Update: Robust Scheduling and Modeling of Airline Capacity Reductions

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Overview

- Review of robustness in airline planning
  - Problem motivation
  - What we’d done before
  - Your feedback
  - Our revised results
  - New ideas?

- Introduction to new research analyzing impact of capacity reduction
  - What role should we be playing in policy discussions? Who should the collaborators be?
Motivation for Robust Scheduling

- Delays are bad. And frequent.
- Lots of causes that are difficult to control (e.g. weather, air traffic control, mechanical)
- But many delays are caused by other delays – propagation from upstream delays, due to network effects
- Fundamental conflict – planning metrics discourage slack but slack is essential to stop delay propagation
Challenges

- How much extra *planned* cost should we incur to reduce *potential* delay costs in operations?
- How do we *measure* robustness?
- How do we *value* robustness?
- How do we *achieve* robustness?
Our Initial Approach

- Can we side step some of these challenges, at least for now?
- Try to improve operational robustness without increasing planned costs
- How? Redistribute existing slack to places where it has greatest benefit
- Keep crew, routing assignments unchanged
- Limit time windows to maintain demand
### Results

<table>
<thead>
<tr>
<th>Data Set</th>
<th>Duty Restrictions</th>
<th>Single-Layer Model</th>
<th>Multi-Layer Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>6.3%</td>
<td>7.2%</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>23.0%</td>
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<tr>
<td>2</td>
<td>10</td>
<td>34.4%</td>
<td>41.5%</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>43.1%</td>
<td>52.2%</td>
</tr>
</tbody>
</table>
Your Concerns

- Our surrogate metric for robustness is the sum of expected delay minutes across all *independent* root delays, viewed individually.
- Of course, delays don’t happen one-at-a-time.
- We sometimes over-count (both in the original and “optimized” schedule).
- We sometimes under-count (both in the original and “optimized” schedule).
Simultaneous Disruptions

Root delay: 25 minutes

Root delay: 30 minutes

Individual delays in $f_0$ and...
## New Results -- Simulation

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<th>Multi-Layer Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>(5.7%, 6.1%)</td>
<td>(7.2%, 7.6%)</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>(19.7%, 20.4%)</td>
<td>(25.6%, 26.2%)</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>(32.7%, 33.5%)</td>
<td>(38.0%, 38.6%)</td>
</tr>
<tr>
<td>1</td>
<td>15</td>
<td>(42.3%, 43.1%)</td>
<td>(47.5%, 48.2%)</td>
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<tr>
<td>2</td>
<td>0</td>
<td>(4.9%, 5.3%)</td>
<td>(5.8%, 6.2%)</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>(25.2%, 25.7%)</td>
<td>(27.1%, 27.6%)</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>(39.3%, 39.9%)</td>
<td>(41.3%, 42.0%)</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>(50.0%, 50.7%)</td>
<td>(52.0%, 52.6%)</td>
</tr>
</tbody>
</table>
What’s Next?

- Correlated delays within optimization model?
- Itinerary protection?
- Recovery interventions?
- Permitting crew, tail modifications?
- ???
Lots of discussions in the press, in the government, in other academic circles about the airline industry

Many of those participating in these discussions don’t have a good appreciation of network impacts – critical to understanding, measuring airline decisions

What role should we play in policy discussions?
ATA estimates as many as 100 communities could lose service this year, 200 next year

Small airports are halting expansions, reducing headcount, freezing hiring

Large airports also impacted by reduction, even if not elimination
Capacity Reduction Impacts

- Many other airports maintain some service but limited routes
- 400 routes eliminated between March and September of 2008

The Plain Dealer, Sep. 3 2008
Capacity Reduction Impacts

- Leisure markets
- Secondary airports (e.g. Midway, Islip, Oakland)
- Regional jet non-stops

USA Today, Jun. 4 2008
Fort Lauderdale will have almost 10% fewer seats this fall than last year
United pulling out altogether
JetBlue flying same number of flights but some with smaller aircraft; fares are going up
Impact on hotel bookings is clearly visible
  - Rely on vacation travelers
  - As fares go up, trips become discretionary
Impact on Leisure

- Hawaii likewise heavily affected
- 25% less scheduled air service than a year ago
- Honolulu to mainland down by 10%
- Estimated impact: 1 million tourists per year

USA Today, June 4 2008
Not Just the U.S.

- ANA may halt service to Guam and Taipei
- XL Airways cancels service from Great Britain to the Caribbean
- Delays of service to China (American, USAir, Northwest, United…)

Reuters, Aug 5. 2008; Telegraph.co.uk, Aug. 29, 2008; WSJ Spe. 2, 2008
Secondary Airports

- San Francisco not seeing much change, but Oakland losing about 20% of seats
- Continental pulling out of Midway
- Delta leaving Islip
- In total, Islip and Manchester (NH) each losing more than 10%

USA Today, June 4 2008
Cuts in Non-Stops/Fewer Regional Jet Flights

- Austin losing 8 – 9 out of fifty nonstops
- Embraer predicts 250 – 350 fifty-seat RJs to shed over the next five years in North America
- Eg. Delta eliminating 20 – 25 RJs

What We Do Know

- Many communities have seen dramatic reduction in service
- Often, not the congested areas
- Lots of invested constituents
What We Also Know

- Things aren’t as simple as they look from the outside
- Network effects play a major role in these issues
- Example – Carey Treado, U. Pitt.
Research Goals

- To develop models needed to accurately capture impacts of capacity reduction, integrating both airline and community impacts
- To develop models needed to better understand passenger behavior as a result of changes in service
- To develop models of environmental impact
- To communicate the results with broader visibility
Questions for Discussion

- What role should the Global Airline Industry Program be playing in policy-making?
- What is the relationship between industry/academia/government in these areas? How do we effectively work together? What are the potential conflicts?
- What are the key policy questions we should be focusing on?