Operational Evaluation of Dynamic Weather Routes at American Airlines

Dave McNally, Kapil Sheth, Chester Gong, and Paul Borchers
NASA Ames Research Center
Moffett Field, California

Jeff Osborne, Desmond Keany, Brennan Scott, and Steve Smith
American Airlines, Integrated Operations Center
Fort Worth, Texas

Scott Sahlman, Chuhan Lee, Jinn-Hwei Cheng
University of California, Santa Cruz
Moffett Field, California

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Takeaway Message

• DWR in daily use operations at American Airlines operations center since July 2012

• DWR a continuous search engine finds opportunities for more efficient routes

• Integration of en route Center and Traffic Flow Management automation enables users to consider factors important to airlines, controllers, and traffic managers

• Strong airline and industry interest in DWR and commercialization options
What’s the Problem

• Convective weather leading cause of delay in US National Airspace System

• Weather avoidance routes planned 1-2 hours in advance, include large buffers to forecasted weather

• Weather changes, dispatchers & traffic managers busy, opportunities for more efficient routes may be missed
Outline

• Concept and Weather Model

• Trial Architecture and Operating Concept

• Data Analysis
  – Accepted, rejected, and actual reroutes
  – Reasons for rejects and recent upgrades
  – Sector congestion
  – Potential savings all Fort Worth Center flights

• Conclusions
Dynamic Weather Routes

Current active Center flight plan route
Dynamic Weather Routes

Current active Center flight plan route

Flight plan fix inside limit region

Reference route, saves 5+ min wind corrected
Dynamic Weather Routes

Current active Center flight plan route

Dynamic Weather Route

Waypoints inserted to resolve weather conflicts or weather & traffic conflicts, fix-radial-distance format
Dynamic Weather Routes

Current active Center flight plan route

Dynamic Weather Route

Waypoints inserted to resolve weather conflicts or weather & traffic conflicts, fix-radial-distance format

Snap-to nearby named fix option

Reference: ICAS2012 paper
7 out of 10 pilots will avoid contour

Convective Weather Avoidance Model, MIT Lincoln Laboratory
System Architecture

FAA Center Traffic Management Coordinators

Today’s system & procedures
DWR system & procedures

AA ATC Coordinators (Primary Users)

American User Display

Repeater at AA ATC Desk

American User Display

Center Trajectory Automation (CTAS)

Autoresolver

Weather Model

Traffic Flow Management Trajectory Automation (FACET)

AA Flight Dispatchers

ACARS

AA SOC System

Inputs

Center track/flight plan, 12 sec update
National track/flight plan, 1 min update
Weather, 5 min update
Special Use Airspace, 15 min update
Winds, temperature pressure, 60 min
Users & Operating Concept

American Airlines System Operations Center, Fort Worth, Texas
Test Schedule

• Fort Worth Center traffic only

• System runs 23 hrs/day, 7 days/week

• 11:00 AM to 4:00 PM local time nominal staffing (varied depending on availability & training)

• July 31, 2012 to October 31, 2012 test period (data for this paper)
User Display

DWR List

Center Traffic Display

Traffic Flow Management Display

Trial Planning
Trial Planning

Sector congestion on flight plan route

Accept, Reject, Cancel

Flight plan
DWR route

Flying Time Savings (or Delay)

Active Special Airspace

Savings (or Delay)
Dynamic Weather Routes

DWR

Sample Fort Worth Center reroutes from 2012 Operational Trial with American Airlines
Email Alerts and Daily Report

### Inbox

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<td><a href="mailto:mercury@ntx.org">mercury@ntx.org</a></td>
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### DWR Report Thurs Sept 13, 2012

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<th>Type</th>
<th>Flights</th>
<th>Estimated Savings (min)</th>
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<td>Total DWR Initialized Flights</td>
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<tr>
<td>Evaluated</td>
<td>11</td>
<td>76.3</td>
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<tr>
<td>Accepted</td>
<td>9</td>
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<td>19.4</td>
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<tr>
<td>Canceled</td>
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<tr>
<td>Total AA Initialized Flights</td>
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<td>0</td>
</tr>
<tr>
<td>Accepted</td>
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<td>0</td>
</tr>
<tr>
<td>Canceled</td>
<td>1</td>
<td></td>
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</tbody>
</table>
Proposed Routes and User Actions
Cumulative, July 31, 2012 - October 31, 2012

Potential flying time savings for AA flights in Fort Worth Center (min)

Routes proposed by DWR: 5,274 min

Evaluated by AA: 1,208 min

Accepted by AA: 470 min

Rejected by AA: 150 min

Trial routes initiated & accepted by AA: 13 min

More effective to let automation find high value routes.

Significantly more savings could be acceptable to AA users.

637 156 71 18 11 Number of flights

6000
5000
4000
3000
2000
1000
0

Number of flights

American Airlines
Proposed Routes and User Actions
Daily Activity by Flight Count

Days from July 31, 2012 to October 31, 2012

Flights with Proposed DWRs
Flights with DWRs accepted by AA
Proposed Routes and User Actions

Daily Activity by Flight Count

Days from July 31, 2012 to October 31, 2012

- Flights with Proposed DWRs
- Flights with DWRs accepted by AA
- Flights Evaluated by AA, but without proposed DWRs

User activity subsides for flights without proposed DWR routes
Proposed Routes and User Actions

Daily Activity by Potential Time Savings

Most user activity occurs on heavy weather days, 17 out of 90 days with over 100 minutes potential savings.
Sample: Tampa/Chicago

Accepted DWR Savings: 23.6 min
Estimated Actual Savings: 23.8 min
Accepted DWR and Host amendment assumed correlated when
- User comments indicate a route request to Center and
- Host route amendment observed -5 to +20 min from user “Accept”

78 minutes actual flying time savings for AA flights in first 3 months of trial

Coordination and execution latency generally reduces potential savings
User Feedback

Main Reasons for Rejected Routes

• Merging arrival streams
• Playbook Routes, Traffic Management Initiatives
• Narrow weather gaps
• Sector congestion

Desired New Features

• Maneuver start point
• Adjacent Center traffic
DWR Without Gap Detection

Potential Savings 5.0 min
Gap Parameters

- **Width**
- **Distance Along Track**
DWR With Gap Detection

Potential Savings 2.5 min
DWRs Through Merging Arrival Streams

Multiple conflicts with Dallas arrivals

Savings: 5.5 min

Maneuver Start present position, FL190
DWRs Through Merging Arrival Streams

Multiple conflicts with Dallas arrivals

Savings: 4.7 min

Maneuver Start: 5 min, FL270
Most DWR routes (73 out of 83) either no impact or favorable impact on Traffic Flow Management sector congestion metrics.

Out of 10 flights, one with proposed congestion within 30 minutes.
Potential Savings All Flights in ZFW by Airline

July 31, 2012 - October 31, 2012

Reference direct route 5 min or more

Flight at or above FL250

$3.9M potential savings* over three months in one Center

*168/min average operating cost (IATA 2011)

2,671 flight operations, 23,278 minutes, 8.7 min average per flight
Concluding Remarks

• DWR in daily use operations at American Airlines operations center, Fort Worth, Texas since July 2012

• Continuous, automatic search engine, audible alerting are important features for users

• More effective to let automation find high value reroutes

• 71 DWRs, 45% of those evaluated, worth 470 min flight time savings, acceptable to AA users in first 3 months

• Most DWR routes (88%) no impact or favorable impact on Traffic Flow Management sector congestion metrics

• Work ongoing to address issues uncovered during trial, explore commercialization options