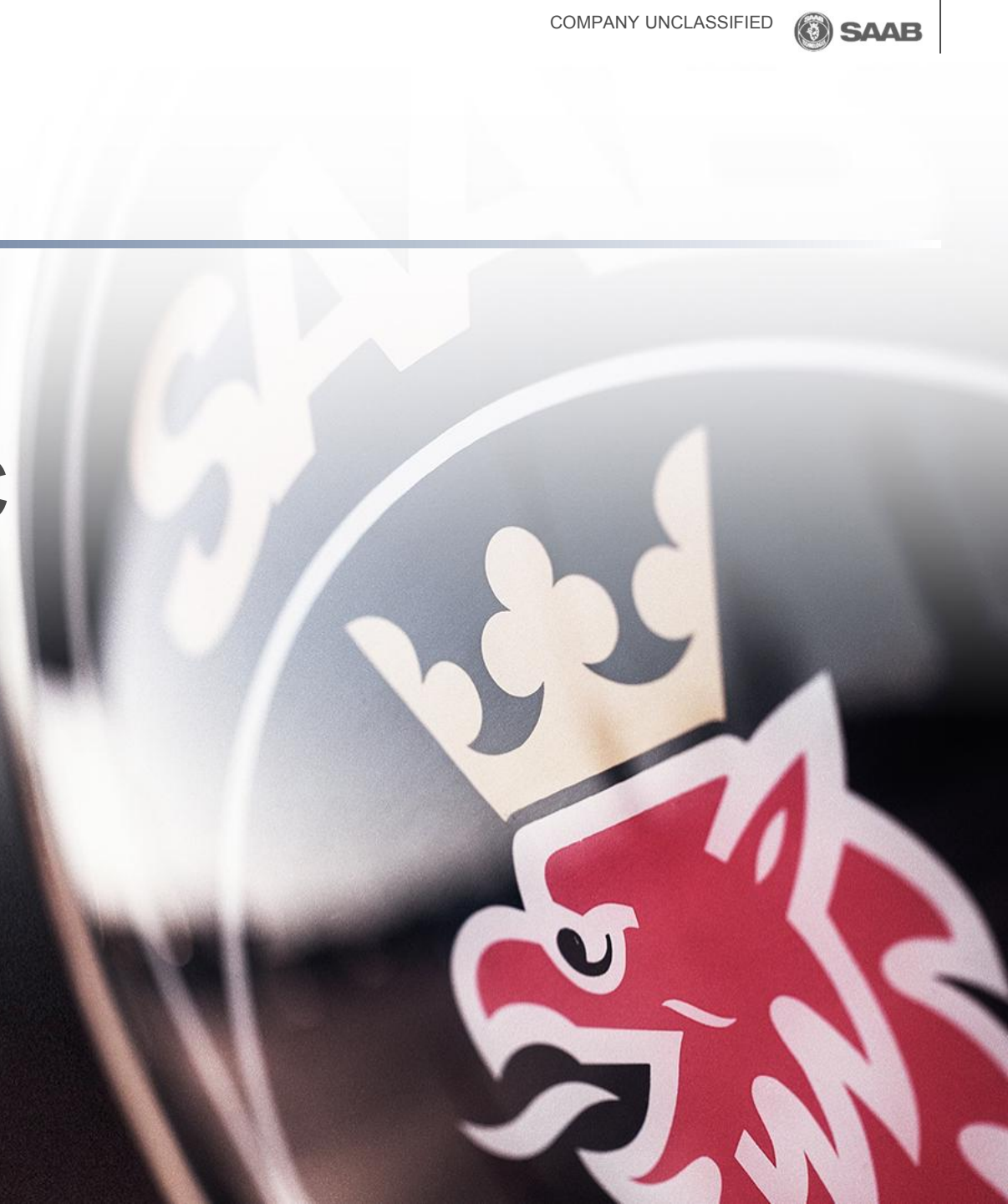
DETECT AND AVOID FOR REMOTELY PILOTED AIRCRAFT IN AIR TRAFFIC CONTROL SIMULATIONS



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PRESENTATION OVERVIEW

- Introduction
- Method
- Results and discussion
- Conclusions

INTRODUCTION 1(4)

- As part of the European detect and avoid (D&A) project MIDCAS (Mid-air Collision Avoidance System), simulations have been performed with a remotely piloted aircraft system (RPAS) flying according to Instrument flight rules (IFR) in an Air Traffic Control (ATC) environment
- The purpose of the project is to identify adequate technology, contribute to standardization and demonstrate a D&A system for RPAS able to fulfil the requirements for traffic separation and mid-air collision avoidance in non-segregated airspace

INTRODUCTION 2(4)

- Detect and avoid for remotely piloted aircraft
  - Non-segregated airspace
  - Mid-air collision avoidance
  - Traffic avoidance
- Real life vs. Simulations
- European detect and avoid project MIDCAS
  - Identify technology
  - Contribute to standardization
  - Demonstrate a D&A system
- ATC simulations

INTRODUCTION 3(4)

- Purpose
  - Study the D&A system from an operational perspective
  - Evaluate the interaction with ATC
- Objectives
  - Traffic avoidance
  - Collision avoidance
  - ATC communication
  - Pilot situation awareness
  - Workload
  - Failure cases

INTRODUCTION 4(4)

- Studied system
  - Surveillance phase
  - Traffic avoidance phase
  - Collision avoidance phase
- Not scare others

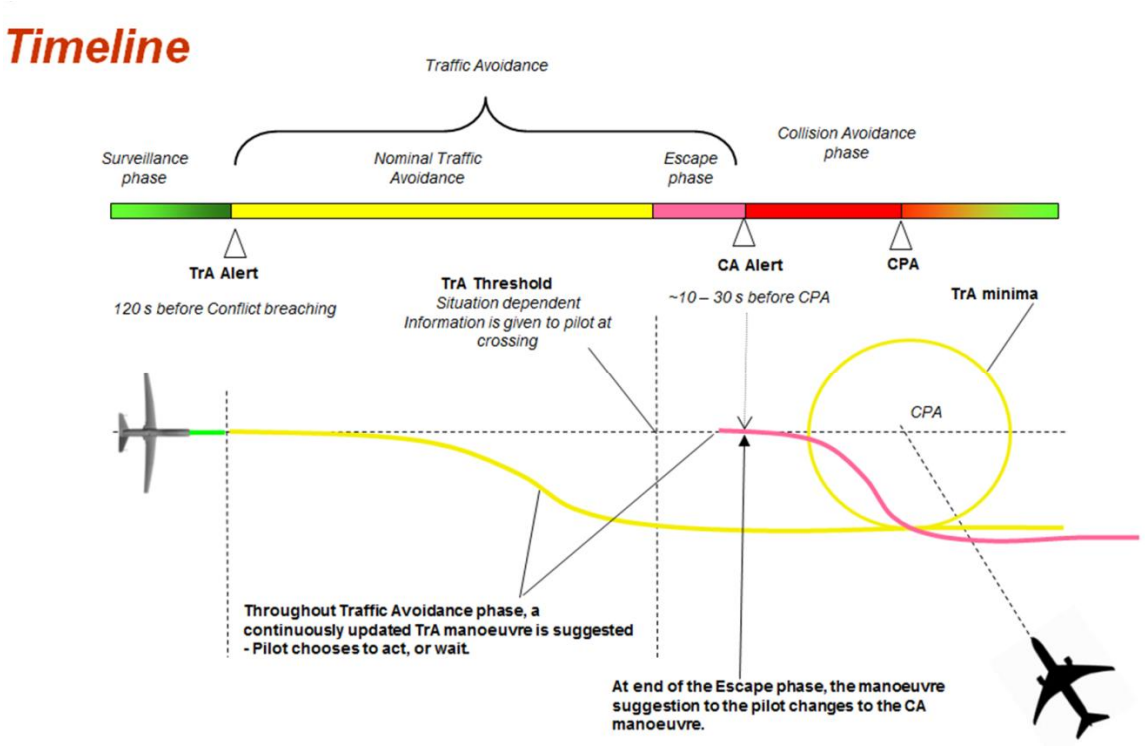
vs.

Avoid physical contact

- Routine situations

vs.

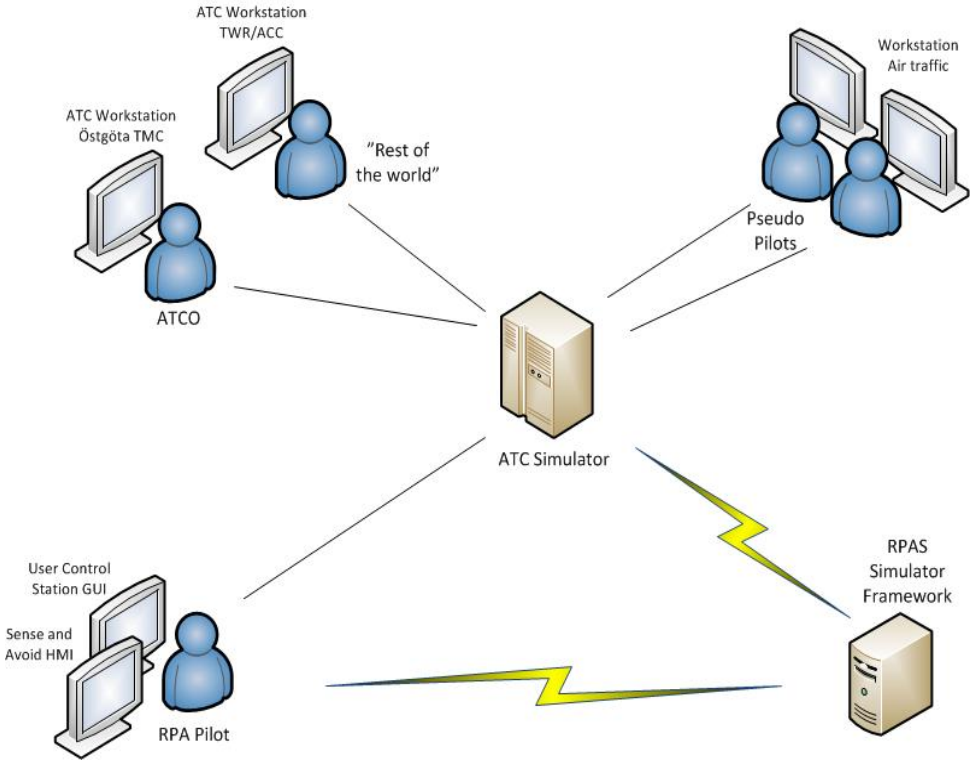
All or most of RPA performance



METHOD 1(6)

- Human in the loop simulations
  - Three campaigns
- Main subsystems
  - Sense subsystem
  - Avoid subsystem
  - Human Machine Interfaces
- Participants with highly relevant background and training
  - Pilots mostly military or commersial backgrpound and some experience from piloting a RPAS
  - ATCOs all working at the actual Östgöta TMA

METHOD 2(6)

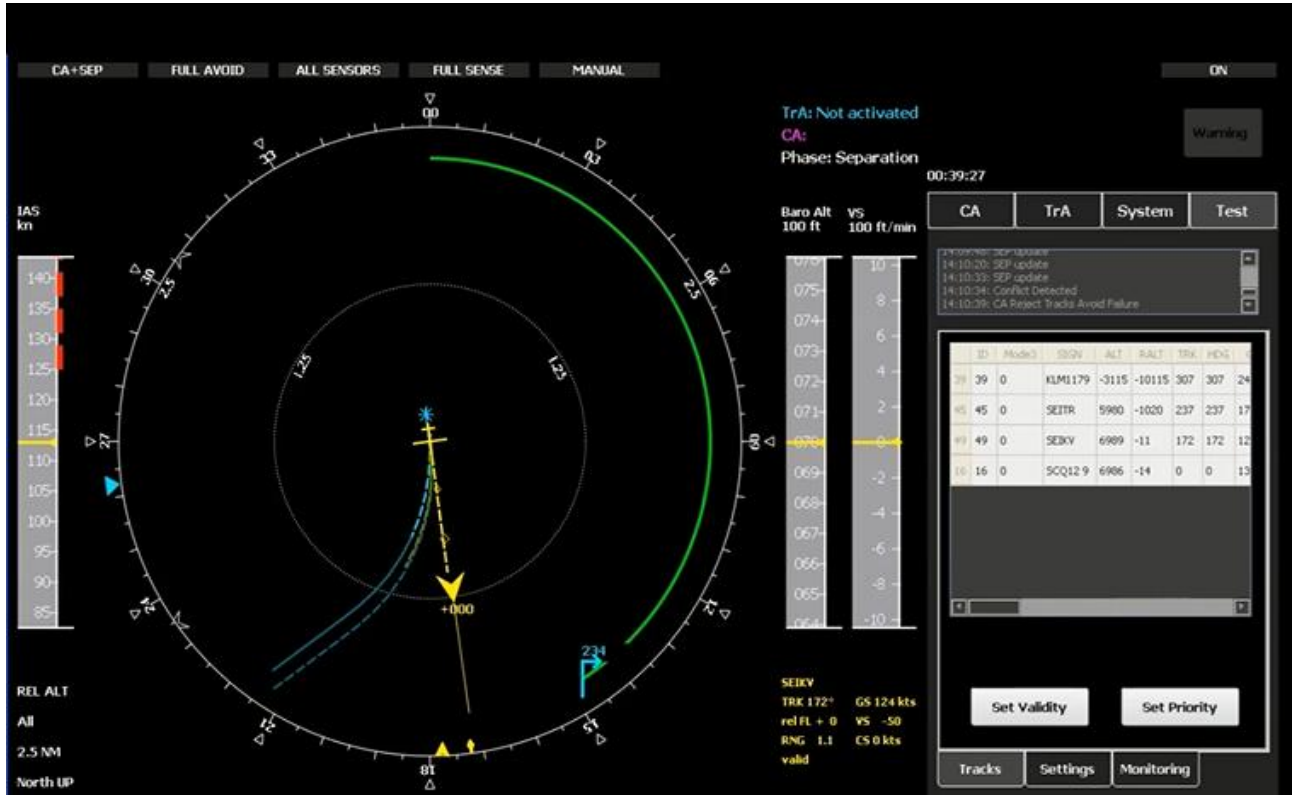


Technical setup

METHOD 3(6)

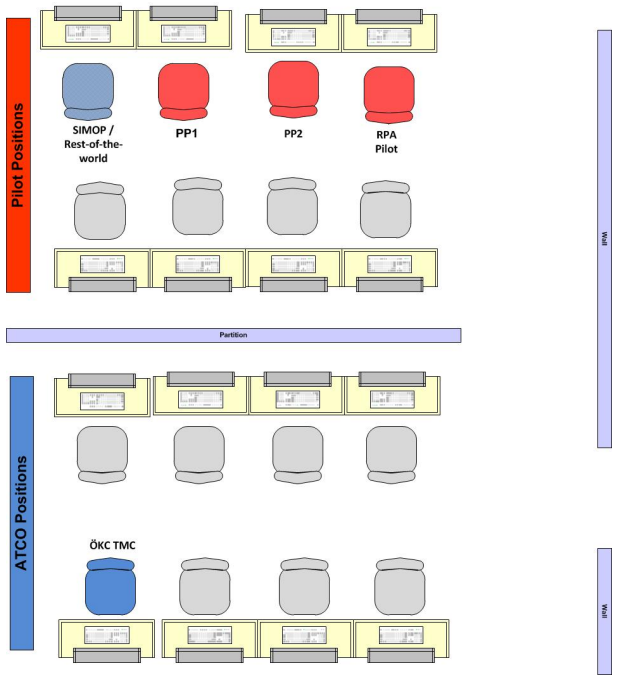
An overview of the remote pilot work station

METHOD 4(6)



A part of the human machine interface used by the remote pilot

METHOD 5(6)



Overview of the seating for the third campaign

METHOD 6(6)

Overview of the Östgöta TMA in the south of Sweden, and the RPA flightplan from south to north

RESULTS AND DISCUSSION 1(9)

- Supported MIDCAS concept validation together with air traffic controllers and remote pilots
  - Debriefings
  - Workshops
  - Questionnaires
- First campaign,
  - Structuring requirements on the system
- Second and third campaign
  - Lessons learned
    - Updated instructions for the remote pilot
    - Remote pilot was instructed to ask for new clearance before traffic avoidance maneuver
  - Easier for remote pilot to follow instructions
  - Refined objectives, phraseology

RESULTS AND DISCUSSION 2(9)

- No collisions: MIDCAS system solved all situations
  - Autonomously
  - In cooperation with the remote pilot
  - Cooperation remote pilot – ATCO
- Complex situations, positive results regarding the MIDCAS concept
- ATCO (campaign 3, run 2, team 2): *I feel confident in the system. The RPA behaves pretty much as a manned aircraft. Turns can be a little bit different but are still reasonable. In the first ATC simulation campaign I felt I had to monitor the RPA more than other traffic. There were some strange manoeuvres. It does not feel like that anymore. I can treat and monitor the RPA in the same way as other traffic*

RESULTS AND DISCUSSION 3(9)

- Questionnaire, key performance areas:
  - ATCOs experienced the system as more mature
    - Remote pilots helped in this
  - No indication that there would be any problem for the MIDCAS system to:
    - Scale up
    - Various operational contexts
    - Geographical area

RESULTS AND DISCUSSION 4(9)

- Initial acceptance of the suggested communication (end of trial, ATCO#1, second campaign) – Question, Assess the suitability of the proposed phraseology (safety, exedincy). a) when manoeuvres are requested from the remote pilot b) in the recovery phase: *The used phraseology is good and understandable and confirms to older implemented phrases. ”Request right turn heading xxx to avoid traffic” for example, and b) Cleaer of conflict after the collision avoidance is good and conforms with TCAS phraseology. No special phraseology is needed after the TrA. Ask for a new clearance.*

RESULTS AND DISCUSSION 5(9)

- Traffic avoidance:
  - ”Clear of conflict” not good for ATCO for TrA (there has not been a conflict)
  - ”Clear of traffic instead”
  - Or: Nothing at all
- Contact with traffic:
  - Call contact in a similar manner as for manned trafic (visually)
  - ”Visual contact” misleading
  - ”CDTI contact”
  - ”Sensor contact”

RESULTS AND DISCUSSION 6(9)

- Designing a D&A-system is a fine balance between safety and operability:
  - Finding that operability is more important than safety in some regards for TrA
  - Impact on design
  - Stable maneuver rather than optimal
    - Not switching direction
    - Not switching type
    - Supporting ATCO communication
  - Remote pilot perspective:
    - Not logic, not trustworthy to change suggestion from left to right too often
    - Hard too communicate to ATC (not only that it changes, but also all the information in an ”optimal” suggestion)

RESULTS AND DISCUSSION 7(9)

- When an intruder makes an unexpected and sudden manoeuvre close to the RPA is outside the scope of the TrA function
- Remote pilot: The traffic avoidance functionality is desirable
- The system warnings should not come too earli or too late
- Remote pilot: No TrA warnings if not indicated to pass within +-1000 ft altitude (all airspace classes)
- Remote pilot: Increased trust if warning come along with manoeuvre proposal

RESULTS AND DISCUSSION 8(9)

- MIDCAS system suggested to work the same way as TCAS in respect to that it has tp be clear when the pilot takes the responsibility. When activating a collision avoidance manoeuvre. ATCO: *The pilot is expected to act within his clearance. But if he has to do a manoeuvre to stay safe he is allowed ta manoeuvre. It is up to the pilot if he considers he has anough time to first ask for new clearance or if he has to act right away.*
- ATCO: Wants to see the traffic start turning within ten seconds (exact heading is less important)
- The TrA function should not be executed in controlled airspace if it is not according to clearance
- The system should warn the pilot, perhaps suggest manoeuvres and input for ATC communication

RESULTS AND DISCUSSION 9(9)

Loss of situation awareness

CONCLUSIONS 1(2)

- Support the validation of the MIDCAS concept
- The MIDCAS system supported the work of ATCO and remote pilots
- More important with stable manoeure and not switching direction or type than optimal
- From a remote pilot perspective the traffic avoidance function is desirable
- D&A system should support cooperation pilot/ATC, for instance in asking for clearances

CONCLUSIONS 2(2)

- System warnings should not come too early, nor too late
- Traffic avoidance warnings should not be presented unless an intruder is indicated to pass within +- 1000 ft altitude, for any airspace class
- Future work includes further development of system functions and potentially transfer of results and lessons learnded to the domain of decision support for manned aircraft

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THANK YOU!