MIDCAS PROGRAM

The European Research Initiative for the Collision Avoidance of UAS

Unmanned Aerial Systems: civilian applications and technology challenges

Matteo Cervo

Turin, 10th November 2011

AleniaAeronautica

AGENDA

- MIDCAS European Research Program Overview
- MIDCAS CONOPS & Functional Design
- MIDCAS Demonstrator & Integration on Sky-Y
- MIDCAS In Flight Demonstration with Sky-Y

MIDCAS Program Context and Objective

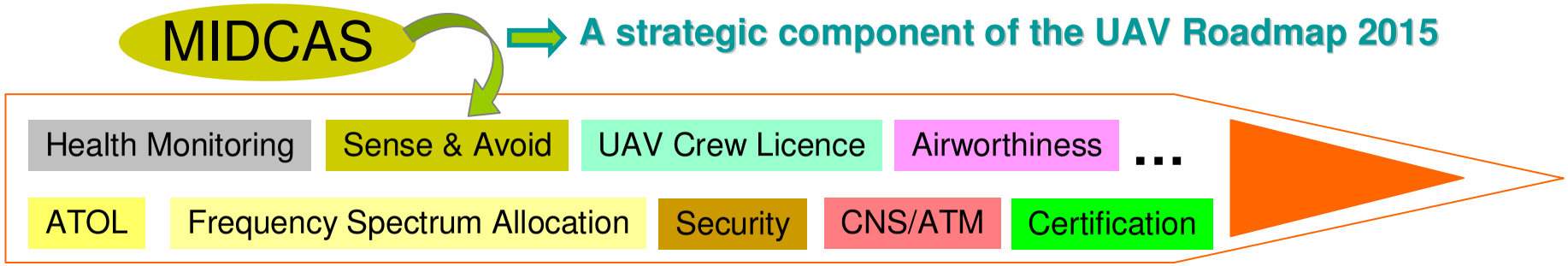
Main Objective of MIDCAS Program:

Demonstrate the baseline of solutions for the **UAS Mid-air Collision Avoidance Function**, acceptable by the manned aviation community, compatible with UAS operations in non-segregated airspace by 2015.

AIR4ALL

UAV Insertion into General Air Traffic

AIR4ALL Vision:
"To open European Air Space and have the required technology demonstrations in order to produce UAS that can routinely fly across national borders"



« UAV insertion into General Air Traffic » roadmap

MIDCAS Consortium

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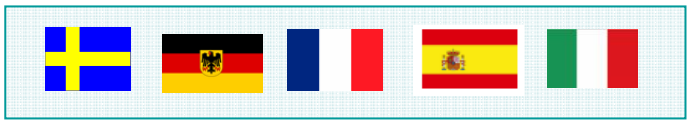
EDA Ad Hoc Category B Project

Contract signed with EDA on June 2009
Start of Work: September 2009
Duration: 4 years



5 Nations Project :Project Coordinator Sweden

Consortium (Co-Contractor) of 13 European companies and Research Centers, Industry Coordinator: SAAB

SAAB · AleniaAeronautica A Finmeccanica Company · CIRA · DIEHL BGT Defence · DLR · CASSIDIAN AN EADS COMPANY · ESG

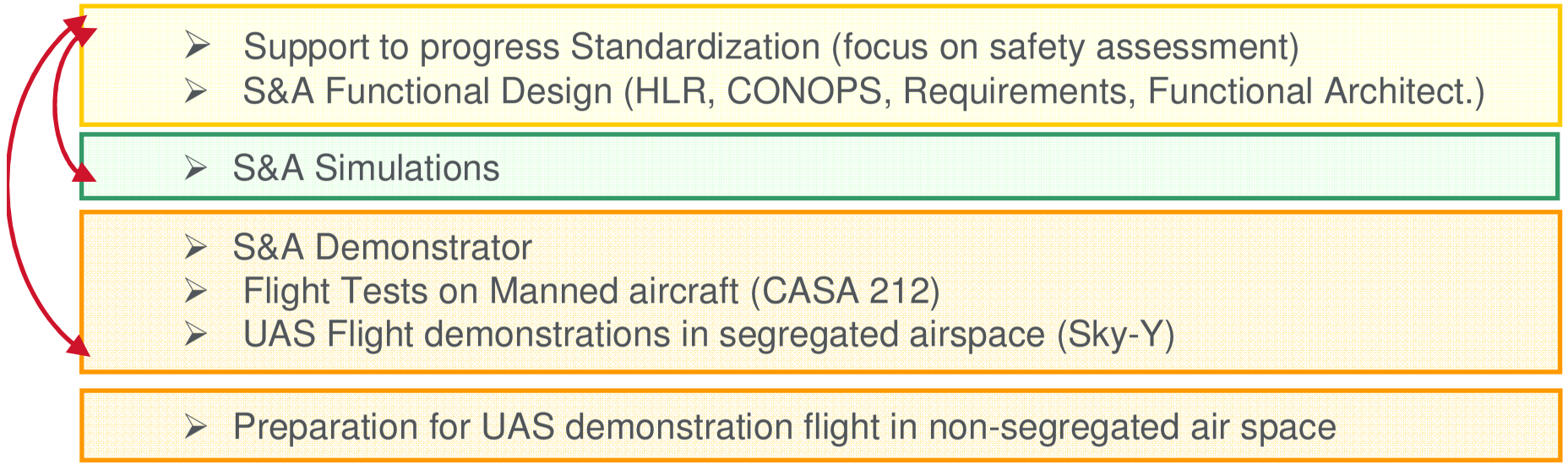
indra · SAFRAN Sagem · SELEX Communications A Finmeccanica Company · SELEX GALILEO A Finmeccanica Company · SELEX Sistemi Integrati A Finmeccanica Company · THALES

MIDCAS Development Approach

The MIDCAS project is designed with focus on 3 main tracks:

- Provide the technical background for the for the development of a **Sense & Avoid Standard** with active interaction with **Regulatory Bodies** (WG73, EUROCOTROL, EASA) **and Stakeholders** (CAAs, industries, pilots)
- Design of a **Generic S&A Function** to be tested in simulations
- Design of a **S&A Demonstrator** to be tested in flight

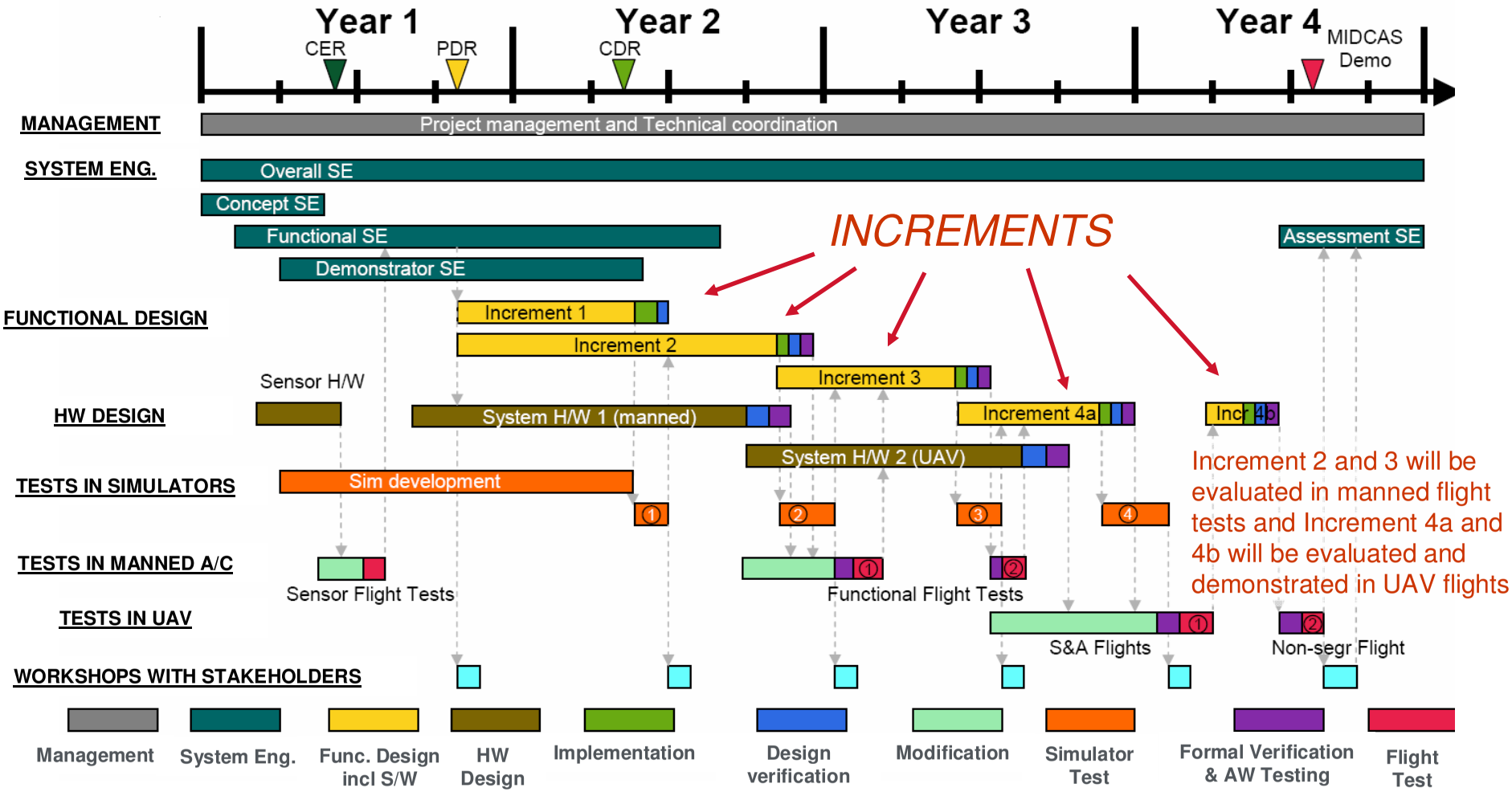
All being integrated in **iterative development logics** with frequent feedback to account for progress in standards and as well as evaluation results



MIDCAS Development Approach (cont.)

System development will go through functional increments, following a spiral approach.

Simulation and Demonstration will be used in the different phases of the MIDCAS development to support the design and validate the developments.



S&A Simulations

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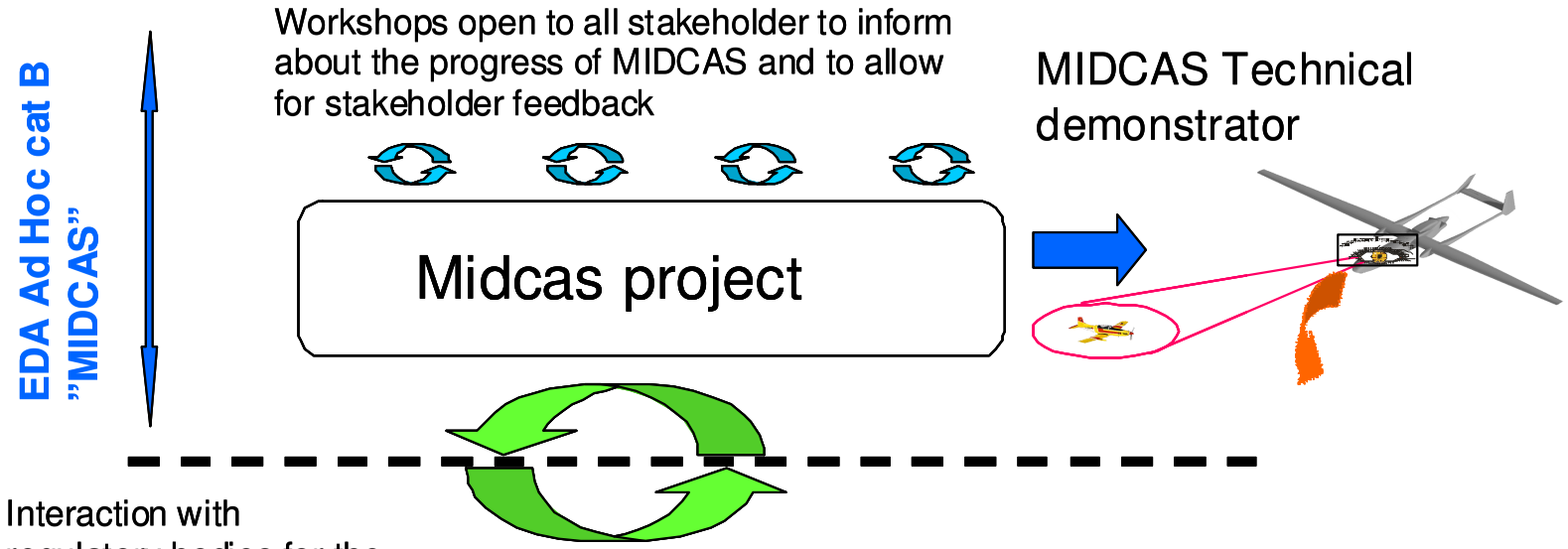
Types of Simulation in MidCAS project

- **S&A simulation models** (Subsystem simulation)
- **Desktop simulation** with Monte Carlo capability (Integration of S&A models in a Simulator framework)
- **ATC simulation** (Interface with Desktop Simulator)
- **Hardware In the Loop** HIL simulation (Rig Testing)

Simulations will be used to:

- Help in the design of system architecture and performance verification.
- Demonstrate the Sense and Avoid capabilities.
- Evaluate the HMI needed for the UAV pilot situational awareness and interaction.
- Provide statistical data based on extensive computer simulations in a short time.
- Support the standardization process with the stakeholders.
- Demonstrate the safety level relative to mid air collision including ATC interactions
- Demonstrate auto-compatibility (MIDCAS equipped UAS vs MIDCAS equipped UAS) and compatibility with TCAS.

Support to progress Standardization



MIDCAS Functional Design: CONOPS

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➢ **The *S&A System* will be able to:**

- detect another airborne vehicle within a defined field of view,
- classify the conflict risk & decide if the situation is hazardous,
- alert the UAS-pilot
- take appropriate action to avoid a potential collision.

➢ **Other S&A System main requirements:**

- Be able to operate in all airspace classes (A-G)
- Be compatible with TCAS II logics
- Manage S&A capability towards cooperative and non-cooperative intruders
- Be compatible with existing regulations (particularly with the ICAO Rules Of the Air)
- Minimize impact on ATM procedures

➢ This *S&A System* will provide the **following capabilities** for the overall UAS:

- ✓ Providing traffic information to allow the UAS pilot to build situational awareness related to the surrounding traffics.
- ✓ Providing assistance to pilot perform self separation when required, to remain well clear of other traffics.
- ✓ Performing collision avoidance.

MIDCAS Functional Design: Avoidance concept (1)

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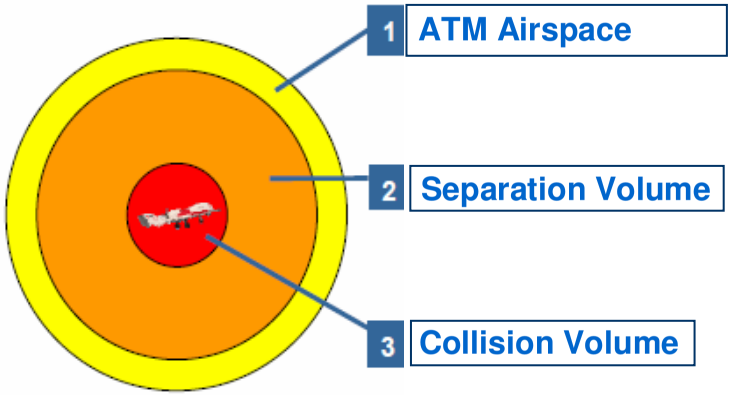
Separation & Collision Volume

MIDCAS current logic based on forecasted intruder trajectory **breaching a predefined volume** around the UAS



- **Two Main Phases**:

1. **Self Separation**
   - When: Intruder is predicted to breach SEP Volume
   - S&A provides traffic situational awareness and suggests manoeuvre to maintain separation minima
   - Pilot follows suggested sep. manoeuvre

2. **Collision Avoidance**
   - When: Intruder breached SEP Volume and is predicted to breach CA Volume
   - CA Manoeuvre is automatic when last chance to avoid collision volume is reached
   - CA is onboard the UAV, operating whatever C^2 availability

MIDCAS Functional Design: Avoidance concept (2)

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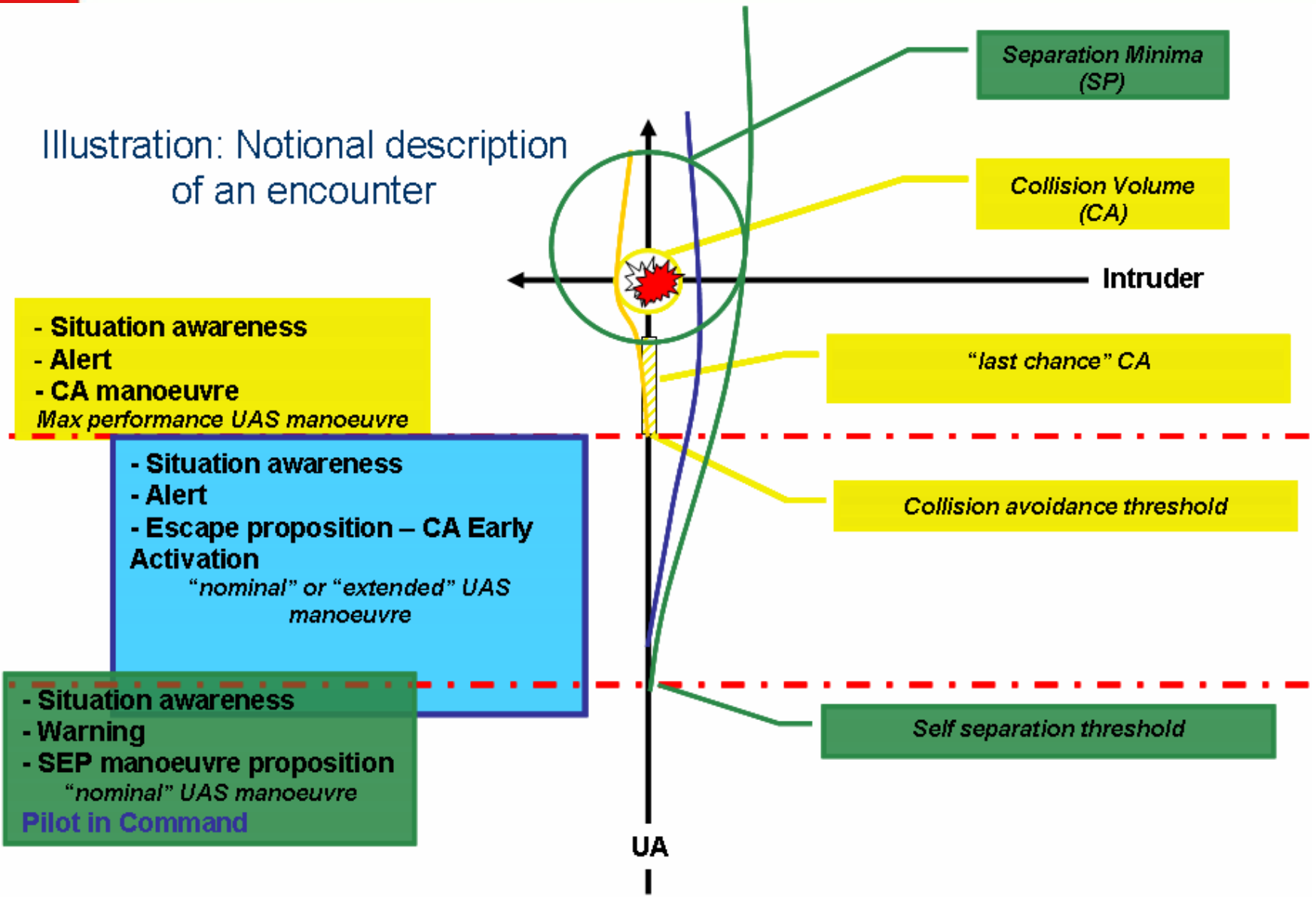

MIDCAS Functional Design: Avoidance concept (2)

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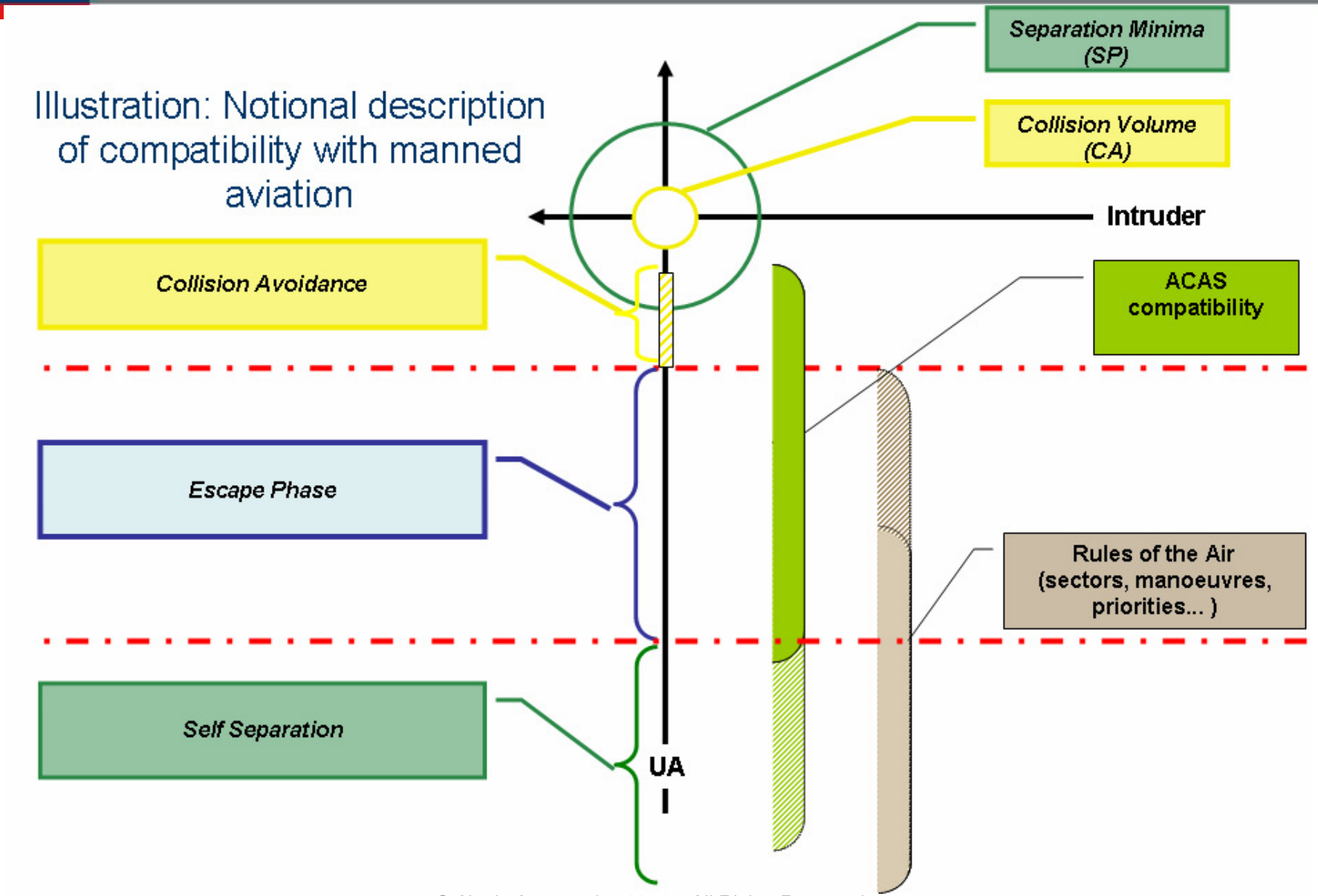
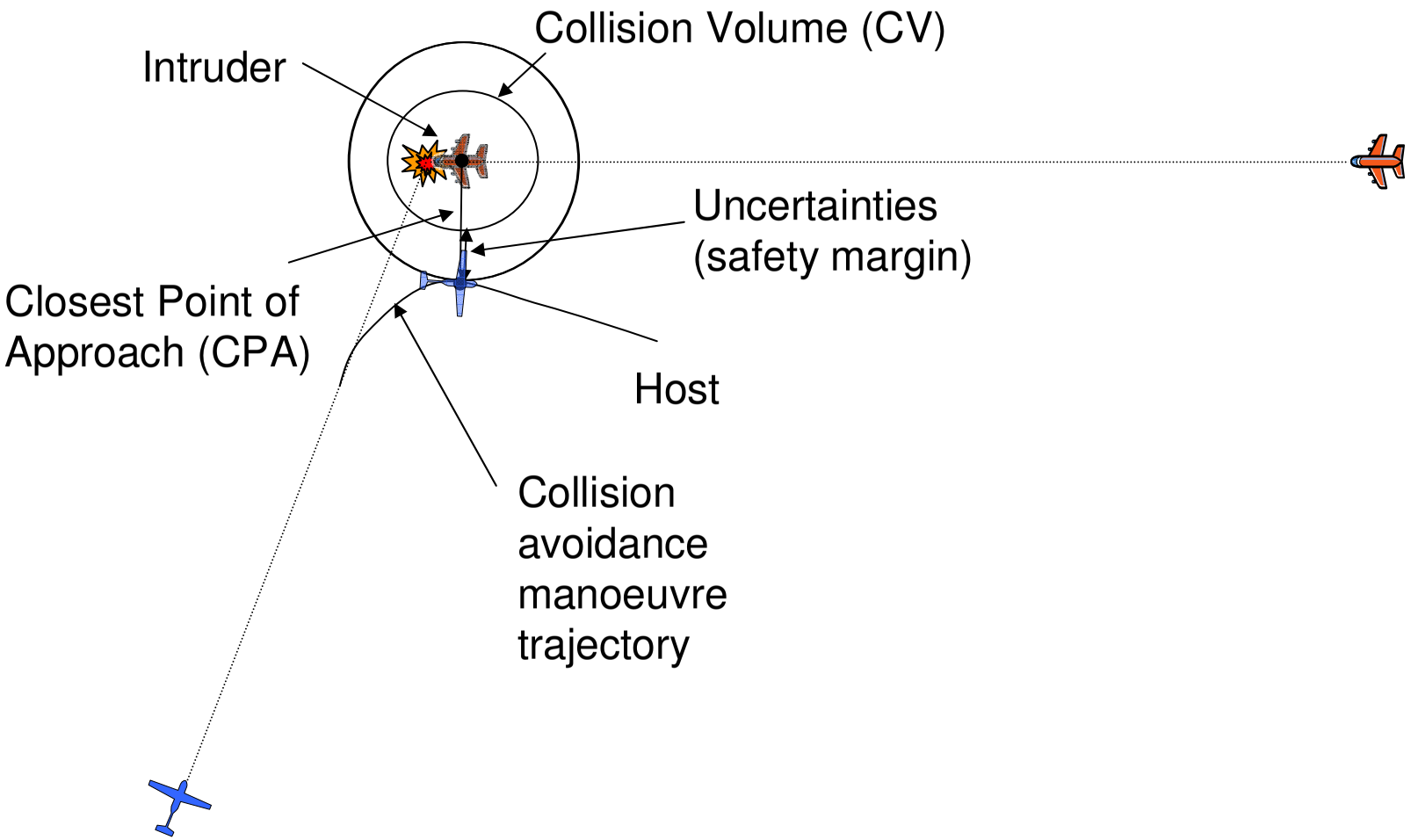


MIDCAS Functional Design: CA Maneuver



MIDCAS Functional Architecture (cont)

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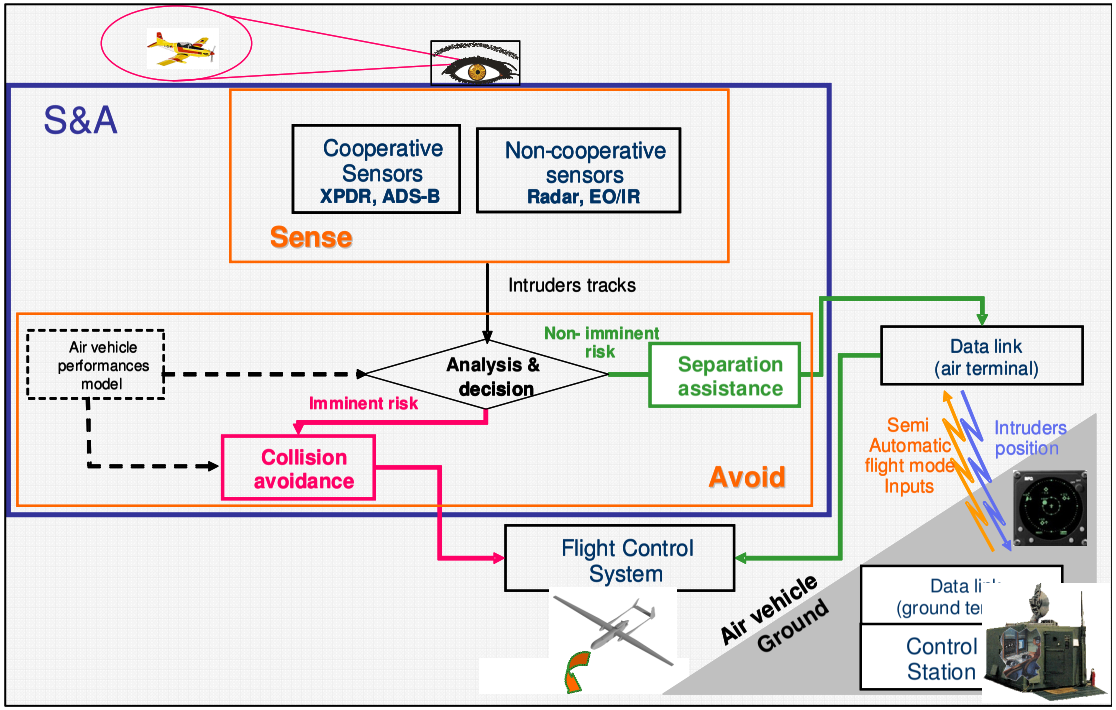
- **Sense subsystem**
  - Detect and track cooperative (IFF, ADS-B Rx), and non cooperative intruders (Radar, E/O, IR)
  - Information from different sensors are merged in a fusion sub-function before providing them to the Avoid and HMI subsystems.
- **Avoid subsystem (SEP and CA)**
  - Estimate collision risk (Vol. breach)
  - Compute priorities within threats
  - Compute avoidance manoeuvre (TCAS compatibility, ROA)
  - Provide the solution to the HMI and the UAV FCS
- **Human machine interfaces**
  - Provide situation awareness (to the UAS pilot)
  - Provide controls to approve / inhibit collision avoidance manoeuvre (to the UAS pilot)



- **S&A Demonstrator:** developed based on Generic Functional Architecture, but using currently available COTS and technologies

ALENIA contribution to MIDCAS Program

- **Definition of System Requirement**
- **Collision Avoidance Function development**
- **Development of Sky-Y Simulation for the overall MIDCAS Simulator Framework**
- **S&A Demonstrator Integration on Sky-Y flight segment:**
  - S&A sensors (cooperative and non-cooperative) and relative controlling units
  - Integration of S&A MC hosting fusion and avoid function
  - Integration between S&A MC and UAS FCC to perform automatic CA manoeuvres
  - Integration of S&A MC with Mission Data Link flight segment
- **S&A Demonstrator Integration on Sky-Y flight segment:**
  - Integration of S&A Demonstrator HMI in the Ground Control station
- **Conduction of UAS Flight Test activity (2 Test Campaigns)**

Sky-Y: UAV technology demonstrator

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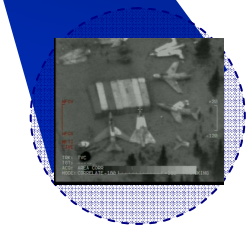
Dimensions	
Length	9.725 m
Span	9.937 m
Weights	
MTOW	1200 kg
OEW	850 kg
Fuel	200 kg
Payload (*)	150 kg
Performances	
LOS Radius	70+nm
Range	500 nm
Altitude	25.000 ft
Endurance	14 h
(* Typical)	

Sky-Y Baseline System Description

Data Link



UAV Ground Station

- FCS/NAV Integrated system
- Medium and High Level A/P modes (i.e autonomous navigation), Contingency plan in case of C^2 loss
- Flight Termination System (parachute)
- CFC Complete Airframe
- Dual FADEC Diesel Aviation Engine
- Dual redundant C^2 Data Link (> 70 NM LOS)
- ATOL
- Dedicated Mission Data Link
- On Board Mission Computer
- Mission Payload (typical: E/O turret)
- Demonstrated Operational Capabilities:
  - 8 Hrs Endurance
  - Low Light operation
  - Automatic Sensor Management

MIDCAS Demonstrator: Integration on Sky-Y

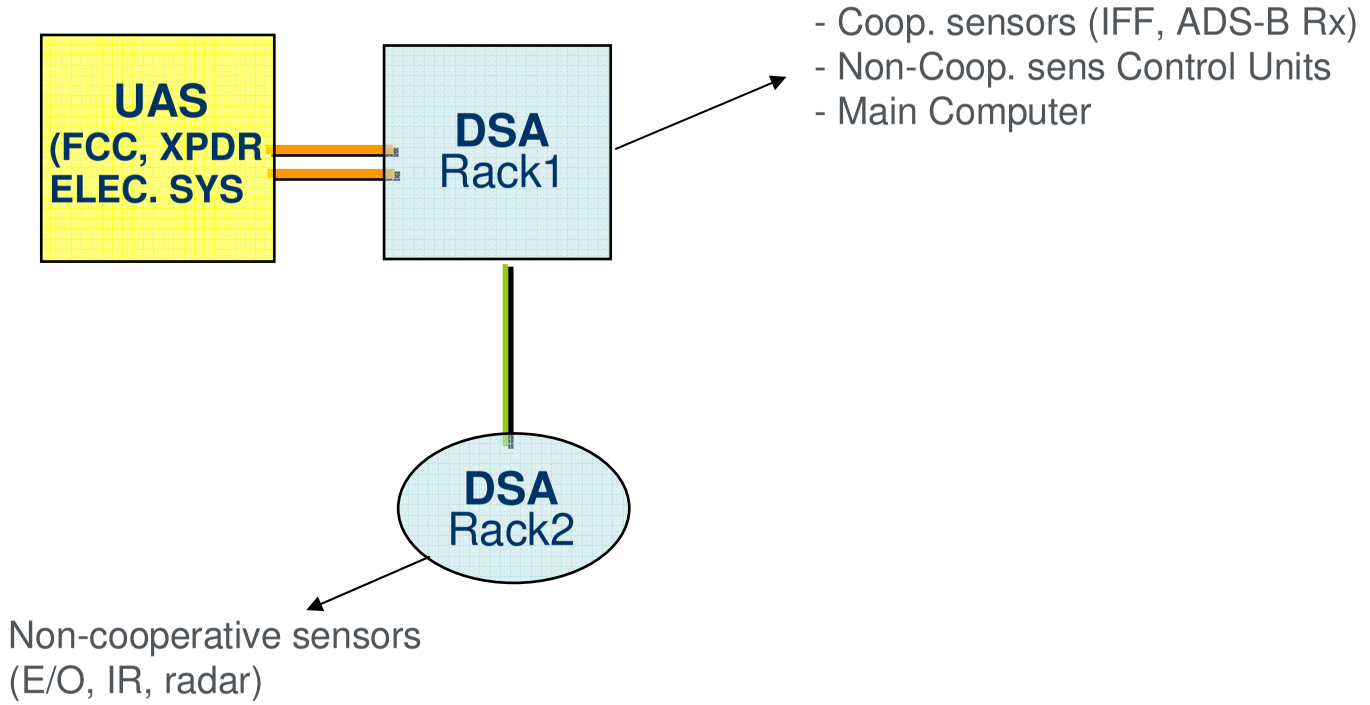
The DSA will be installed in two areas (rack 1:avionic bay, rack 2:payload bay)

➢Main issues:

-installation in Sky-Y airframe for best sensors operations, space and mechanical constraints, environmental reqs.

-radar compatibility, XPDR integration with IFF and ADSB-Rx

- safe connection with UAS FCC, adaptation of existing A/P modes to CA manoeuvres



MIDCAS Demonstrator: Integration on Sky-Y (3)

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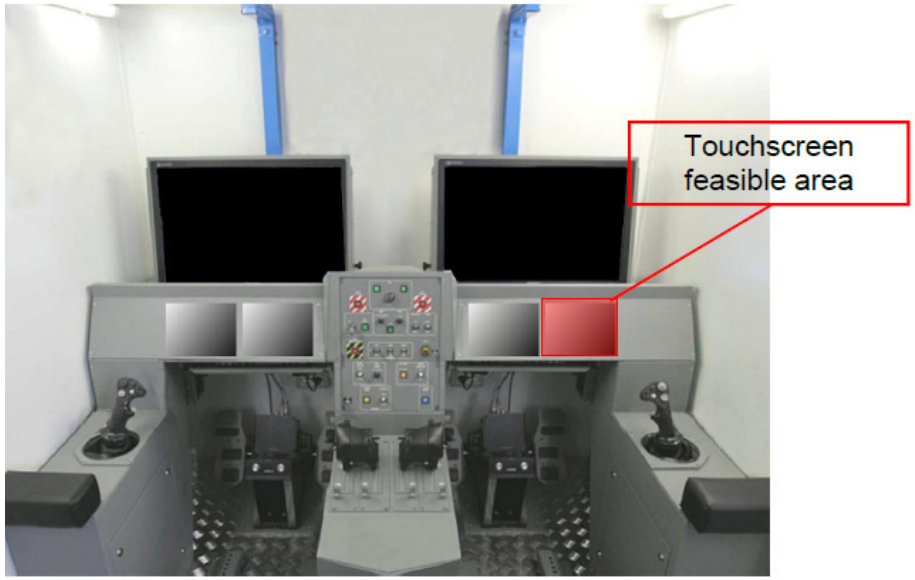
MIDCAS Ground HMI is a part of the overall MIDCAS system and needed for the UAS pilot situational awareness and interaction

Dedicated UAS-pilot HMI will be a stand-alone system in order to minimize all the impacts (SW and HW) on the existing demonstrator GCS architecture.

Solution: dedicated touch screen on the GCS frontal Console



MIDCAS: In Flight Demonstration (1)

Flight tests are scheduled in several steps to support feedback to the design, to build confidence in simulation and safety case and to support the acceptance of the proposed solutions.

- **Manned A/C (CASA 212)** will be used at a first stage to cover more scenarios and have an efficient and cost effective testing of the S&A functionality.

- **Sensor Flight Tests De-Risking** consisting in recording data from available off-the-shelf. Campaign performed at the earlier stages of the program for Increment 1 sw

- **Functional Flight Tests 1**, a second campaign, comprising 20 flights (60 fh) with15 flights with real intruders

- **Functional Flight Tests 2**, the third campaign, comprising 20 flights (60 fh) with15 flights with real intruders

MIDCAS: In Flight Demonstration

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❑ UAS Flight Demonstration (Sky-Y)

Flight tests will verify complete integration of the S&A system in UAS including automatic manoeuvres

Two flight test campaigns foreseen (Vidsel or Spain)

➢ **Verification Flight Test Campaign**

A build up approach to assess MIDCAS functionalities gaining benefit from the previous Manned Flight tests and simulations
- initial use of Virtual Intruder (injection of ground based simulation of cooperative / non cooperative intruders)
- testing with actual intruder A/C (Biz jet and Small aircraft)

➢ **Demonstration Flight Test Campaign**

Demonstration campaign to complete final validations needed ahead of the final flight planned for non-segregated air space.
Pending CAA approval, flights will be performed in non-segregated airspace
Additional test methods or safety measures could be used to support the flight in non-segregated air space.

Thank You

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Questions ?

M. Cervo

+39 011 7565403

mcervo@alenia.it