

iFly Project

Airborne Separation in Advanced En-Route ATM

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Innovative project for EC DG-TREN (6th Framework)

Consortium: 11 universities + 7 from ATM/aviation

iFly project duration: May 2007- August 2010

Total effort: ~ 50 person-years

Builds on theoretical results of **HYBRIDGE project for
EC DG-INFOS (2002-2005)**



Project Consortium

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- ★ National Aerospace Laboratory (NLR) 
- ★ Honeywell 
- ★ Isdefe 
- ★ University of Tartu 
- ★ Athens University of Economics And Business 
- ★ Eidgenossische 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 



iFly Overview

What?

iFly's objectives

Why?

Airborne Separation in SESAR/NextGen

How?

Project Structure

Previous Research

Main research areas





Develop & Validate



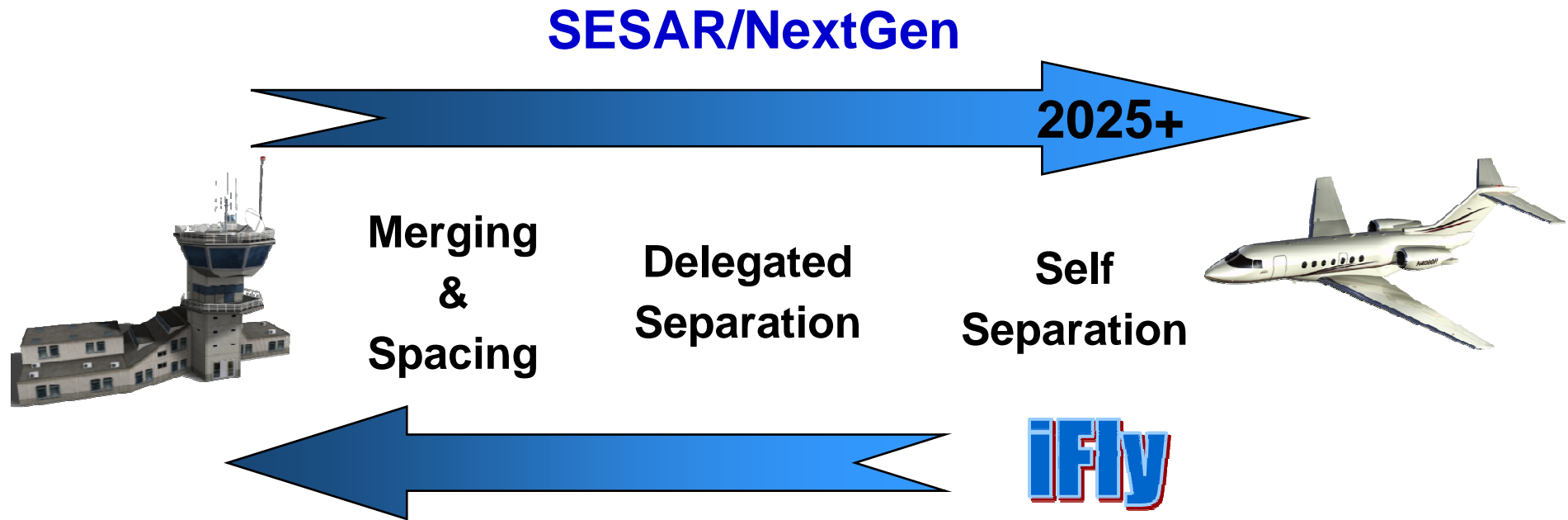
Highly automated ATM design for en-route traffic based on autonomous aircraft concept.

Key design aspects:

- Human responsibilities
- Traffic Complexity
- Safety Assessment using SESAR compliant safety targets

Airborne Separation in Future ATM

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iFly's Scope:

- ✓ High Density Traffic
- ✓ Only Self Separation Capable Aircraft

Research Questions

Two Design Cycles To Answer Two Main Research Questions:



- ❖ Up to which en route traffic demands is (pure) Self Separation sufficiently safe? (A3 design cycle)
- ❖ Which complementary support services from ground ATM are needed in order to accommodate higher traffic demands ? (A4 design cycle)

iFly Project Structure



Autonomous aircraft concept

- ✓ Free Flight
- ✓ AFAS
- ✓ Gate-to-Gate
- ✓ CARE-ASAS
- ✓ MFF
- ...

State-of-the-art

A3 Design Cycle WP1

- Assessment:
- Safety (WP7)
 - Efficiency (WP7)
 - Human factors (WP2)
 - Capacity (WP7)
 - Economy (WP6)

HYBRIDGE (2002-2005)

Distributed Control and Stochastic Analysis of Hybrid System

A4 Design Cycle WP8

- Complexity (WP3)
- Situation Awareness (WP4)
- Conflict Resolution (WP5)

WP9 & 8

Air and Ground Requirements

Advanced Operational Concept

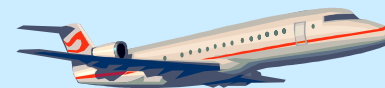
Previous Research

Theoretical Methods – Hybridge

- Novel methods in rare event modelling and estimation.
- Novel methods in conflict modelling and resolution.
- Accident risk simulation results for Mediterranean Self Separation.

Free Flight (Self Separation) Concept

- Free Flight
- AMFF
- DAG-TM (AATT)



Main Research Areas

- **Safety simulations (rare event modelling)**
- **Human factors**
- **Complexity metrics and prediction**
- **Situation awareness & modelling of complex hybrid systems**
- **Conflict resolution methods**



Safety Validation

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Hazards Identification

Safety Assessment – Rare event modelling based on the Hybridge project (TOPAZ)

Complex System Modelling – Piecewise Deterministic Markov Processes represented by Dynamically Coloured Petri Nets

Air Traffic Simulation – Sequential Monte Carlo Methods

Relevant Standard considered: RTCA/Eurocae ED78a Safety Assessment

Two Essential Tasks:

- 1. Provide Input To Both Design Cycles**
- 2. Analyse and Identify Bottlenecks of Designed Systems and Propose Solutions**

Main Issues

- Analysis of the current pilot's en-route tasks,
- Cockpit crew responsibility analysis,
- Pilot's workload studies
- Situation awareness maintenance
- Identification of bottlenecks



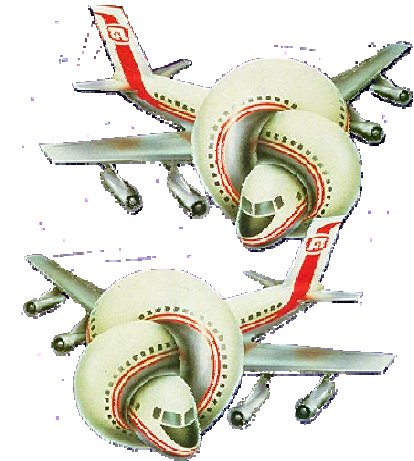
Complexity Metrics

Main Issues

- ❖ Complexity has not unique definition.
- ❖ Requirements are typically application-dependent.
- ❖ Existing metrics of Air Traffic Complexity are mostly related to the controller's workload (e.g., dynamic density).

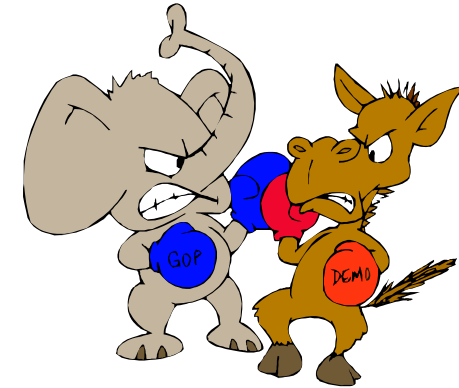
Considered Approaches

- ✓ Intrinsic metrics (not application dependent) – e.g., some topological or geometrical characteristic.
- ✓ Application dependent – tightly related to the CR methods (both airborne or ground-based).



Conflict Resolution

- **Long Term CR Methods** (behind one hour)
 - Both centralized (ground-based) and distributed methods
- **Mid Term CR** (tens of minutes)
 - Distributed methods, questions of suitable intent information
- **Short Term CR** (minutes)
 - Distributed methods, interface with TCAS



Main Issues

- Choice of suitable CR maneuvers
- Priority rules (if needed),
- Coordination of CR maneuvers between conflicting aircraft,
- TP uncertainty handling
- Conflict of multiple aircraft (clustering)
- Optimization (selection) criteria

Situation Awareness & Hybrid Systems

Two parallel approaches:

Conventional

Based on the expert assessment and subsequently validated – used in the both design cycles.

Theoretical (formal)

Based on the modelling of the complex hybrid system and subsequent analysis of the critical observability.

Vs.



Conclusions

iFLY objectives

- Assess maximum en-route traffic to be accommodated by self separation
- Develop en-route high traffic demand Self Separation concept (A3).
- Develop complementary ATM ground support concept (A4) which further increases capacity of self separation.

Web site: <http://iFLY.nlr.nl>

Coordinator: Henk Blom (NLR)

Currently within first design cycle (A3) – High-level ConOps delivered.

Thank You!

