On-Demand Assessment of Air Traffic Impact of Blocking Airspace

Future Air Traffic Management; Modelling and Simulation Promises and Challenges
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Problem: Airspace is a limited resource

Demand on its use is becoming limitless

Note: Rendering notional. Sizes of buildings and representational air/space craft not to scale.

Image Source: MITRE
Research Objectives

• **Increase transparency and collaboration** in integration of new entrants into National Airspace System (NAS) by:
  • Enabling instantaneous assessment of the impact of blocking airspaces using a what-if analysis paradigm
  • Ensuring accessibility to a broad range of airspace users
    • FAA, new entrants, DoD & airlines
    • Require no prior knowledge of air traffic pattern
Research Tasks

Data Reduction & Encoding
(Support Interactive Querying & Efficient Memory Management)

Traffic Projection Model

NAS Impact Model

Prototype to Test Intended Use

Instrumentation for massively parallel runs on MITRE High Performance Computing Environment
Instantaneous Response – Using Route Segment Density Map

Cape Canaveral Launch Site

Traffic on 8th August, 2014
Reduce to Traffic Pipes

Impacted Flights = X + y + (z+Z)
NAS Wide Route Segments
Efficacy of Route Segment Maps – Actual vs Assessed Flight Crossings

<table>
<thead>
<tr>
<th>Airspace</th>
<th>RSquare</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Airspace</td>
<td>0.983004</td>
</tr>
<tr>
<td>Florida Airspace</td>
<td>0.948678</td>
</tr>
<tr>
<td>Center Airspace</td>
<td>0.938896</td>
</tr>
<tr>
<td>North-West Airspace</td>
<td>0.866413</td>
</tr>
<tr>
<td>West Airspace</td>
<td>0.948552</td>
</tr>
</tbody>
</table>

Actual vs Assessed Correlation
Model Traffic Projections

Step 1. Analyze historical traffic trends by aggregating on daily, weekly and monthly

Step 2. Predict using distribution of Route Segment usage in historical days similar to the predicted day:
- 2010 to 2015 data used to predict 2016
- Similar historical days are the same day-of-week and in the week number of predicted
- Previous and next 2 weeks are additionally selected to arrive at a sample size of 30 similar historical days
- Estimated range is based on 25 and 75 percentile distribution values
Projection Accuracy

<table>
<thead>
<tr>
<th>Airspace</th>
<th>Percent In Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Airspace</td>
<td>81.4</td>
</tr>
<tr>
<td>Florida Airspace</td>
<td>82.4</td>
</tr>
<tr>
<td>Center Airspace</td>
<td>79.7</td>
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<tr>
<td>North-West Airspace</td>
<td>96.7</td>
</tr>
<tr>
<td>West Airspace</td>
<td>88.5</td>
</tr>
</tbody>
</table>

Projection Accuracy for Sample Airspaces

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Modeling Impact

Impact Metrics Supported
- Flights
- Airline Mix
- Sectors Levels
- Origin-destination pairs
- Domestic-foreign proportions

Planned Additional Metrics
- Extra Distance
- Delay

Segment information
- Bi-directional flight count
- Sector usage
- Airline mix
- Origin-destination pairs
- Domestic flights

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MITRE visualization over Google Earth
Conclusions & Next Steps

- Research demonstrated viability of assessing the impact of blocking airspaces, using a “what-if” analysis paradigm
- Data reduction technique resulted in efficiency in data size and memory management, with negligible loss in accuracy
- Traffic projection model performed well, given the uncertainties of traffic pattern
- Research results are preliminary, further study to evaluate sensitivity of model performance to constraints such as location, airspace size and closure time are ongoing
- Alternate approach to projection based on using a grid to capture traffic is being explored
- Assessing additional impact metrics, namely delay and extra distance is being researched
Thank You
Impact Assessor (ANSP View)
World-wide Traffic Data
Impact Assessor (Space Operator View)
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