Data-driven evaluation of a flight re-route air traffic management decision-support tool*

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AHFE Technical Session 111
24 July 2012

*This work was sponsored by the Federal Aviation Administration under Air Force Contract No. FA8721-05-C-0002. Opinions, interpretations, conclusions, and recommendations are those of the authors and are not necessarily endorsed by the United States Government.
Departure re-route reasons

New York City area air traffic
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NYC-area airspace
• Complex, multiple airports
• Congested, causes ¾ of U.S. air traffic delays

Weather
• 70% of delays due to weather, often with thunderstorms
• Thunderstorms are unpredictable and have recently increased
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Departure re-route considerations

New York City area air traffic

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Decisions include
- Demand vs. capacity
- Forecast weather locations and impacts
- Coordination of flight changes

Key:
- EWR, LGA, JFK departures
- EWR, LGA, JFK arrivals
- PHL arrivals
- BOS, DC traffic

September 7 1215Z
Heavy traffic on mixed RED / YELLOW routes using merged traffic flows

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Underlying decision support tools

New York City area air traffic

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Weather forecast tools

- Geospatial forecast (CIWS*)
- Departure routes (RAPT**)

30-minute forecast, 5-minute bins

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*CIWS = Corridor Integrated Weather System
**RAPT = Route Availability Planning Tool
Underlying decision support tools

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- VIL Echo top

*CIWS = Corridor Integrated Weather System
**RAPT = Route Availability Planning Tool
Integrated Departure Route Planning (IDRP) Tool

Capabilities
1. Integrated with CIWS and RAPT.
2. 30-minute demand forecast per departure route
3. 60-minute demand forecasts and congestion alerts per departure fix, in 15-minute bins

Not shown: flight list and re-route alternatives list.

Prototype jointly developed by MIT Lincoln Laboratory and MITRE.

Forecast calculations updated every minute. Wheels-off predictions use filed flight plans (ASPM) and radar-based surface (ASDE-X) locations.
Tool evaluation plan

- Summer 2011, deployed to 12 locations involved in NYC-area air traffic
- Data analyses for 2 fair and 10 convective weather days at 5 high-volume NYC-area airports:
  Newark, LaGuardia, JFK, Teterboro, White Plains
- Data mined from IDRP (predictions), ASPM* (actual departure times)

*ASPM = Aviation System Performance Metrics
Tool evaluation – 3 system metrics

Predicted wheels-off forecasts* within 30-minute planning horizon

A. At 11:27:00, first forecast of 11:56:21 in 30-minute planning horizon

B. At 11:54, actual wheels-off of 11:54

C. Latest forecast of 12:07:39

D. Earliest forecast of 11:51:00Z

Predicted wheels-off error (accuracy)

Metric 1. error = actual wheels-off time (B) – predicted wheels-off time (A)

Predicted wheels-off spread (reliability)

Metric 2. spread = latest pred. wheels-off time (C) – earliest pred. wheels-off time (D)

Hourly predicted fix demand spread (24 fixes, in 15-minute bins)

Metric 3. fix spread = largest – smallest total hourly fix demand

* Flights must have ASPM and must not have been rerouted
Results – Predicted wheels-off error

Over 15,000 departure flights included:
- Median error was near zero minutes for fair and convective weather days.
- Half of prediction errors fell within -10 to 12 minutes for convective days*, and -10 to 5 minutes for fair days.
- Highest 10% of prediction errors ranged from 30 to 50 minutes on convective days** and 15 to 18 minutes on fair days.

*Except for August 25, when the upper bound reached 20 minutes.
**Except for August 25, when the upper bound reached 70 minutes.
Results – predicted wheels-off spread

- Forecast spread 20 minutes or less for most flights on fair and convective days.
- Convective days have a long tail to the distribution and some flights with spreads in excess of 30 minutes.
- Highest 10% of forecast spreads ranged from 50 to 70 minutes on convective days* and 34 to 38 minutes on fair days.

*Except for August 25, when the upper bound reached 90 minutes.
Hourly fix demand spread by day, grouped by weather:
- Predicted fix demand spread was 9 flights or less for half the flights*.
- The spread was 19 flights or less for 75% of departures on convective days**.
- Highest 10% spread ranged from 17 to 55 flights on convective days, and 8 to 19 flights on fair days.

*Except for September 7, when the spread reached 14 flights.
**Except for July 29 and September 7, each having 28 and 34 flights.
Results – fix demand example day

July 19\textsuperscript{th}, long-lived, local weather impacts, forecast demand spread in 15-minute bins.
Discussion/Conclusions

1. Forecasts were overall less accurate and reliable on convective weather days:
   a. Wheels-off error had late predictions for over 25% of flights
   b. Wheels-off spread was 30+ minutes, which is greater than the planning horizon
   c. Hourly fix demand spread was highest on days with long-lived weather impacts

2. Forecast uncertainty may influence tool usage and air traffic management decisions
   a. Possible disuse (under utilization), or misuse (overreliance) of tool
   b. System may cause over-control, paralysis, or poor decisions

3. Predicted wheels off calculations need improvements to reduce error and volatility
Thank you

Questions?