Some Challenges in Air Traffic Management Research

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2nd CFES Workshop
Cambridge, 24th March 2010

EUROCONTROL

The European Organisation for the Safety of Air Navigation

Outline

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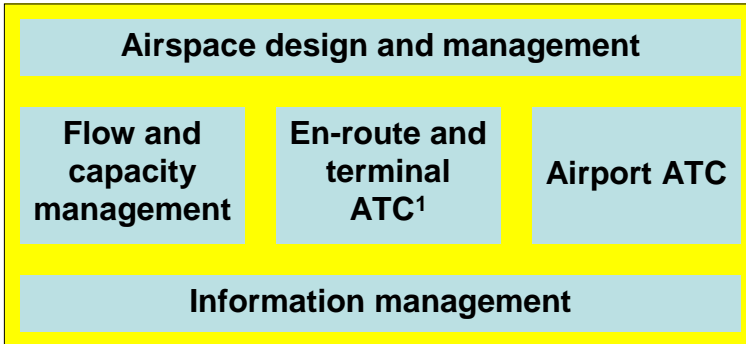
- **Introduction**
  - **Current European institutional arrangements**

- **Some challenges**

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Outline

- **Introduction**
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What is Air Traffic Management?

Here's a traditional view with five elements:

Airspace design and management		
Flow and capacity management	En-route and terminal ATC[1]	Airport ATC
Information management		

[1]Air Traffic Control

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European ATM Institutions

ECAC

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EU

Switzerland
Monaco
Albania
Moldova
FYROM
Croatia
Ukraine
Bosnia & Herzegovina
Serbia
Armenia
Montenegro

Netherlands	Slovakia
France	Poland
Belgium	Slovenia
UK	Bulgaria
Portugal	Germany
Greece	Lithuania
Luxembourg	Denmark
Spain	Romania
Hungary	Czech Rep
Italy	Norway
Turkey	Austria
Ireland	Malta
Sweden	Finland
Cyprus	

Latvia
Estonia

Georgia
Azerbaijan
Iceland
San Marino

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SESAR Joint Undertaking

www.sesarju.eu

- EU is developing Single European Sky (SES) legislation to reduce fragmentation and increase performance
- SESAR = Single European Sky ATM Research
- SJU is a European PPP[1] formed to coordinate ATM R&D
- Founding members: EU and EUROCONTROL
- 15 industry members
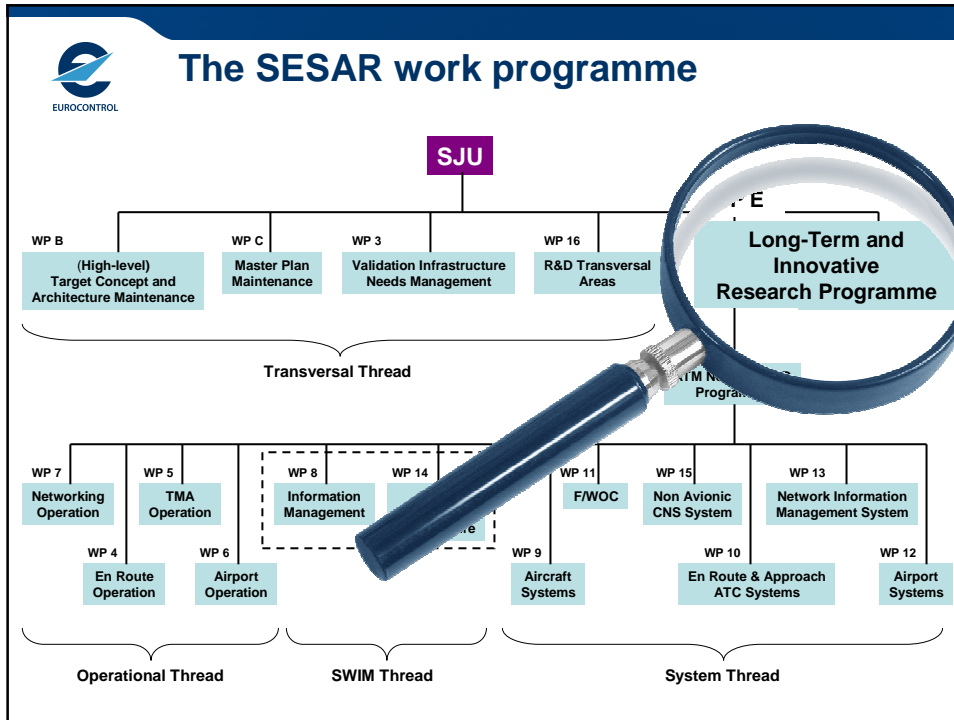- Total budget: €2.1 billion (8 years)

[1]PPP = Public Private Partnership

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25/03/2010

The SESAR work programme

SJU

E

WP B	WP C	WP 3	WP 16	
(High-level) Target Concept and Architecture Maintenance	Master Plan Maintenance	Validation Infrastructure Needs Management	R&D Transversal Areas	**Long-Term and Innovative Research Programme**

Transversal Thread

WP 7	WP 5	WP 8	WP 14	WP 11	WP 15	WP 13
Networking Operation	TMA Operation	Information Management		F/WOC	Non Avionic CNS System	Network Information Management System

WP 4	WP 6		WP 9	WP 10	WP 12
En Route Operation	Airport Operation		Aircraft Systems	En Route & Approach ATC Systems	Airport Systems

Operational Thread   **SWIM Thread**   **System Thread**

Outline

- **Introduction**
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An overarching challenge: improve in all the ICAO key performance areas

Societal Outcome

Safety

Security

Environmental Sustainability

Operational Performance

Cost Effectiveness

Capacity

Efficiency

Flexibility

Predictability

Performance Enablers

Access & Equity

Participation

Interoperability

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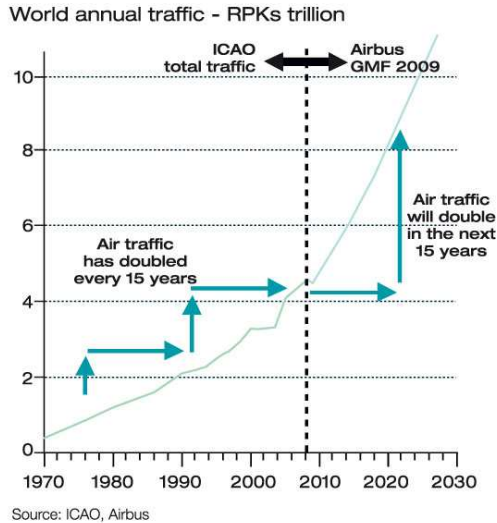
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Challenge #1: Forecasting the future

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Challenge #1: Forecasting the future

We are accustomed to seeing curves like this ...

Forecasting the future:
Short-term forecasting

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Slide 15

Forecasting the future:
Long-term forecasting

IFR Movements/Year (Thousands)

Forecast — Constrained ScA — Constrained ScB — Constrained ScC
— Constrained ScD — Unconstrained ScA — Unconstrained ScB
— Unconstrained ScC — Unconstrained ScD — ◆— _Actual

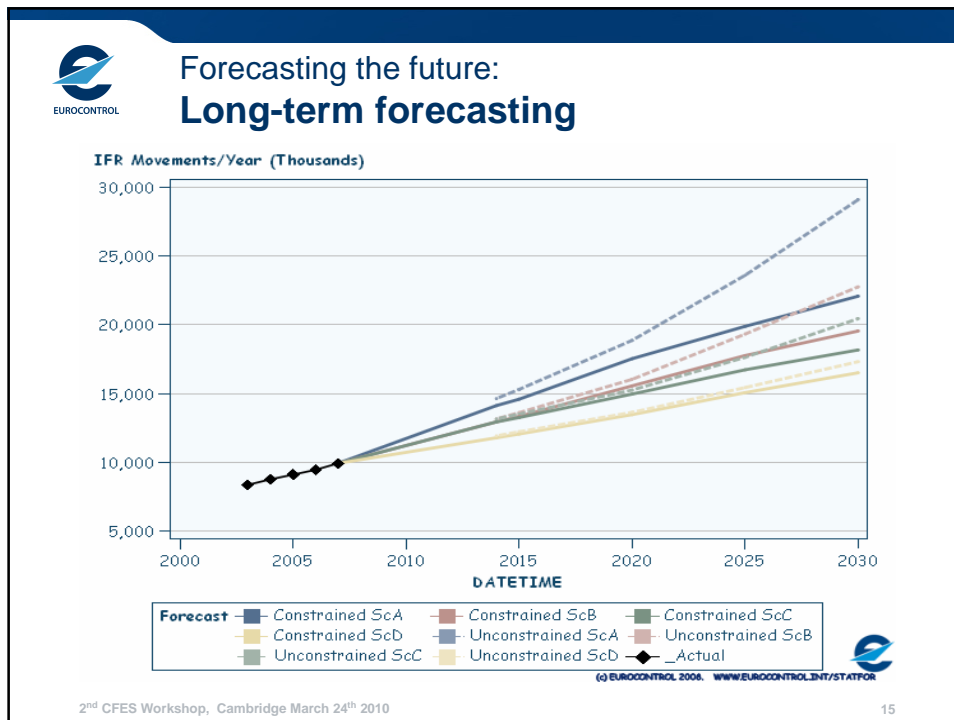(c) EUROCONTROL 2006, WWW.EUROCONTROL.INT/STATFOR

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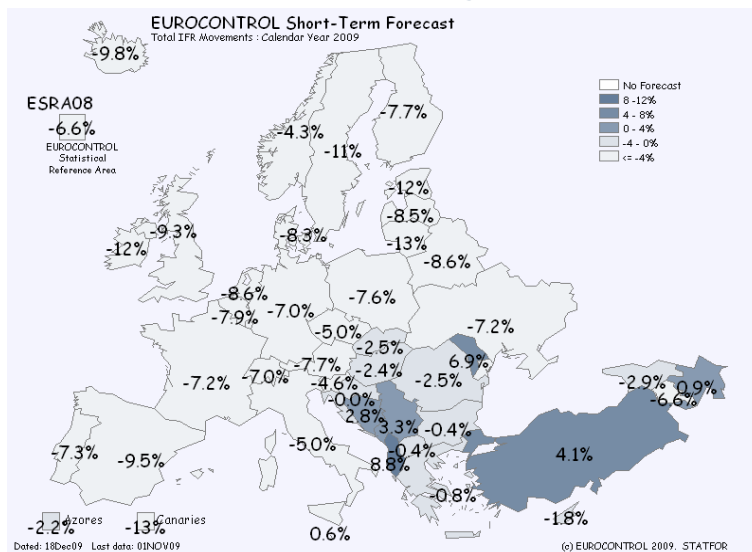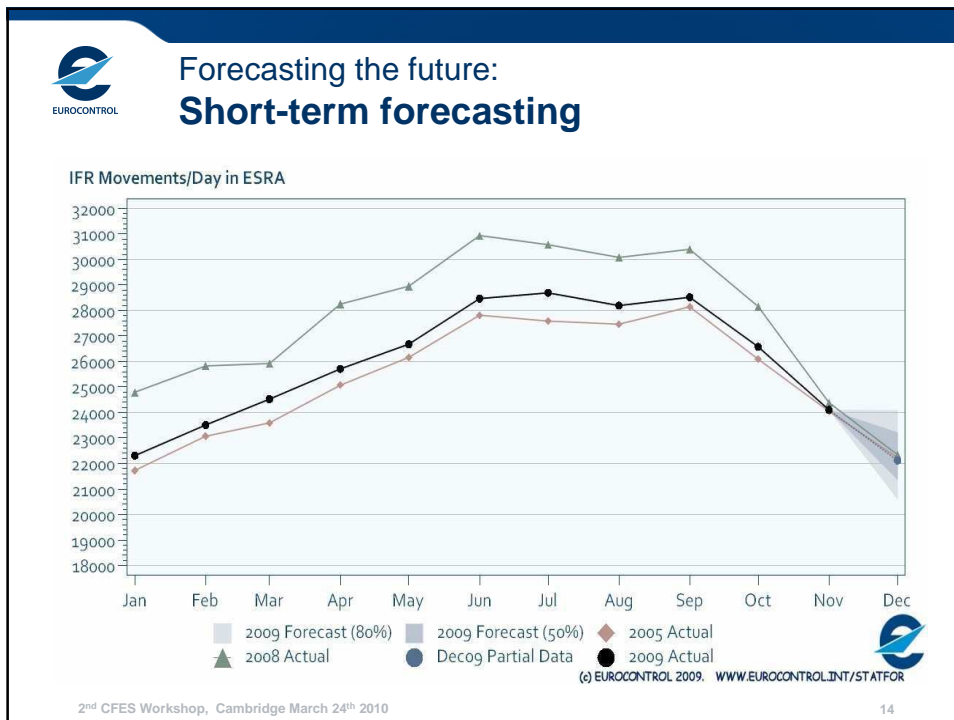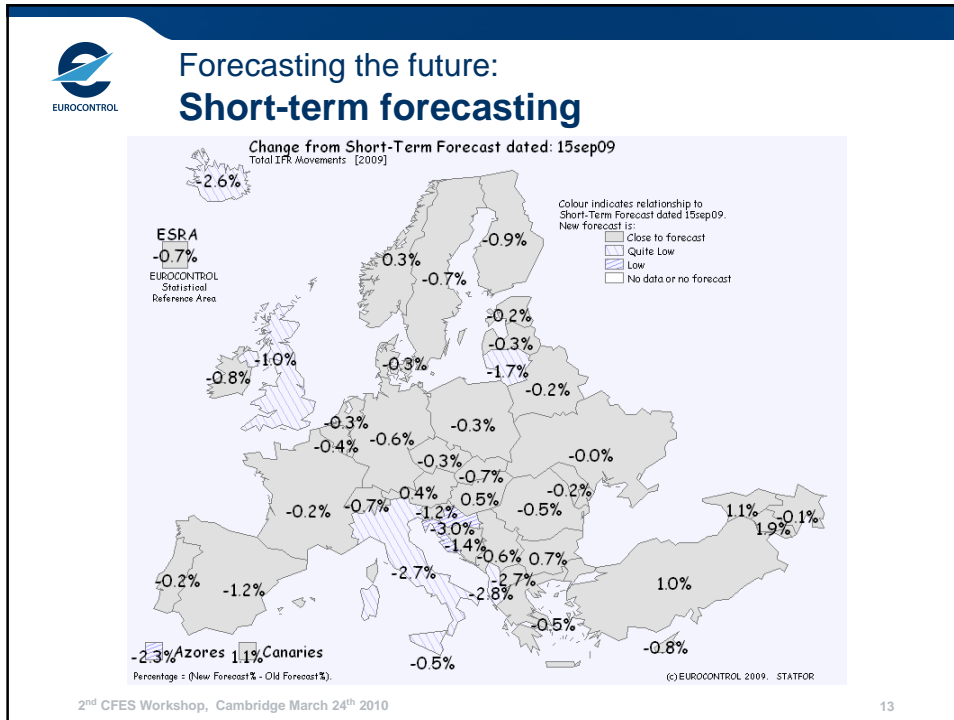
Forecasting the future:
Why does it matter?

1. The sustainability debate needs credible data

2. R&D investment is directed towards the current hot topic
   - In recent years this has been a moving target:
     - Capacity (delays)
     - Security (9/11)
     - Efficiency (low-cost carriers, economic fragility, fuel prices)
     - Environment

   "SESAR needs to deliver results on the industry's top priorities - safety, environmental responsibility and financial sustainability"
   Giovanni Bisignani – Director General and CEO, IATA

   - Were these the top priorities when SESAR was conceived?

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Challenge #2: Mastering the complexity of the ATM system

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Mastering the complexity of the ATM system:
What is a complex system?

- Definitions vary, but they should exhibit some or all of these:
    - Tightly coupled sub-systems
    - Non-linear aggregations
    - Emergent properties
    - Difficulty to define appropriate closure/system boundary
    - Difficulty to capture all attributes of a system for a given time
    - Difficulty to translate between different model scales and granularities - interactions between different scales
    - System evolution: stability of the system is a simplifying assumption which is, in most cases, not true

    Perrow: *"On the whole we have complex systems because we don't know how to produce the output through linear systems"*

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Mastering the complexity of the ATM system
Could help us to ...

- Better understand system dynamic, congestion, delay propagation etc.

- Better understand emergent properties (safety, efficiency, ...)
  - On the introduction of technologies (e.g. air-ground datalink), new procedures etc.
  - With the introduction of higher degrees of automation
  - With significant changes in business model, fuel price etc.

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Mastering the complexity of the ATM system
Could help us to ...

- Understand interactions when changes are made to different parts of the system

- Better identify where changes are likely to be most effective

  SESAR will introduce many improvements over the next few years

- Speed up the innovation cycle?
  - Very slow - average 18 years from idea to implementation
  - Institutional complexity from research through validation, certification etc. is high

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Challenge #3: Overcoming our automation demons

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"Humans will be central in the future European ATM system as managers and decision-makers".

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Overcoming our automation demons:
Degrees of automation

Level	Degree
1	The computer offers no assistance: human must take all decisions and actions.
2	The computer offers a complete set of decision/action alternatives, or
3	… narrows the selection down to a few, or
4	… suggests one alternative, and
5	… executes the suggestion if the human approves, or
6	… allows the human a restricted time to veto before automatic execution, or
7	… executes automatically, then necessarily informs humans, and
8	… informs the human only if asked, or
9	… informs the human only if it, the computer, decides to.
10	The computer decides everything and acts autonomously, ignoring the human.

According to Sheridan

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Overcoming our automation demons:
Why automate?

- To overcome human limitations
  - Imprecision
  - Slowness
  - Inefficiency
  - Inability to have a global view
  - Costliness

- To eliminate human variability that can cause accidents

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Overcoming our automation demons:
Why haven't we succeeded?

- No pressing need:
    - Today's system is very safe
    - Humans are exceptional at resolving complex situations
- Perceived threat to social partners
- Push-back against a technology-driven approach
    - Engineers just want to clean up the mess!

- Too much emphasis on cognitive engineering approaches

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Overcoming our automation demons:
Key questions

- Is it possible to take a system-wide view of automation, or are we confined to incremental change?

- Can we shift the responsibility for safety assurance from the human to technology?

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Challenge #4: Helping ensure the sustainability of the industry

- ATM is a very small part of the aviation sustainability debate ... but we can play our part
  - In all events, reducing fuel burn is an evident win-win
- Meeting the challenges described above will help
- Recent and ongoing improvements include
  - RVSM, CDA, FUA[1], route length reductions, etc
- Returns are generally rather small (a few percent)

- But we are still unable to agree on baselines, metrics and numbers

[1]Reduced Vertical Separation Mode; Continuous Descent Approach; Flexible Use of Airspace

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Summary

- Air traffic management is one of the most complex socio-technical systems around
  - It is target-rich in research opportunities

- We must face up to some major challenges if we are to make significant progress

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