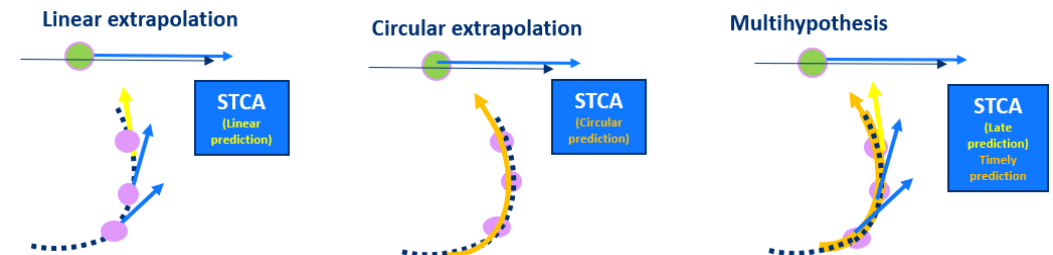
- **Conventional SNETs** relies on a linear extrapolation: cases where conflicts are shown too late to be resolved.
- **Enhanced SNETs** introduce circular extrapolation: it has demonstrated higher accuracy compared to the Linear one -> conflicts are detected earlier and more precisely.
- Earlier alerts support ATCOs to resolve the conflicts. **Multihypothesis extrapolation is the optimal extrapolation:** identifying higher number of potential conflicts, **allowing timely alerts** -> reducing the % violations.

APW case Timely alert

Reference vs solution En-Route



STCA case Timely alert



IRINA Solution 0379 – EXE001 – Conclusions

- RPAs identification : Representing RPAs with a **distinct symbol on the CWP**, as well as maintaining a list of flying RPAs, helps reinforce ATCOs' situational awareness.
- **Delta configuration** differ depending on the environment. The optimal deltas configuration for the validated scenario:
 - APW and MSAW -> 25% increase
 - STCA -> TMA: 60% and En-route: 50% increase
- ✓ The **percentage of violations** as a function of the number of conflicts in each run decreases as the deltas and extrapolation are adjusted.
- From **safety perspective**, EXE001 has demonstrated the need to **enhanced safety nets** (increased thresholds + multi-hypothesis extrapolation) to support RPAS integration in controlled airspace classes A to C.
 - The **communication delay** is critical in establishing an adequate safety level. It negatively impacted all tested scenarios, both reference and solution cases, and across en-route and TMA airspace.
 - A delay of 2 seconds per communication was tested, and was considered unacceptable by ATCOs, especially when there is a **mix of fast and slow aircraft** and when the **communication frequency is overcrowded**.
- The results show that **human performance** within the evaluated concept is generally consistent with controller capabilities and limitations, although certain areas require further refinement.
 - In scenarios that applied the multi-hypothesis extrapolation thresholds with best deltas configuration, controllers did not experience nuisance alerts, workload remained optimal and trust in the system increased.
 - The analysis of team communication indicates that the defined phraseology generally supported controllers in delivering complex clearances in both nominal and degraded scenarios.
 - Job satisfaction, considering the changes introduced by the RPAS, can be considered acceptable, even the conditions differed from real operations and affected ATCOs' perception of the concept.

Solution 0379 – EXE001 – Recommendations

- Regarding enhanced ground-based safety nets, **functionalities** must be adapted to the specific characteristics of the target operational environment, including the type of traffic, associated complexity, coverage of the area of application, and other intrinsic factors. **Standardization and Regulation**
- It is recommended that **ATCO training** be tailored to the characteristics of that specific airspace so that controllers become fully proficient in the scenario where the enhanced safety nets will be deployed.
- It is recommended to develop a dedicated **performance model for RPAS**, including their specific maneuverability, mission profiles and latency-affected responses, would significantly improve the reliability and representativeness of future validations.
- Acceptable **communication delay** thresholds must be defined to ensure safe integration. A 2-2second communication delay was tested and deemed unacceptable by ATCOs, especially in critical situations.
- To test the enhanced SNETs system the scenarios were intentionally designed with high number of conflicts and alerts, it is recommended that further testing be conducted under more **realistic scenarios**, using the deltas or thresholds considered adequate by the controllers, in order to fully mature the concept.

Solution 0379 – EXE001 – Your view matters!

Which aspects do you think have the greatest impact on ATCOs when using ground-based safety nets for the integration of RPAS operations in Class A–C airspace?

- A. ATCO Increased workload
- B. Delays in RP–ATCO communications
- C. C2 link loss situations
- D. Differences in performance between RPAS and conventional aircraft



ACAS Xu Real Time Simulation (RTS)
TVAL.03.0 and TVAL.08.0 (EXE003 and EXE008 – SOL0379)
DSNA

Yannick Seprey
17th February 2026

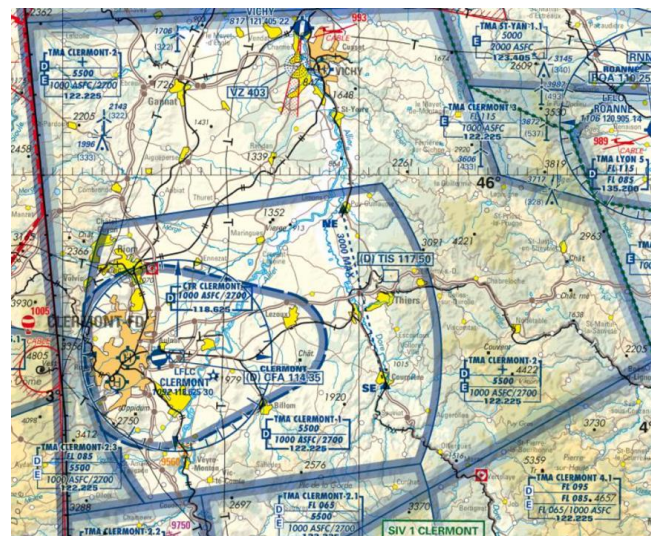
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TVAL.03.0 and TVAL.08.0

EXE-003 and 008 Solution 0379

Environment

- Clermont-Ferrand TMAs Class D and E. Class C separation applied (IFR separated from IFR and VFR) for the RTS.
- Low/medium complexity
- Diverse traffic and tasks for ATCO:
 - ☐ Manage Rodez approach
 - ☐ Departures and arrivals from/to small aerodromes in the vicinity (~30NM around)



Clermont-Ferrand
VFR map

ATCO HMI screenshot
during RTS



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TVAL.03.0 and TVAL.08.0

EXE-003 and 008 Solution 0379
Scenario

- Real traffic from 30th of June 2024: IFR and VFR
- Two simulated RPAS (Safran and Thales) piloted from Paris and Toulouse respectively
- All other IFR and VFR flights pseudo-piloted
- One aircraft flying VFR simulated a rogue non-cooperative aircraft
- Several conflicts and loss of well clear situation were generated on Safran Patroller DAA
- Thales RPAS simulated a search and rescue pattern



Thales UAS-100 trajectory



Safran Patroller



Conclusions

- Use of the prefix “remote” well accepted and easy to use.
- No issues to use the RWC coordination phraseology proposed at the same of the RTS.
- When IFR flights are separated from IFR and VFR flights, the Remain Well Clear function is rarely triggered.
- Real interest of the Remain Well Clear function for situation awareness on intruders (non-cooperative and not in contact).
- Two RPAS flights (strategically already deconflicted) at the same time was not an issue, either on Human Performance or on safety.
- RPAS particular “VFR types” trajectories not problematic, but in IFR a bit confusing.
- RPAS integration requires training on aircraft/systems performances and characteristics.

Fast Time Simulation (FTS) Results

TVAL.02.0 (EXE002 – SOL0379)

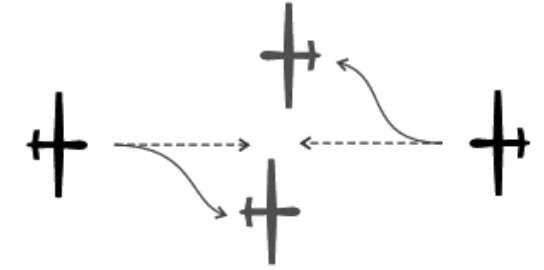
THALES SIX

Davide Cavone
17th February 2026

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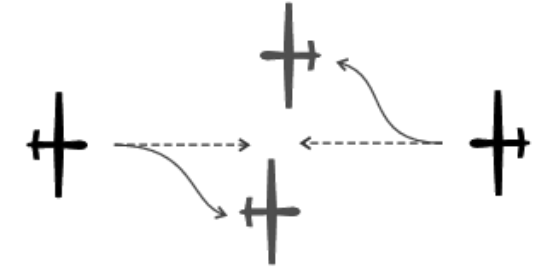
- Fast Time Simulation (FTS): How does it work?
- Safety and Operational metrics
- Aircraft equipage models
- Remote Pilot model for THALES FTS (Basics)
- FTS scenarios and results for THALES
- Simulation examples

FTS: How does it work?



- Several millions of close 2-aircraft encounters from the European Collision Avoidance Fast-time Evaluator (CAFE) Revised Encounter Model for Europe (**CREME**) have been used to simulate DAA (Detect and Avoid) functionality on RPAS (Remotely Piloted Aircraft Systems), i.e. simulated DAA are **ACAS Xu** and **EUDAAS**
- **Correlated** encounters generated by Correlated Encounter Model (CEM) for solution 0379 involve at least one aircraft under ATC and in **uncorrelated** encounters by Uncorrelated Encounter Model (UEM) for solution 0380 both aircraft are not under ATC.
- **Safety** encounters are intended for estimating collision risk and **operational** encounters for estimating alert rates.
- The encounters from CEM and UEM are split into 2 groups:
 - RPAS-RPAS i.e. an RPAS meets another RPAS
 - RPAS-Other i.e. an RPAS meets a non-RPAS aircraft.
- “Other” aircrafts can be equipped with a CAS (TCAS II or ACAS Xa) and a Transponder or only a Transponder or non-transponding
- “RPAS” aircraft are equipped with a DAA system and a Transponder

FTS: How does it work?



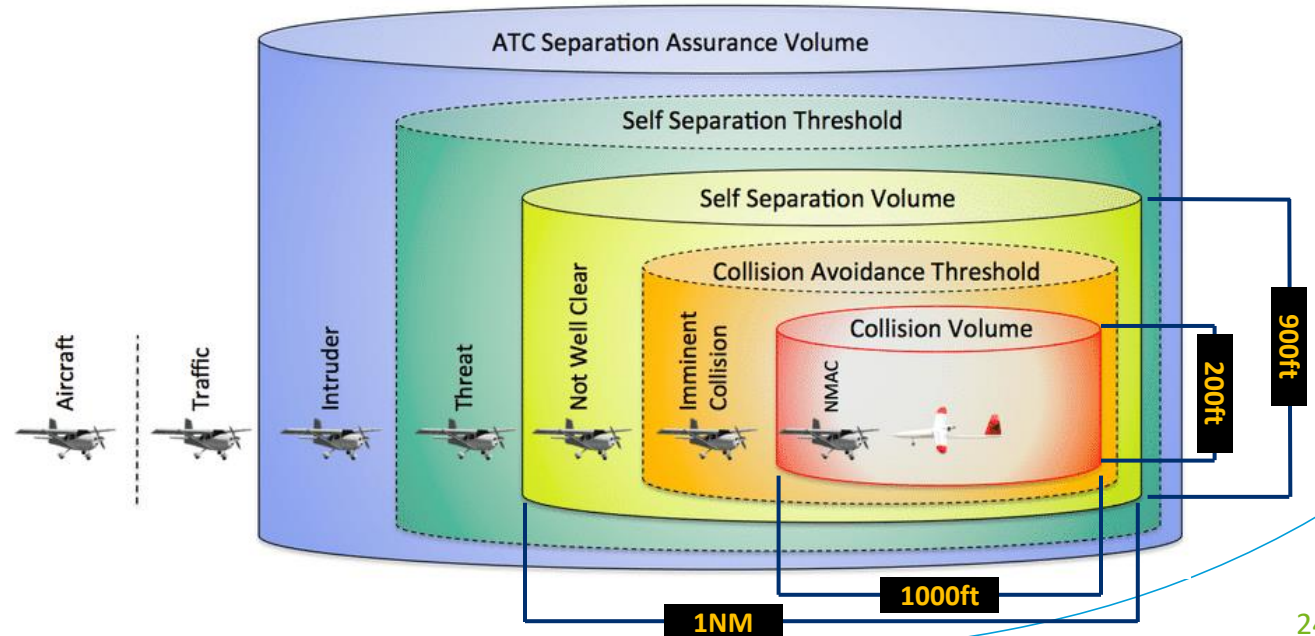
- RPAS includes:
 - LUAS = Light Unmanned Aircraft System
 - TUAV = Tactical Unmanned Aerial Vehicle
 - MALE = Medium Altitude Long Endurance
- Within each group, sets of encounters are organised by altitude layers 1 – 4:
 - Below FL50 (approach/ GA operations)
 - FL50 to FL135 (TMA)
 - F135L to FL285 (transitioning)
 - Above FL285 (en-route)
- Horizontal behaviour was classified as **point-to-point** or **loiter**. Point to point follow a classical waypoint route whereas loiter corresponds to a racetrack pattern or combing pattern.
- Nominally encounters are created from 240 seconds before the time of closest approach (TCA) to 30 seconds after TCA.

Safety metrics

- Several metrics have been defined to assess safety and operational performance of DAA systems. The most significant in FTS domain is **Collision Avoidance Risk Ratio** and **Loss of Well Clear Risk Ratio** for safety encounters.
- The ratios express the benefit of DAA in proportional terms, as follows:

$$RR(CA) = \frac{\text{risk of NMAC with DAA}}{\text{risk of NMAC without DAA}}$$

$$RR(LoWC) = \frac{\text{risk of LoWC with DAA}}{\text{risk of LoWC without DAA}}$$



Safety metrics

- There are two components of the ratio:
 - Induced Risk Ratio (IRR): encounters where there was no NMAC/LoWC without DAA and where DAA induced an NMAC/LoWC

$$IRR = \frac{\text{risk of Induced NMAC/LoWC with DAA}}{\text{risk of NMAC/LoWC without DAA}}$$

- Unresolved Risk Ratio (URR): encounters where there was already an NMAC/LoWC without DAA and where DAA failed to resolve the NMAC/LoWC

$$URR = \frac{\text{risk of Unresolved NMAC/LoWC with DAA}}{\text{risk of NMAC/LoWC without DAA}}$$

Safety metrics

- Typical values of Ratios thresholds for FTS depends on the type of intruders in an encounter:

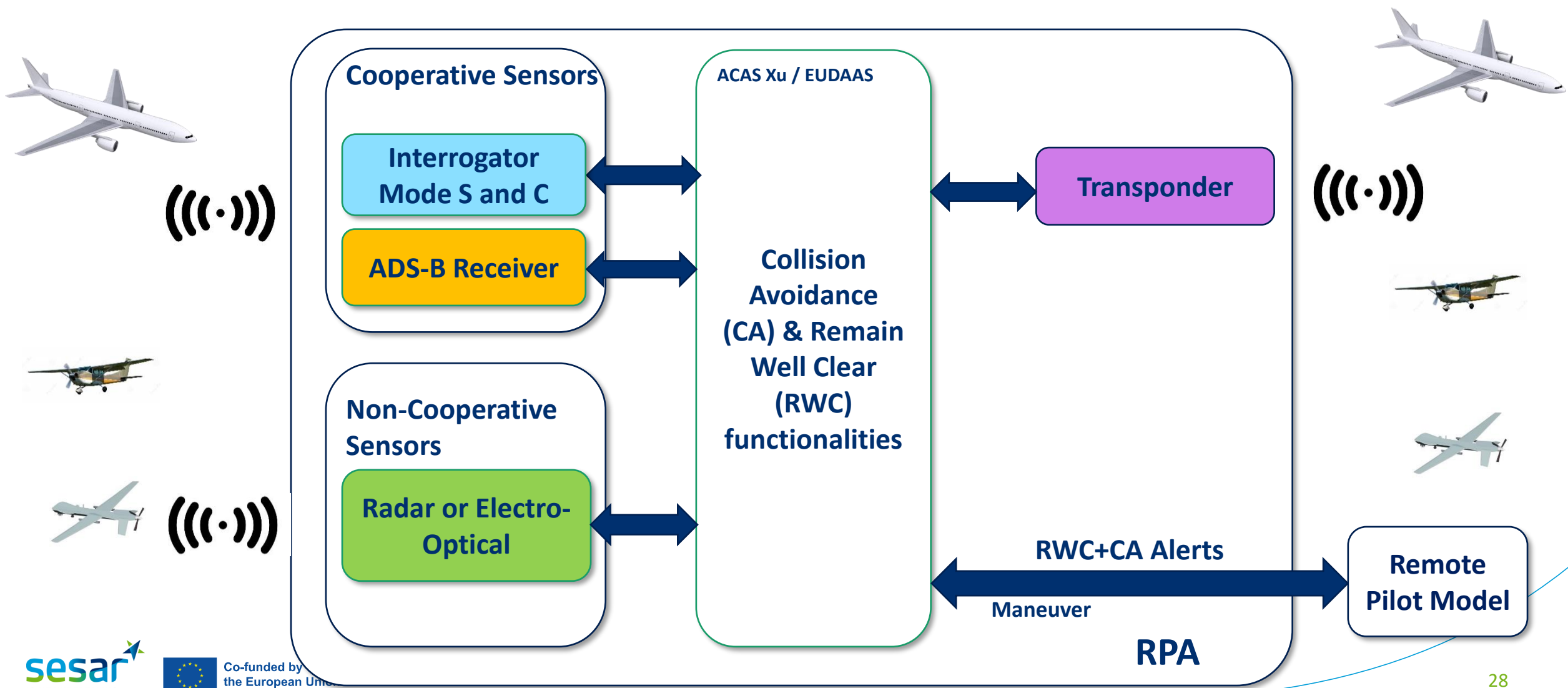
	CA Risk Ratio	LoWC Risk Ratio
Intruders equipped with a CAS and a transponder	$\leq 0,04$	$\leq 0,4$
Intruders with only a transponder	$\leq 0,18$	$\leq 0,4$
Non-cooperative intruders (non-transponding aircrafts)	$\leq 0,3$	$\leq 0,5$

- These values come from ICAO evaluation

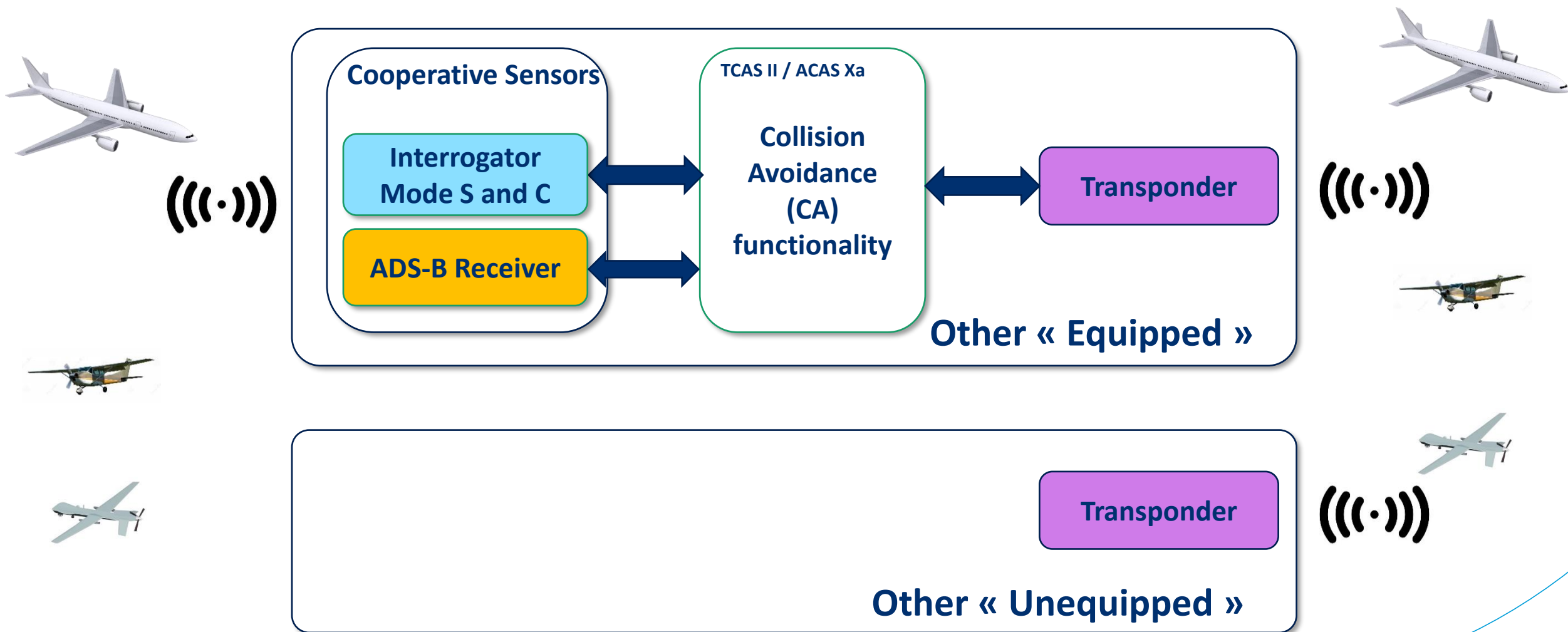
Operational metrics

- Operational metrics are mostly based on RA and RWC alert rates and they are compared to existing CAS.
- Typical operational metrics are:
 - Rate of unnecessary RWC caution alerts (not in ATM Separation Volume)
 - Rate of RA encounters with large separation
 - Distribution of time between initial RWC alert and initial RA alert
 - Rate of RAs against a single aircraft
 - Rate of RA encounters with high deviations

Aircraft equipage models for RPA

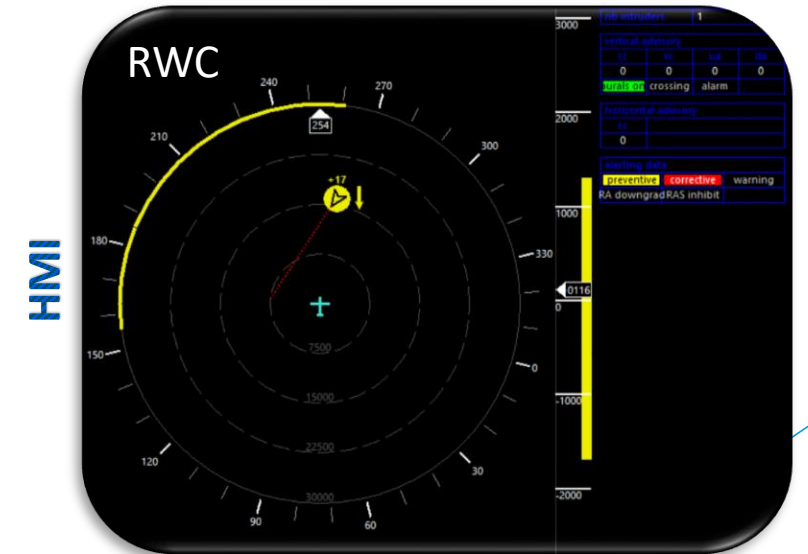
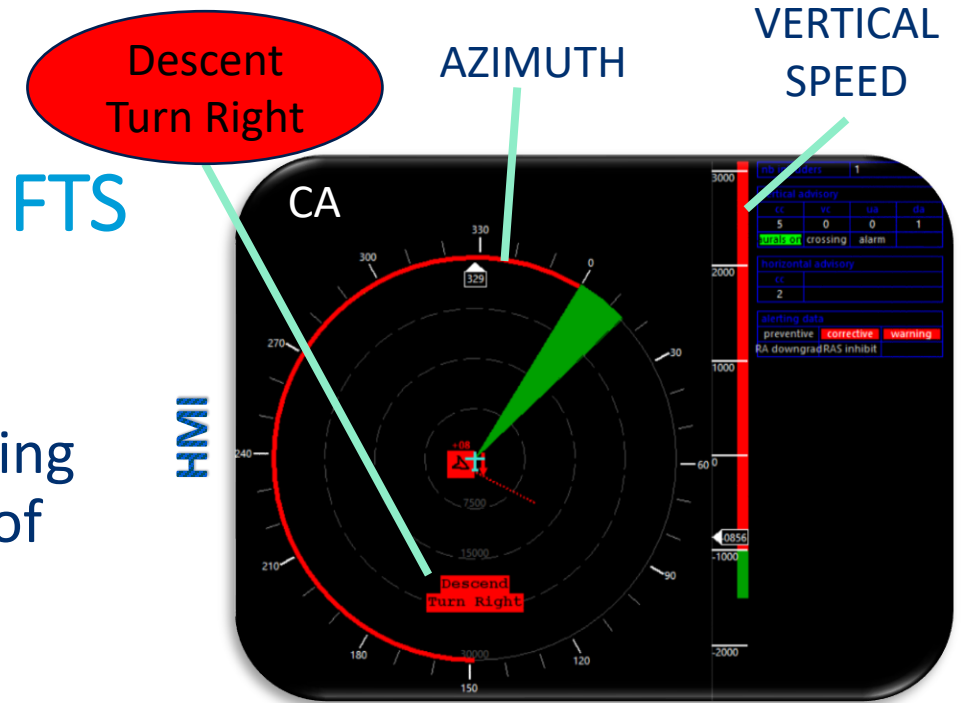


Aircraft equipage models for “Other” aircrafts

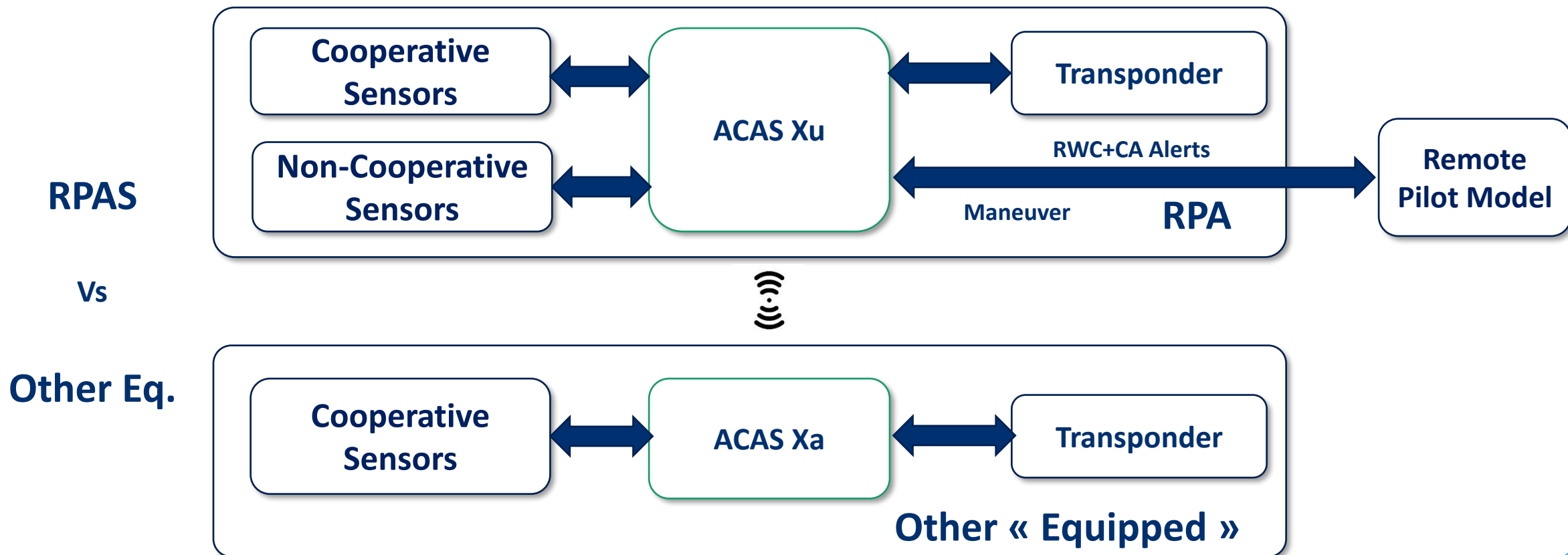


Remote Pilot model for THALES FTS

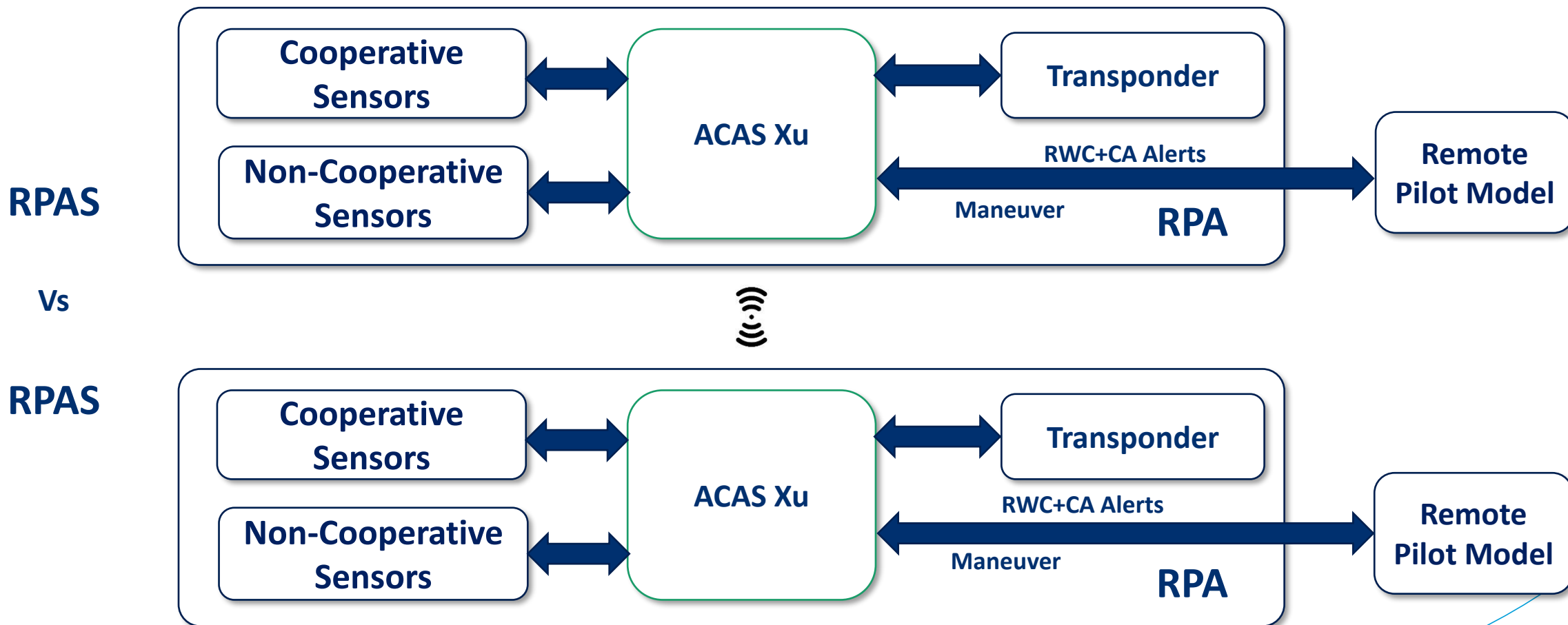
- Collision Avoidance (CA)
 - The pilot follows vertical and horizontal RA according to ownship aircraft capacities with a typical delay of 5s
- Remain Well Clear (RWC)
 - The pilot manoeuvres in order to reach the closest azimuth and vertical speed out of the yellow bands, according to ownship aircraft capacities. In controlled airspace the pilot waits 15s before starting the manoeuvre, otherwise 5s.



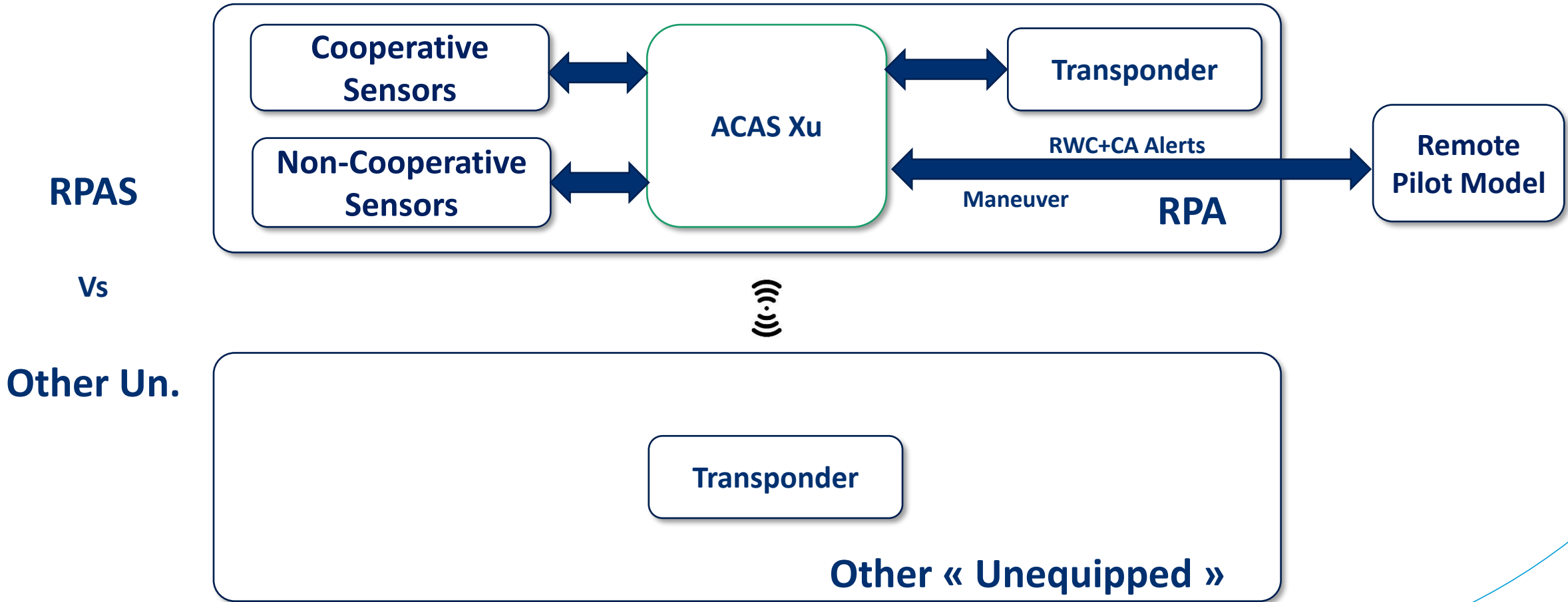
Results: Scenario 1 for THALES FTS



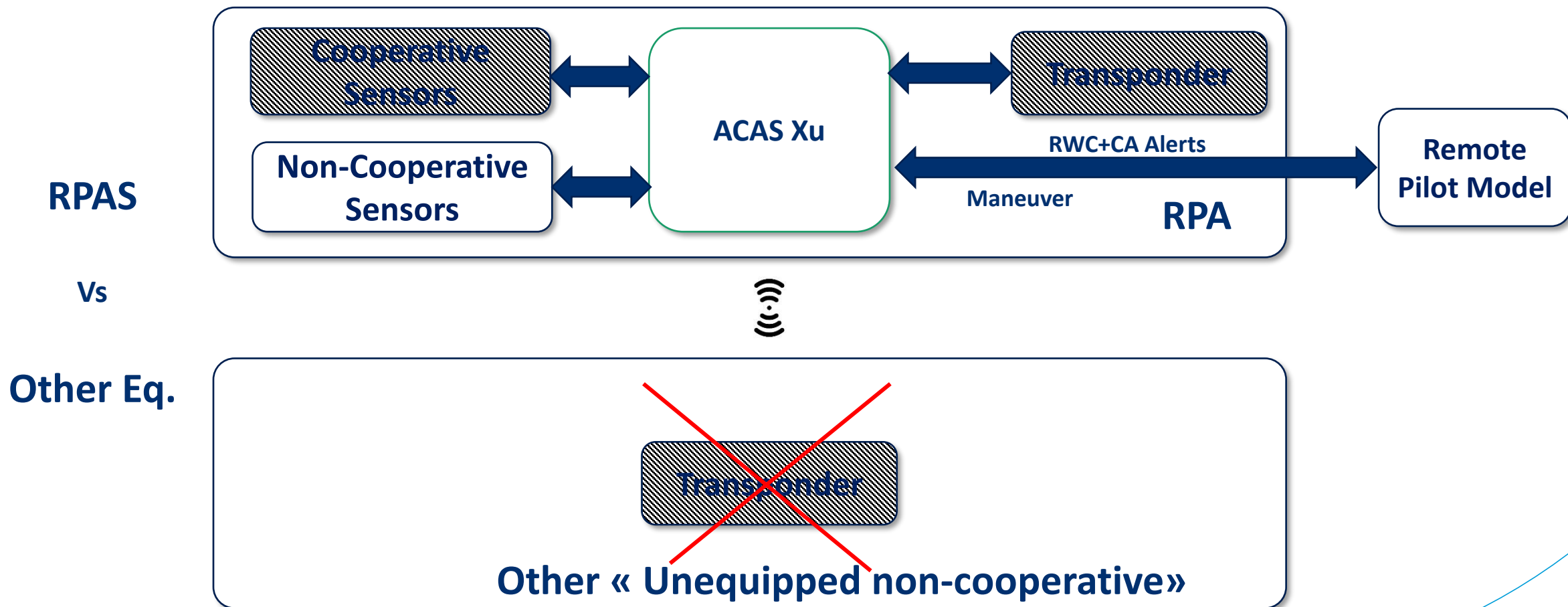
Results: Scenario 2 for THALES FTS



Results: Scenario 3 for THALES FTS



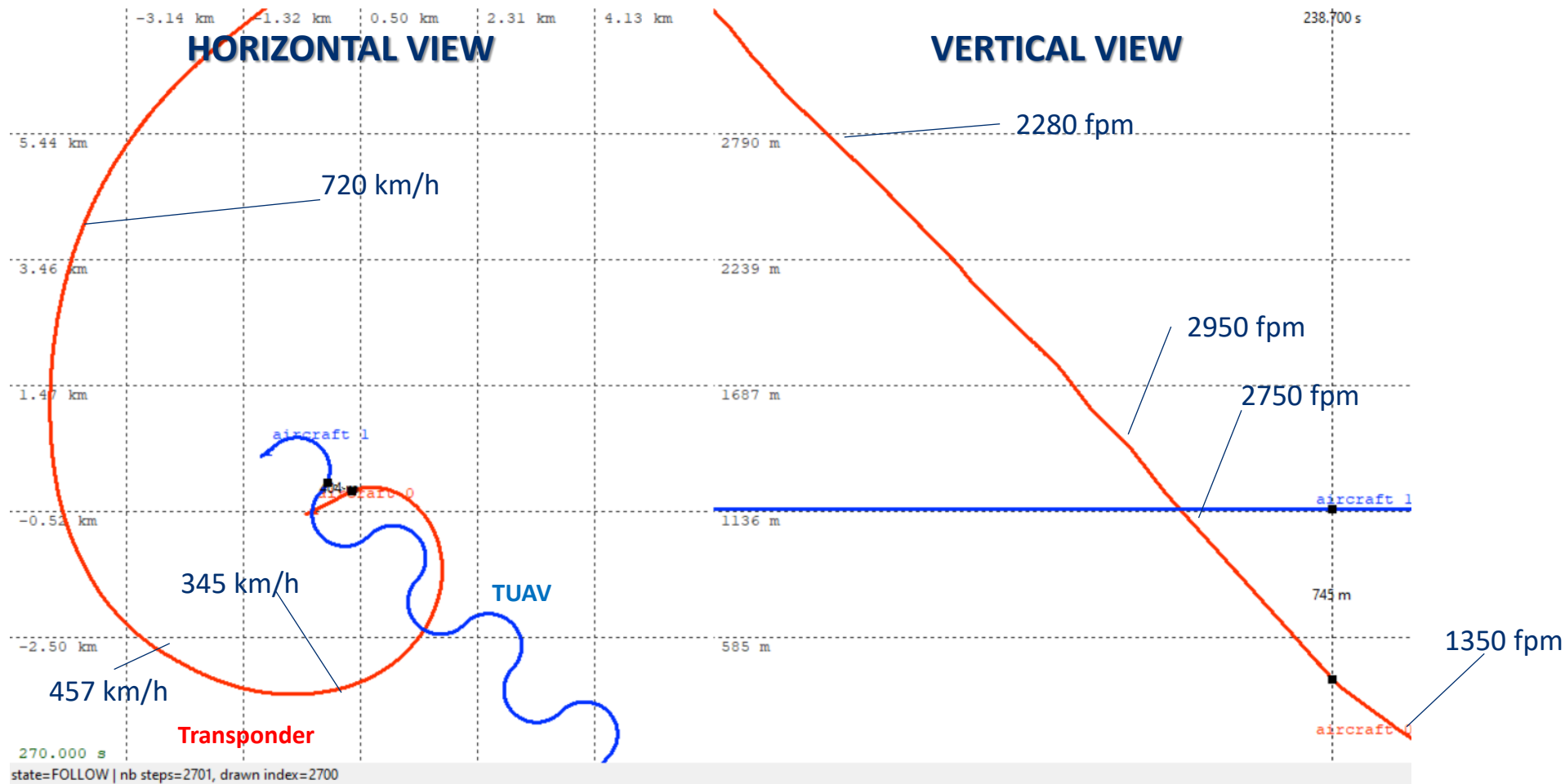
Results: Scenario 4 for THALES FTS (Transponder Failure)



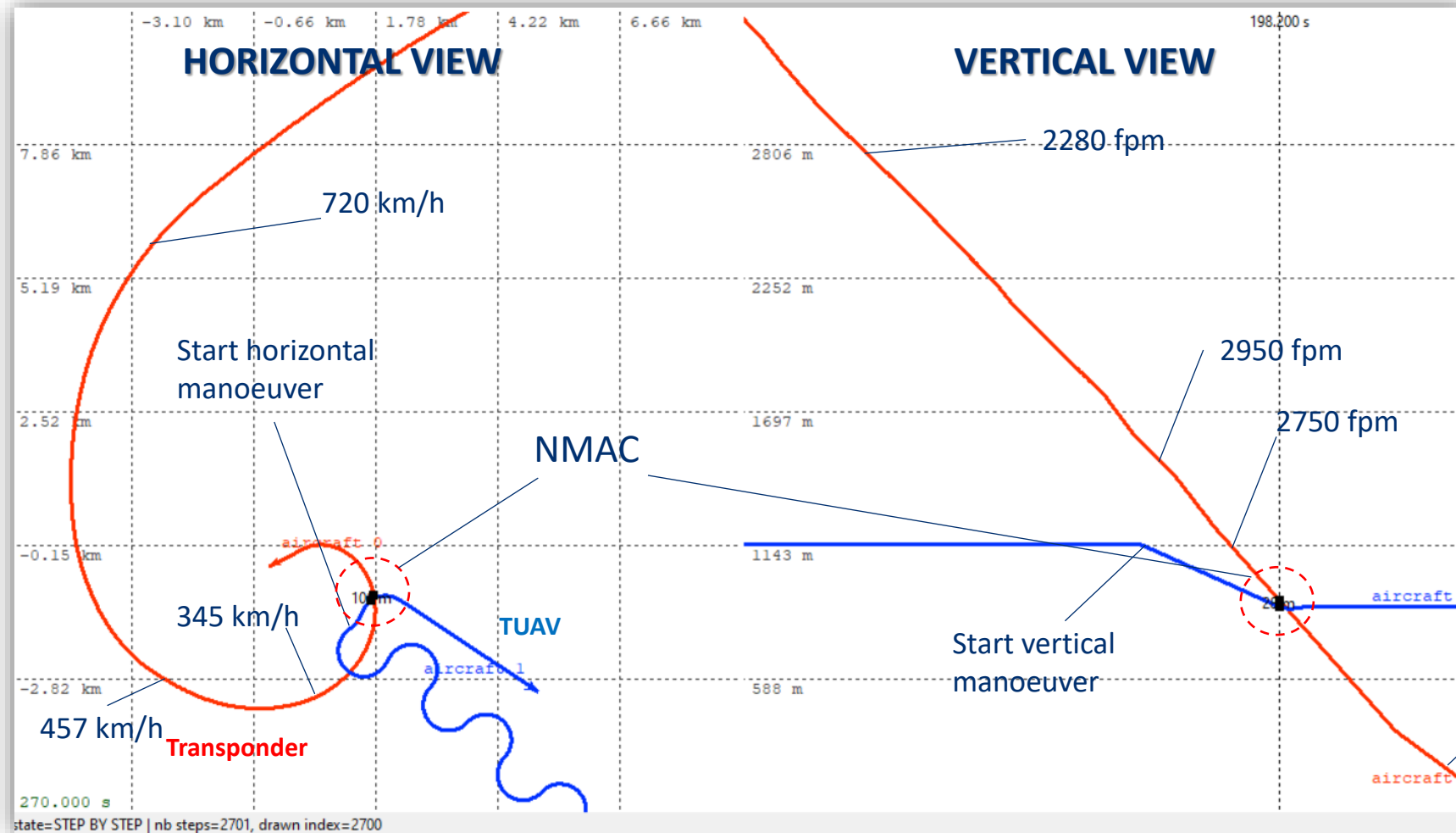
FTS Results for THALES

- Simulation results for scenarios 1 and 2 (RPAS vs Other Eq. and RPAS vs RPAS) show that the CA Risk Ratio and LoWC Risk Ratio are below FTS thresholds meaning that ACAS Xu reduces significantly the risk of collision and LoWC.
- Regarding scenario 3 (RPAS vs Transponder) LoWC Risk Ratio is below FTS threshold but there are some cases of induced and unresolved NMACs that degrade significantly the CA Risk Ratio. Some examples are reported in the next slides.
- Regarding scenario 4 (RPAS vs Transponder failure) CA and LoWC Risk Ratios are above FTS threshold meaning that reduction of the risk of collision and LoWC is not sufficient or absent. Some examples are reported in the next slides.

Example n1 scenario 3 (no NMAC)

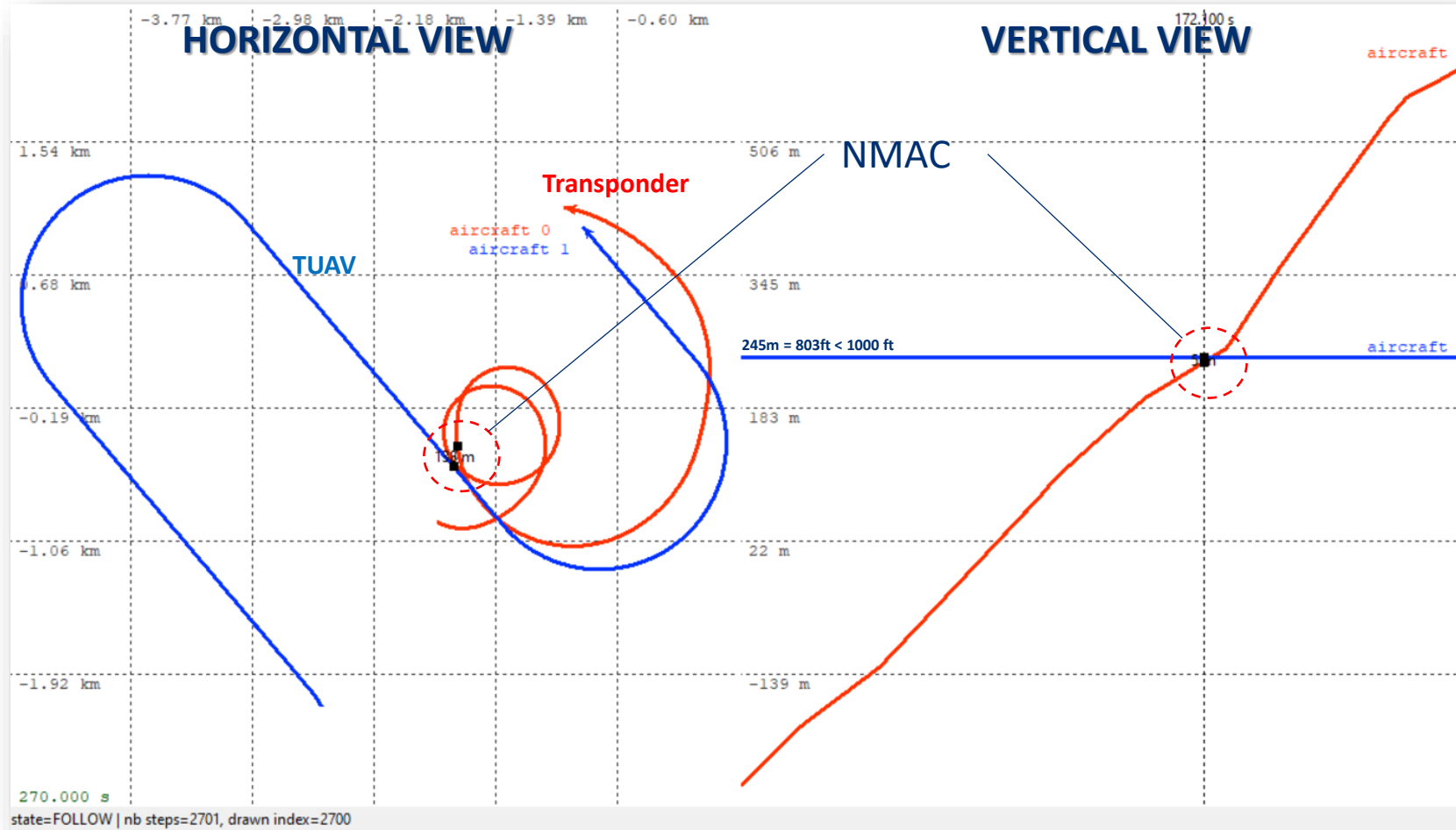


Example n1 scenario 3 (induce NMAC)



- Extremely high Intruder speed below 10000 ft and very high deceleration (Not realistic path?)
- ACAS Xu guidance induces NMAC

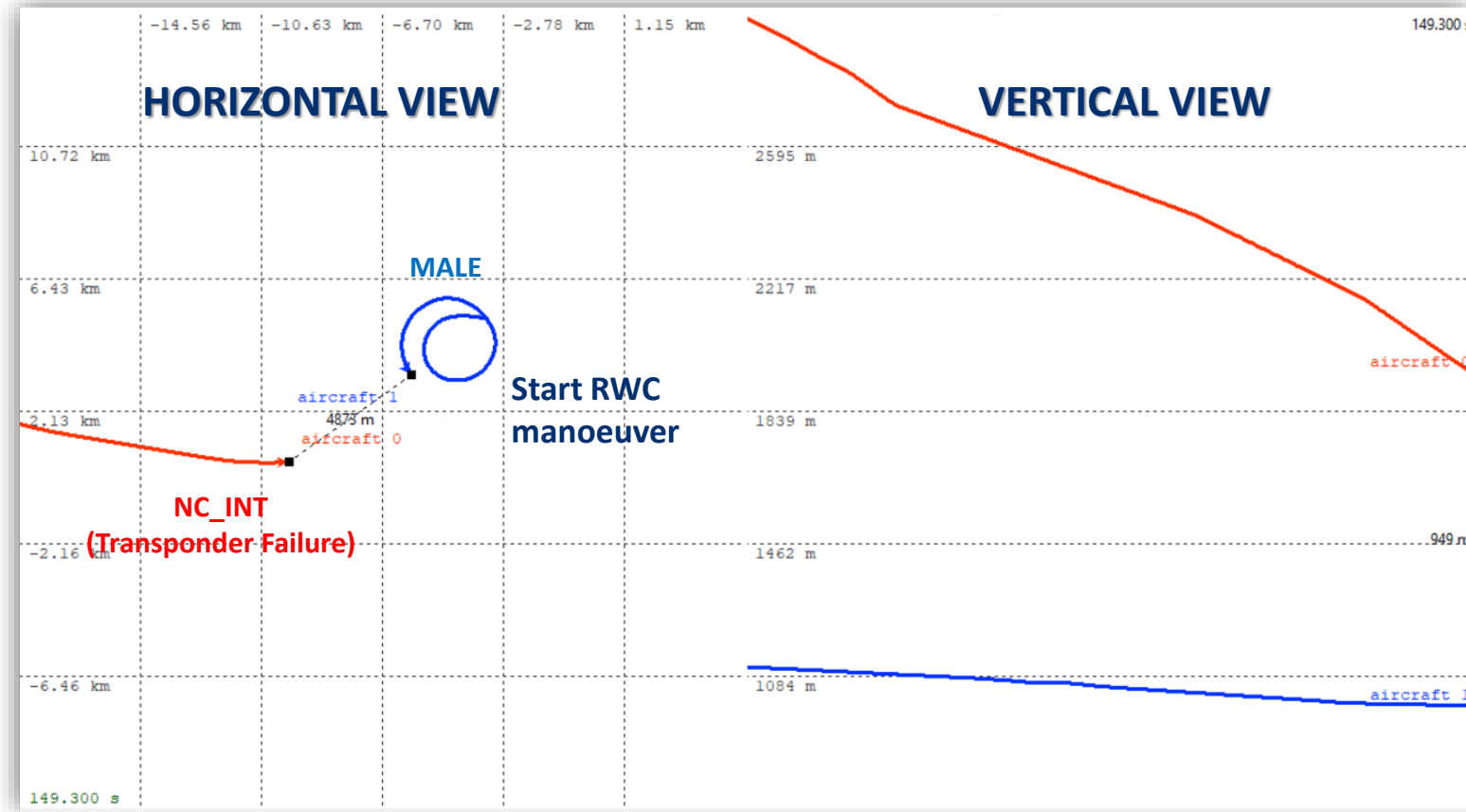
Example n2 scenario 3 (unresolved NMAC)



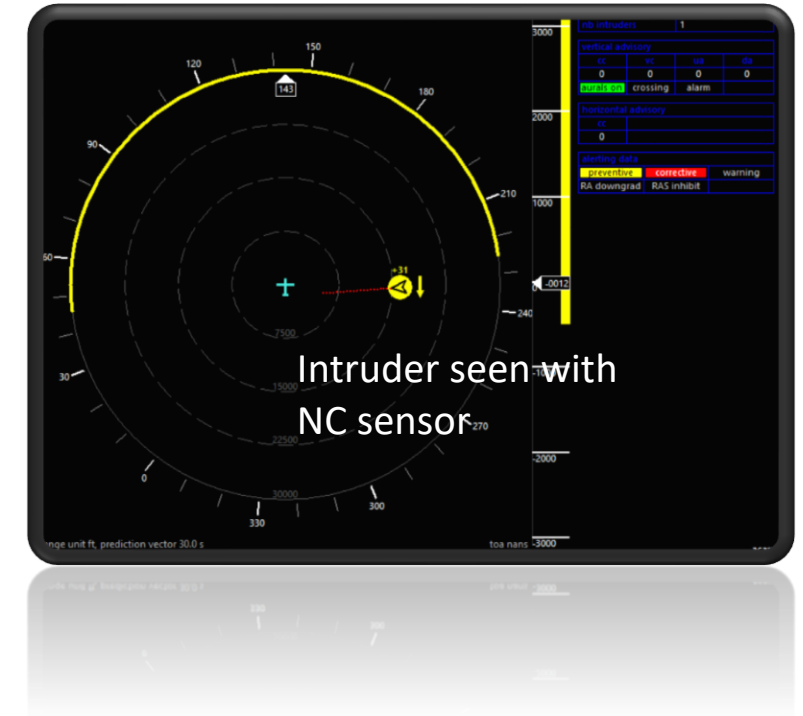
- CA and RWC of ACAS Xu are inhibited for altitudes less than 1000ft

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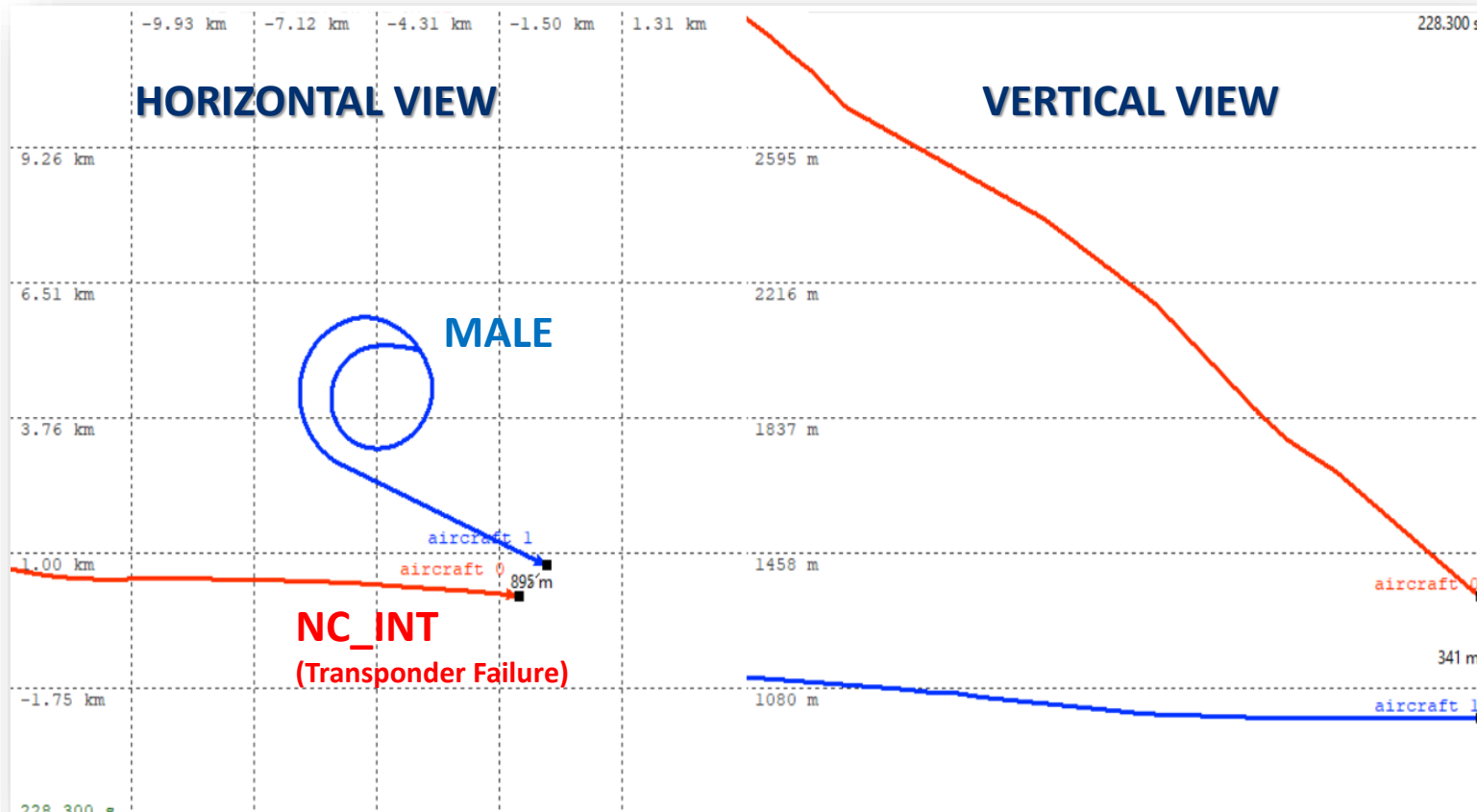
Example n3 scenario 4 (part 1, induced NMAC)



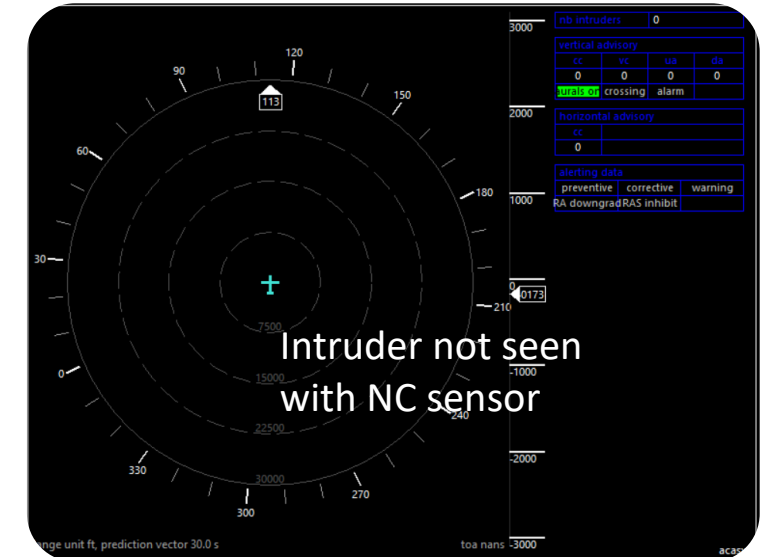
HMI



Example n3 scenario 4 (part 2, induced NMAC)



HMI



- Limited FOV of NC sensors ($\pm 110^\circ$ Az, $\pm 15^\circ$ El)
- Towards an induced NMAC

- Do FTS with related scenarios and metrics contribute significantly to the assessing of DAA systems in European airspace?

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THANK YOU

Fast Time Simulation (FTS) Results

TVAL.05.0 (EXE005 – SOL0379)

HONEYWELL

Petr Casek
17th February 2026

	Airspace A-C (Solution 0379)	Airspace D-G (Solution 0380)
Safety Net: Role of DAA Collision Avoidance (CA)	Primary mean	Primary mean
Tactical Conflict Management: Role of DAA Remain Well Clear (RWC)	Auxiliary mean Complementing ATC – traffic awareness, suggestive guidance, maneuvering upon ATC approval	Primary mean

For RWC:

- Safety objectives driven primarily by uncontrolled airspace
- Operational acceptability challenges to large extent driven by controlled airspace & interaction with ATC

DAA Operational Acceptability Challenges:

- No rigorous definition
- Lack of operational data from real (non-segregated) environment
- Comparison with TCAS II (the only real safety system with available reference data) is complicated
 - TCAS II TA has completely different role than RWC
 - TCAS II CA (RA) is usually very different than DAA CA (horizontal maneuvering included, differences in design objectives,...)

Illustrative Results: Altitude Layer FL 50 – FL135 (1M encounters)

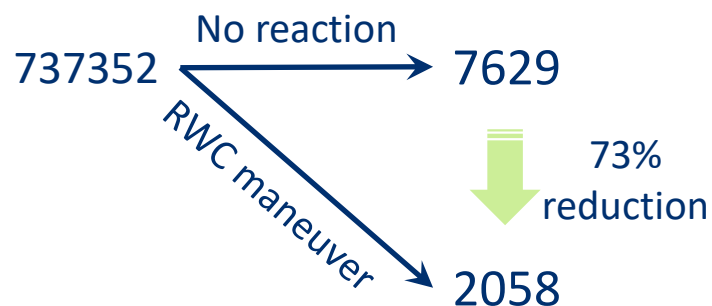
Number of encounters with alerts

DAA RWC

DAA RA

TCAS II TA

TCAS II RA



48428

39% reduction

29549

4603

57% reduction

1986

ACAS Xu Ownship



TCAS II Intruder



Safety Metrics

**Risk Ratio
(NMAC)**

**Risk Ratio
(LoWC)**

0.0

0.0

0.0

0.0

**All NMAC
solved in
both cases**

**All LoWC
solved in
both cases**

Illustrative Results: Altitude Layer FL 50 – FL135 (1M encounters)

	DAA RWC	DAA RA		TCAS II RA	
ACAS Xu Ownship 	94s	44s	Time to CPA	37s	TCAS II Intruder 
	7.5NM	2.6NM	A/C Spacing	1.8NM	

DAA Guidance Acceptability:

- **Split RA:** 0.6% of all RA
- **Reverse RA:** 1.6% of all RA
- **RWC guidance:** ~11 band changes per encounter

Deviations due to DAA (RWC) maneuvering:

- **Average Horizontal Deviation at COC/COT:** 0.85NM
- **Average Vertical Deviation at COC/COT:** 135ft

- ACAS Xu is very efficient in reducing both risks of mid-air collision and risk of Loss of Well Clear – both risks are mitigated even without reaction to RWC.
- Reaction to RWC strongly reduce the number of RAs both for ownship and intruder, however, RWC alerting rate is very high.
- Alerting time provides remote pilot with sufficient time to solve the situation:
 - RWC in average 72s prior RA and 94s prior Closest Point of Approach (CPA),
 - TCAS II RA in average 44s prior CPA.
- ACAS Xu RA guidance exhibits very small number of undesirable behavior (less than 2 %).
- ACAS Xu RWC guidance is relatively dynamic → more human-in-the-loop studies needed.

Based on the observed results it is not recommended to require for ACAS Xu that remote pilot always contact ATC in case of RWC alert but rather to preserve auxiliary role of RWC leaving a specific reaction to RWC on remote pilot's discretion.

Open Question

- What additional/different metrics would you suggest to assess operational acceptability – considering all relevant stakeholders?

Flight Test (FT) Results

TVAL.06.0 (EXE006 – SOL0379)

HONEYWELL

Petr Casek
17th February 2026

IRINA Honeywell Flight Test in non-segregated European airspace

Main goals of validations:

- Evaluation of ACAS Xu operational behavior when running onboard aircraft in real (non-segregated) ATM environment
 - ACAS Xu running on laptop but receiving real-time inputs from integrated avionics
- Comparison of TCAS II and ACAS Xu outputs
 - Observation of differences between the two safety systems sharing the same inputs

Flight testing

- Europe, 4 days in May 2025
- Overall flight time above 13 hours
- Airspace of Iceland, Germany, Netherlands, Czech Republic and Poland
- Honeywell Embraer ERJ-170



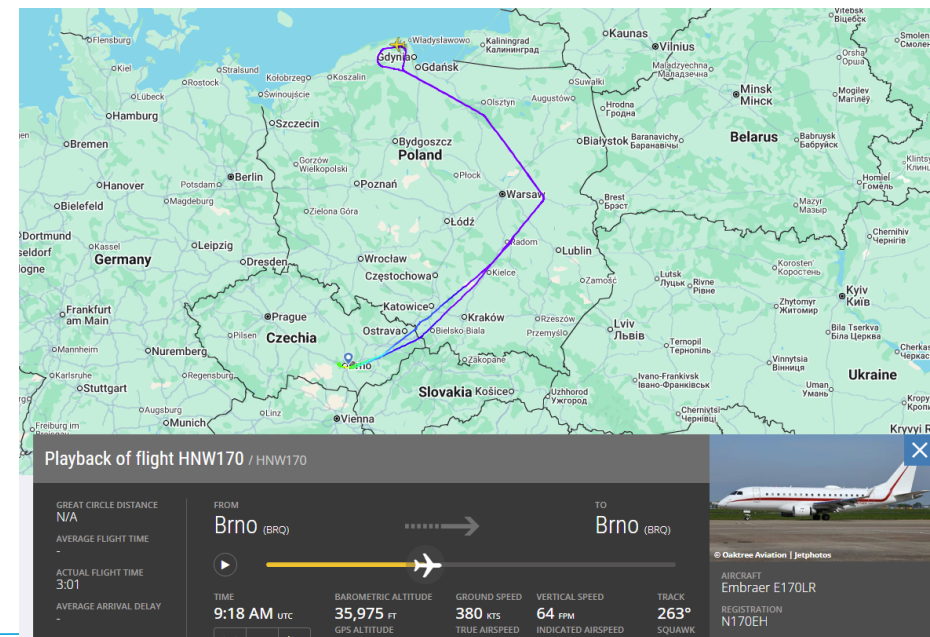
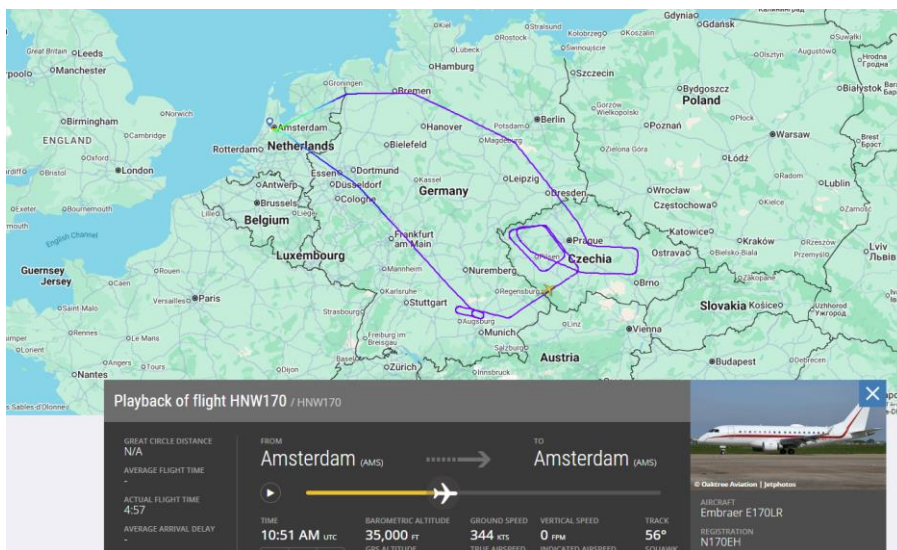
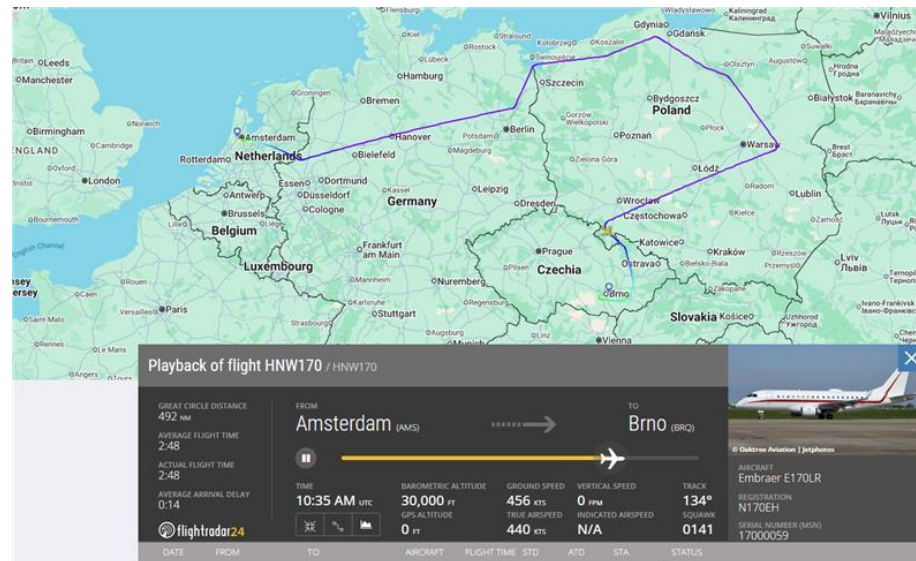
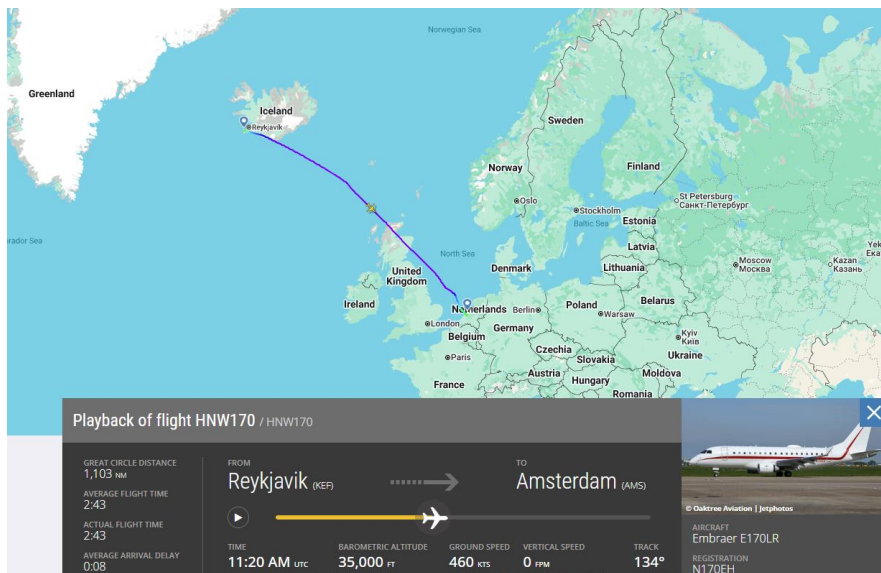
- ✓ Technical integration - ACAS Xu to read real time data from sensors and integrated avionics (GPS, IMU, Air data, FMS)
- ✓ Intruder data obtained from installed TCAS II

- No DAA (ACAS Xu) alert triggered during operations – nuisance alerting not observed
- Tracking & information about intruders provided by ACAS Xu on traffic display consistent with TCAS II
- No unexpected or unwanted behaviour of the installed DAA system observed
 - In real time
 - Within post-processing analysis.



Maximum number of simultaneously tracked intruders: 29.

IRINA Honeywell Flight Test: Flight Profiles



EUDAAS VALIDATIONS Solution 379 EXE009 and EXE011

EUDAAS Overview
Presented by: Ramin Dabiri

FTS By SAAB
Lead: Felicia Törning

Joint RTS by SAAB and LFV
Lead: Jakob Gölén

EUDAAS OVERVIEW

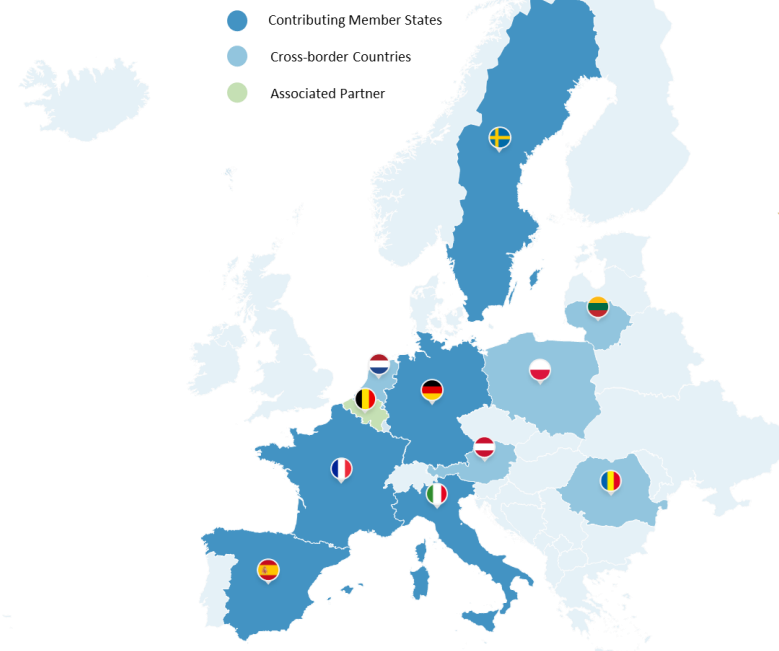
DAA Projects EUDAAS

EUDAAS = European Detect And Avoid System

European Defense Fund (EDF) project

Collaboration between multiple different companies to create a standard for a DAA system

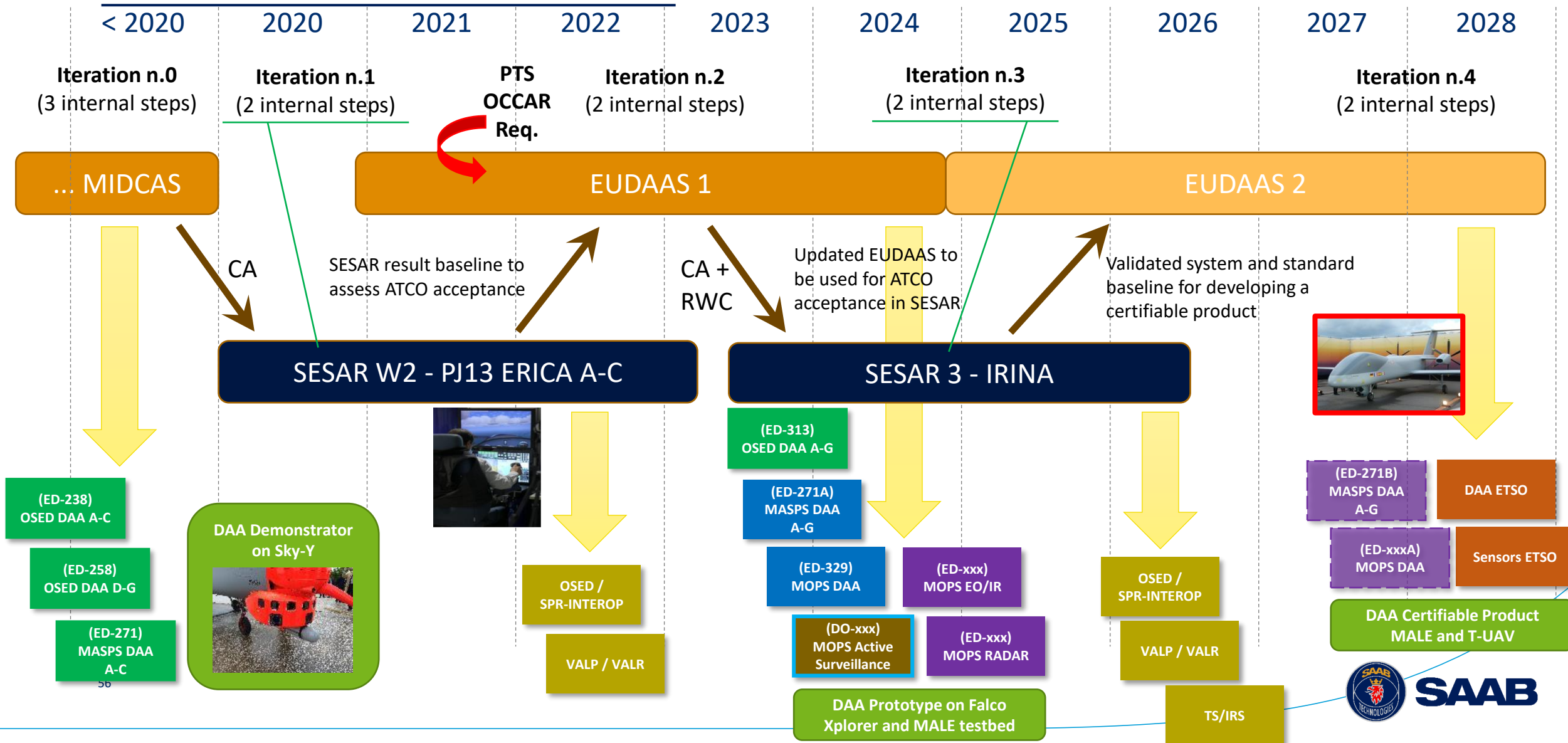
Led by SAAB



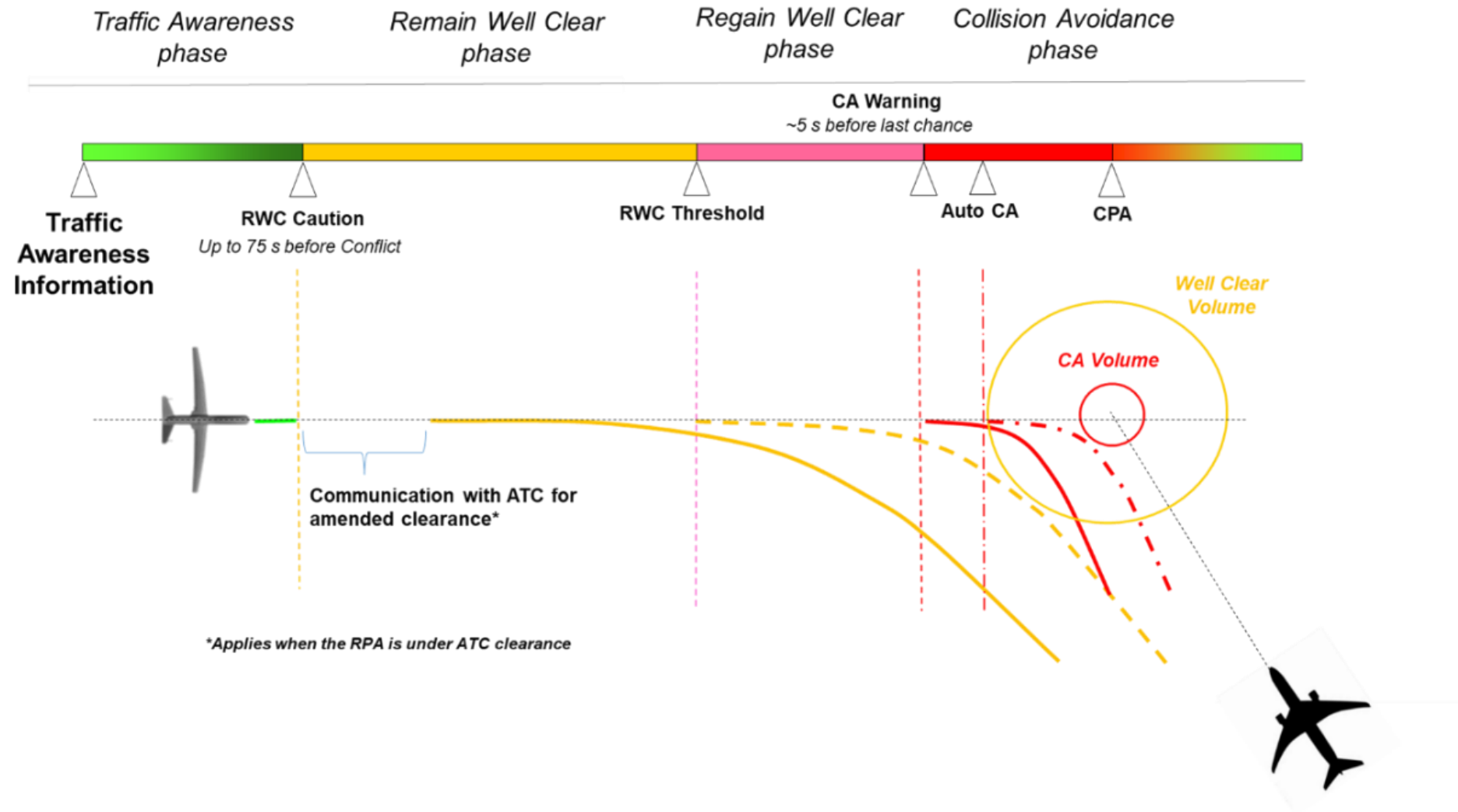
Co-funded by the European Union



DAA Roadmap



DAA Timeline



EUDAAS in flight tests



EUDAAS used in SKELDAR, TUAV/Falco Xplorer and DO 228 flight tests

EUDAAS FTS – EXE009

Overview of EUDAAS FTS

Objective:

To validate the EUDAAS DAA system in A-C airspace with fast time simulations.

The simulated airspace will be based on correlated encounter models from Eurocontrol.

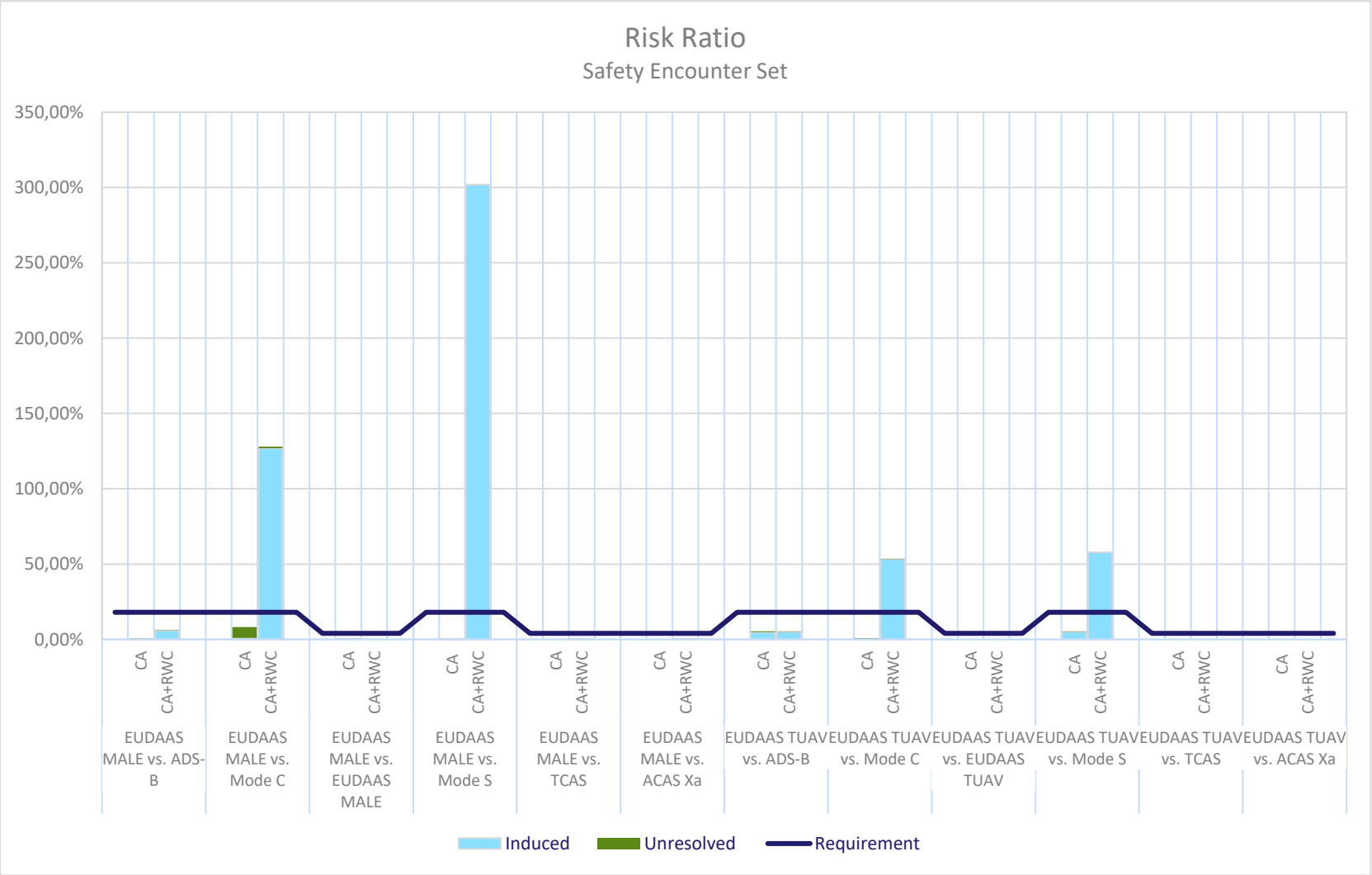
Studies Covered:

- Nominal Operations
- Non-nominal operations (simulated with only CA and without RWC)
- C2 Link Delay
- Interoperability between EUDAAS and ACAS Xu/ACAS Xa/TCAS

Reference scenario: TCAS and ACAS Xa (Metrics have been compared)

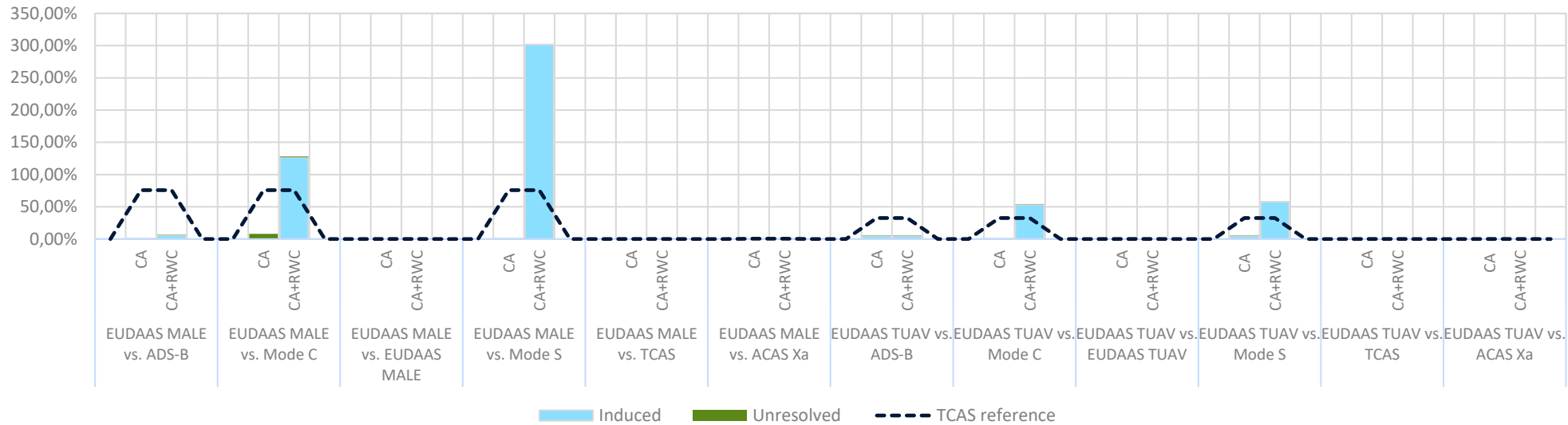
Results of EUDAAS FTS

Risk Ratios, nominal batches

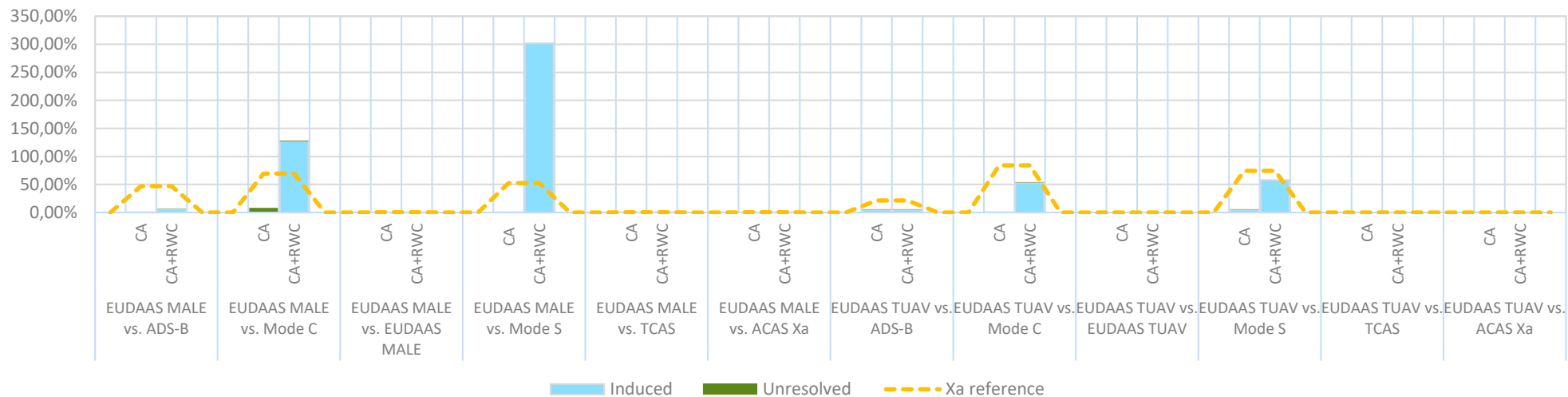


Expected result	Status
Risk ratio not greater than 18% if intruders are not ACAS equipped and 4 % if the intruders are ACAS equipped	Passed for all except against mode S or mode C equipped intruders.
At least as good as TCAS II reference	Passed for all except against mode S or mode C equipped intruders. (plots on next slide)

Risk Ratio, with TCAS reference Safety Encounter Set



Risk Ratio, with ACAS Xa reference Safety Encounter Set



Summary of EUDAAS FTS

Overall good results for nominal and non-nominal scenarios

Further investigation needed:

- Wind Simulations
- Multi-ship encounters
- Mode-S only and Mode-C only intruders

SAAB/LFV RTS – EXE011

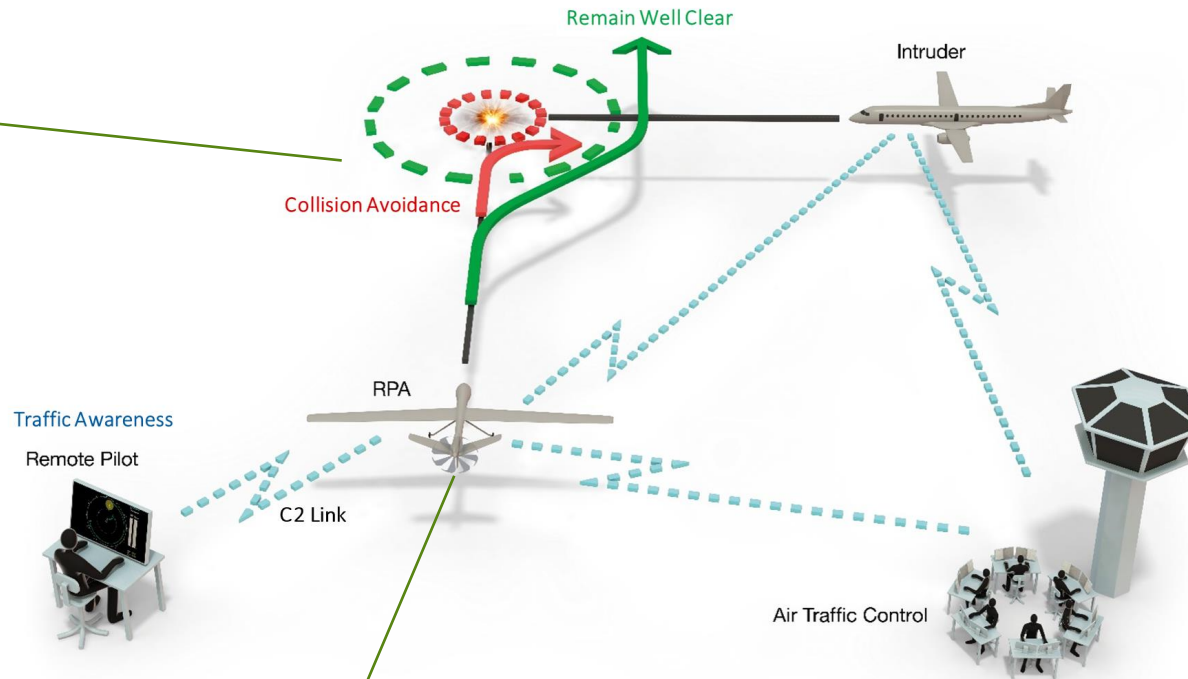
Overview

Operational validation of acceptability from operational use by RP and ATCO related to DAA

- Analysing all DAA functions (TrAW, RWC, CA) and their effect of different Sensor characteristics
- 4 days of validation

Full functional chain
from sensors through
avoid logics HMI and
manoeuvring

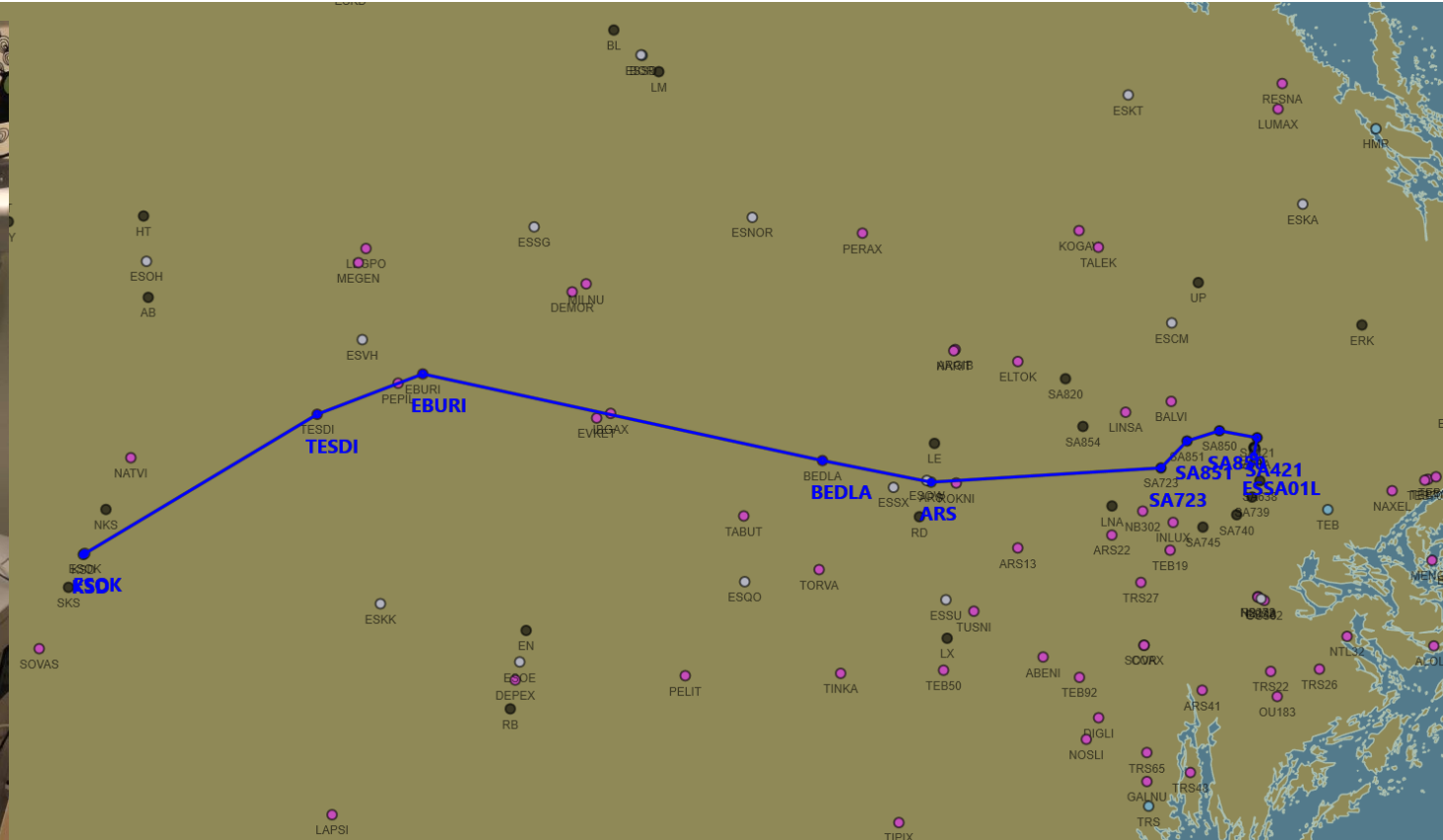
- RPS with DAA HMI
- Qualified Pilot



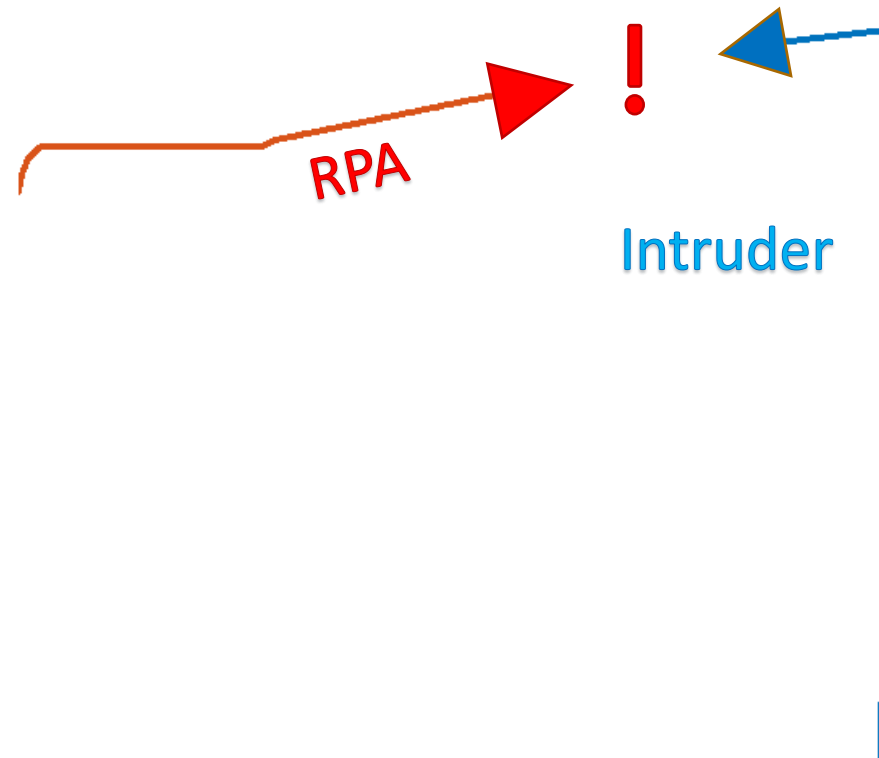
- MALE
- TUAV

Setup

- Operational Acceptability (ATCO and RP)
- Nominal and Non-nominal conditions with regards to DAA

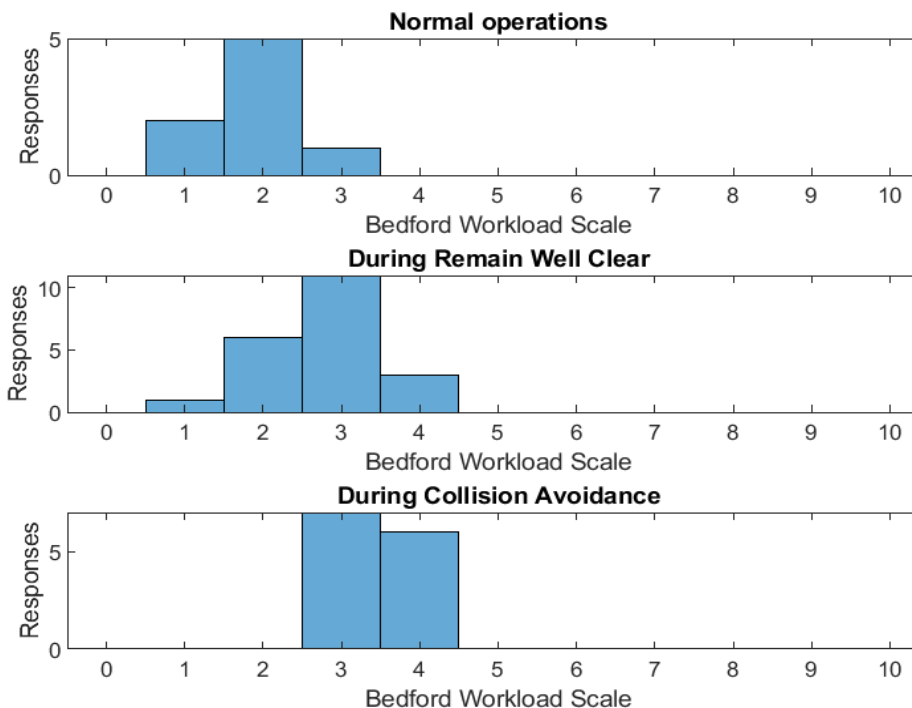


Nominal scenario

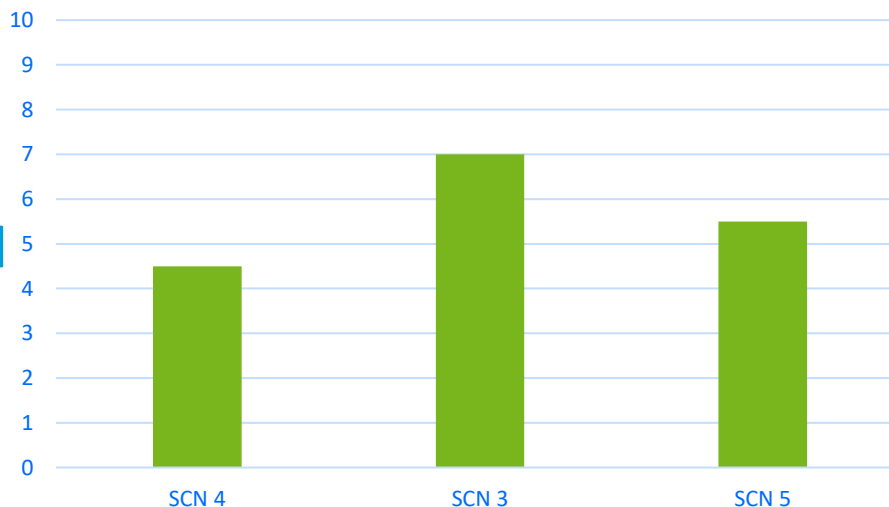


Results

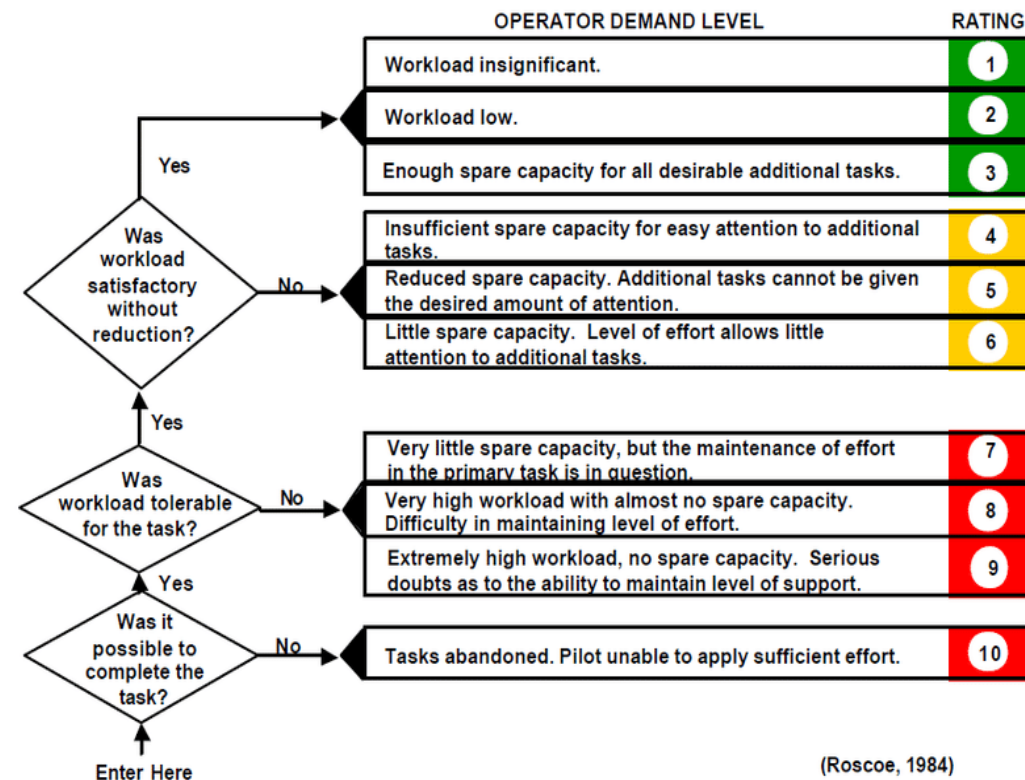
RP Workload



ATCO Workload

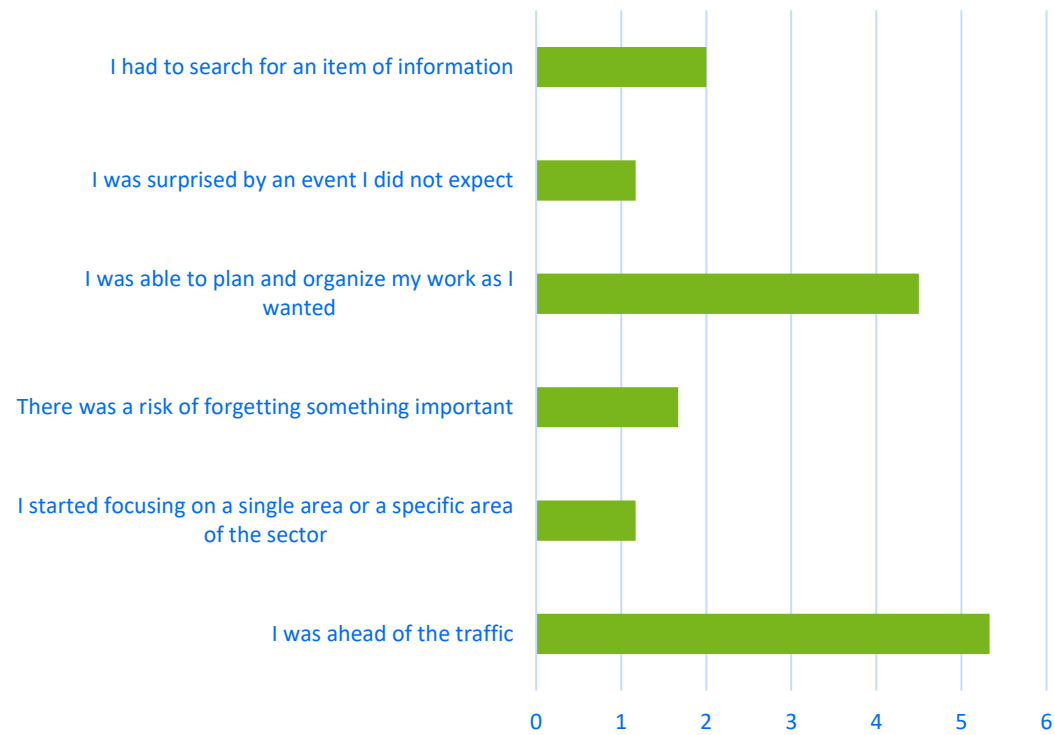


Bedford Workload Scale

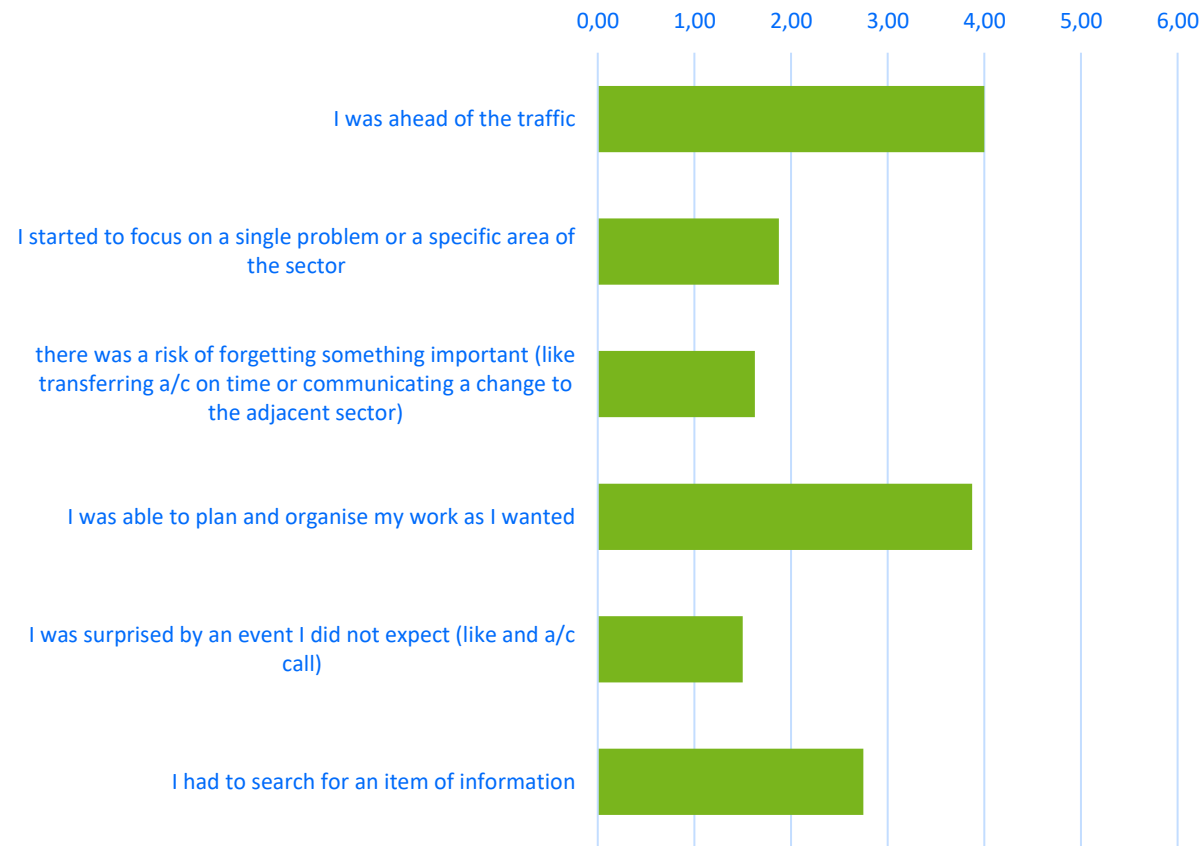


Results

Post-run questionnaire items relevant to situational awareness



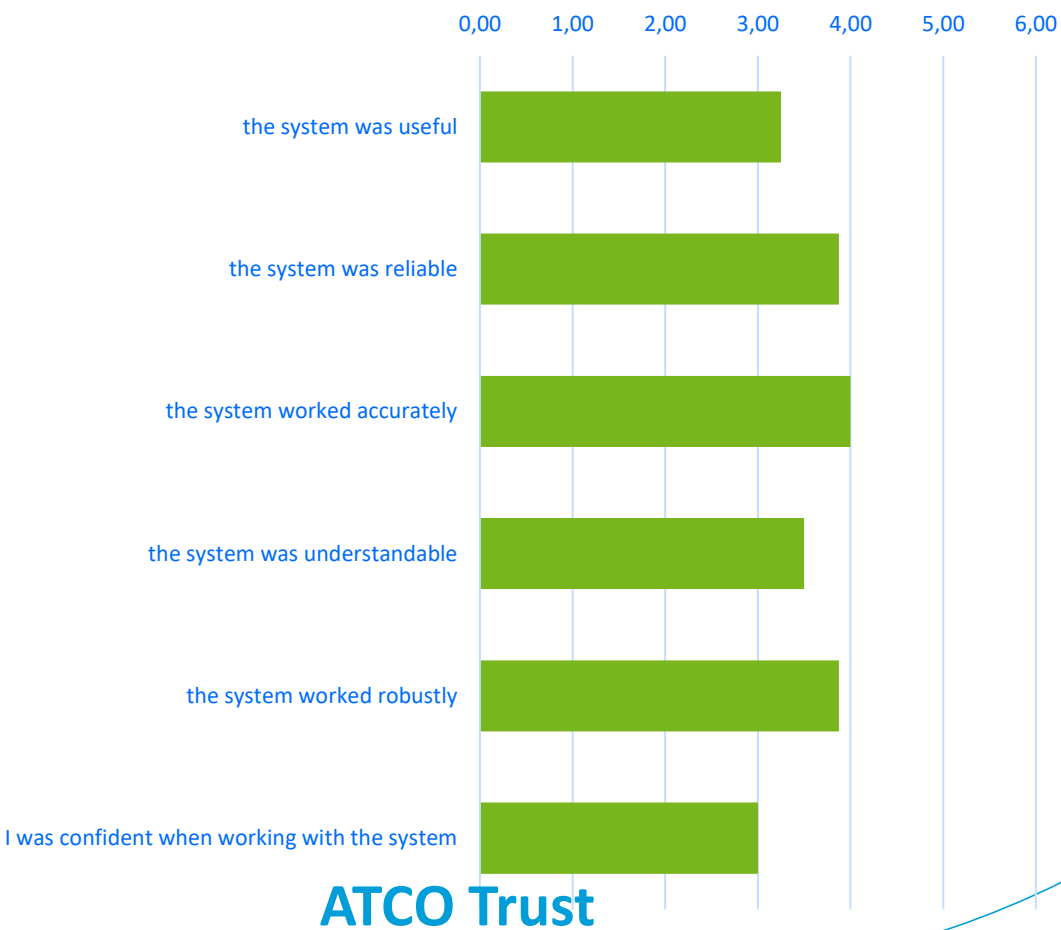
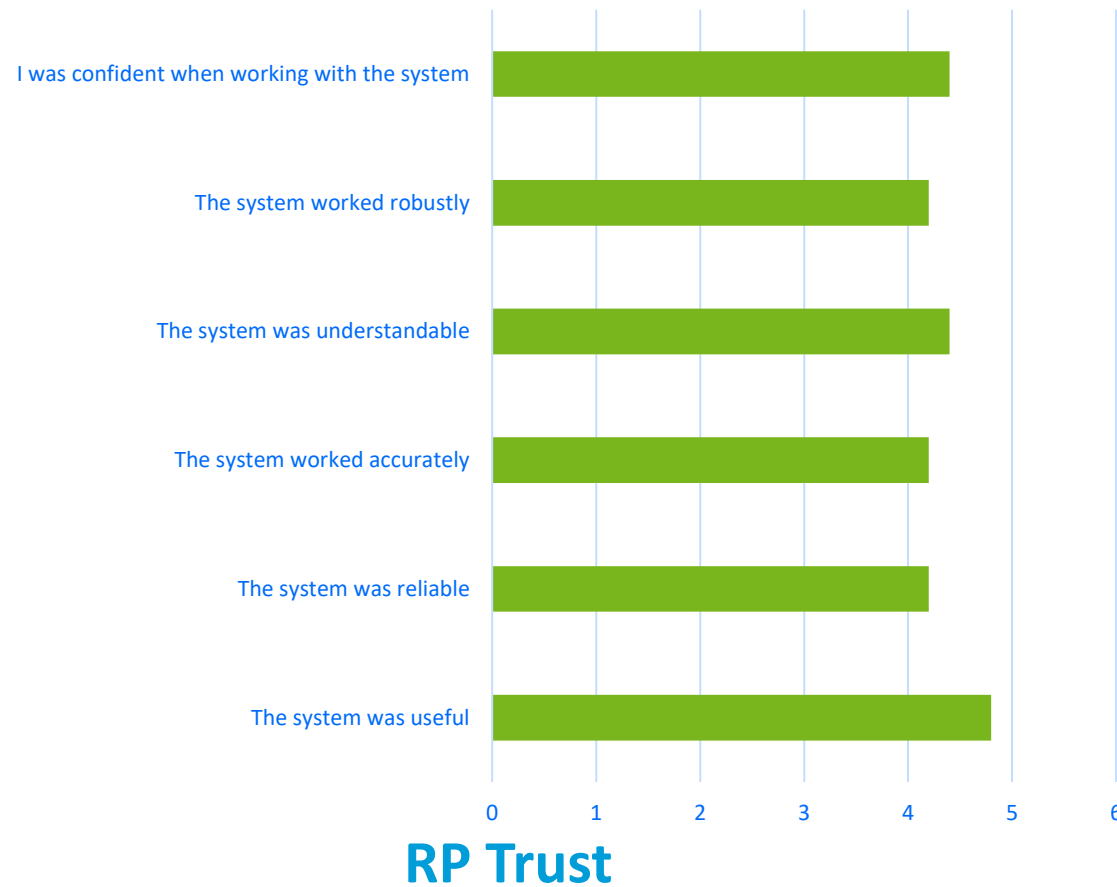
RP Situational awareness



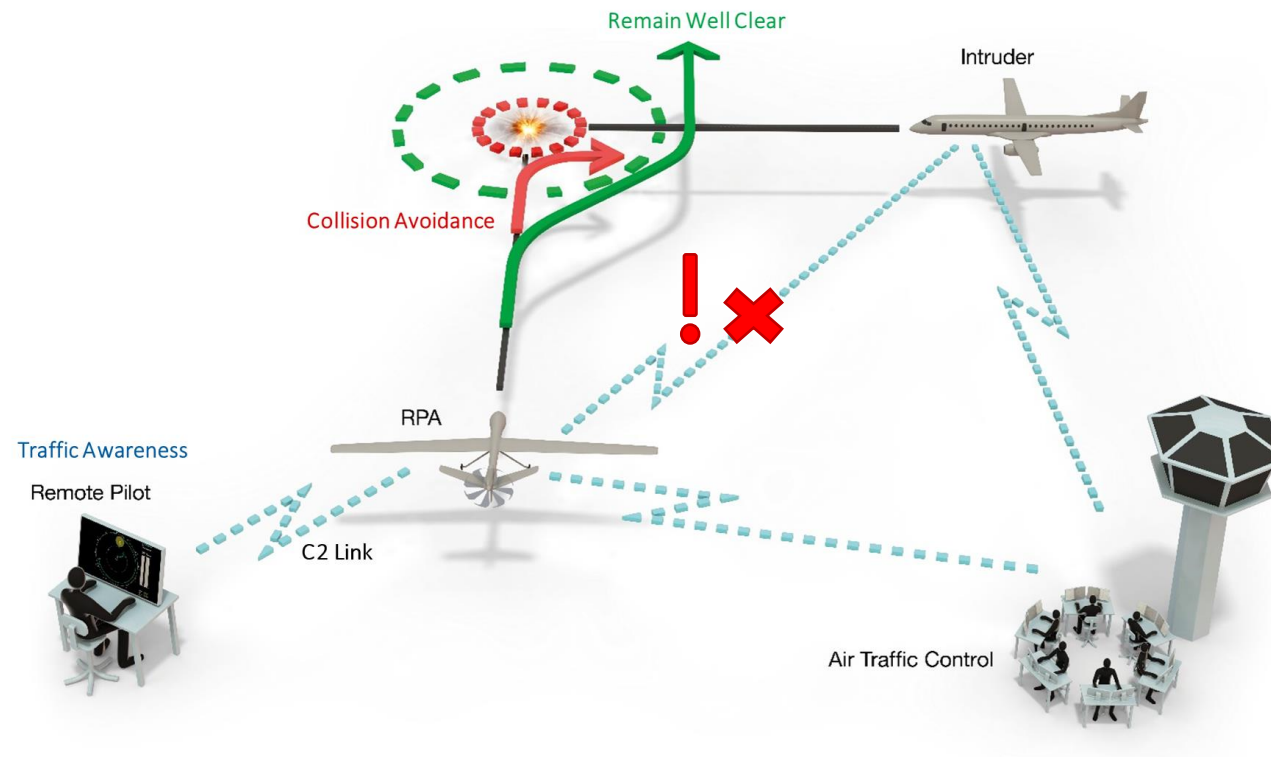
ATCO Situational awareness

Results

Post-run questionnaire items relevant for the trustworthiness of the system

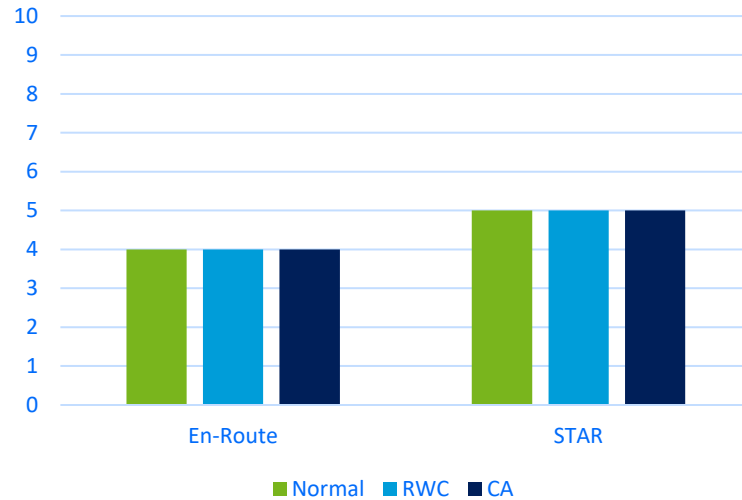


Contingency

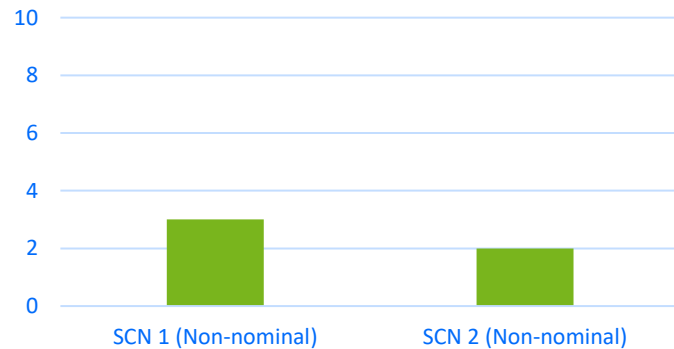


Results

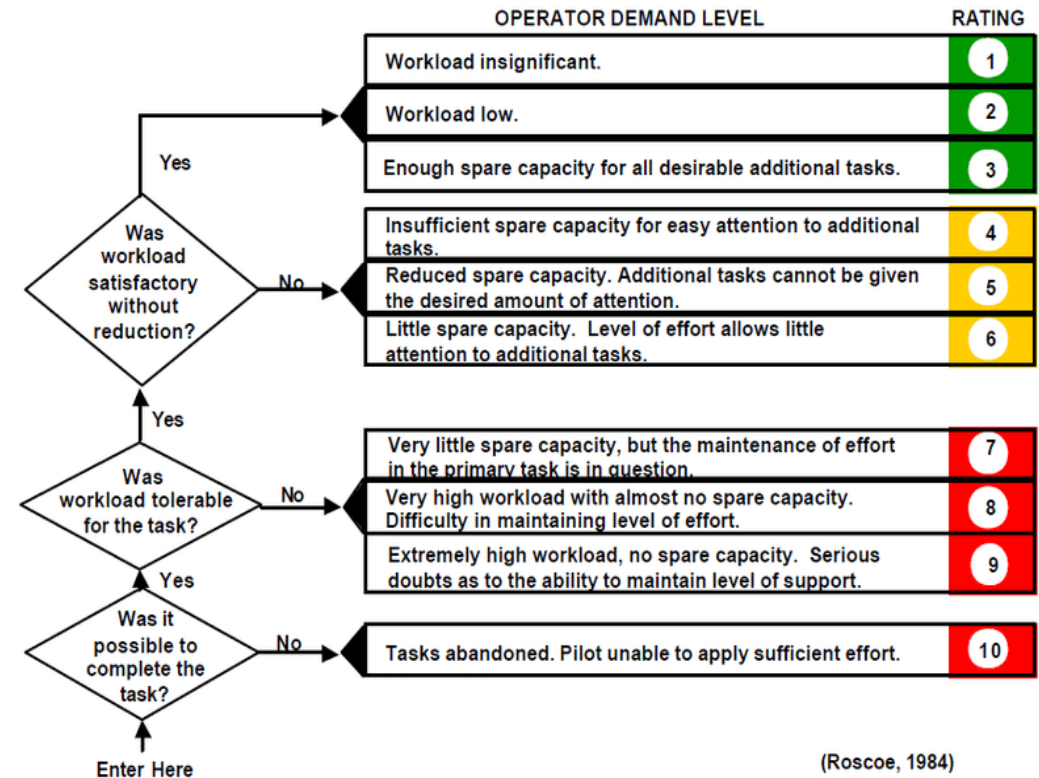
Bedford Workload Scale



Average value per SCN

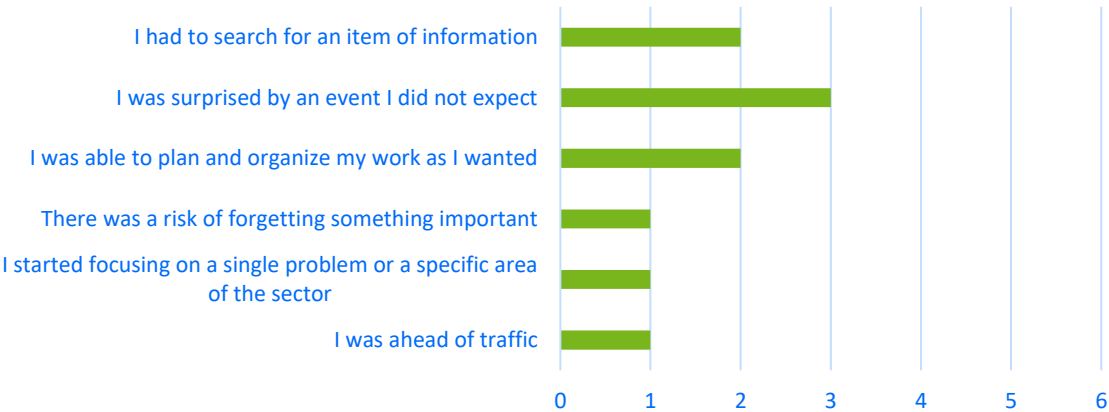


Bedford Workload Scale



Results

Pos-run questionnaire items relating to situational awareness



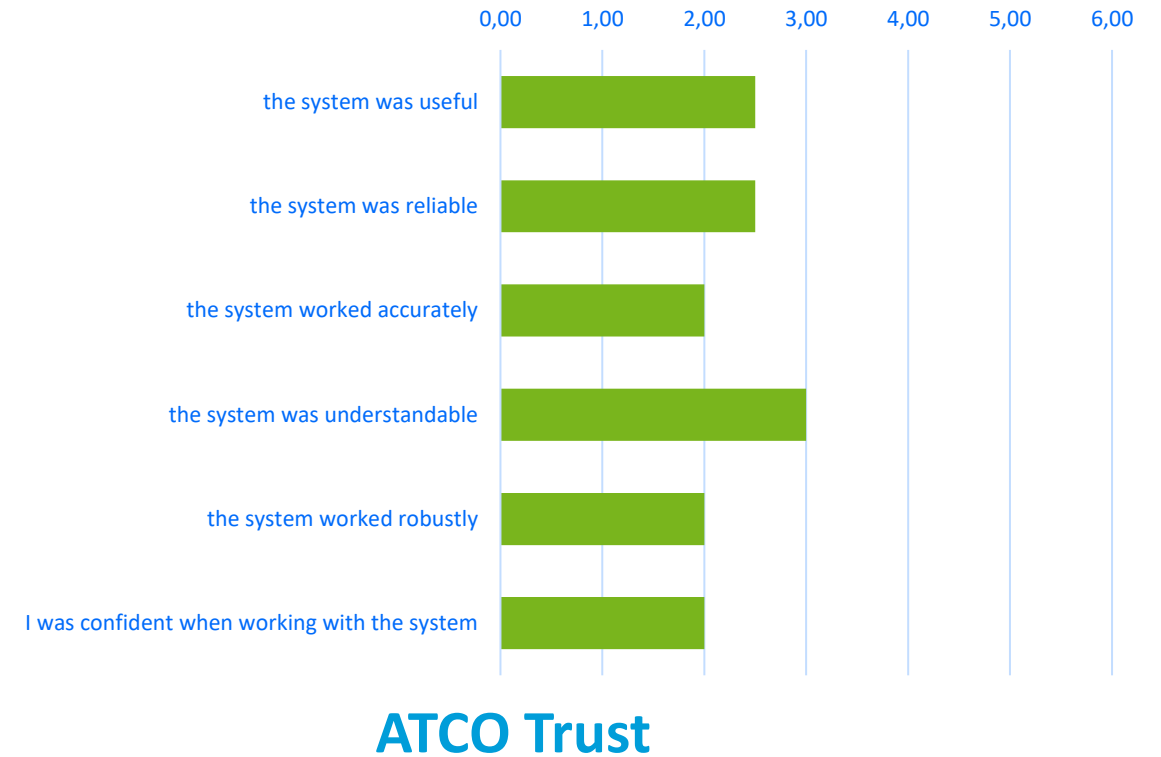
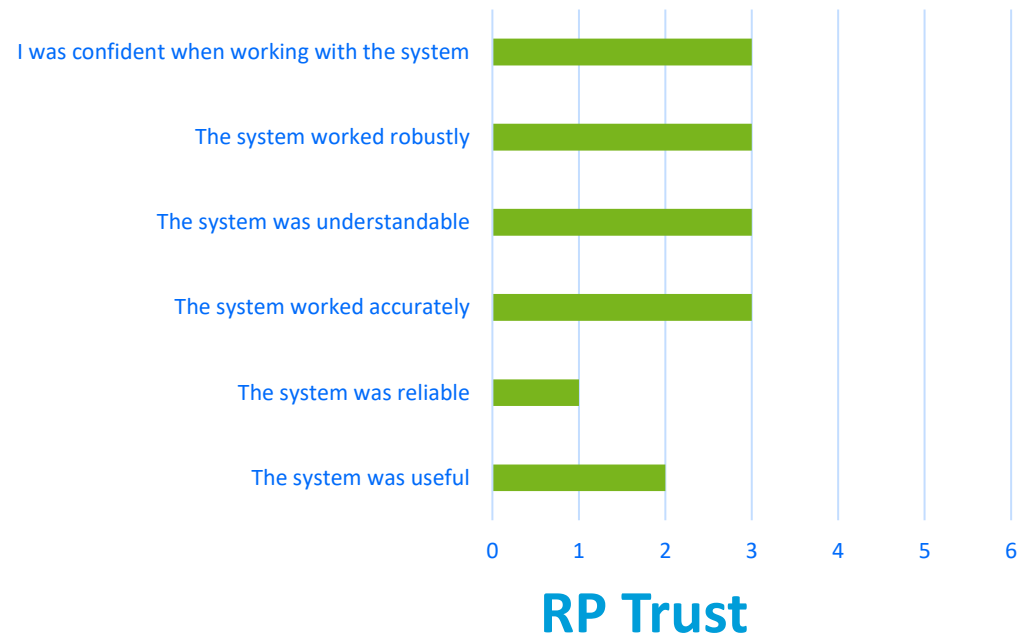
RP Situational awareness



ATCO Situational awareness

Results

Post-run questionnaire items regarding trust in the system



Recommendations

- Test how the DAA system behaves during holdings and parallel approaches to investigate nuisance.
- Perform more interesting planned near mid-air collision scenarios. During this exercise, the NMACS were dynamically induced at the pseudo-pilot's own discretion.
- Develop procedures for the ATCOs regarding the DAA system. Only procedures for remote pilots using the system were used during this validation.

Thank you for your time!

IRINA

IRINA Stakeholder Workshop 2026 **17th February 2026** **Solution 0379 – Safety conclusions**

Ángela Abad Gracia (INECO) – Safety Expert
(angela.abad@ineco.com)

Agenda

- 01** Safety Assessment Methodology

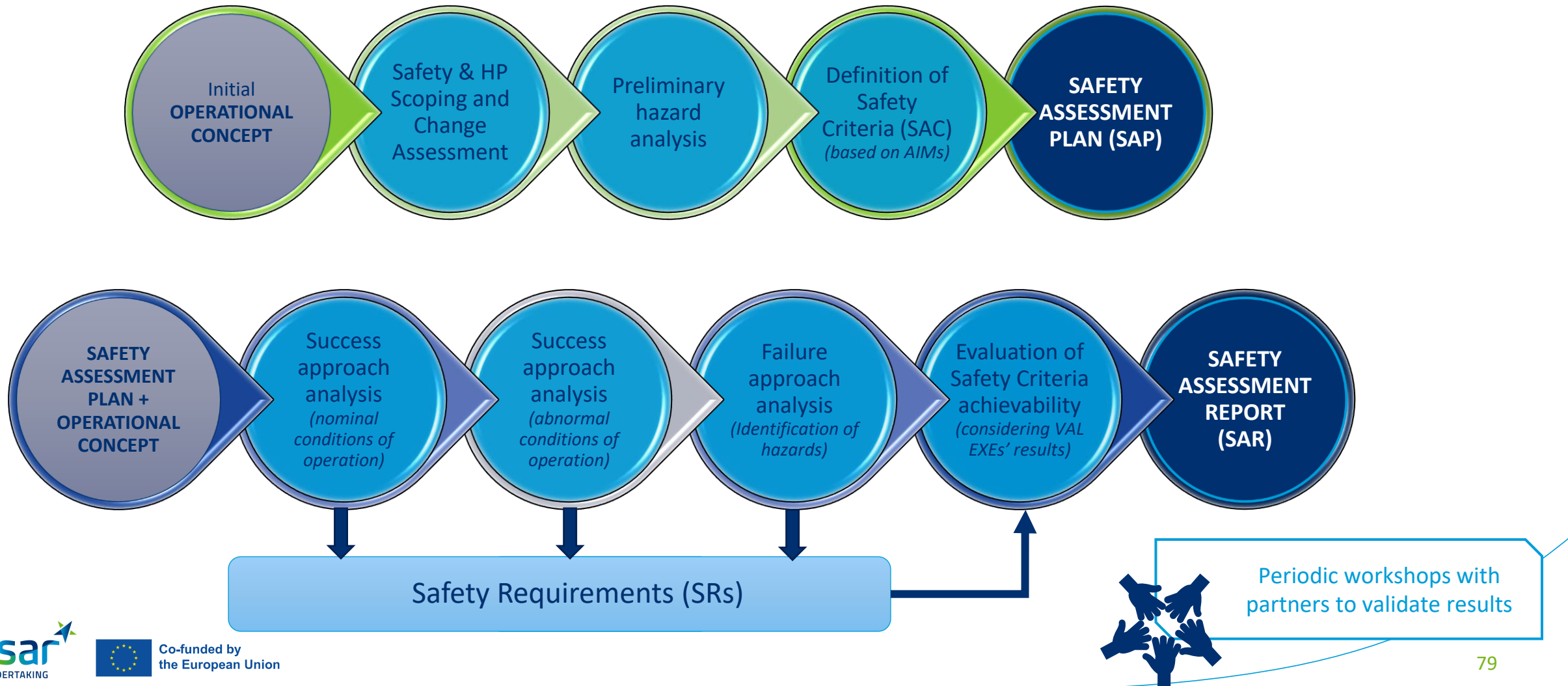
- 02** Nominal conditions analysis

- 03** Abnormal conditions analysis

- 04** Failure mode analysis

- 05** Main safety conclusions & recommendations

1. Safety Assessment Methodology – E-SRM (Eurocontrol)



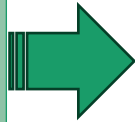
2. Nominal conditions analysis

Pre-flight phase:

- Contingency procedures publication
- Flight Plan filling

IFR RPAS Operations:

- Flying SID.
- Flying STAR.
- Flying en-route.
- Use of ground-based safety nets (STCA, APW & MSAW).
- Use of airborne tools to avoid conflicts with other aircraft (DAA).



The main Safety Requirements derived from this analysis are related to:

- RPAS flight planning:
 - Publication and use of AIP information and other data + availability of GNSS/Satellite coverage.
 - Inclusion of information related to emergency and contingency procedures (for example, alternate airport).
- RPAS compliance with current regulations: FPL submission, maintaining direct two-way communication channel with appropriate ATC, complying with ATCOs instructions, or provision of info (onboard trajectory data and relevant updates when required - Extended Projected Profile or EPP).
- RPAS compliance with equipment requirements applicable to the airspace within which they intend to operate.
- RPAS info about being unmanned: use of “REMOTE” on first radio contact, or identification of RPAS on the CWP through dedicated symbology / to other Airspace Users.
- Use of standard ICAO phraseology during communication with ATCO (including the need to develop specific phraseology for RWC alert communication).
- Ground-based safety nets being able to provide prediction and violation alerts for conflicts involving RPAS.
- Airborne tools to avoid conflicts with other aircraft being able to provide traffic awareness info using different sensors (cooperative vs non-cooperative), and provision of RWC and CA alerts to the RP.
- ATCOs training: communication latency, RPAS performances and characteristics, prevention of imminent or actual hazardous situations for RPAS traffic, capabilities of DAA (specially RWC function).
- RPAs training: operating in controlled airspace, capabilities of DAA.
- Definition / update of procedures: transfer of control of RPAS between ATS Units.

3. Abnormal conditions analysis

The main Safety Requirements derived from this analysis are related to:

- Common with / adapted from nominal conditions:
 - RPAS compliance with equipment requirements.
 - Use of standard ICAO phraseology during communication with ATCO (including the need to develop specific phraseology for communication of C2 link loss information).
 - RPAS compliance with current regulations: maintaining direct two-way communication channel with appropriate ATC, provision of info (onboard trajectory data and relevant updates when required - Extended Projected Profile or EPP).
 - Definition / update of procedures: transfer of control of RPAS between ATS Units.
 - ATCOs training: management of RPAS contingency/emergency situations.
 - RPs training: management of RPAS contingency/emergency situations.
 - RPAS compliance with equipment requirements, for example, Mode S transponder.
- RPAS contingency and emergency procedures compatible with existing emergency/failure procedures for manned aircraft.
- Existence and use of an alternative communication means.
- C2LL contingency: use of a unique squawk (7400), automatic activation of the pre-programmed C2LL trajectory (as defined by ICAO for en-route and TMA airspaces), alert to the RP, provision of info to the ATCO, presentation of RPA flight intention to the ATCO using EPP reports.
- Continuous review of the weather along the RPAS flight path done by the RP in order to anticipate manoeuvres, level changes or rerouting in coordination with ATS unit.

- 
- **RPAS Emergency Activation:** RPAS avionics failure with no possibility to recover.
 - **RPAS Flying En-route and TMA:** loss of communication.
 - **C2 link loss.** This includes:
 - Flying SID.
 - Flying En-route.
 - Flying STAR.
 - **Weather degradation or sudden change in weather conditions** (weather conditions not according to forecasted ones).
 - **Wake turbulence encounter.**

4. Failure mode analysis

The failure modes / issues that have been considered relevant for RPAS integration are the following:

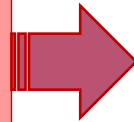
- A** Possible Remote Pilot failures when operating RPAS in controlled airspace (nominal conditions).
- B** Possible ATCO failures when managing RPAS in controlled airspace (nominal conditions).
- C** Ground-based safety nets issues related to RPAS specificities (STCA, APW, MSAW).
- D** New airborne tools to avoid conflicts with other aircraft (Detect and Avoid - DAA).
- E** Issues related to the Command and Control (C2) Link (latency, loss of C2L, conflicting C2L trajectories).
- F** Possible failures while managing emergencies.

4. Failure mode analysis (A. RP failures when operating in controlled airspace)

The main Safety Requirements derived from this analysis are related to:

What happens if:

- RPAS Operator does not (correctly) manage the definition, update and submission of a FP.
- RP fails to comply with ATC instructions.
- RP fails to implement ATC instructions in a timely manner.
- RPAS infringes an airspace including unauthorised penetration of airspace.

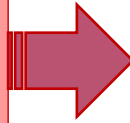


Causes prevention	Operational effects mitigation
• Compliance with the regulations when filling and submitting the Flight Plan → training. • RPAS Flight Plan including information related to emergency and contingency procedures (for example, alternate airport).	Assumptions: • The local ATFM and the regional ATFCM units are trained to ensure that FPs contain the necessary information in the appropriate fields. • The current training of ATCOs prepares them for managing situations in which the FP are not received.
• RPs training to operate in controlled airspace and comply with the rules applicable to manned aircraft to interact with ATCOs. • RPAS providing information about subsystems' health status to RPs so that technical issues can be identified. • RPAS communication latency limited to the extent that it is compatible with the current timeliness requirements of ATC.	• Assumption: ATCOs can detect possible deviations or issues related to the RPA expected behaviour due to their continuous monitoring of traffic through radar. • Availability of appropriate ground-based safety nets.
• RPs training to operate in controlled airspace. • RPAS providing information about subsystems' health status to RPs so that technical issues can be identified.	• Availability of appropriate ground-based safety nets. • Availability of appropriate airborne tools to avoid conflicts with other aircraft.

4. Failure mode analysis (B. ATCO failures when managing RPAS-nom)

What happens if:

- ATCO fails to manage RPA operations (ATCO does not (correctly) assess the traffic situation and/or the feasibility of clearances, considering RPAS specific performances).



Assumption: The current training of the ATCOs (TWR, APP, ACC Units) prepares them to:

- Provide instructions, clearances or flight plan updates.
- Perform adequate separation procedures between IFR- IFR, IFR -VFR and VFR-VFR traffics.
- Input clearances and relevant data adequately into CWP.
- Detect possible deviations or issues related to the aircraft expected behaviour due to their continuous monitoring of traffic through radar.
- Scan the traffic in order to detect, assess and solve possible conflicts between different aircraft, in this case, the affected RPAS and the traffic surrounding it.

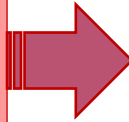
The main Safety Requirements derived from this analysis are related to:

Causes prevention	Operational effects mitigation
• Identification of RPAS in CWP. • ATCOs training regarding RPAS.	• ATCOs training regarding RPAS. • Availability of appropriate ground-based safety nets. • Availability of appropriate airborne tools to avoid conflicts with other aircraft .

4. Failure mode analysis (C. Ground-based safety nets issues)

What happens if:

- There is a lack of or incorrect adaptation of the ground-based safety nets to adequate thresholds for alerts' declaration (prediction and violation) for conflicts involving RPAS.



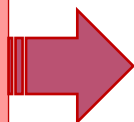
The main Safety Requirements derived from this analysis are related to:

Causes prevention	Operational effects mitigation
• ATCOs training regarding RPAS. • Availability of appropriate ground-based safety nets → STND / REG	• Assumption: ATCOs can detect possible deviations or issues related to the RPA expected behaviour due to their continuous monitoring of traffic through radar. • Availability of appropriate airborne tools to avoid conflicts with other aircraft .

4. Failure mode analysis (D. DAA-related issues)

What happens if there is a

- Failure / degradation / loss:
 - DETECTED, in electronic traffic acquisition system...
 - UNDETECTED, in electronic traffic acquisition system...
 - DETECTED, in RPA traffic awareness functionality...
 - UNDETECTED, in RPA traffic awareness functionality...
 - DETECTED, in RPA DAA RWC functionality...
 - UNDETECTED, in RPA DAA RWC functionality...
 - DETECTED, in RPA DAA CA functionality...
 - UNDETECTED, in RPA DAA CA functionality...
- Contradictory instructions between ATCO and RWC.



The main Safety Requirements derived from this analysis are related to:

Causes prevention	Operational effects mitigation
• RPAS providing updated information to RP, regarding the health status of the RPAS if the status of any subsystem is degraded. • The DAA system ensuring that the possibility of failure is reduced to an acceptable minimum → STND/REG • DAA meeting statistically defined metrics and acceptability criteria that are assessed in encounter sets. • ATCOs receiving training regarding: the updated nominal operating method of the DAA RWC and CA functions, and the operating method for abnormal and faulted conditions of DAA.	• Definition of contingency operating procedures in order to manage a situation in which it is detected that the DAA system has suffered a failure or degradation. • Assumption: ATCOs can detect possible deviations or issues related to the RPA expected behaviour due to their continuous monitoring of traffic through radar. • ATCOs training regarding the operating method for abnormal and faulted conditions of DAA. Specifically, the ATCO shall be aware that DAA sensing includes the ability of detecting non-cooperative traffic • RPs receiving training on the different capabilities of the DAA system (TrAw, RWC & CA) and how he/she shall respond to it.
• There shall be enough time between the first level of conflict (RWC alert triggering) and the following one (CA alert triggering), so that the conflict situation can be corrected. • STND / REG: Modification of Regulation 923/2012 to include behaviour in case of DAA RWC and DAA CA (same as ACAS RA).	• RPs receiving training on the different capabilities of the DAA system (TrAw, RWC & CA) and how he/she shall respond to it. • The HMI providing the RP with methods of distinguishing different intruder surveillance sources. • Availability of appropriate ground-based safety nets. • RPAS having airborne tools to avoid conflicts with other aircraft, in this case, DAA CA functionality, that need to be certified and adapted to the specificities of these aircraft.

Contradictory instructions between ATCO and RWC

The main Safety Requirements derived from this analysis are related to:

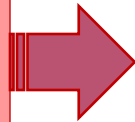
Causes prevention	Operational effects mitigation
• There shall be enough time between the first level of conflict (RWC alert triggering) and the following one (CA alert triggering), so that the conflict situation can be corrected. • ATCOs receiving training regarding: • the updated nominal operating method of the DAA RWC and CA functions. • the operating method for abnormal and faulted conditions of DAA. • STND / REG: Modification of Regulation 923/2012 to include behaviour in case of DAA RWC and DAA CA (same as ACAS RA).	• RPs receiving training on the different capabilities of the DAA system (TrAw, RWC & CA) and how he/she shall respond to it. • The HMI providing the RP with methods of distinguishing different intruder surveillance sources. • RPs operating in controlled airspace establishing and maintaining direct two-way communication channel with appropriate ATC during IFR operations. • RPs using standard ICAO phraseology during communication with ATCO. Specific phraseology for communication of RWC alert communication shall be defined and kept consistent with future ICAO recommendations • ATCOs training: considering RPAS performances and characteristics in detecting and solving conflicts. • Availability of appropriate ground-based safety nets. • RPAS having airborne tools to avoid conflicts with other aircraft, in this case, DAA CA functionality, that need to be certified and adapted to the specificities of these aircraft

4. Failure mode analysis (E. C2L-related issues - 1/3)

The main Safety Requirements derived from this analysis are related to:

What happens if:

- There is an inappropriate voice-voice communication latency through C2L.



Causes prevention	Operational effects mitigation
• RPAS communication latency being limited to the extent that it is compatible with the current timeliness requirements of ATC. • ATCOs training on potential latency introduced by RPAS in performing their routine operations. • Ensure that the availability of the C2L service close to airports is high → relays to reduce C2L latency • C2 Communications Service Provider (C2CSP) informing ATCO / RPAS operator about the quality of the link and, specifically, about an increasing latency. • ATS Providers evaluation of the impact of C2 link communications latency in their airspace and identify measures to reduce its impact, if necessary. • If a link degradation is detected, the number of RPAS operating in the environment needs to be limited.	• ATS Providers evaluation of the impact of C2 link communications latency in their airspace and identify measures to reduce its impact, if necessary. • ATCOs training on potential latency introduced by RPAS in performing their routine operations. • Availability of appropriate ground-based safety nets.

4. Failure mode analysis (E. C2L-related issues - 2/3)

The main Safety Requirements derived from this analysis are related to:

What happens if:

A C2LL situation arises and:

- RPA incorrectly executes a C2LL contingency.
 - RP incorrectly manages a C2LL contingency.
-
- ATCO incorrectly manages a C2LL contingency.
-
- There is an incorrect / no coordination between the ATCO and the RP during a C2LL contingency.



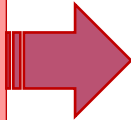
Causes prevention	Operational effects mitigation
• RPs receiving training regarding the operating methods, contingency plans and responsibility during contingency procedures. • RPAS being able to have pre-programmed C2LL trajectories, which may be rechecked and updated by the Remote Pilot when needed. • RPAS systems checking that the pre-programmed/re-programmed contingency trajectory is not in conflict with terrain/obstacles. The C2LL pre-programmed/re-programmed trajectory shall be built with a protection that ensures that it is also protected from terrain/obstacles. • The required pre-programmed trajectory equipment performance and integrity standards meeting at least the navigation requirements in the targeted class of airspace → STND / REG	• Assumption: It is procedurally expected for en-route / TMA (generic procedure) that, if an RPA loses the C2L, they will follow a procedurally defined trajectory according to ICAO specifications (PANS/ATM lost C2L). • The C2L infrastructure ensuring that loss link frequency is acceptable from a Safety perspective. → STND / REG. • At any time during the flight, the RP should be able to have access to and provide ATC the pre-programmed intentions of the RPA • There shall be mechanisms for a trajectory update information sharing, during a C2LL situation. • Availability of appropriate airborne tools to avoid conflicts with other aircraft s. • Availability of appropriate airborne tools to avoid conflicts with other aircraft .
• ATCOs receiving training in the management of RPAS contingencies. • ATCOs being able to identify the RPAS through specific symbology in CWP / first radio contact. • Existence of mechanisms for a trajectory update information sharing, during a C2LL situation. • In case of loss of the primary communication link, existence of an independent alternative communication system. • RPAS contingency procedures compatible with existing ones for manned aircraft	

4. Failure mode analysis (E. C2L-related issues - 3/3)

What happens if:

- Two (or more) different RPAS have conflicting C2LL pre-programmed trajectories.

A C2LL could be due to different causes such as the loss of the antenna after the collision with a bird, which may affect a single RPAS, or a signal loss, which may affect several of them.



The main Safety Requirements derived from this analysis are related to:

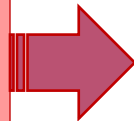
Causes prevention	Operational effects mitigation
• The C2L infrastructure ensuring that loss link frequency is acceptable from a Safety perspective. → STND / REG. • It shall be ensured that the availability of the C2L service close to airports is high. Therefore, it is necessary that: • The C2 Communications Service Provider (C2CSP) implements appropriate means (redundancies), • Airport Operators install relays or radio line of sight stations close to the runway. • Procedures to manage contingency situations in order to avoid that more than one RPAS affected by a C2LL fly in the same airspace shall be defined. • ATCO training in the management of RPAS contingencies. Including communicating to other RPASs planned to fly in that sector / incoming RPAS the possibility that the C2 link could be lost.	• In case of loss of the primary communication link: establishment of communication using the independent alternative communication system. • Availability of appropriate airborne tools to avoid conflicts with other aircraft: if the C2 link is not active (in the case of C2LL), the CA function will automatically activate.

4. Failure mode analysis (F. Emergency management issues)

The main Safety Requirements derived from this analysis are related to:

What happens if:

- Failure to set the emergency squawk 7700.
-
- An emergency arises while a C2LL is active:
 - Failure to manage an emergency occurring while a C2LL is active.
 - ATCO is unaware of the RPAS emergency while a C2LL is active.



Causes prevention	Operational effects mitigation
• RPA onboard systems being able to internally analyse the different failures that can lead to an emergency. In the event that a multiple or major failure has been detected by the system → automatically squawk 7700. • RPAS being fitted with a Mode S operable transponder being able to operate in manual mode.	Assumptions: • ATCOs can detect possible deviations or issues related to the RPA expected behaviour due to their continuous monitoring of traffic through radar. • ATCOs can remind RPs to set the emergency code, once they are aware of the emergency.
• ATCOs training in the management of contingency and emergency procedures defined for RPAS. • RP training regarding the operating methods, contingency plans and responsibility during contingency procedures, such as C2LL and communication loss. • RPAS providing updated information regarding the health status of the RPAS if the status of any subsystem is degraded, to the RP. • RPAS complying with equipment requirements applicable to the airspace within which they intend to operate, and to the specific flight rules.	• ATCOs training in the management of contingency and emergency procedures defined for RPAS. • RPs training regarding the operating methods, contingency plans and responsibility during contingency procedures. • Availability of appropriate ground-based safety nets. • Availability of appropriate airborne tools to avoid conflicts with other aircraft. → DAA continue providing CA even with a C2LL.

5. Main safety conclusions & recommendations (1/2)

The integration of RPAS in controlled airspace is plausible from a safety point of view, given that:

- The identified requirements are fully implemented.
- The regulatory aspects are addressed by the Competent Authorities of the European Union (European Commission / European Member States).
- The pending aspects are analysed and resolved.

Regulatory aspects, related to:

- The provision of information to ATCOs and the RPAS operator about the quality of the C2 link and, specifically, about an increasing latency (C2 Communications Service Provider (C2CSP)). → ICAO Annex 10 - Volume VI.
- The provision of adequate thresholds for the adaptation of the ground-based safety nets. → EUROCONTROL technical guidance material.
- C2L:
 - The Command and Control (C2) infrastructure ensuring that loss link frequency is acceptable from a Safety perspective.
 - The availability of the C2L service close to airports.
 - The RPAS systems available to manage C2LL contingencies, and the required pre-programmed trajectory equipment performance and integrity standards meeting at least the navigation requirements in the targeted class of airspace.
- DAA:
 - The DAA system on each RPAS ensuring that the possibility of failure is reduced to an acceptable minimum.
 - The specific functionalities of the DAA system. For example, when a RWC caution is received by the RP, the RP is not allowed to manoeuvre the RPA to remain well clear without prior negotiation with ATC. Therefore, the pilot is required to communicate with ATC that may propose a manoeuvre that is more compatible to the overall situation than that provided by the DAA solution (SERA.11014 of Regulation 923/2012).
- ATCOs additional training needs (Regulation 340/2015).
- RPs additional training needs (Regulation 1178/2011).

5. Main safety conclusions & recommendations (2/2)

Pending aspects for future R&D activities:

- Aspects related to the strategic planning of operations (pre-tactical) have not been fully assessed or validated.
- Merging issues when performing approach manoeuvres need to be analysed.
- Regarding C2L procedures, technologies and infrastructure, both the impact of latency and the management of C2LL conditions need to be further assessed.
- CFIT situations need to be further assessed, especially the use of GPWS / TAWS, since they have only been addressed from a subjective perspective (ATCOs/RPs answers to questionnaires) and regarding the MSAW ground-based safety net.
- DAA technologies shall be tested in more complex operational situations, as well as with different surveillance technologies.
- Abnormal conditions:
 - Impact of wake turbulence: wake turbulence categories of aircraft should be further analysed considering RPAS models, since RPAS may have specific characteristics which require an adaptation of separation distances to this regard.
 - Encounters with adverse weather conditions that may generate risks associated with the operation, including potential emergencies, must be properly assessed. Phenomena such as icing, encounters with cumulonimbus clouds or LVP procedures, among others, must be thoroughly evaluated to ensure full RPAS integration into controlled airspace. In IRINA, no type of adverse-weather encounter was tested during the validation exercises, except for some wind scenarios.

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Thank you!

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IRINA Workshop Solution 0379 Human Performance Conclusions CRIDA

Juan Antonio López Sánchez
17th February 2026

1. What is Human Performance?

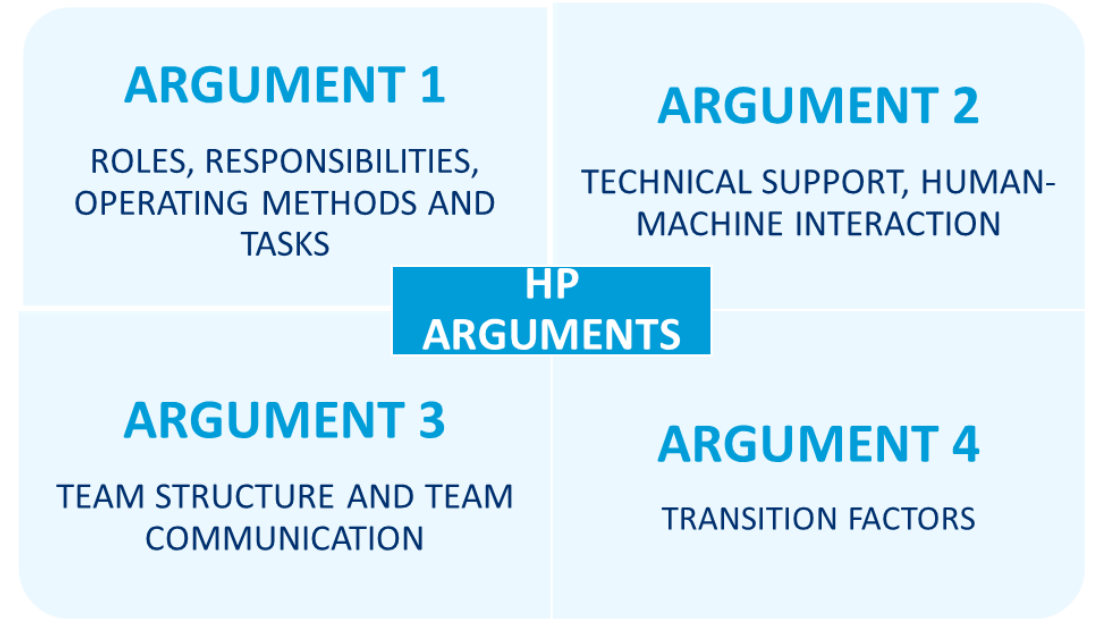
- Human Performance is a **transversal area within SESAR**
- It assesses the **impact on human factors** when a solution is introduced
- Focuses on the **impact of changes in human performance** due to solution implementation

2. Human Performance Assessment

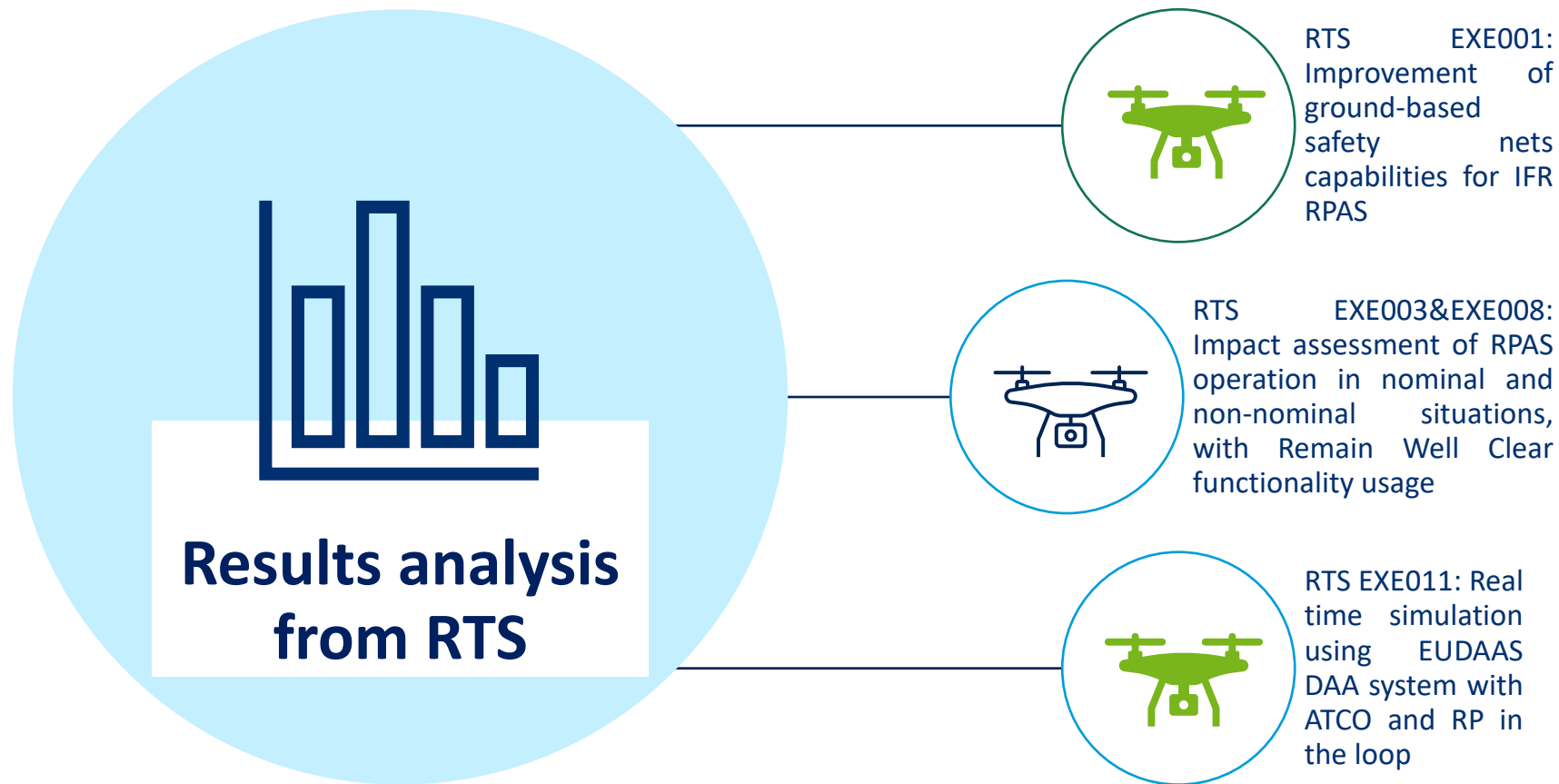
- Analysis of **changes introduced by the solution (SOL)**.
- Assessment performed **per area or arguments** and using results from **validations**.
- Identification of **issues and benefits**.

3. Human Performance Outcomes

- **Issues:** observed and materialized during the assessment.
- **Benefits:** positive effects identified and confirmed.
- **Recommendations and requirements.**



Exercises with Human Performance assessment



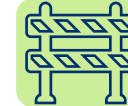
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Argument 1: Roles, responsibilities, tasks and operating methods



Positive outcomes

- Stable ATCO Workload (WL) and acceptable Situational Awareness (SA). DAA functions improved anticipation of conflicts
- Acceptable RP's WL and SA



Limitations

- Procedures for contingency scenarios (C2Link Loss) needed to be clearly defined, for ATCOs and RPs interactions
- Lack of information and training sessions for ATCOs on RPAS capabilities and expected services.



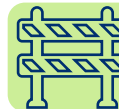
Recommendations and requirements

- Recommended training for pilots on DAA timeline of functions.
- ATCOs would benefit to be trained in the various RPA characteristics and performances..
- The ATCOs shall through training be made aware the RPAS may perform traffic avoidance in all dimensions (up/down and sideways).



Positive outcomes

- For ATCOs and RPs, DAA RWC integration in their HMI supported to maintain acceptable Workload (WL) and Situational Awareness (SA) levels
- The integration of RWC in ATCOs' HMI helped to anticipate coordination with RPs



Limitations

- Rapid changes in RWC guidance challenged ATCOs' SA
- Limitations in information provided by DAA system (conflict context) challenged ATCOs' SA
- ATCOs and RPs found lack of training in how to handle RWC alerts and CA manoeuvres



Recommendations and requirements

- Ground-ground safety net parameters shall be configured appropriately to avoid generating nuisance alerts and to support timely management of conflicts.
- Provide ATCOs with specific training to familiarise with the new system functionalities: DAA capabilities, RWC and CA functions.

Argument 3: Team structure and communication



Positive outcomes

- ATCOs considered that communication means available (voice and CPDLC) support RPAs operations adequately
- Phraseology used (plain language) supported ATCOs in managing DAA situations and delivering clearances



Limitations

- Communication latencies affected the timeliness of interactions between ATCOs and RPs, particularly causing overlaps and repetitions.
- RPs found the necessity to be trained with regard to phraseology related to DAA



Recommendations and requirements

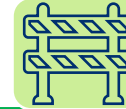
- Further latency values should be tested in future exercises to further enhance the concept.
- ATCOs and RPs should be trained with regard to phraseology specifically related to DAA.

Argument 4: transition factors



Positive outcomes

- Impacts on ATCOs' job satisfaction caused by the changes introduced by solution and technology considered acceptable



Limitations

- Minor limitations with lack of familiarization with the new DAA alerts affected ATCOs' acceptance of the concept



Recommendations and requirements

- ATCOs' training shall include familiarization with the new system functionalities, features, and operating methods to enhance acceptance of the concepts.
 - Training prior to RPA integration to classes A-C shall cover training & simulation needs, phraseology, aircraft pilot training, and remote pilot & RPAS knowledge. Training shall be conducted for ATCOs, RPs, and classic pilots

Conclusions and Next steps



Main conclusions

ATCOs' WL and SA in general at acceptable levels within the Solution

DAA integration (RWC & CA) improved anticipation of conflicts, but system in development

RPAs: Specific performance characteristics, challenging ATCOs' SA

Communication latencies affect timeliness in interactions ATCO-RP

Phraseology used was adequate for ATCOs



Next steps

Training will be defined for ATCOs and RPs in DAA capabilities, RWC and CA functions.

Training sessions for ATCOs on RPAs capabilities and expected services.

Further latency values to be tested

Enhance conflict information provided by DAA system

Training for RPs in phraseology (specially for DAA)

Questions

1

From your perspective, Which of the HP Arguments is more critical for IRINA Project?

a) Argument 1: Roles, responsibilities, Operating methods, tasks

c) Argument 3: Team structure and communication

e) The four arguments are equally critical

b) Argument 2: Technical support, human-machine interaction

d) Argument 4: Transition factors

2

According to your point of view, which of the following issues may affect more negatively ATCO's Workload and Situational Awareness?

a) Procedures for C2L Loss scenarios not clearly defined

c) Working with RPs poorly trained on DAA functions

b) Lack of training for ATCOs in RPAs characteristics and performances

d) All of them are equally negative for ATCOs' WL and SA

Questions

3

Which of the following measures is in your opinion the most important to strengthen ATCO's SA?

a) An adequate configuration of the ground-ground safety net parameters to avoid nuisance alerts

b) Specific training for ATCOs to familiarise with the new system functionalities (DAA capabilities, RWC and CA functions)

c) Enhanced information provided by DAA system (conflict context)

d) All of them are equally important

4

From your perspective, which measure is the most important to improve communication between ATCOs and RPs?

a) Training for ATCOs and RPs in phraseology to be used

b) Assessment of different latency values

c) Define a phraseology for DAA different from the one used between ATCOs and classic pilots

d) All of them are equally important

5

According to your point of view, which of the following issues will cause more impact on ATCOs' job satisfaction

a) Lack of familiarisation with DAA alerts

b) Lack of knowledge of RPs and RPAs performance

c) Working with RPs poorly trained on RPA integration to airspace classes A-C

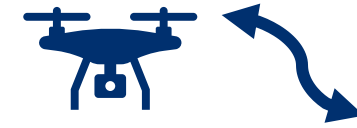
d) Working with classic pilots poorly trained on RPA integration to airspace classes A-C

e) All of them are equally important

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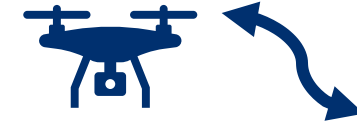
IRINA Solution 0379

Conclusions



DAA Operational feasibility and acceptability:

- In terms of safety, DAA systems, with RWC and CA provide an effective additional safety layer. RWC gives additional support allowing early detection/anticipation of conflict situations, received positive feedback from both ATCOs and RP.
- The results show that the level of safety is maintained between the reference scenario and the full RPAS integration scenario, under both nominal and non-nominal conditions.
- Some limitations regarding alert timing and degraded modes: in certain cases, the time between an RWC alert and the required CA manoeuvre is reduced, limiting the RP to request a new heading or altitude from ATCOs. However, this can be mitigated through clearly defined procedures and appropriate training.
- From ATCO perspective, workload and overall situational awareness remained largely stable, both in nominal scenarios and non nominal scenarios
- From Remote Pilot perspective, workload remained within acceptable limits, with increases mainly during DAA events, mainly linked to human-machine interface aspects and the management of alerts and manoeuvres under time pressure.
- Some limited situations still require further analysis, mainly related to communication challenges and coordination in degraded or complex scenarios.

**DAA Technical feasibility:**

- No major technical issues were identified regarding our specific system tests in the scope of this solution, and the ATC system adaptations made for our validations are compatible with existing system architecture
- ACAS Xu proved technically feasible in the scope of the validations, while EUDAAS requires further development for final technical conclusions.

FTS related conclusions:

- **ACAS Xu** showed strong safety and operational performance in the simulated encounters. The risk of NMAC and LoWC was significantly reduced with ACAS Xu RA manoeuvres, with further improvement when earlier RWC manoeuvres were applied. A small number of degraded results were linked to limitations in the rare-event modelling methodology rather than system weaknesses, highlighting key improvements for future validation within IRINA.
- Stronger models improve safety metrics, smoother models slightly reduce margins, but all remain within acceptable bounds; pilot response has moderate influence.
- **EUDAAS** improves both safety and operational performance, whether using only Collision Avoidance or the full DAA functionality. Additionally, EUDAAS performs well against TCAS-, ACAS Xa- and ACAS Xu-equipped traffic and has shown robustness to C2 link delays. Main limitations occurred with Mode C/S intruders without ADS-B Out, likely due to challenging encounter models; further simulations are needed

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STD & REG recommendations from Sol 0379

- **Safety and system enhancements are required** — including improved ground-based safety nets, refined alert thresholds, and further validation of detect-and-avoid (DAA) systems under diverse operational conditions.
- **Regulatory gaps persist** — current rules lack clear requirements for human-performance training, C2-link usage for non-critical communications, operational planning for nominal/emergency trajectories, and reporting of non-cooperative intruders.
- **Communication and coordination issues remain unresolved** — including unclear phraseology for remain-well-clear (RWC) procedures and insufficient guidance on protecting airspace structures from uncontrolled RPAS activity.
- **Technical limitations must be addressed**, such as communication latency in C2 links, the need to adjust safety-net timing parameters, and incomplete validation of onboard DAA across mixed surveillance environments.
- **Operational challenges complicate integration** — including remote-pilot/ATCO situational-awareness issues, increased controller workload, delayed conflict resolution, and limited trust in automation.
- **Improvements depend on training, procedural refinement, and interoperability**, requiring updated encounter models, more complex operational scenarios, clearer DAA procedures for remote pilots, and expanded testing with systems like ACAS Xu.

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IRINA Solution 0379 CBA

IRINA SOL 379 – CBA

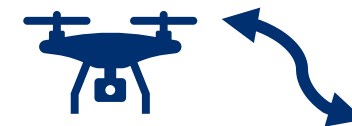
- CBA for IRINA Solution 379 indicates a **positive and good business case** for enabling RPAS IFR operations in classes A–C.
- While the results are promising, several data components need to be closely monitored when progressing towards initial deployment, especially concerning the traffic and fleet projections, benefits quantification (only the cost-efficiency benefits being initially monetized) and scenarios description.
- Continued stakeholder engagement, validation data collection, and refinement of modelling assumptions will be essential to progressively improve representativeness and quality of CBA.
- Further details will be given in following workshops

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Final Recommendations

IRINA Sol 379 Recommendations



- **Extend operational scenarios:** Recommending in next phases moving towards more realistic and demanding operational scenarios, including multi – aircraft encounters and including more complex traffic situations.
- **Human-in-the-loop:** involve a larger number of remote pilots and ATCOs in future exercises to capture better variability in operational strategies and human performance.
- **Further assessment of DAA :** future validations should include different surveillance equipage, such as Mode C and Mode S intruders, and a wider range of nominal and non-nominal situations.
- Clarify the **operational role of RWC in controlled airspace:** RWC alert and suggestive guidance will be always assessed by remote pilots and only if he/she considers the avoidance maneuvering as needed he/she will contact ATC asking for clearance. Further refinement of RWC- related procedures, training material and guidance is therefore recommended
- **Phraseology align with ICAO:** It is recommended: defined specific phraseology for RPAS-related situations, such as C2 link loss or the communication of RWC alerts. Also, future validations should apply ATCO procedures defined in the ICAO SARPs and PANS-ATM proposed amendments developed by the ICAO RPAS Panel.



- **Communication latency needs further assessment:** the voice delay between the remote pilot and the ATCO should be further analysed and tested, and it should be as close as possible to the delays currently experienced in manned aviation.
- **FTS: improve encounter modelling, methodologies and interoperability**
Refining encounter geometry and dynamics, integrating multi-ship encounters in A to C airspace, and revisiting encounter models that led to degraded safety results.
Next project needs to clear define previously assumptions about sensors performance, Remote pilots models
- Future **R&I** may focus on extending interoperability assessments to additional operational contexts and equipage combinations, in order to further consolidate mixed-equipage operational concepts.
- **Extend DAA validation** to different weather conditions, multi-ship encounters in A–C airspace, and updated encounter models, especially for previously degraded scenarios.
- Establish **statistics on aircraft equipage** in European airspace, focusing on Mode C/S without ADS-B Out, and define a clear nomenclature for intruder equipment for DAA validation.
- **Safety gaps** and : pre-flight management, CFIT scenarios, traffic merging, emergency procedures, weather degradation and wake turbulence.
- **Training needs for next phases: specific training on DAA-related procedures, phraseology and RPAS performances characteristics.**

Which step would be the most challenging in moving SOL 0379 from this validation to operational deployment? Operational/technical/ regulatory difficulties?

- A. Scaling up to higher traffic density and complexity
- B. Ensuring reliable C2 link performance and managing latency
- C. Updating procedures and providing effective training
- D. Obtaining regulatory approval and certification



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Thank you for your attention!

