The cost of delay
Cook, A.J.

The cost of delay

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University of Westminster
Overview

• A brief history

• Methodology and refinements

• Trends and headlines

• Users and example SESAR projects

• Where next?
A brief history
A brief history

• 2000: SES launched by Commission
  – specifically in response to increasing delays

• Early 2000s: cost of delay
  – state of the art not very mature
  – no single, comprehensive study meeting industry needs
  – various values; lack of consensus

• University of Westminster started from scratch
  – review of method
  – all minutes are not equal
  – 2002-2004 (260 page ‘summary’) 
  – data sources: secondary & primary, extensive interviews ...
Acknowledgements

The authors would like to thank the following for data provision and advice generously offered during the course of this research. We would especially like to thank the airlines who made particular, and often extensive, efforts to provide the detailed financial and operational data required as inputs to this Study.

Air France
Airbus Industrie
Austrian (Airlines)
Aviation Industry Press
Boeing Commercial Aircraft
Britannia Airways
British Airways
Condor Flugdienst
Cranfield College of Aeronautics
CSA Czech Airlines
Deutsche Flugsicherung
EasyJet
Four (anonymous) aircraft lessors
Four anonymous handling agents
IATA (Geneva & London)
Iberia
KLM Royal Dutch Airlines
Lido GmbH
Lufthansa
The Airline Monitor
The Federal Aviation Authority
Various airport charges' offices

The authors are also heavily indebted to continuous technical support and advice from PRU at all stages of this Study, and to Mr Vittorio Pimpinelli for so ably chairing a valuable workshop held in Brussels to review Edition 2 of this Report.
A brief history

2010 cancellations
111 000 – Eyjafjallajökull
26 000 – strikes France & Spain
45 000 – bad weather
Yet limited effect on punctuality

Sources: PRR 2010, 2015 (draft)
A brief history

![Graph showing departure and arrival punctuality in Europe from 2006 to 2015. The graph indicates a peak in 2007 with a percentage of flights arriving within 15 minutes of the scheduled time. The percentage drops significantly in 2008. After 2009, the percentage steadily increases, reaching 82.1% in 2015.]

Source: PRR 2015 (draft)
A brief history

<table>
<thead>
<tr>
<th>metric</th>
<th>2000</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFR flights</td>
<td>8.4M</td>
<td>9.8M</td>
</tr>
<tr>
<td>% flights arr. &gt; 15 mins late</td>
<td>27%</td>
<td>18%</td>
</tr>
<tr>
<td>turnaround delay</td>
<td>?</td>
<td>33%</td>
</tr>
<tr>
<td>reactionary delay</td>
<td>39%</td>
<td>46%</td>
</tr>
<tr>
<td>ATFM/ANS delay</td>
<td>23%</td>
<td>13%</td>
</tr>
</tbody>
</table>

Sources: PRR 2000, 2015 (draft)

NB1. SESAR target for 2020:  > 95% of flights arrival delay ≤ 3 mins  other 5%: average delay < 10 mins

NB2. Traffic in 2008:  10.1M (peak, start of slowdown and fall)
A brief history

• Key objectives of the ‘new’ framework
  – comprehensive & transparent approach
    ▪ including margins of error
  – consultation and industry agreement
    ▪ common reference values
  – operationally meaningful – aligned with AO mind set
    ▪ bottom line in accounts (*very* challenging); interviews
  – shift the focus away from fuel-only costs
  – useful at network level, e.g. total and average ATFM delays
A brief history

• Key features

  – tactical cost of delay
    ▪ incurred on the day of operations, not planned in advance
    ▪ mostly marginal costs
    ▪ e.g. aircraft waiting at-gate

  – strategic cost of delay (then a new concept)
    ▪ incurred in advance, often difficult to recover later (‘sunk’ cost)
    ▪ mostly unit costs
    ▪ e.g. schedule buffer (‘opportunity’ cost) & route extension (later)

  – passenger cost of delay
    • ‘hard’ cost to AO
    • ‘soft’ cost to AO
    • internalised costs (c.f. US)
A brief history

- Novel features of 2004 report
  - “ground” and “airborne” costs of delay
    - taxi and arrival management in method but subsumed in output
  - “short” and “long” delay types
    - 15-minute and 65-minute delays taken as models
  - by aircraft type (Annex N) and by cost scenario (low, base, high)
    - B733, B734, B735, B738, B752, A319, A320, A321, AT43, AT72; B744, B763
  - other public domain European costs, also by aircraft type
    - fuel burn tables and BHDOCs (industry sourced/verified)
A brief history

• Non-linear models, things of the future...
  – delay cost by duration
  – reactionary delay models

Table 2-22: Reactionary delay multipliers

<table>
<thead>
<tr>
<th>Duration of delay</th>
<th>Reactionary delay multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 minutes</td>
<td>1.05</td>
</tr>
<tr>
<td>65 minutes</td>
<td>1.20</td>
</tr>
</tbody>
</table>
Methodology and refinements
## Methodology and refinements

<table>
<thead>
<tr>
<th>element</th>
<th>types of cost (in-house models, except fuel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>fleet</td>
<td>all fleet costs (depreciation, rentals &amp; leases)</td>
</tr>
<tr>
<td>fuel</td>
<td>Lido/Flight, BADA, manufacturers</td>
</tr>
<tr>
<td>crew</td>
<td>schemes, flight hours, on-costs, overtime</td>
</tr>
<tr>
<td>maintenance</td>
<td>extra wear &amp; tear powerplants/airframe</td>
</tr>
<tr>
<td>passenger</td>
<td>‘hard’ &amp; ‘soft’ (not internalised costs)</td>
</tr>
<tr>
<td>ground handling</td>
<td>aircraft and passengers – penalty if late / delayed on gate</td>
</tr>
<tr>
<td>airport charges</td>
<td>various aeronautical charging manuals and policies consulted</td>
</tr>
<tr>
<td>en-route ATC charges</td>
<td>based on GCD entry/exit – requires significant re-route due delay</td>
</tr>
<tr>
<td>CO₂</td>
<td>considered allocated permits and CO₂ price; small % fuel variation</td>
</tr>
</tbody>
</table>
Methodology and refinements

<table>
<thead>
<tr>
<th>element</th>
<th>strategic</th>
<th>tactical</th>
</tr>
</thead>
<tbody>
<tr>
<td>fleet</td>
<td>$= f$ (service hours)</td>
<td>$\neq f$ (utilisation) $= 0$</td>
</tr>
<tr>
<td>fuel</td>
<td></td>
<td>$=$ (e.g. no hedging between phases)</td>
</tr>
<tr>
<td>crew</td>
<td>unit</td>
<td>marginal (0 ... full o/t)</td>
</tr>
<tr>
<td>maintenance</td>
<td>unit</td>
<td>marginal (e.g. fixed LTOs)</td>
</tr>
<tr>
<td>passenger</td>
<td>0</td>
<td>dominate, non-linear</td>
</tr>
</tbody>
</table>
### Table 1-1: Airline operating costs and revenues

<table>
<thead>
<tr>
<th>Non-operating items</th>
<th>Direct operating costs</th>
<th>Indirect operating costs</th>
<th>Operating revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Losses</strong></td>
<td>variable</td>
<td>fixed</td>
<td></td>
</tr>
<tr>
<td>retirement of equipment or property, when depreciated (residual) values are not realised</td>
<td>direct engineering costs: - related to block hours and/or cycles - (e.g. spares, A-D checks)</td>
<td>engineering overheads: - fixed staff costs (unrelated to a/c utilisation) - maintenance administration a</td>
<td>-</td>
</tr>
<tr>
<td>interest paid on loans</td>
<td>a/c fuels: - fuel - oil b</td>
<td>a/c standing charges: - depreciation - rentals c / leases - insurance</td>
<td>-</td>
</tr>
<tr>
<td>losses from affiliated companies, subsidiaries and shareholdings</td>
<td>flight crew subsistence and bonuses - cabin crew subsistence and bonuses</td>
<td>annual flight crew costs (fixed salaries, pensions etc unrelated to flying hours) + administration - annual cabin crew costs (fixed salaries, pensions etc unrelated to flying hours) + administration - amortisation of crew training costs *</td>
<td>-</td>
</tr>
<tr>
<td>miscellaneous losses from foreign exchange transactions, sales of shares</td>
<td>miscellaneous gains from foreign exchange transactions, sales of shares</td>
<td>airport aeronautical charges a - landing charge - airport parking/hangerage - (departing) pax charge - ground handling en-route ATC a</td>
<td>station and ground expenses d - ground equipment, property, transport depreciation - ground staff</td>
</tr>
<tr>
<td>government subsidies</td>
<td>- pax delay compensation - pax meals/hotel expenses f - third-party pax handling</td>
<td>ticketing - passenger service staff - passenger accident / liability insurance</td>
<td>sales revenues: - AO own effort - from other AOs (e.g. flex tickets, off-loads)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>amortisation of route development costs</td>
<td></td>
</tr>
</tbody>
</table>

**Footnotes:**
- classified by ICAO as an indirect operating cost (although few AOs adopt this classification)
- very small overall cost compared with fuel – not costed further in this study
- high leasing levels will normally be associated with (very) low depreciation charges, as rental charges for leased a/c cover both depreciation and interest charges paid by lessor
- at outstations often includes maintenance, due to difficulties of cost separation
- may be considered as a direct operating cost, especially when not amortised
- for example if accommodation is provided for transit passengers
- often documented / categorised as “maintenance burden”
### Table 2-7: Template for gate-to-gate cost calculations

<table>
<thead>
<tr>
<th>Cost Allocation Phase</th>
<th>Direct @ Ground A</th>
<th>Direct Airborne</th>
<th>Incurred @ Ground B</th>
<th>@ Gate B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OOOI Sequence</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ IN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ OUT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ OFF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ IN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ Gate A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Off-gate A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cost Element</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel maintenance</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
</tr>
<tr>
<td>Flight crew salaries and expenses</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
</tr>
<tr>
<td>Cabin crew salaries and expenses</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
</tr>
<tr>
<td>Depreciation of flight equipment</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
</tr>
<tr>
<td>Rental of flight equipment</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
</tr>
<tr>
<td>Amortisation of flight equipment leases</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
</tr>
<tr>
<td>Flight equipment insurance</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
</tr>
<tr>
<td>Station expenses (ground &amp; pass handling)</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
</tr>
<tr>
<td>Passenger service staff (term)</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
</tr>
<tr>
<td>Ground equipment, property and staff</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
</tr>
<tr>
<td>Airport charges (e.g. terminal)</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
</tr>
<tr>
<td>En-route &amp; approach air nav charges</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
</tr>
<tr>
<td>All other pax costs</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
</tr>
<tr>
<td><strong>Column Totals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provision of col. total allocated to phase</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
</tr>
<tr>
<td>Average cost per minute for phase</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
</tr>
<tr>
<td>Avg cost per min excl. incurred costs @ B</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
<td>[val]</td>
</tr>
</tbody>
</table>

[val] => value to be calculated; see Annex J
Methodology and refinements
2004 ➞ 2010
# Methodology and refinements

<table>
<thead>
<tr>
<th>Cost element</th>
<th>2004</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pax hard cost</td>
<td>Treated as zero for &lt;15 minutes of delay</td>
<td>Major update - full cost curves (power curve) derived as function of primary delay</td>
</tr>
<tr>
<td>Pax soft cost</td>
<td>Treated as zero for &lt;15 minutes of delay</td>
<td>Major update - full cost curves (logit curve) derived as function of primary delay; scalability now accounted for: small fraction of total now used in most contexts</td>
</tr>
<tr>
<td>Crew</td>
<td>Treated as zero for &lt;15 minutes of delay</td>
<td>Extensive new model addressing crew payment schemes and overtime rates; costs assigned to all delay magnitudes</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Overheads not fully assessed; costs based on block-hour costs</td>
<td>Overheads fully assessed; cost base extended and re-calibrated on full ICAO data sets</td>
</tr>
<tr>
<td>Fleet</td>
<td>Major model developed, based on extensive financial literature</td>
<td>Cost base extended and re-calibrated on full ICAO data sets, supplemented with update from financial literature</td>
</tr>
<tr>
<td>Fuel</td>
<td>0.31 EUR/kg</td>
<td>0.60 EUR/kg; carriage penalty now applied to arrival management</td>
</tr>
<tr>
<td>Reactionary</td>
<td>Two multipliers: one for below 15 minutes of delay, one for above</td>
<td>Extended model: multipliers fully quantified as function of primary delay magnitude, caps applied using new rotationary models</td>
</tr>
</tbody>
</table>
Methodology and refinements

- Passenger costs modelling in 2010 (2nd edition)
  - originally Austrian + ‘Airline Z’ (very close), single average value
  - logit curve (soft), power curve (hard) – basic, but $f(\text{duration})$

In-house, bespoke surveys & airline models

$c_h = pt^q$

Regulation 261 + airline policy.
Limited airline data & literature; care & reaccommodation model
Methodology and refinements

- Reactionary costs modelling in 2010 (2\textsuperscript{nd} edition)
  - per cost element; n/b & w/b; recovery; l/b/h ... also $f(\text{duration})$

![Graph showing reactionary delay vs. primary delay](image)

- our model: narrowbody and widebody (upper)
- Caps: B735, 4hrs, €17k; B744, 5 hrs, €106k
Methodology and refinements

- Reactionary costs modelling in 2010 (2\textsuperscript{nd} edition)
  - rotational \& non-rot.; at-gate; statistical c.f. explicit modelling
Methodology and refinements

- Major updates in 2015 (3rd edition) – 2014 basis; WP-E
  - 3 aircraft added (DH8D, E190, A332)
    - now 15 aircraft, 63% coverage of CFMU area
  - rotations per day, service hours, average MTOWs, ATFM delay distributions, seat & load factors; reactionary data – all updated
  - APU fuel added at-gate (average 25% running, base scenario)
  - crew & maintenance: ↑; fleet: ↓↓ (all continuing 2010 trends)
  - passenger costs: still only limited evidence
    - EC Impact Assessment (Reg. 261) + limited literature (e.g. claim rates)
    - UoW consultation document Aug-Oct15; 400+ contacts (mostly AOs)
    - 8.8% (inflationary) ... pax densities => net = 20%
Trends and headlines
Trends and headlines

• Difficult to establish consistent trends
  – crew and maintenance costs least volatile (from overall perspective)
  – fleet costs most dependent on particular a/c types
  – passenger costs to AO most dependent on legislation (later)
  – fuel prices most volatile

• Cost of fuel
  – Jet A1, into-plane; typical lag c.f. spot prices
  – price (EUR/kg): 0.80 (2014), 0.60 (2010), 0.31 (2004)
  – often separated-out by phase (e.g. for DCI)
Trends and headlines

- Primary at-gate increase: 18%; en-route: 22% (c.f. 2010)

---

Table 30. European ATFM delay cost estimates

<table>
<thead>
<tr>
<th>Factor</th>
<th>2014 value</th>
<th>2010 value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average cost of delay of an ATFM-delayed aircraft</td>
<td>1 970</td>
<td>1 660</td>
</tr>
<tr>
<td>ATFM delay cost averaged over all flights</td>
<td>103</td>
<td>130</td>
</tr>
<tr>
<td>Network average cost of ATFM delay, per minute</td>
<td>100</td>
<td>CARE! 81</td>
</tr>
</tbody>
</table>

*Costs in Euros. 2014 delay weights use 2014 ATFM data.*

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NB. The decrease in the ATFM delay cost averaged over all flights is driven by a decrease in the number of flights with ATFM delay as a percentage of all flights, from 7.9% in 2010 to 5.2% in 2014.
## Trends and headlines

### Table 26. AT-GATE / BASE / full tactical costs

<table>
<thead>
<tr>
<th>Delay (mins)</th>
<th>5</th>
<th>15</th>
<th>30</th>
<th>60</th>
<th>90</th>
<th>120</th>
<th>180</th>
<th>240</th>
<th>300</th>
</tr>
</thead>
<tbody>
<tr>
<td>B733</td>
<td>70</td>
<td>430</td>
<td>1550</td>
<td>7020</td>
<td>19160</td>
<td>36220</td>
<td>49040</td>
<td>66480</td>
<td>89310</td>
</tr>
<tr>
<td>B734</td>
<td>80</td>
<td>480</td>
<td>1740</td>
<td>7930</td>
<td>21690</td>
<td>40960</td>
<td>55340</td>
<td>74780</td>
<td>100040</td>
</tr>
<tr>
<td>B735</td>
<td>70</td>
<td>390</td>
<td>1400</td>
<td>6280</td>
<td>17110</td>
<td>32350</td>
<td>43900</td>
<td>59720</td>
<td>80590</td>
</tr>
<tr>
<td>B738</td>
<td>90</td>
<td>540</td>
<td>1940</td>
<td>8860</td>
<td>24270</td>
<td>45750</td>
<td>61740</td>
<td>83220</td>
<td>110920</td>
</tr>
<tr>
<td>B752</td>
<td>100</td>
<td>620</td>
<td>2290</td>
<td>10620</td>
<td>29250</td>
<td>55150</td>
<td>74240</td>
<td>99700</td>
<td>132200</td>
</tr>
<tr>
<td>B763</td>
<td>170</td>
<td>900</td>
<td>3200</td>
<td>14780</td>
<td>39960</td>
<td>85300</td>
<td>121880</td>
<td>152860</td>
<td>191990</td>
</tr>
<tr>
<td>B744</td>
<td>240</td>
<td>1370</td>
<td>5000</td>
<td>23430</td>
<td>63710</td>
<td>136330</td>
<td>194330</td>
<td>242440</td>
<td>302200</td>
</tr>
<tr>
<td>A319</td>
<td>70</td>
<td>440</td>
<td>1600</td>
<td>7320</td>
<td>20040</td>
<td>37850</td>
<td>51240</td>
<td>69420</td>
<td>93180</td>
</tr>
<tr>
<td>A320</td>
<td>80</td>
<td>500</td>
<td>1820</td>
<td>8350</td>
<td>22920</td>
<td>43250</td>
<td>58420</td>
<td>78890</td>
<td>105380</td>
</tr>
<tr>
<td>A321</td>
<td>100</td>
<td>580</td>
<td>2160</td>
<td>10010</td>
<td>27580</td>
<td>51990</td>
<td>70060</td>
<td>94250</td>
<td>125240</td>
</tr>
<tr>
<td>AT43</td>
<td>30</td>
<td>180</td>
<td>610</td>
<td>2610</td>
<td>6960</td>
<td>13290</td>
<td>18550</td>
<td>26360</td>
<td>37610</td>
</tr>
<tr>
<td>AT72</td>
<td>40</td>
<td>240</td>
<td>820</td>
<td>3600</td>
<td>9690</td>
<td>18430</td>
<td>25380</td>
<td>35350</td>
<td>49210</td>
</tr>
<tr>
<td>DH8D</td>
<td>40</td>
<td>250</td>
<td>890</td>
<td>3900</td>
<td>10530</td>
<td>19990</td>
<td>27480</td>
<td>38120</td>
<td>52780</td>
</tr>
<tr>
<td>E190</td>
<td>60</td>
<td>320</td>
<td>1150</td>
<td>5140</td>
<td>13970</td>
<td>26440</td>
<td>36060</td>
<td>49420</td>
<td>67340</td>
</tr>
<tr>
<td>A332</td>
<td>180</td>
<td>990</td>
<td>3550</td>
<td>16480</td>
<td>44620</td>
<td>95330</td>
<td>136120</td>
<td>170480</td>
<td>213660</td>
</tr>
</tbody>
</table>

*With reactionary costs.*
Trends and headlines

- 2014 15-minute distributions very similar to those for 2010
- Pax costs also dominate en-route at higher delays
Trends and headlines

Figure J1. Full tactical cost as a function of $\sqrt{\text{MTOW}}$
Users and example SESAR projects
Users and example SESAR projects

- EUROCONTROL (EHQ & EEC); SESAR
  - tactical and strategic, planning and assessment levels
- Airlines (two-way process); Working Group
- ANSPs, airports, national government
  - expansion and privatisation
- Legal cases (large delay compensation claims)
- Industry (e.g. delay management software)
- Academia (more global reach c.f. above)
Users and example SESAR projects

• SATURN project (SESAR WP-E; led by University of Trieste)
  – market-based demand-management mechanisms to redistribute air traffic in the European airspace, at the strategic level
  – SES Charging Regulation 391/2013 – “Modulation of charges”
    ▪ modulation of en-route charges (peak & off-peak rates per ANSP)
    ▪ whole European airspace modelled (30 000 flights; busy day in SEP14)

• Key results
  – peak pricing a viable option, respecting ANSP revenue neutrality
  – about 9% of sector-periods were heavily loaded (>90% utilisation) on test day; SATURN mechanisms reduced this to 5%

• Future work
  – exploring flexible capacity provision
  – improved AO choice determinants (incl. price elasticities)
  – extension to include AO tactical cost benefits
Users and example SESAR projects

• ComplexityCosts project (SESAR WP-E)
  – comparative effectiveness of various mechanisms at increasing cost resilience under different types of disturbance
  – mechanisms (baseline and enhanced)
    ▪ A-CDM; pax reaccommodation tools; DCI; increasing ATCO hours
  – disturbances (with background ATFM; local and disperse)
    ▪ local airport weather; ATC strikes; ATC capacity (staffing)
  – differential stakeholder adoption by ANSP, AO & airport type
    ▪ current, early adopter (baseline -> enhanced), follower (new uptake)

• Current work
  – stochastic, event-driven model: interacting elements & feedback
  – capture of complex dependencies often overlooked in trade-offs
  – airports: 200 ECAC + 50 external (month + busy day in SEP14)
  – full cost allocations to (>2.5M) passenger itineraries, and AO types
  – new resilience metrics – including strategic and tactical costs
Where next?
LIS–HEL, B738 (22 minutes delay)

Primary cost (k€)

Delay (mins)

EUROCONTROL Agency Research Team
Ninth meeting

ENAC, Toulouse
24 March 2016
Flightpath 2050 – 4 hours D2D for 90% of pax?

Multiple D2D pathways: some legs (= =) are more compressible; regional / 2° options

Airport access, process and egress particularly compressible
- road congestion; PT (priorities); interchange times / direct access; frequencies / capacities
- K2G (automation & smart systems): check-in (baggage); security / passport control; + MCTs

Gate-to-gate (G2G) performance relatively pretty good
- 82% of arrivals within 15mins (buffers); e/r ATFM = 0.73 mins/flt; hor. e/r ineff = 4.7% (2015)

Compare 3h49 average CDG connections
Where next?

• Further research needed
  – pax costs evaluation: Reg. 261 revision (e.g. 2 hours; 90 minutes)
  – metric integration (A-CDM; 4H D2D; RP3?): pax delay ≠ flight delay
  – reactionary delay (PRRs) and propagation; cancellation costs
  – Standard Inputs for EUROCONTROL CBA (etc.) – updated web tools

• Applications
  – integration with strategic and tactical tools
    ▪ ANSP (rostering) and AO (scheduling and routing)
    ▪ ground (e.g. Sabre; A-CDM) and airborne (e.g. PACE) tools
  – flight prioritisation mechanisms (e.g. UDPP)
  – EU policy/mobility evaluation, e.g. Reg. 261 and beyond ... 4H D2D
Thank you

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http://www.eurocontrol.int/publications/european-airline-delay-cost-reference-values