The CASSIS Flight Trials

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Overview

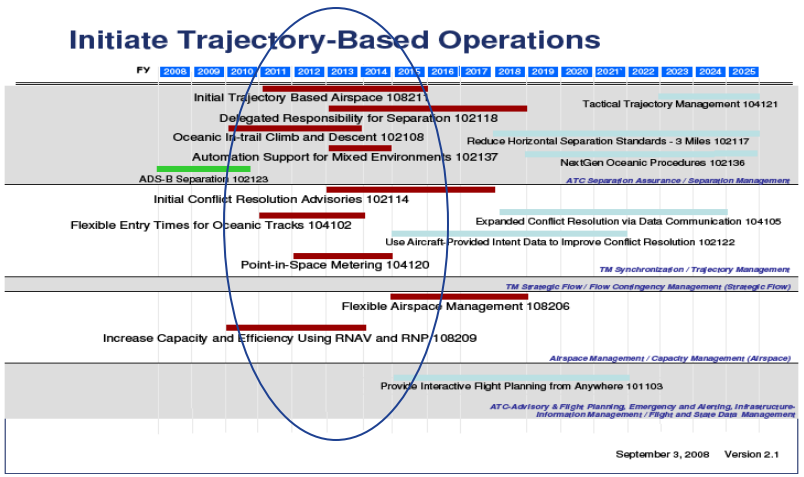
- CASSIS Background
- Trajectory Based Operations
  - How do we get from here to there?
- CASSIS Flight Trials
  - Objectives
  - Setup
  - Results
- Conclusions & Next Steps

CASSIS - CTA / ATM System Integration Studies

- Explore the concept feasibility
- Conduct several hundred trials with revenue-flights
- Produce CTA ConOps document

http://www.eurocontrol.int/tma2010/public/standard_page/CASSIS.html

What are we trying to solve?



A two-pronged approach

POLICY:

Integration of Air+Ground and C+N+S Industry Consensus: RTCA NextGen Task Force

TECHNICAL:

Use best existing equipage for Mid-Term

Importance of operational evaluations that "Learn and Leave Behind"

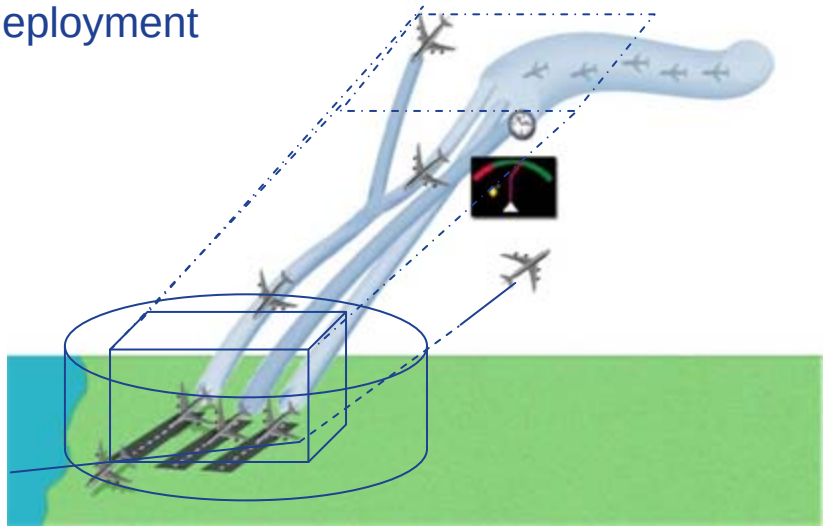
Take managed investment risks in deployment

"Path to Performance"

RNAV= (2D) Flexible Routing

RNP = (3D) RNAV +Integrity +Availability +Containment

4D-RNP TBO = (4D) RNP + Negotiation with ATC via datalink for Reference Business Trajectory. Time-guidance < 10 second accuracy anywhere in profile.



Value of CASSIS

Bringing all players together to “break the cycle”

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Stockholm – Arlanda (ESSA)

Objectives of Trial Flights

Delay En Route

- Avoid holdings by taking delay en route instead

Improve Arrival Management

- Strategic Planning – extend planning horizon

Delay on Ground

- Pop-up flights disrupt the arrival sequence

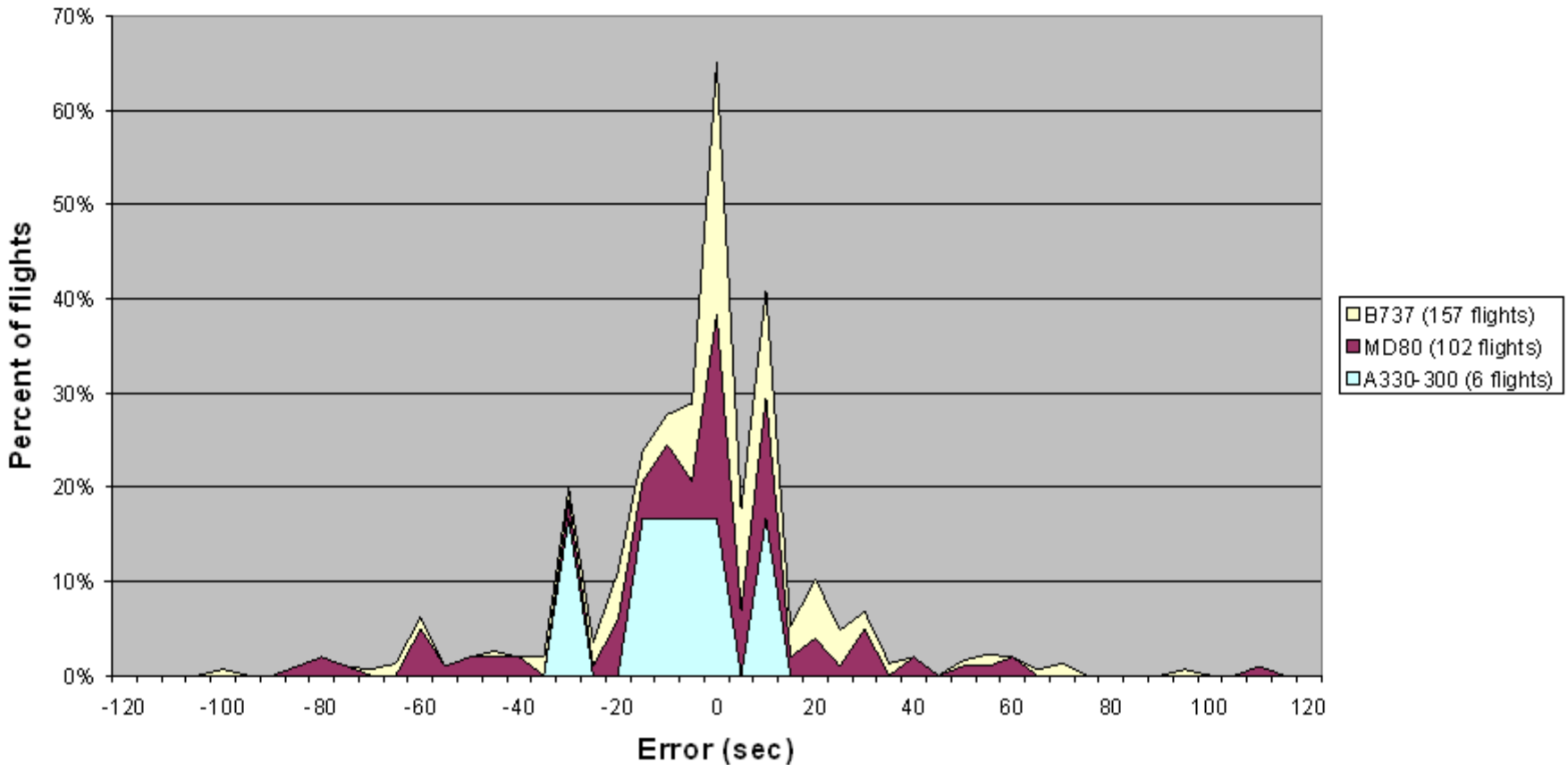
“Royal Flights”

- 32 flights, RTA to IAF or Runway

CASSIS 2008 CTA Flight Trials
- *Over 300 flight tests!*

	Round 1 June-July 2008	Round 2 September, 2008	Round 3 December 2008
Number of flights	~100	~100	~100
Traffic situation	Low	Low and High	Low and High
Delay on ground	No	Yes	Yes
“Royal Flights”	No	Yes	No
CTA as a spacing tool	No	Yes	Yes
Entry points	Hammar (Northern)	Hammar (Northern)	Hammar (Northern) Eltok (Western)
Aircraft Types	MD80 Family, B737NG	MD80 Family, B737NG	MD80 Family, B737NG A330-300

Completed Cassis Flights
All types of aircraft and trial types



Experiment Infrastructure

Intent Bus in B737 since 2006

- **ARINC 702A-1 Trajectory Bus**
  - **Aircraft current-state information 2Hz**
  - **Aircraft 4D trajectory predictions (Intent)**
    - Each minute or when FP changes
    - Full trajectory to runway
    - Includes vertical wpts and turns

Dedicated ARINC 429 Bus and/or via ACARS

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ACARS Downlink: Stockholm to Malmo Flight

Route: ESSAESMS10

---------starts here----------

1,,,N59397E017581.

1,R,113,N59401E018009,108,090122.

C,,,N59376E018019,500,090227.

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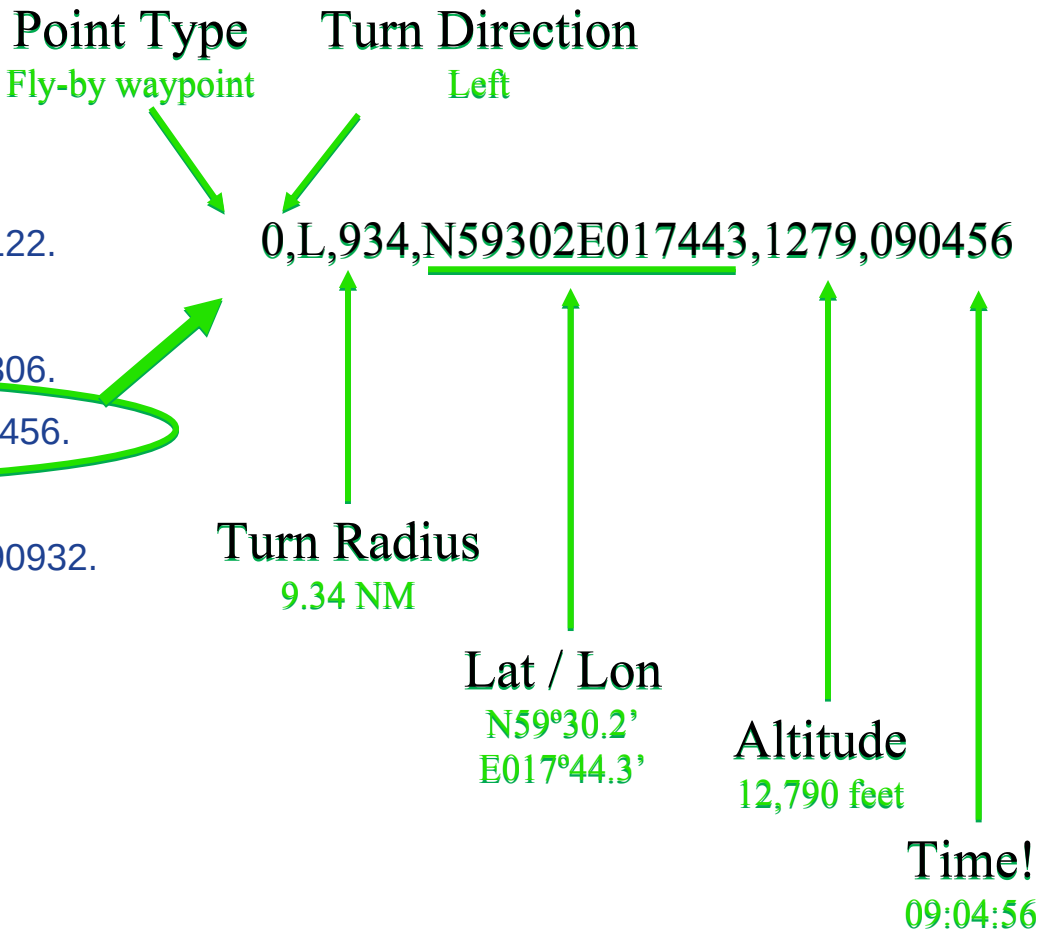

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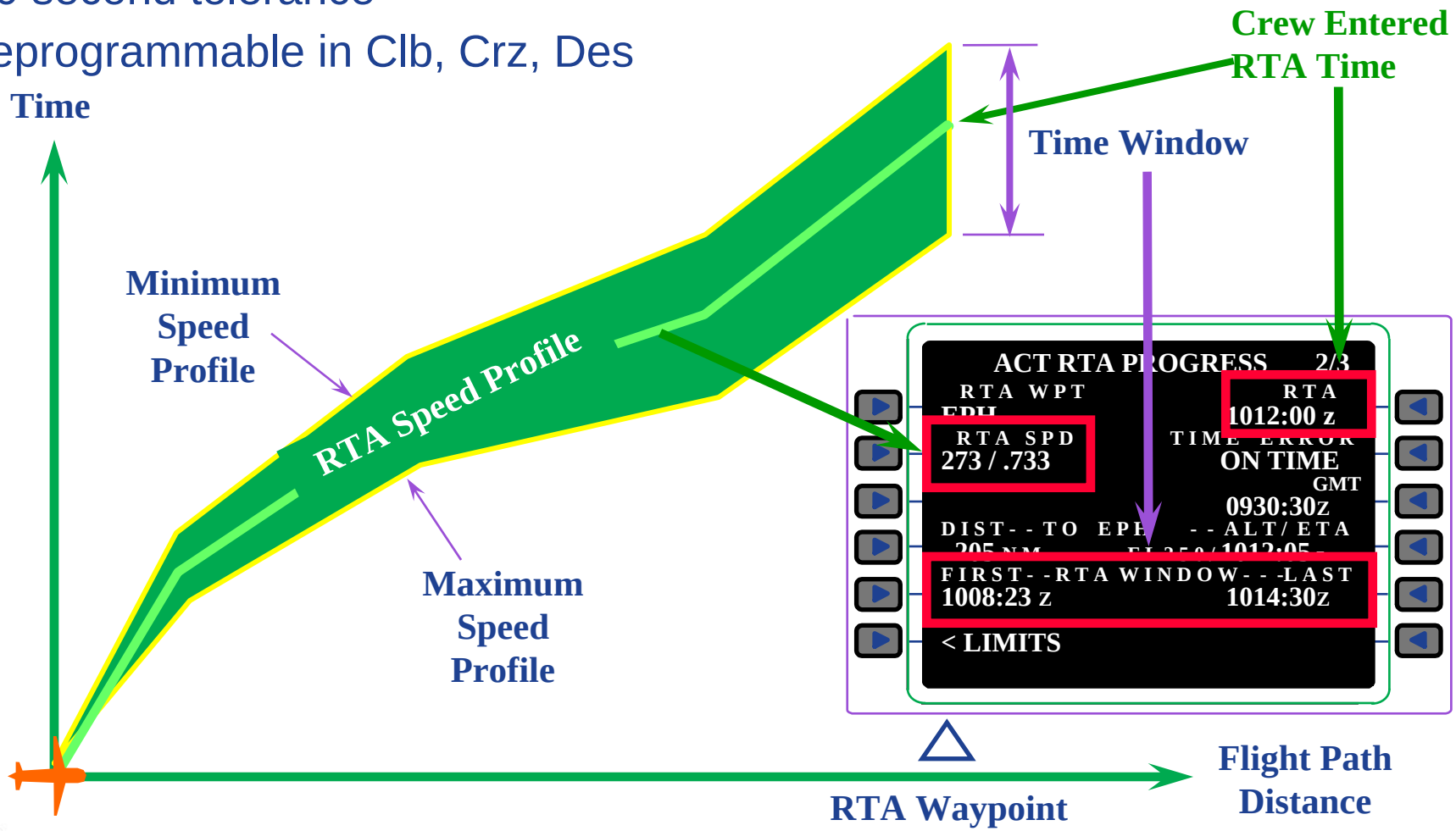
Required Time of Arrival (RTA)

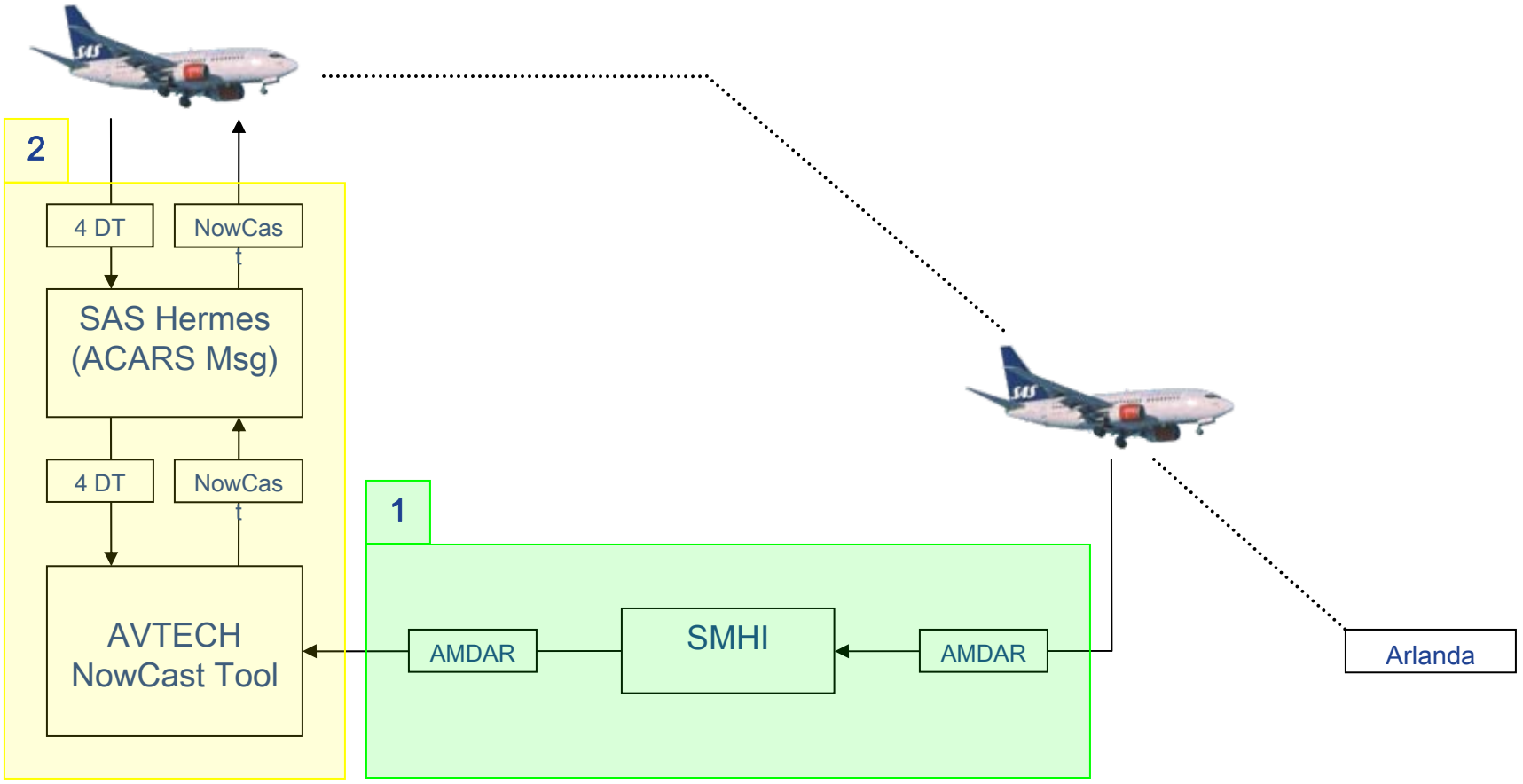
RTA accuracy based on the FMS precision ‘4D’ trajectory

6.0 second tolerance

Reprogrammable in Clb, Crz, Des



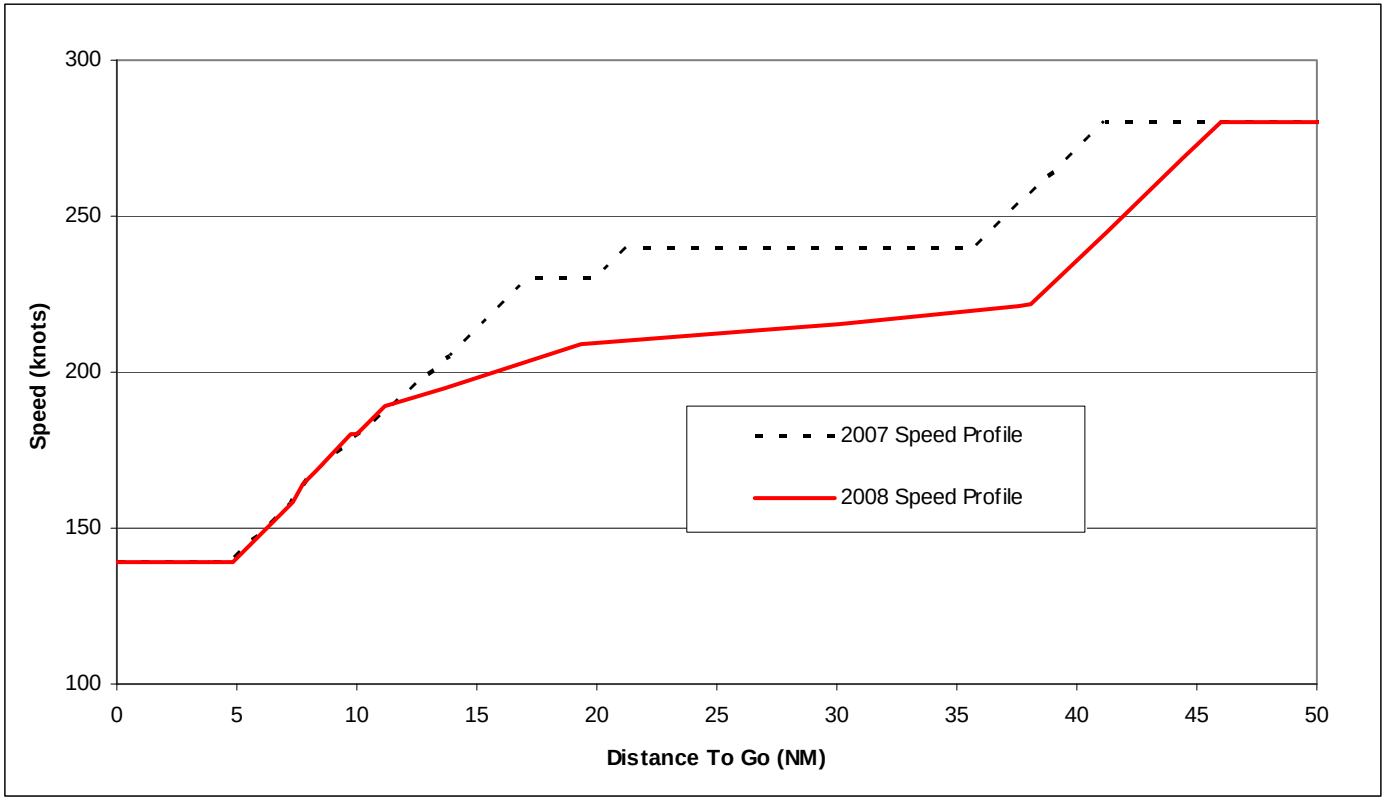
AVTECH NowCast wind uplink



Results of Royal Flights

	CTA Accuracies				
	IAF	*Threshold (All)*	*Threshold (ETA)*	*Threshold (ETA+2)*	*Threshold (ETA-2)*
Rel. Mean	-0.4 sec	3.3 sec	7.6 sec	-6.6 sec	3.1 sec
Rel. σ	5.9 sec	17.3 sec	10.9 sec	19.7 sec	23.6 sec
Abs. Mean	4.0 sec	14.7 sec	10.9 sec	17.0 sec	19.4 sec
Abs. σ	3.9 sec	9.4 sec	7.1 sec	9.1 sec	11.4 sec

Impact of speed and altitude constraints



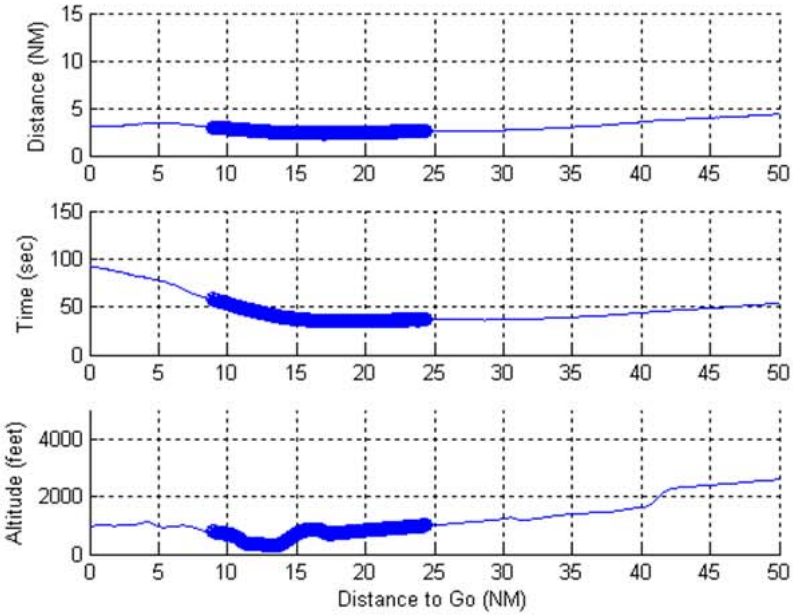
Separation Evaluation

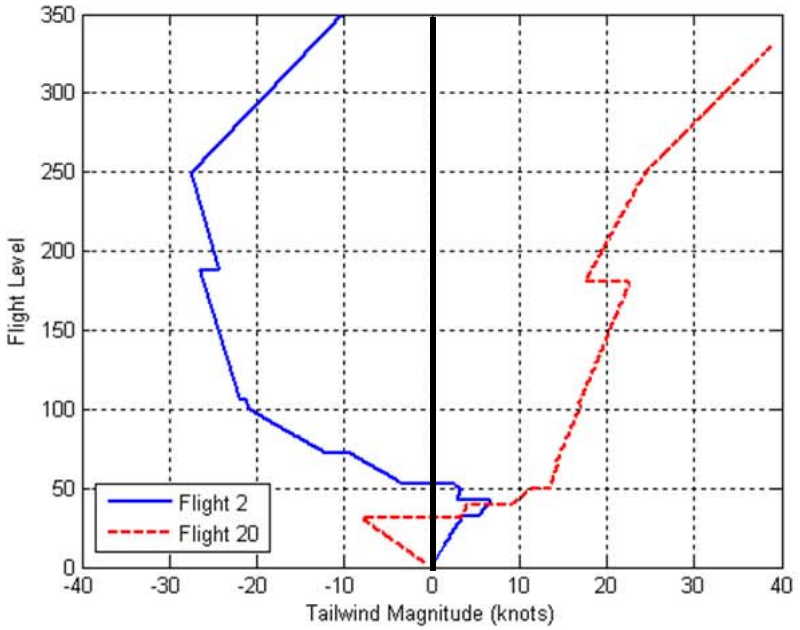
- Using Quick Access Recorder (QAR) Data
- "Time Shift" one flight for ΔRTA relative to a second flight
- Examine flights with RTA at runway only
  - Flights to same runway and STAR only
- 33 valid flight pairs ➢ 66 comparisons
- Runway spacing of 60 – 120 seconds

Theoretical Separation Evaluation

Target Landing Separation	3NM / 1000 ft Separation Violations	
	Number	Percent
60 sec	64	97.0%
75 sec	57	86.4%
90 sec	9	13.6%
105 sec	1	1.5%
120 sec	0	0.0%

Evaluation of Individual Cases Revealing





Flights occurred on different days, with very different wind conditions

“Green Ap

Scandinavian Airlines reports:

>4000 Green Approaches so far

- 60kg fuel saved on each
- 756 Metric Ton CO2 reduced
- 2,300 kg of NOx reduced
- 240,000 kg of fuel saved

SAS-Sweden potential 36,000 Green Approaches yearly into Stockholm alone

- $5.8M fuel reduction plus $4M yield improvement yearly
- 23,000 Metric Ton CO2 reduction yearly
- 79 Metric Ton of NOx reduction yearly
- Noise reduced by 50% (65db exposure area)

LFV committed to 80% “Green Approaches” by 2012!

Conclusions

- 4 second accuracy at IAF, < 15 seconds at the runway threshold
- Wind error major impact on time accuracy
- Flap extension and speed/altitude constraints significant role beyond IAF
- Separation must be dealt with, but not an impossible problem to solve
- Further integration with ATM tools an integral next step

Next Steps

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CASSIS 2

Continue success of CASSIS

Expand to other operators and aircraft

- **Novair, KLM**
- **B737, A320**

Improve integration with ground equipment

- **Thales ATM**
- **Egis Avia**

MINT – Minimum CO_2 in the TMA

AIRE project

Sponsored by SESAR

RNP AR flights with Novair A321

Further use of CTA in descent

4DTRAD Standarization

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RTCA SC-214 / EUROCAE WG 78

- **4D Trajectory Datalink (4DTRAD)**
- **Queue Management using RTA / CTA**
- **Primarily focused on communication, but navigation and surveillance also important:**
  - **How will trajectory be used?**
  - **How will RTA / CTA be used?**
  - **What implications does this have for the FMS?**
  - **What impact do different implementations have?**

RTCA SC-214 / EUROCAE WG 78

The need for standardization

- **Downlink of performance?**
- **Number of Speed Changes?**
- **Monitoring (who and when)?**

Two Approaches

- **New EUROCAE WG focusing on 4D Nav**
- **RTCA Committee looking at TBO at a higher level**

Thank You!

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