iFly project: Airborne Self Separation as basis for advanced en route ATM

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5th ASAS-TN2 Workshop/2nd FLYSAFE Forum
September, 17-19th , 2007, Toulouse

iFly

- iFly project
- HYBRIDGE based safety risk simulation
- Conclusions

iFly project and motivation

- Innovative project for EC DG-TREN (6th Framework)
  - Partners: 11 universities + 7 from ATM/aviation
  - iFly project duration: May 2007- August 2010
  - Total effort: ~ 50 person-years

- Motivation:
  - Free Flight (airborne self separation) has been “invented” as a potential solution for high traffic demand airspace
  - During recent years ATM community research trend is to direct self separation research to situations of less demanding airspace

- Builds on theoretical results of HYBRIDGE project for EC DG-INFSO (2002-2005)
  - Novel methods in rare event modelling and estimation
  - Novel methods in conflict modelling and resolution
  - Accident risk simulation results for Mediterranean Self Separation

iFly participants

1. NLR (NL)
2. Honeywell (CZ)
3. ISDEFE (ES)
4. Univ. of Tartu (EE)
5. Athens U. Economics & Business (GR)
6. ETH Zurich (CH)
7. L'Aquila University (IT)
8. Politecnico di Milano (IT)
9. Cambridge Univ. (UK)
10. NTU Athens (GR)
11. Twente Univ. (NL)
12. ENAC (FR)
13. Dedale (FR)
14. NATS En Route (UK)
15. INRIA (FR)
16. Eurocontrol Experimental Centre (F)
17. DSNA-DTI-SDER (FR)
18. Leicester Univ. (UK)

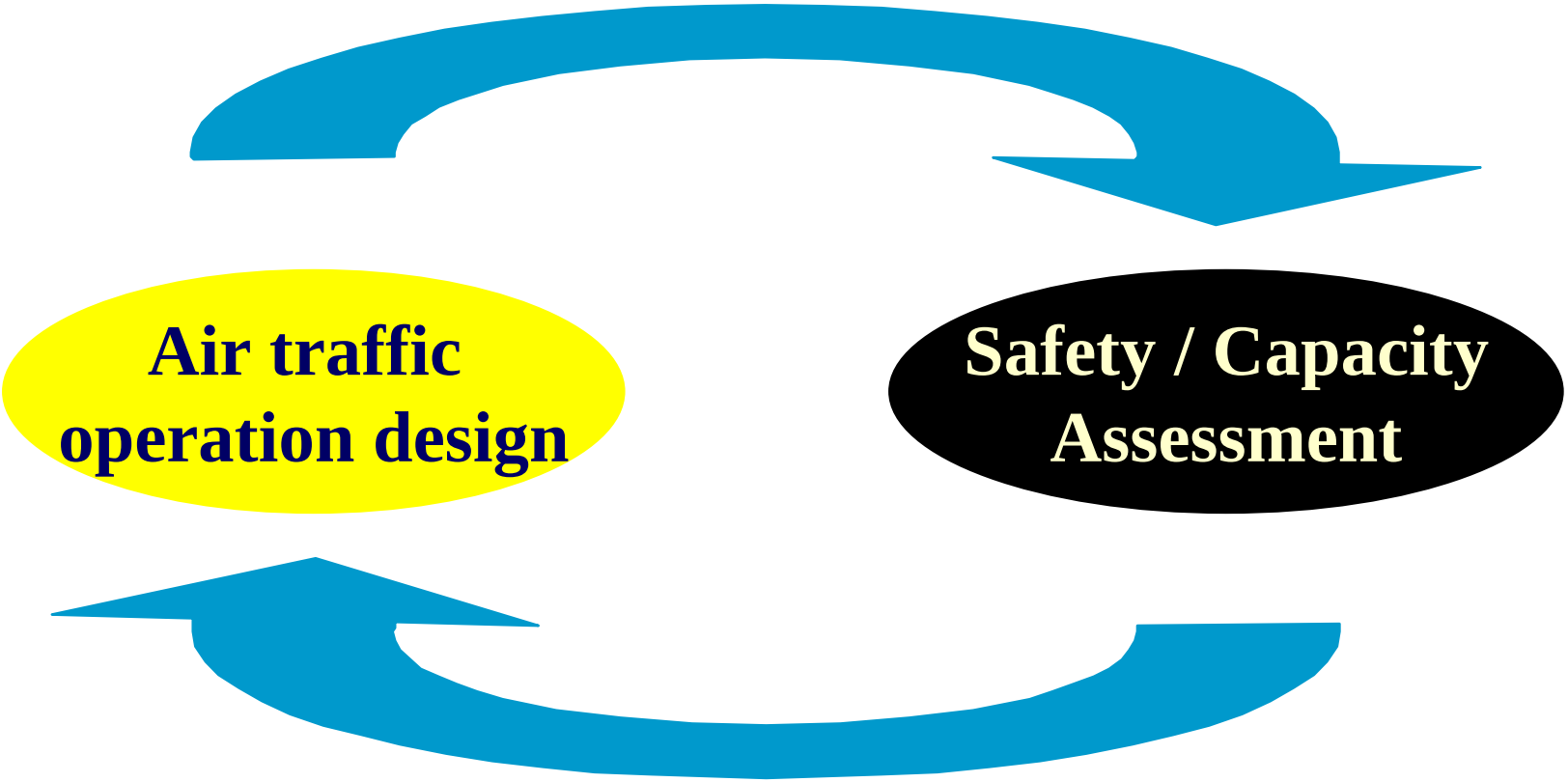
iFly objective

- Objective: developmentment of two advanced en route concepts:
  - High capacity Self Separation concept
  - Complementary ATM ground support of Self Separation equipped aircraft

- Key research questions:
  - At which en route traffic demands is Free Flight sufficiently safe ?
  - Which complementary support services from ground ATM are needed in order to accommodate higher traffic demands ?

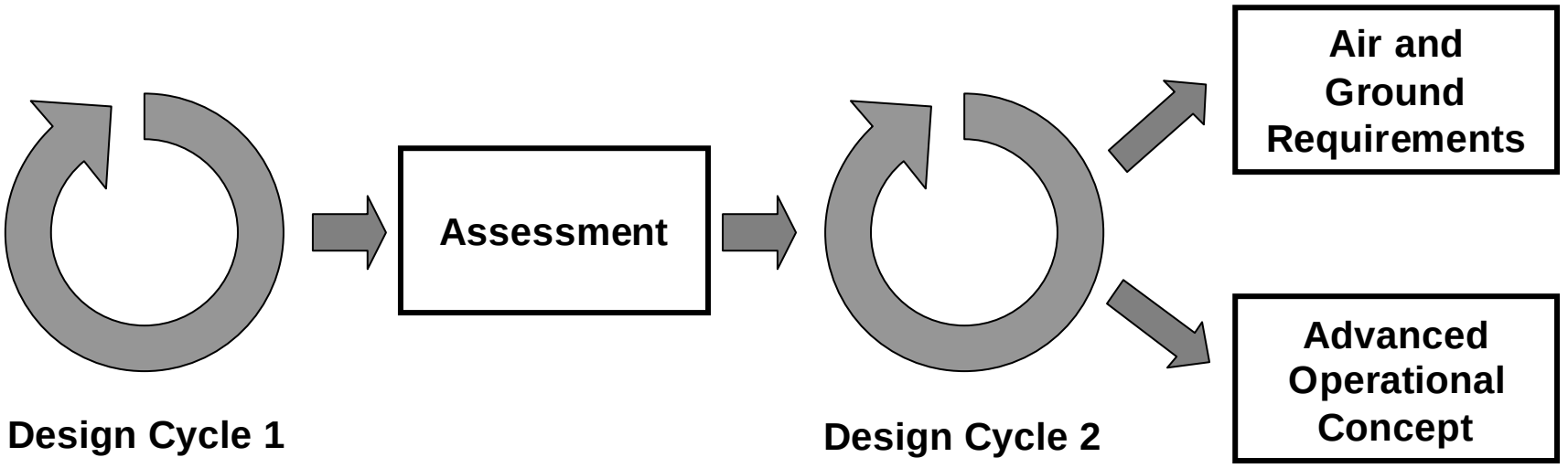
- Key design aspects
  - Human responsibilities are leading
  - Complexity is well understood
  - SESAR compliant safety targets

Safety feedback based design



iFly design cycles

First cycle starts on basis of Hybridge based safety risk simulation results



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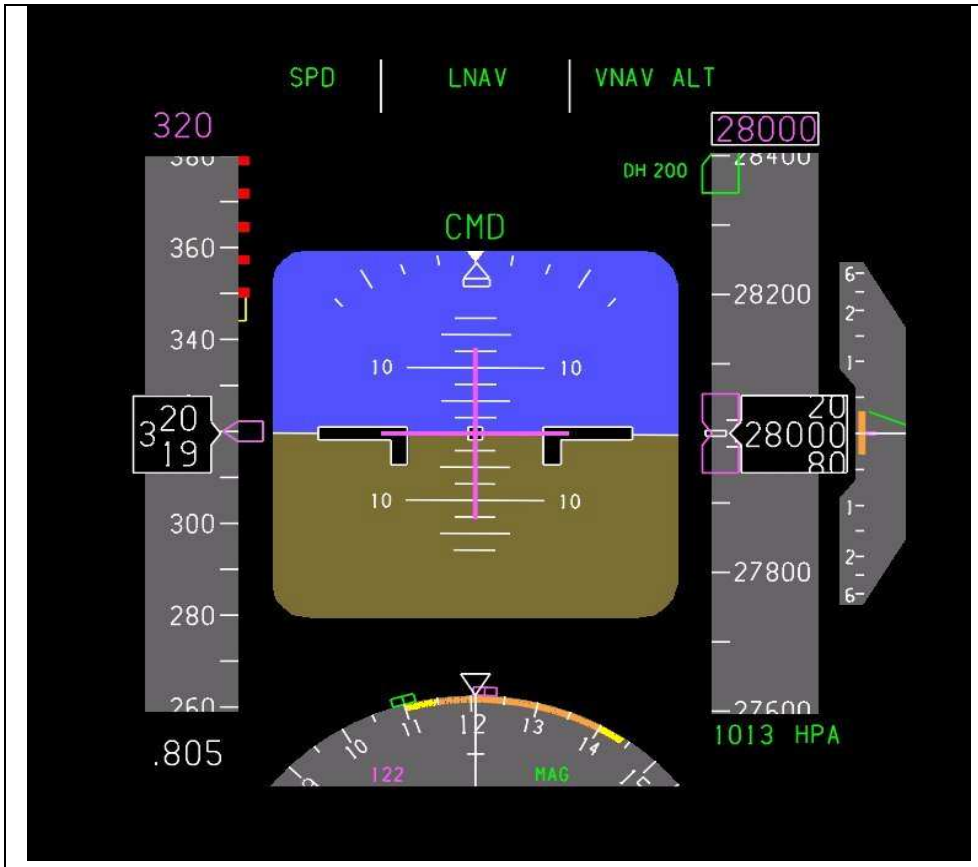
Autonomous Mediterranean Free Flight (AMFF)

- Future concept developed for traffic over Mediterranean area
- Aircrew gets freedom to select path and speed
- In return aircrew is responsible for self-separation
- Each a/c equipped with an Airborne Separation Assistance System
- In AMFF, conflicts are solved one by one (pilot preference)
- RTCA/Eurocae ED78a safety assessment for pair of aircraft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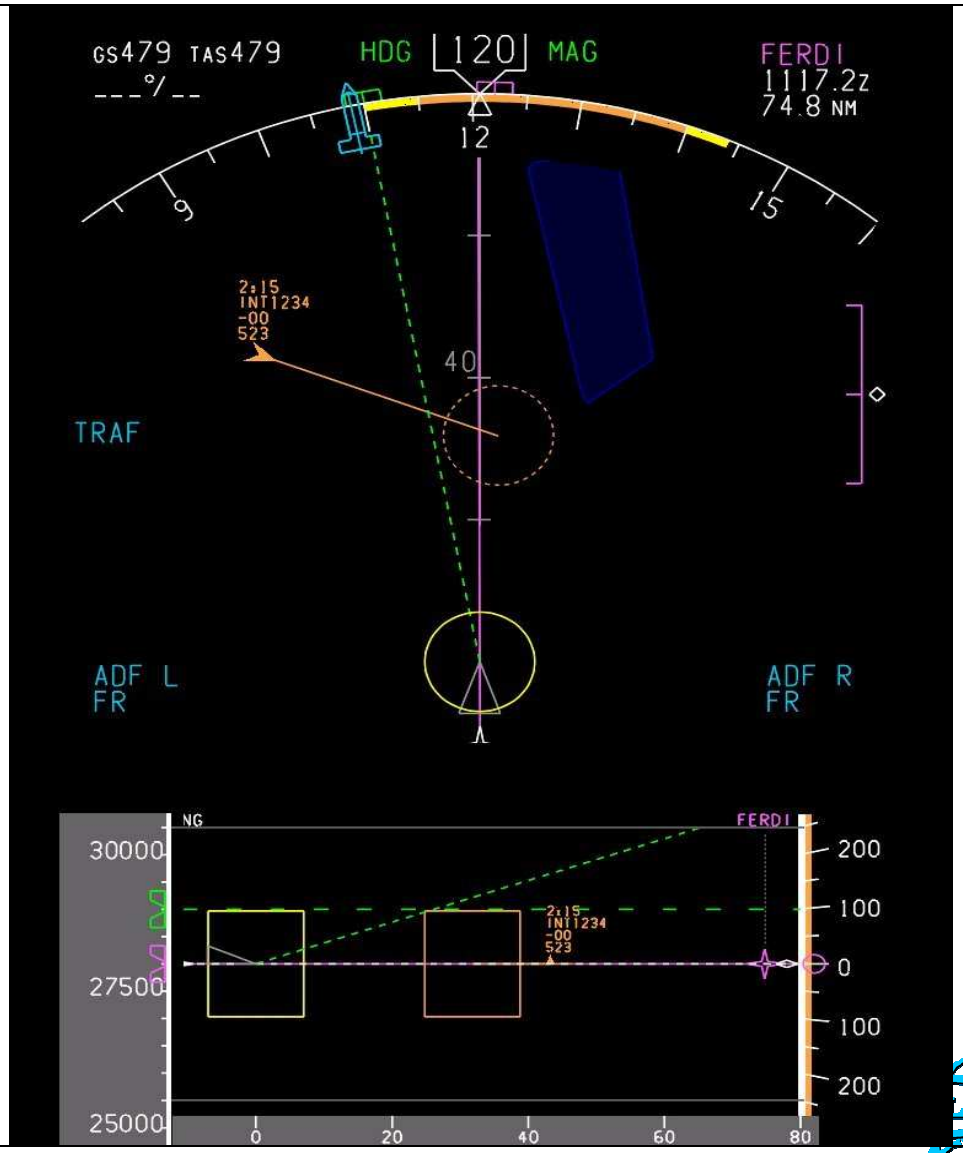
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20
40
60
80

Parameter values used in baseline simulation of AMFF enabling technical systems

Model Parameter	Probability
Global GPS down	$1.0 \cdot 10^{-5}$
Global ADS-B down	$1.0 \cdot 10^{-6}$
Aircraft ADS-B Receiver down	$5.0 \cdot 10^{-5}$
Aircraft ADS-B Transmitter down	$5.0 \cdot 10^{-5}$
Aircraft ASAS System mode corrupted	$5.0 \cdot 10^{-5}$
Aircraft ASAS System mode failure	$5.0 \cdot 10^{-5}$

Monte Carlo simulated scenarios

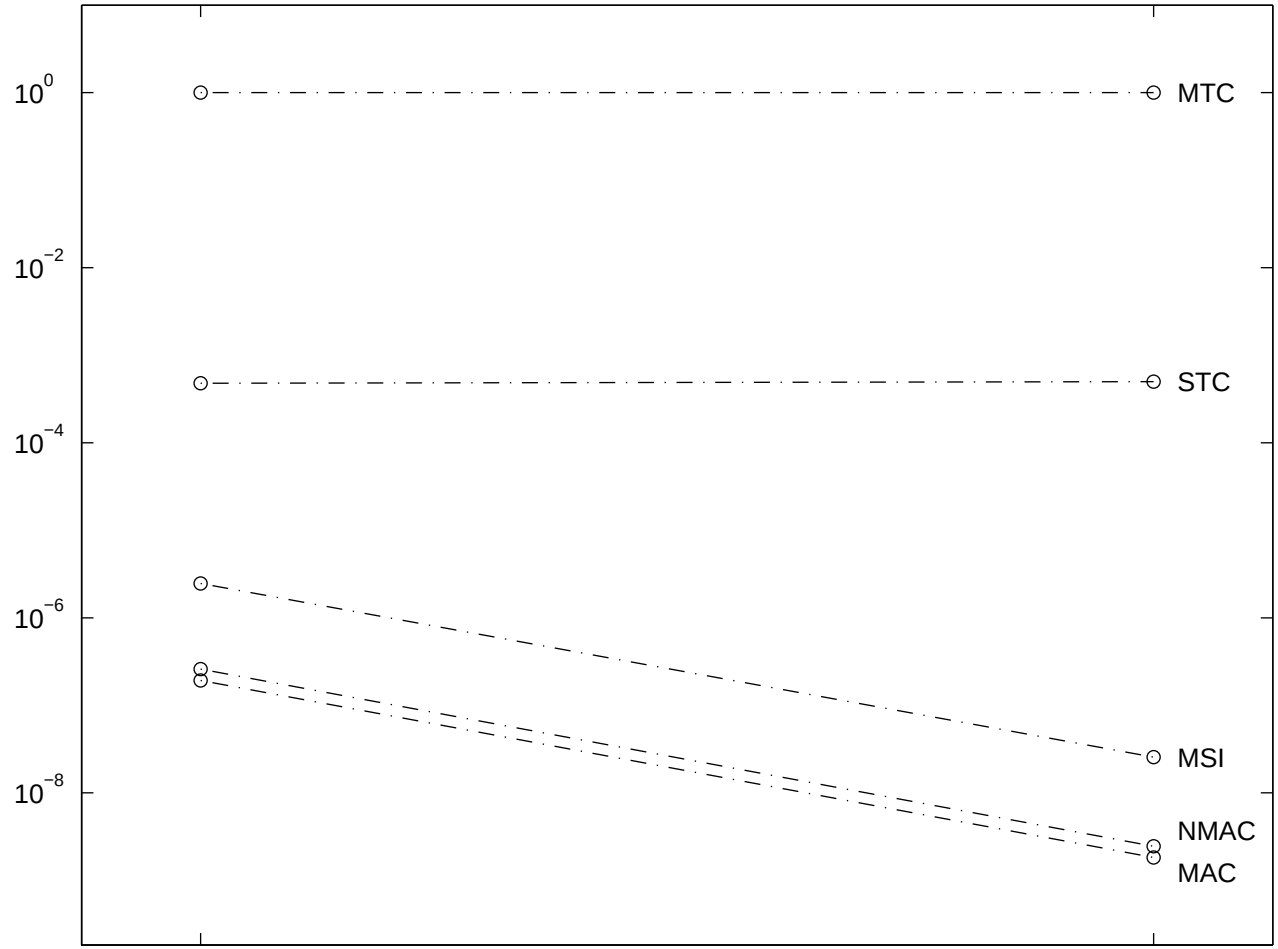
1. Two aircraft head on encounter
2. Eight aircraft encounter
3. Random traffic very high density

Safety related events assessed

Event	MTC	STC	MSI	NMAC	MAC
Prediction time (minutes)	8	2.5	0	0	0
Horizontal distance (Nm)	4.5	4.5	4.5	1.25	0.054
Vertical distance (ft)	900	900	900	500	131

MTC = Medium Term Conflict
STC = Short Term Conflict
MSI = Minimum Separation Infringement
NMAC = Near Mid-Air Collision
MAC = Mid-Air Collision

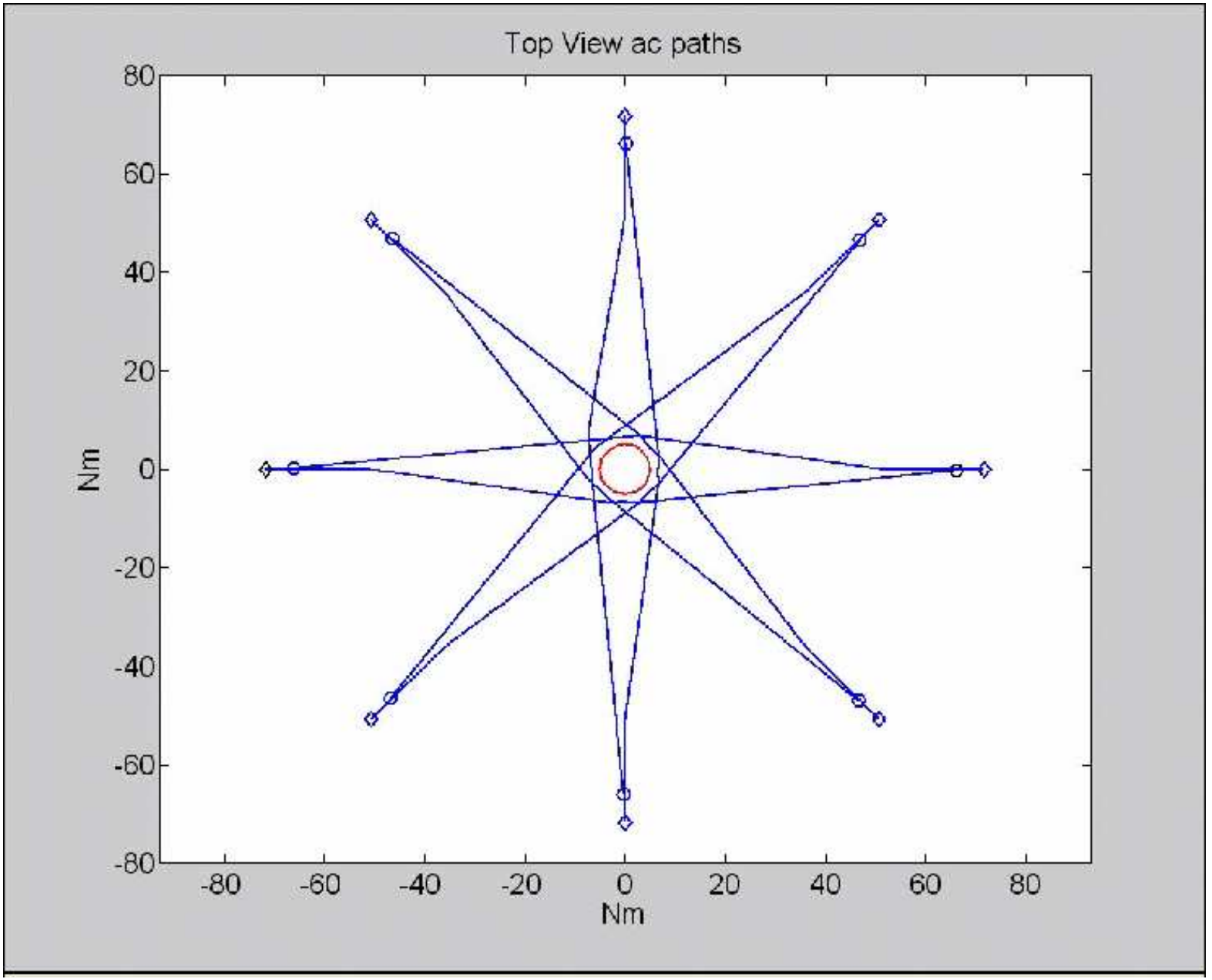
Figure 1. Two aircraft encounter under AMFF; dependability on GNSS, ADS-B and ASAS systems



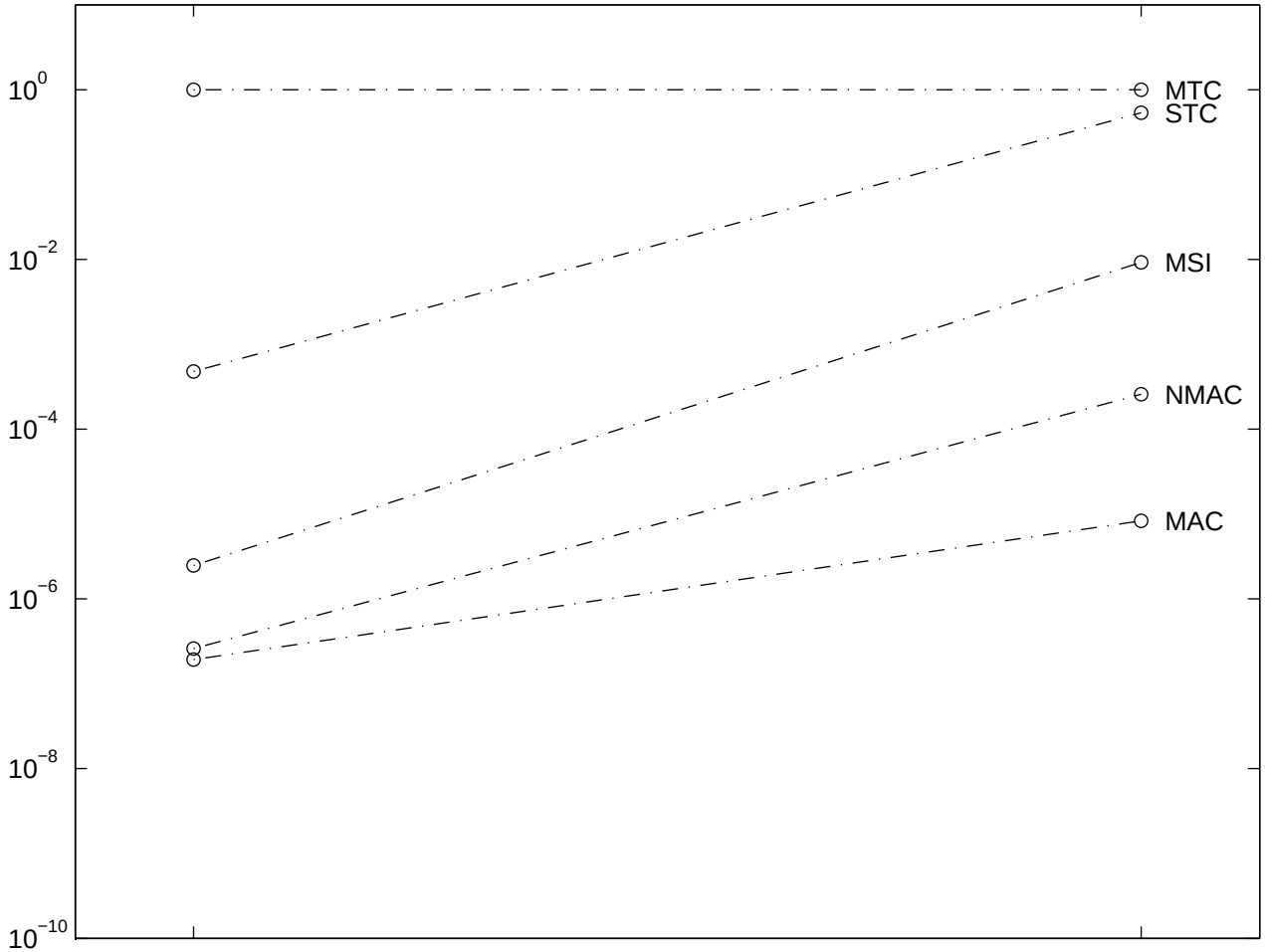
Baseline → High

Availability/reliability

Eight aircraft encounter - coordinated resolution



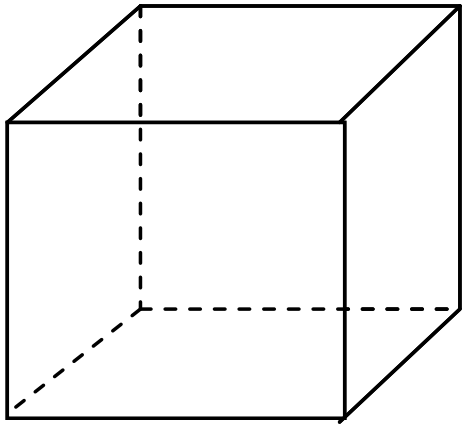
Two aircraft encounter vs. eight aircraft encounter



2 a/c → 8 a/c

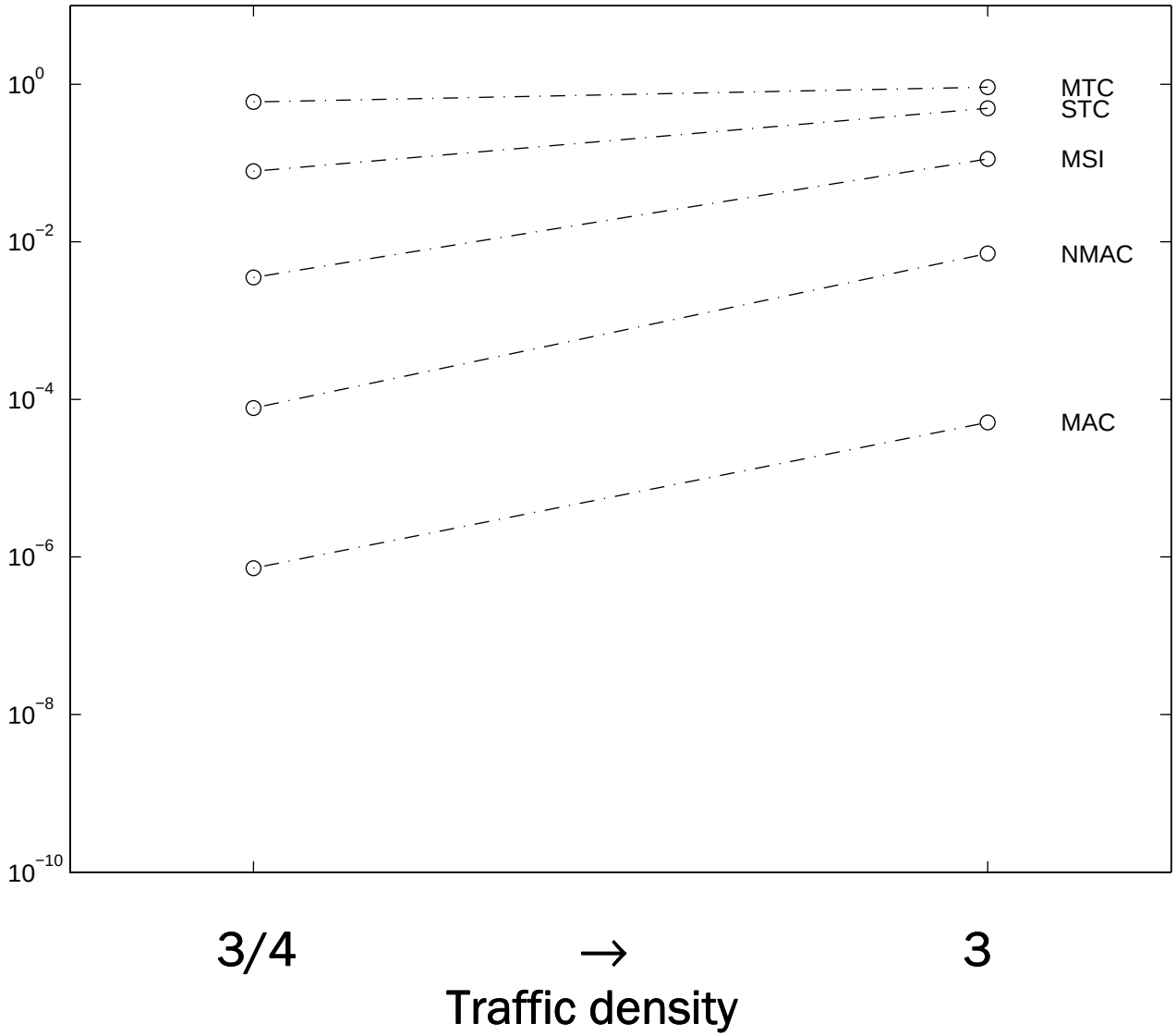
# of aircraft

Scenario 3
Random traffic, high density



- **Eight aircraft per packed container**
  - 3 times as dense above Frankfurt on 23rd July ’99
  - factor 4 lower dense

High density random traffic



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Conclusions

- HYBRIDGE theoretical developments enabled to assess safety risk of self separation concept, and has deserved iFly continuation
- Self Separation in combination with solving conflicts one by one, appears to fall short in accommodating high en-route traffic demand.
- iFLY objectives
  - Assess maximum en-route traffic to be accommodated by self separation
  - Develop en-route high traffic demand Self Separation concept
  - Develop complementary ATM ground support concept which further increases capacity of self separation
- Web site: http://iFLY.nlr.nl

Thank You !