A^3 Concept of Operations – Overview

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iFLY – Highly Automated Air Traffic Management

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iFly Purposes:

Develop highly automated ATM design for en-route traffic based on autonomous aircraft concept

- Assess the highest level of en-route traffic demand in which equipped aircraft can safely self separate
- Develop preliminary airborne system requirements that must be met to ensure safe 2025+ operations
- Development of algorithms
- Preliminary Cost – Effectiveness Analysis

Consortium:

- National Aerospace Laboratory (NLR)
- Honeywell
- Isdefe
- University of Tartu
- Athens University of Economics And Business
- Eidgenoessische Technische Hochschule Zurich
- University of l'Aquila
- Politecnico di Milano
- University of Cambridge
- National Technical University of Athens
- University of Twente
- Ecole National de l'Aviation Civile
- Dedale
- UK NATS En Route Ltd.
- Institut National de Recherche en Informatique et en Automatique
- Eurocontrol EEC
- DSNA-DTI-SDER
- University of Leicester

Scope of Self Separation in iFly

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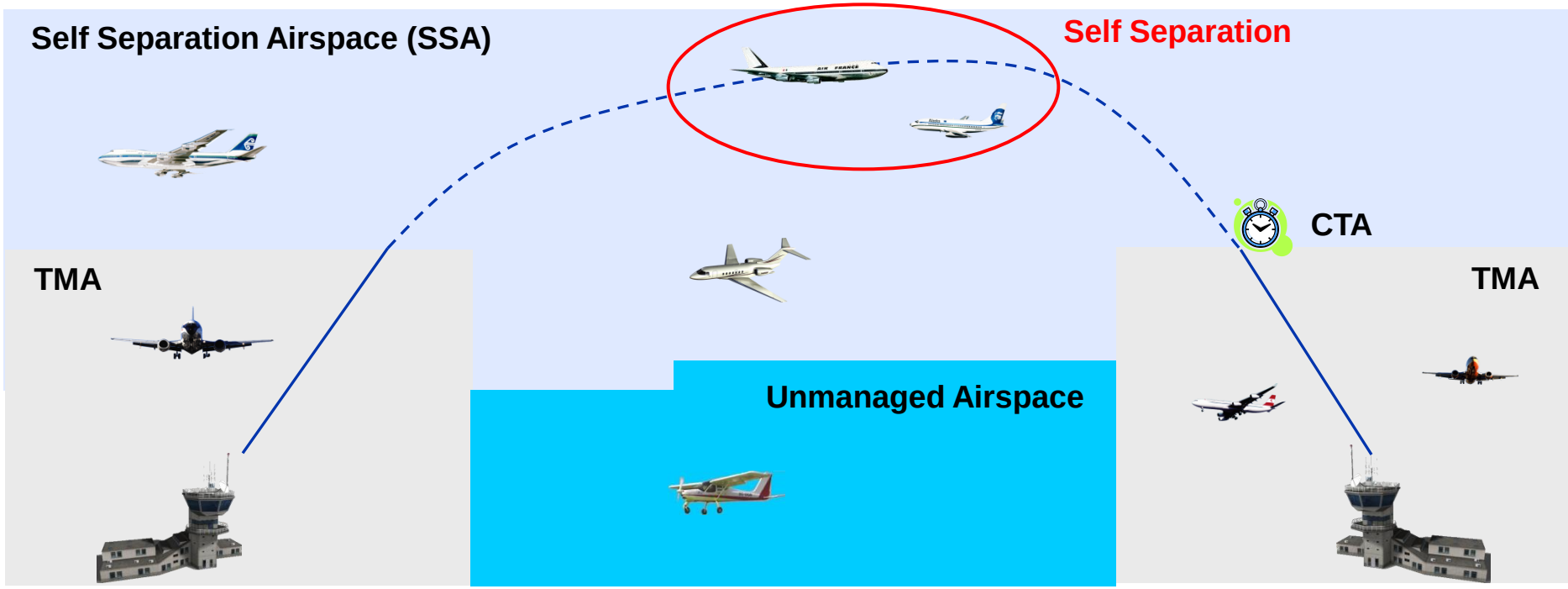

iFly's Scope:

- ✓ En-route phase of the flight
- ✓ All aircraft are equipped to self separate
- ✓ No ATC involvement
- ✓ Ground information sharing support (SWIM) available

A³ Concept of Operations – Structure

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Operational Rules:

- Coordination
- Information sharing
- Rights

Onboard Processes:

- Required Onboard Functionalities
- Human – Avionics Interactions
- Onboard Procedures

A³ ConOps – Operational Aspects

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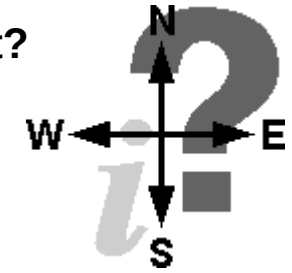
Issues:

- How to ensure availability of relevant information onboard a self separating aircraft?
- How to coordinate simultaneous maneuver of multiple aircraft?
- How to avoid maneuver of excessive number of aircraft?
- How to avoid excessive maneuver of single aircraft?
- How to incorporate global strategic aspects into distributed control?



Tools:

- ✓ Autonomous Flight Rules (AFR)
- ✓ Priority Rules
- ✓ ADS-B (In and Out)
- ✓ Ground information sharing support

A³ ConOps – Data Links (Traffic Data)

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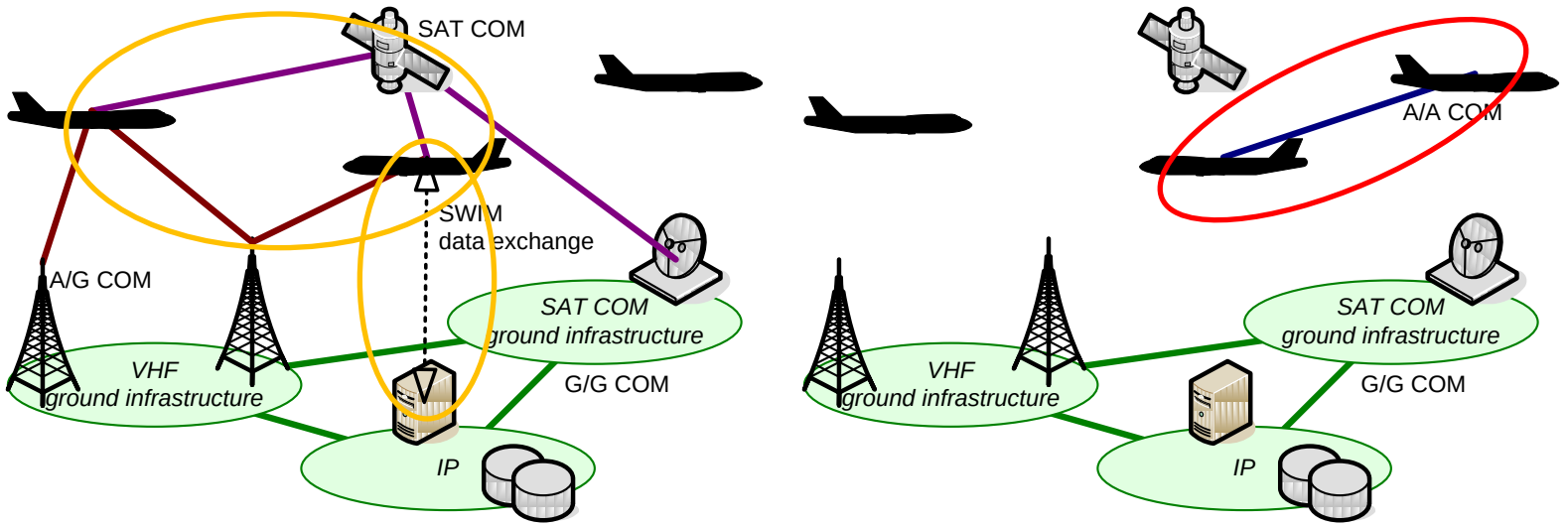
Primary Source of Information:

Reception of data broadcasted by other aircraft



Secondary Source + Backup:

Querying ground infrastructure (e.g., SWIM)

Direct querying another aircraft

A^3 ConOps – Information Sharing Support

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Information Sharing Services

Level 1: Air–Air Broadcast, State only

Level 2: Air–Air Broadcast, State + Intent

Level 3: Air–Air Broadcast + SWIM support, State + Intent

Limitations

- Air–Air data link range
- Conflict Detection (CD) limited by accuracy of state-based trajectory prediction.
- No information back up

- Air–Air data link range
- CD limited by the range of available intent information
- No information back up

- Range defined by the area of interest (in principle)
- CD limited by the range of available intent information
- Information back up (point-to-point communication, SWIM)

iFly considers Level 3, but performance and safety assessment may be performed for multiple levels.

A³ ConOps – Ground Support

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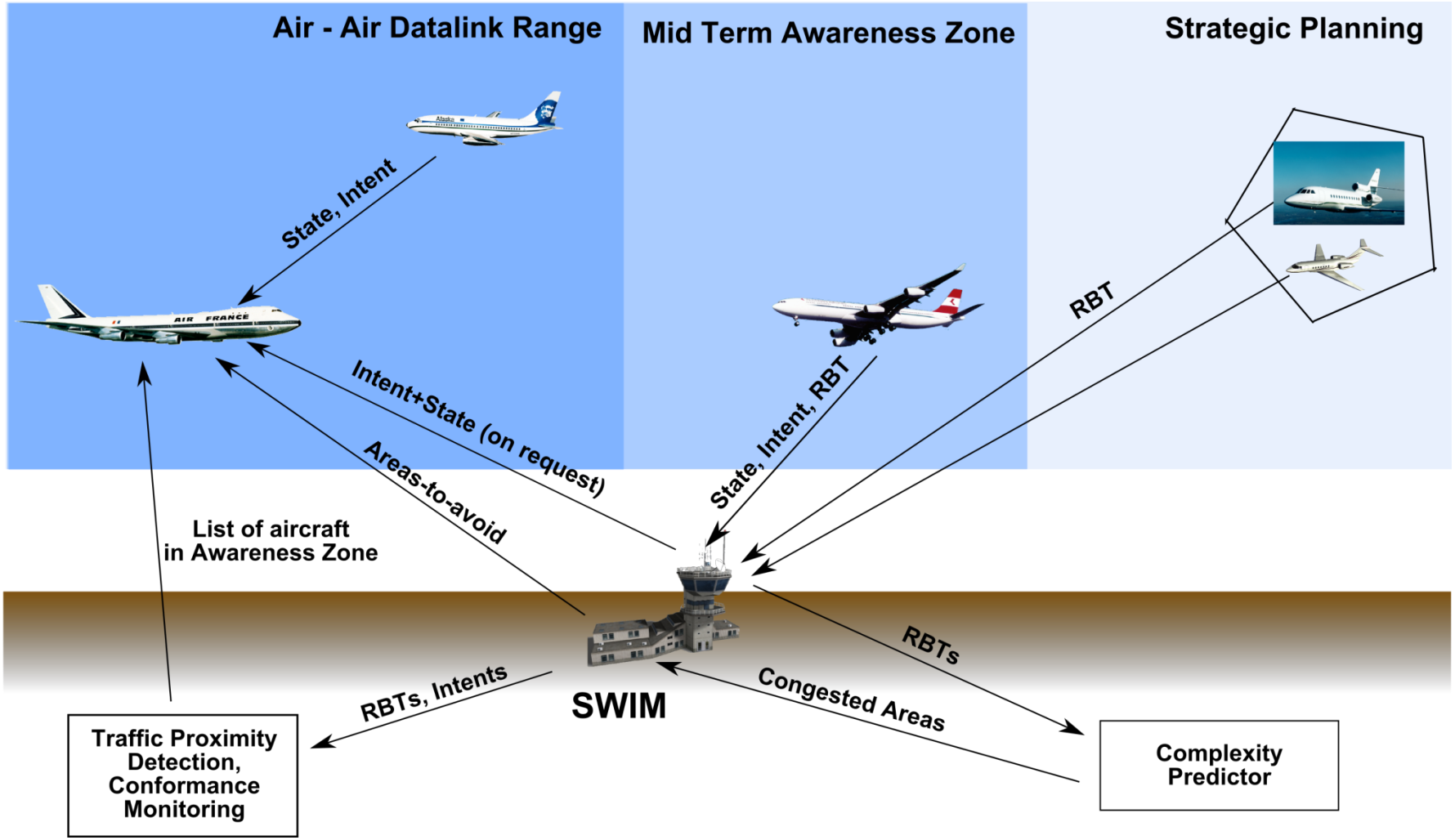

A³ ConOps – Envisioned Onboard Functions

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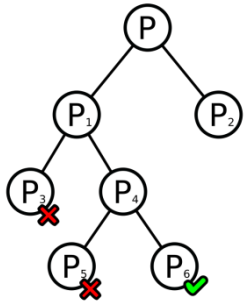
- ✓ Onboard Information Management

- ✓ Conflict and Threat Detection
  - ✓ Conflict Detection
  - ✓ Complexity prediction



- ✓ Conflict Processing Logic reflecting AFR
- ✓ Conflict Resolution
- ✓ Human Machine Interface (HMI) – ASAS* is an onboard supporting tool for the flight crew. The pilot is the final decision maker!

*ASAS = Airborne Separation Assistance System

A³ ConOps – Separation Management

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Two-level Process

Short-Term Time Threshold (STT)
(from predicted Loss of Separation)

CR Maneuver can be started before STT

Priority Rules

(only aircraft with low priority maneuvers)

CR Maneuver cannot be started before STT

Implicit Coordination

(all aircraft maneuver)

No explicit communication among conflicting aircraft.

*CR = Conflict Resolution

A³ ConOps – Envisioned Conflict Resolution

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Flight path modifications = temporary lack of situation awareness for surrounding aircraft

Two envisioned CR processes

Trajectory Modification

- Full intent information available for surrounding aircraft, but
- More complex flight update
- Requires more time for flight crew to understand and decide
- Anticipated execution delay (flight crew information processing*) about 2 minutes.

Tactical Maneuvering

- Only limited intent information available to surrounding aircraft, but
- Simple
- Allows for fast reaction to a detected threat
- Anticipated execution delay (flight crew information processing*) about 30 s.

*Information processing includes 4 steps: info acquisition, info analysis, decision selection, and action implementation.

HMI Airborne System Requirements

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Airborne Separation Assistance System (ASAS) = Flight Crew Decision Support Tool

Selected Flight Crew Tasks:

Achieve and maintain situation awareness

Decision Making:

- **Assessment of the flight path modifications proposed by ASAS**
- **Adjustment of a modification (if needed)**
- **Initiation of the approved flight path changes**

Required:

- HMI must be designed to allow for a quick and easy data input/understanding, which is tailored to users needs
- Appropriate level of automation
- Appropriate level of information

A3 ConOps Team

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iFly WP1 Authors:

- Frank Bussink (NLR)
- Ignacio Echegoyen (former Isdefe)
- Petr Cásek (Honeywell)
- Gustavo Cuevas (Isdefe)
- Aavo Luuk (University of Tartu)
- Claudia Keinrath (Honeywell)
- Rosa Weber (Honeywell)
- José García García (Isdefe)

iFly Partners and Reviewers contributing by providing feedback

iFly A3 ConOps has also benefitted from NASA's pro-bono involvement:

- NASA's advanced airborne self separation ConOps and research
- Active iFly participation by NASA Langley ATM Research Team
  - David Wing, Maria Consiglio
  - Frank Bussink, previously at LaRc on loan from NLR

A³ ConOps – References

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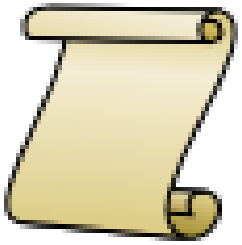
A³ related references:

- ✓ ***iFly: ASAS Self Separation – Airborne Perspective*;** Presentation at ASAS-TN Workshop in Rome 2008, (Petr Cásek and Rosa Weber).
- ✓ ***Airborne System for Self Separation in Trajectory-Based Airspace*;** 7th Eurocontrol Innovative ATM Research Workshop, EEC Bretigny 2008 (Petr Cásek and Claudia Keinrath).
- ✓ ***Comparison of Pair-Wise Priority-Based Resolution Schemes Through Fast-Time Simulation*;** 8th Innovative Research (INO) Workshop, Bretigny, 2009 (Richard Irvine).
- ✓ ***Priority Rules in a Distributed ATM;*** 1st International Air Transport and Operations Symposium, TU Delft, 2010 (Petr Cásek and Silvie Luisa Brázdilová).



Thank You!

http://ifly.nlr.nl

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