Airport slot allocation: performance of the current system and options for reform

Towards a comprehensive performance framework

SESAR Innovation Days  27th November 2013
Introduction: Problem statement

Several ways of dealing with this problem:

i. Capacity enhancement programs
ii. Demand control strategies
iii. Queuing delays

The European Context

- Slot control dominant approach in Europe (Reg. 95/93 and 793/2004)
- Administrative slot control leads to inefficiencies and hinder competition
- The EC recently recognized the need to revise the Slot Regulation

Aim of the paper

- Set the basis for an analytical framework for assessment of different slot allocation mechanisms
- First step within WP-E project
Introduction: The ACCESS Project

Application of Agent Based Computational Economics to Strategic Slot Allocation

- **Four partners**
- **Launched in May 2013**
- **Duration: 30 months**

**Baseline**
- Analysis of the current airport slot allocation system
- Review market-based mechanisms used in other sectors
- Identification of potential improvements

**Model formalisation**
- Modelling of the retained options
- Development of the performance assessment framework

**Platform development**
- Coding of the model-based simulation platform
  - Autonomous agents
  - Different trading strategies
  - Analytical functionalities

**Analysis**
- Comparative assessment of the different options
- Recommendations
- Suggest Roadmap for implementation

Current Project progress

Website: [www.access-sesar.eu](http://www.access-sesar.eu)
The current system: Actors involved

- **Coordinators**: qualified natural or legal person whose neutrality should be unquestioned;
  - Coordination Committee: to mediate, make proposals, guidelines, discuss
    - Airport managing body;
    - Air traffic control authorities;
    - Air carriers using the airport and their representative organisations;
    - General aviation using the airport regularly.

- **European Commission**: proposes new regulations or amendments;
- **European Parliament & European Council**: adopts regulations;
- **Member States**: designate airports, appoint coordinator;
  - International Air Transport Association (IATA): publishes the *Worldwide slot guidelines*.

- **Coordinated**: airports where air carriers need a slot to be able to operate flights;
- **Schedule facilitated**: airports where there is a potential for congestion in certain time windows and a schedules facilitator is appointed to facilitate operations.

- **Airports**:
- **Regulators**:
  - **European Commission**: proposes new regulations or amendments;
  - **European Parliament & European Council**: adopts regulations;
  - **Member States**: designate airports, appoint coordinator;
    - International Air Transport Association (IATA): publishes the *Worldwide slot guidelines*.

- **Airspace Users**:
- **Commercial Aviation**
  - Network carriers;
  - Low cost operators;
  - Cargo operators;
  - Regional carriers;
  - Charter operators;
- **General Aviation**;
- **Military is excluded from slot control**.
The current system: slot allocation process

**Member State**
- Airport Capacity Assessment
- Airport Designation
- Appointment of Slot Coordinator
- Ensure determination of coordination parameters

**Airport Operator**
- Determination of declared capacity

**Airport Coordinator**
- Revision of declared capacity & coordination parameters
- Scheduling Season’s available Slots
- Initial Allocation of Slots
  - Allocation of Historical Slots
  - Allocation of Slots to New Entrants
  - Allocation of Slots to Remaining Requests
- Participation in WSC
- Revision of slot exchanges & Transfers by Airlines
  - Permission/denegation of exchange/transfer
  - Update Slot Pool & Reallocation of slots
- End of Scheduling season

**Airspace User**
- Analysis of airports declared capacity & coordination parameters
- Initial Slot Request
- Submission of Slot Requests
- Analysis of Slot allocation
- Participation in WSC
- Exchanges & Transfers requests
  - Request OK / not OK
- Update Pool
- New requests
- Operation of Slots
- End of Scheduling Season

**IATA**
- Organization of Worldwide Scheduling Conference

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## Perspectives for reform: Market-based approaches

### Primary allocation of slots

<table>
<thead>
<tr>
<th>Objective</th>
<th>Main options</th>
</tr>
</thead>
<tbody>
<tr>
<td>To reflect willingness to pay of the user</td>
<td>• Withdrawal of grandfather rights and auctioning of these slots;</td>
</tr>
<tr>
<td>✗ Need for combinatorial auctions;</td>
<td>• Auctions of pool slots when new capacity is created;</td>
</tr>
<tr>
<td>✗ High implementation costs;</td>
<td>• Auctions for all pool slots.</td>
</tr>
<tr>
<td>✗ Not individual rational.</td>
<td></td>
</tr>
</tbody>
</table>

### Secondary slot-trading

<table>
<thead>
<tr>
<th>Objective</th>
<th>Main options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Redistribution to adjust allocation among airlines</td>
<td>• Bilateral trades between airlines;</td>
</tr>
<tr>
<td>✓ Reflects willingness to pay;</td>
<td>• Central facilitator;</td>
</tr>
<tr>
<td>✓ Compatible with current system;</td>
<td>• External agencies allowed.</td>
</tr>
<tr>
<td>✓ Introduces opportunity costs to slots;</td>
<td></td>
</tr>
<tr>
<td>✗ Practically Airlines non perfect-rational agents.</td>
<td></td>
</tr>
</tbody>
</table>

### Congestion pricing

<table>
<thead>
<tr>
<th>Objective</th>
<th>Main options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflect the external costs generated by the user</td>
<td>• In association with slot control;</td>
</tr>
<tr>
<td>✓ Peak/peak off charges;</td>
<td>• In addition to slot control;</td>
</tr>
<tr>
<td>✗ Estimation of price elasticity;</td>
<td>• In substitution of slot control.</td>
</tr>
<tr>
<td>✗ Institutional barriers;</td>
<td></td>
</tr>
<tr>
<td>✗ Unsuccessful experiences.</td>
<td></td>
</tr>
</tbody>
</table>
Process performance: measurement along Performance areas

Need to establish a number of relevant performance areas

**Consistent with relevant frameworks...**
- ICAO
- SESAR Performance Framework
- SES II Performance Scheme

...but adapted to the specific problem
- Airport context
- Long-term planning
- Strategic decision making

- Economic efficiency
- Capacity and Delay
- Flexibility and Resilience
- Access and Competition
- Equity and Distributional Issues
- Interoperability
Process performance: measurement through indicators

Need to establish an objective, exhaustive and non overlapping set of indicators

Objective way of measuring performance

- Assess different options
- Focus the discussion
- Support decision making
- Monitor progresses towards goals

Different types of indicators

- **Outcome Indicators**
- **Intermediate Indicators**
- **Quantitative Indicators**
- **Qualitative Indicators**
- **Local**
- **Global**
- **System-wide**
- **Stakeholder Indicators**

Preliminary Proposal
Still Work in progress
# Economic Efficiency

## Total Social Welfare

**Max Attainable Social Welfare**

<table>
<thead>
<tr>
<th>Current System</th>
<th>Market Mechanisms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Allocative Efficiency</strong></td>
<td></td>
</tr>
<tr>
<td>✖ Potential inefficient slot allocation:</td>
<td>✗ Slots assigned to the Airlines that value them most</td>
</tr>
<tr>
<td>willingness to pay is not taken into account</td>
<td></td>
</tr>
<tr>
<td><strong>Cost Efficiency</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Cost of operating the system</strong></td>
<td>✖ High cost for designing and operating an auction</td>
</tr>
<tr>
<td>✗ Simple and inexpensive</td>
<td>✗ Secondary trading easier and cheaper</td>
</tr>
<tr>
<td><strong>Dynamic efficiency</strong></td>
<td>✗ No continuity of schedule guaranteed by auctions</td>
</tr>
<tr>
<td>✗ Grandfather rights maintain stability and</td>
<td>✗ Secondary trading could take historic slots as</td>
</tr>
<tr>
<td>continuity in scheduling</td>
<td>baseline</td>
</tr>
<tr>
<td><strong>Cost of Delay</strong></td>
<td></td>
</tr>
<tr>
<td>✗ Tactical delays are reduced in favour of</td>
<td>✖ Allocation of revenues in case of auction is</td>
</tr>
<tr>
<td>scheduled delays</td>
<td>debated</td>
</tr>
<tr>
<td><strong>Revenues</strong></td>
<td>✗ Congestion pricing accounts for externalities</td>
</tr>
<tr>
<td>✗ No additional revenues for Airports</td>
<td></td>
</tr>
<tr>
<td><strong>Externalities</strong></td>
<td></td>
</tr>
<tr>
<td>✖ No account for externalities</td>
<td></td>
</tr>
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</table>
## Capacity and Delay

### Total # Slots

| Actually available # Slots | Throughput of the airport | Different temporal and spatial scales |

### Outcome Indicator

### Current System

- **Capacity specification**
  - The optimal choice of the number of slots at a given airport implies local interpretations and ad-hoc processes.

### Incentives for capacity expansion

- **Incumbent airlines** have incentive to moderate their requests for capacity expansion.

### Delay

- The trade-off between scheduled delay and tactical delay is sought by the slot allocation mechanism.

### Market Mechanisms

- **Auctions or congestion pricing** could create perverse incentives for airports to underinvest in new capacity.
Flexibility and Resilience

Outcome Indicator

\[
\frac{\text{# of slot request/exchanges/transfers accepted}}{\text{total # of slot requests/exchange/transfers requests}}
\]

Ability provided by the system to modify the allocation and use of slots in order to cater for a changing environment

Different temporal and spatial scales

### Current System

**Flexibility of allocation to match airline requests**
- ✔ IATA conferences and hand back of unused slots provide flexibility
- ❌ No mechanism is implemented to link dependent (origin-destination) requests

**Flexibility of use (in normal conditions)**
- ✔ Some flexibility of use in normal conditions given by (80-20) rule

**Flexibility of adaptation to disturbances (Resilience)**
- ❌ Not adaptable to special circumstances (law amendments needed)

**Flexibility of adaptation to local geographical conditions**
- ✔ Definition of coordination parameters, the acceptance of a secondary market and the imposition of PSOs according to local needs

### Market Mechanisms

**Flexibility of allocation to match airline requests**
- ✔ Combinatorial models could take into account dependent assignments
- ❌ Difficult for carriers with lower purchasing power to get slots at busiest airports

**Flexibility of use (in normal conditions)**
- ✔ Secondary slot trading could increase flexibility of use

**Flexibility of adaptation to disturbances (Resilience)**
- ✔ The market would be able to self-adapt to these circumstances

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Interoperability

Level of commonality/compatibility with the IATA guidelines

The system is based on global standards and uniform principles to ensure technical and operational interoperability

Interoperability of slot allocation systems

- Based on IATA guidelines universally applied (except in the U.S.)

Interoperability of flight information

- Historically a lack of consistency between Airport slots and flight plans registered due to poor info sharing between Airports and CFMU
  - SESAR is tackling this issue through Operational Improvement step (DCB-0301) and technical enablers

Current System

Market Mechanisms

- Would require regional/global scope of application
## Equity and Distributional Issues

### Airline shift costs

\[
\frac{\text{Airline}_i \text{ Shift Costs} \times \text{Total # Slots}}{\text{Total Shift Costs} \times \text{Airline}_i \# \text{ Slots}}
\]

<table>
<thead>
<tr>
<th>Outcome Indicator</th>
<th>Current System</th>
<th>Market Mechanisms</th>
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</thead>
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<tr>
<td>Equity of assignment</td>
<td>✗ Historical precedence may harm equity of assignment</td>
<td>✓ Secondary trading just involves transactions if positive utility</td>
</tr>
<tr>
<td>Fairness of assignment</td>
<td>✓ Most incumbent consider historical precedence as proxy for fair assignment</td>
<td>✓ Willingness to pay can be considered proxy for fairness</td>
</tr>
</tbody>
</table>
| Individual rationality | ✗ Historical precedence may harm equity of assignment | ✗ Primary auctions & congestion pricing imply negative utility w.r.t. the current system  
 ✓ Secondary trading just involve transactions if positive utility |
Access and competition

*Slots to new entrants*  
Total # slots

*Slots to Airline_i*  
Total # slots

**Current System**

- **Access costs**
  - Free of charge
  - Few and unattractive slots in the pool
  - Airlines quickly fall outside "new entrant"

- **Public Service Obligations**
  - Guarantees services to regional communities even if not profitable for airlines

- **Transparency of slot information**
  - Transparency and adequacy of slot information provided by coordinators could be improved

- **Independence of the coordinator**
  - The limits of this independence are sometimes vague and may not be clear at first sight.

**Market Mechanisms**

- Easier for airlines with strong business models to get into market
- Difficult for small carriers with lower purchasing power to get slots at the busiest airports
- Could be maintained
- What information is shared, when and with whom are key design parameters

Need for more sophisticated indicators to grasp whether the slot allocation system prevents the entry of new competitors with a higher willingness-to-pay than those airlines operating the available slots.
Indicative summary of performance features
Conclusions and next steps

Preliminary Conclusions

- Complex issue, involving different and sometimes contrasting:
  - Perspectives;
  - Goals;
  - Strategies.
- Need for an objective performance framework extending along multiple dimensions;

A first step towards the ultimate ACCESS goals

- Several types of indicators identified:
  - Different nature and scope;
  - Along six interdependent Performance areas.
- Preliminary high level assessment:
  - Secondary trading outerperforms;
  - Interoperability is the main concern.

Next Steps

- Complete
  - Refine the work
- Consult Stakeholders
  - Obtain from "20 March 2014 Joint ACCESS+SATURN Workshop at University of Westminster (London)"
- Formalise
  - Mechanism design
  - Agent-based simulations platform
- Analyse
  - Apply performance metrics
  - Recommend options and actions
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