ANS Productivity, cost-effectiveness

NAS Performance Workshop
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EUROCONTROL
A cost-effective system?

US-Europe comparisons

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Gate-to-gate ANS costs</td>
<td>US$ 8 900M</td>
<td>€7 100M</td>
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<tr>
<td>(without MET)</td>
<td></td>
<td></td>
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<tr>
<td>IFR flights</td>
<td>18.3M</td>
<td>9M</td>
</tr>
<tr>
<td>Costs per IFR flight</td>
<td>US$ 486</td>
<td>US$ ~ 1000</td>
</tr>
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</table>
ANSP benchmarking

• **Analytic benchmarking**
  – What are the respective performance indicators?
  – Facts, no judgement
  – Detailed analytic benchmarking of European ANSPs in ACE reports
  – Outcome benchmarking (black box + information disclosure: ACE)
  – Insider benchmarking (white box, ANSPs, CANSO)

• **Normative benchmarking**
  – What are the actual and expected performance given specific circumstances (Cost of living, complexity, traffic variability, etc)
  – Econometric techniques tried, not conclusive so far NERA report available
Framework for cost-effectiveness analysis

Ratios higher than 1: better performance in US
Ratios are multiplicative: 1.62 = 1.29 x 0.94 x 1.34

In the US:
- Higher hourly productivity (1.29)
- Higher employment costs compensated by more hours (0.94)
- Lower support costs (1.34)

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Productivity

Raising average productivity to 3rd best: +62%

29% of unit costs
ATCO-hour productivity

- Equivalent densities measured in the sample of ACCs
  Complexity is not a differentiating factor

- Traffic variability
  - Seasonal
  - Weekly
  - Daily

- Match of resources and traffic appears to be a key driver of ATCO productivity
Sector productivity and staffing

- Output (flight-hours controlled)
- Sector-hours open
- ATCO hours on duty
- ATCOs in OPS

Staffing per sector

ATCO-hour productivity

Average hours on duty

Output per ATCO

Productivity and factor cost

- Flight-hours controlled
- ATCO-hours on operational duty
- ATCOs in operations
- Employment costs of operational ATCOs
- Total operating costs (staff and non-staff)

Cost-effectiveness

- ATCO-hour productivity
- Working hours per ATCO
- Employment cost per ATCO
- Support cost ratio
- Operating costs per flight-hour controlled

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Sector productivity and staffing

Cluster 1

Cluster 2

Cluster 3a (ACCs ≥ 5 sectors)

Cluster 3b (ACCs < 5 sectors)

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Employment costs per ATCO-hour (2005, gate-to-gate)
Support costs

- 71% of unit costs

Bar chart showing the financial cost-effectiveness indicator with the category of Capital-related costs per composite flight-hour, Non-staff operating costs per composite flight-hour, and Non-ATCO in OPS staff costs per composite flight-hour. The European system average is €281. The chart includes data for various organizations such as LVNL, Belgocontrol, ATSA, BELROMA, ENAV, NAV Portugal (FIR Lisboa), and others.
Cost-effectiveness target

- Cost-effectiveness: A major European ATM performance issue
- Clear break in the en-route unit cost trend since 2003
- PRC recommends the formal adoption of a cost-effectiveness target at European system level to reduce average real unit costs by 3% p.a. until 2010.
Cost-effectiveness improvements from future developments

Massive value can be generated with improved cost-effectiveness

Improving economic performance

- New generation ATM
- Rationalisation of service provision!

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Improvements through rationalisation of service provision

- **Rationalising support staff (35% of costs)**
  - Opportunity for pooling resources (maintenance teams, etc)
  - Costs should not grow in line with traffic
- **Improving ATCO Productivity (25% of costs)**
  - e.g. better use of resources in low traffic, at night
- **Pooling investments (20% of costs)**
  - Major opportunity for scale effects in ATM infrastructure (currently 60% of investment)
    - Approximately 80% of new systems costs is non-recurring cost (software, certification)
    - Joint development (SESAR)
    - Joint procurement (in FABs, ANSP groupings)
  - Opportunity for scale effects in CNS infrastructure
    - SATNAV, joint procurement/outsourcing of CNS infrastructure
- **Rationalising non-staff operating costs (18% of costs)**
  - Number of facilities, etc

<table>
<thead>
<tr>
<th>ATM/CNS provision costs (€ M)</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff costs</td>
<td>3 960</td>
<td>60.7%</td>
</tr>
<tr>
<td>Direct (non-staff) operating costs</td>
<td>1 194</td>
<td>18.3%</td>
</tr>
<tr>
<td>Depreciation costs</td>
<td>923</td>
<td>14.2%</td>
</tr>
<tr>
<td>Costs of capital</td>
<td>392</td>
<td>6.0%</td>
</tr>
<tr>
<td>Exceptional Items</td>
<td>52</td>
<td>0.8%</td>
</tr>
<tr>
<td>Total</td>
<td>6 520</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

2005 data
Scale effects?

Generic study on fragmentation
- Some evidence of scale effects
- But some small ANSPs are efficient
- Other sources of inefficiencies and factors influencing economic performance

47 European ACCs operating 10 sectors or fewer at maximum configuration
## ATM infrastructure: How big is it? (2003 data)

### COM
- VHF ground stations: 1123
- Ground-ground voice links: 2246
- ACC links (inter-State): 160
- ACC links (intra-State): 388

### NAV
- DME: 601
- NDB: 349
- VOR: 617

### SUR
- En-route primary plus Mode S: 63
- En-route Primary plus MSSR: 5
- Approach primary plus MSSR: 92
- Approach primary only: 43
- MSSR only: 140

### ATM
- ACCs: 68
- Sectors: 792
- Credit cards

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<tr>
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<th>Capital replacement costs</th>
<th>Annual operating costs</th>
<th>Total annual costs</th>
</tr>
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<tbody>
<tr>
<td>COM (outside ACC)</td>
<td>€560m</td>
<td>€60m</td>
<td>€110m</td>
</tr>
<tr>
<td>NAV (en-route)</td>
<td>€230m</td>
<td>€10m</td>
<td>€30m</td>
</tr>
<tr>
<td>SUR (en-route)</td>
<td>€3,000m</td>
<td>€210m</td>
<td>€500m</td>
</tr>
<tr>
<td>ACCs &amp; ATM systems</td>
<td>€4,900m</td>
<td>€2,100m</td>
<td>€2,500m</td>
</tr>
<tr>
<td>Associated support</td>
<td>€1,000m</td>
<td>€1,100m</td>
<td>€1,200m</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>€9,690m</strong></td>
<td><strong>€3,480m</strong></td>
<td><strong>€4,340m</strong></td>
</tr>
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</table>

Replacement of the current system worth ~ €10B

Total annual en-route service provision costs ~ €4.4B
Some factors affecting performance

Fragmentation of service provision, infrastructure, airspace, regulation, decision making
*Fragmentation report (2006)*

Cost of living, Traffic complexity, variability
*Benchmarking report ACE 2005 (2007)*
# Complexity indicators

<table>
<thead>
<tr>
<th>Complexity Dimension</th>
<th>Indicator</th>
<th>Description</th>
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<tbody>
<tr>
<td>Traffic density</td>
<td>Adjusted density</td>
<td>A measure of the potential number of interactions between aircraft in a given volume of airspace</td>
</tr>
<tr>
<td>Traffic in evolution</td>
<td>Potential vertical interactions (VDIF)</td>
<td>Captures the potential interactions between climbing, cruising and descending aircraft</td>
</tr>
<tr>
<td>Flow structure</td>
<td>Potential horizontal interactions (HDIF)</td>
<td>Provides a measure of the potential interactions based on the aircraft headings</td>
</tr>
<tr>
<td>Traffic mix</td>
<td>Potential Speed interactions (SDIF)</td>
<td>Provides a measure of the potential interactions between aircraft of different performances</td>
</tr>
</tbody>
</table>
How are they computed?

- **Interaction**: simultaneous presence of 2 aircraft in a same cell of 20NMx20NMx3000ft

- **Metrics computed at ACC and ANSP level (all airspace 85#FL#405)**
  - Results at ANSP level is a consolidation from results at ACC & APP level
  - Oceanic airspace excluded
Breakdown of traffic complexity indicator at ANSP level (2004 data)
Any influence of complexity on cost-effectiveness? (1/3)

**Cost-effectiveness vs Complexity**

- **Adjusted density**
- **Structural Complexity indicator**
- **Aggregated complexity indicator**

Cost-effectiveness appears to increase with complexity.

**Productivity vs Complexity**

- **Adjusted density**
- **Structural Complexity indicator**
- **Aggregated complexity indicator**

But productivity increases with complexity.

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Any influence of complexity on cost-effectiveness? (2/3)

**Employment costs vs Complexity**

Employment costs are correlated with density, complexity.

**Support costs vs Complexity**

Weak link between complexity and support costs
Any influence of complexity on cost-effectiveness? (3/3)

Cost-effectiveness is significantly influenced by cost of living
- Cost of living influences employment costs (60% of costs)
- but some high cost of living ANSPs are cost-efficient (Nordic States)

Link with complexity is apparent: Complexity is correlated with cost of living, and cost of living with cost-effectiveness

Mixed influence of complexity
- Higher density enables better use of human resources, infrastructure
- Higher complexity increases work load, but also productivity…

Econometrics: failed to determine statistically significant influence of complexity on Costs

Empirical analysis of influence of Complexity, Cost of living, …

GDP per capita vs Complexity
ANS/ATM Cost-effectiveness Performance

Performance to date
- European ANS costs ~ $10.5 billion
- Clear break in unit cost trend since 2003 (Benchmarking has a role!)
- Similar ANS costs in US, but two times more traffic!

Analysis of performance
- Econometrics: unsuccessful so far
- Empirical analysis of influence of Complexity, Cost of living

Targets
- Cost-effectiveness target recommended (reduce average real unit costs by 3% p.a. until 2010) but not adopted yet
- SESAR targets in line with PRC’s, more aggressive beyond 2010 (5%)

Performance improvements
- Rationalisation of service provision
- New generation: one step further!
**ANS/ATM economic performance**

**Economic cost**
- Total economic cost =
  - Direct cost of the service
  - + Indirect costs (delays, non-optimum flight profiles, externalities e.g. environmental impact)
- In Europe, user pays both, wants minimum total cost
- In the US, disconnect between ATM costs (federal budget) and what the user pays makes the link more remote

**Analysis of performance**
- Poor quality of service may compromise benefits from excessive cost savings

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**Graphical representation**

- **Capacity planning**
  - Strategic design of airspace
  - Tactical use of airspace (FUA)

- **Fragmentation (Consolidation)**
  - Low productivity

- **Static economic optimum**
  - Dynamic economic optimum

- **Total economic costs**
  - Cost of capacity

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Framework for analysis of ATM performance

Safety

- Safety management
  - Runway incursions
  - Airspace events
  - Safety culture (reporting, etc.)

Cost-effectiveness

- Cost management
  - Employment costs
  - Support costs
  - ATCO productivity

Economy

- Capacity management
  - Airport/TMA capacity
  - Use of airspace
  - ATFM/Network capacity

Environment

- Network effects & fragmentation
- Political/Environ. Regulations/restrictions

Security

- Gaseous emissions
- Flight efficiency
- Ground delay

Political & Socio-Economic perspective

- Airspace users perspective

Service provider perspective

- Ambient performance affecting factors

- Technical innovations
- Traffic (volume, complexity)
- Weather

To be developed
# ANS Performance status (2006)

<table>
<thead>
<tr>
<th>Performance Processes</th>
<th>Safety</th>
<th>Delays</th>
<th>Flight efficiency</th>
<th>Cost-effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance targets</td>
<td>-</td>
<td>✓</td>
<td>None</td>
<td>Development agreed</td>
</tr>
<tr>
<td>Data flow</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Performance indicators</td>
<td><img src="image" alt="Warning Sign" /></td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
</tr>
<tr>
<td>Regulation</td>
<td>Well advanced, not fully applied</td>
<td>Minimal Incentives in UK only</td>
<td>Single Europ. Sky Functional airspace blocks</td>
<td>Cost recovery Benchmarking Incentives (UK)</td>
</tr>
<tr>
<td>Performance management</td>
<td>Safety Action Plan</td>
<td>Co-operative capacity management</td>
<td>European Co-ordination</td>
<td>Individual plans Benchmarking</td>
</tr>
<tr>
<td>Achieved performance</td>
<td>No conclusive information</td>
<td>Strong improvement Target nearly met</td>
<td>Very slow improvement</td>
<td>Progressive improvement</td>
</tr>
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</table>
A quantum jump in ATM performance

Short-term improvements
- Safety, flight-efficiency, productivity, etc

A quantum jump in performance in medium term
- Safety: x5 for traffic x2, x10 for traffic x3 => SESAR, NEXGEN
- Capacity: x2 (15 years), x3 (30 years)
  - Linked with safety for en-route
  - Linked with traffic spread for airports
- Cost-effectiveness: >2

At least one solution known: US!
Traffic density and complexity ≥ Europe
Capacity and cost-effectiveness targets met
Equivalent aviation safety levels

Driving ATM performance
Operational and technical improvements
- SESAR, NEXGEN

Service provision
- Organisation, Managerial, Governance, Human resources

Regulation
- Single European Sky, ...

Co-operation & co-ordination
- EUROCONTROL
- Improved ATM/Airlines/airports interactions

Co-operation is required from all parties

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Conclusions

- High stakes in ANS performance
  - Safety
  - Economic impact (billions of € per annum)
  - Environmental impact
- Experience with performance-oriented approach in Europe since 1998
- Prerequisites for efficient performance-oriented strategies
  - Reliable information flow
  - Target setting, performance monitoring
  - Adequate regulation
  - Performance management processes
  - Independent performance review (with permanent support)
  - Strong governance of monopoly service providers
  - Accountability for performance
- ANS “Performance” is the “end product” of a complex interrelated system, involving a large number of airspace users, airports and ATM units
- Factors driving performance need to be better understood and measured