Quantifying Aviation Weather Forecast Benefits – an FAA Investment Analysis Perspective

Presented to: Friends/Partners in Aviation Weather Forum

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NAS Acquisition Programs
Flight Efficiency/Delay Savings Claims during Adverse Weather

Surface, Terminal
- ASDE-X
- CSS-WX
- ELVO
- AIMM
- TBFM

En Route
- AIMM
- CSS-WX
- ERAM
- NWP
- ADS-B
- DATA COMM
- ERAM Future
- NVS
- TBFM

Terminal, Surface
- CATMT
- DATA COMM
- ERAM Future
- NWP
- PRM-R
- TBFM
- CSS-WX
- ERAM
- ITWS
- Future Facilities
- ADS-B
- WAAS

Quantifying Aviation Weather Forecast Benefits
FAA Investment Analysis Perspective
The FAA’s Investment Planning and Analysis Office works closely with the program offices to ensure a defensible business case moves forward.

METRICS are identified, developed, and transformed into benefits. All Facilities and Equipment (F&E) acquisition programs go through the investment analysis process.

Legend
1. Concept & Requirements Definition Readiness Decision
2. Investment Analysis Readiness Decision
3. Initial Investment Decision
4. Final Investment Decision
5. In-Service Decision

Post Implementation Reviews (PIRs) are done shortly after deployment -- includes benefits measurements.
<table>
<thead>
<tr>
<th>Program</th>
<th>Forecast Mechanism</th>
<th>Key Benefit Categories</th>
<th>Primary Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather Radar Processor (WARP)</td>
<td>Updated mosaics from NEXRADS</td>
<td>1) Navigating through holes, 2) deviating further upstream, 3) avoiding storm cells behind a front in en-route airspace</td>
<td>Delay savings en-route</td>
</tr>
<tr>
<td>Integrated Terminal Weather System (ITWS)</td>
<td>0-1 hour forecast for terminal areas</td>
<td>1) Arrival transition areas, 2) departure transition areas and 3) runways (better capacity utilization)</td>
<td>Delay savings airborne and ground</td>
</tr>
<tr>
<td>NextGEN Weather Processor (NWP)</td>
<td>ARTCC based tool 0-2 hour forecast, echo tops, includes winter weather products</td>
<td>1) Keeping routes open, 2) pro-active rerouting</td>
<td>Delay savings airborne and ground</td>
</tr>
<tr>
<td></td>
<td>Replaces CIWS prototype</td>
<td></td>
<td>Safety</td>
</tr>
<tr>
<td>NextGEN Weather Processor (NWP)</td>
<td>Longer term forecast – 2 to 8 hours</td>
<td>1) AFP execution management, 2) enhanced playbook reroute planning and execution and 3) enhanced reroute planning</td>
<td>Cost Avoidance</td>
</tr>
<tr>
<td></td>
<td>Replaces CoSPA prototype</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terminal Doppler Weather Radar (TDWR)</td>
<td>Aviation weather products: precipitation, microburst, gust fronts, and related hazardous wind shear thru better detection</td>
<td>Increased safety in the terminal area</td>
<td>Safety</td>
</tr>
</tbody>
</table>
### FAA Program – CATMT-WP2

Capabilities that use Forecast Weather to make Air Traffic Decisions

<table>
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<tr>
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<th>Forecast Mechanism</th>
<th>Key Benefit Categories</th>
<th>Primary Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>CATMT- WP2 Route Availability Planning Tool (RAPT)</td>
<td>Integration of CIWS echo top and precipitation forecasts into display</td>
<td>Better departure route management, Improved route impact planning</td>
<td>Delay savings (ground)</td>
</tr>
<tr>
<td>CATMT-WP2 Traffic Flow Management System (TFMS)</td>
<td>Integration of CIWS products on Traffic Situational Displays (TSDs)</td>
<td>Keeping routes open longer, pro-active rerouting</td>
<td>Delay savings (airborne and ground)</td>
</tr>
<tr>
<td>CATMT- WP2 Collaborative Airspace Constraint Resolution (CACR)</td>
<td>Proposes effective, efficient, and integrated resolutions to airspace congestion problems. Actions are based on 0-2 hour forecast weather</td>
<td>More efficient routes through better utilization of reduced airspace capacity</td>
<td>Delay savings (airborne and ground)</td>
</tr>
</tbody>
</table>
Purpose was to justify ITWS at 12 additional sites through data-driven analysis

Used CLT as existing site to establish the basis for capturing the benefits of ITWS

Meteorology assessment of 1-minute movies of weather and traffic into CLT

GOAL was to determine times when weather “should have” impacted runways and Arrival Transition Areas (ATAs) and Departure Transition Areas (DTAs) in TRACON

Identified a sufficient sample of candidate pre/post day events at CLT since ITWS was operational at time of analysis.

Meteorologists captured start/stop times and storm impact for each day

Output

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Mean Flight Time during Impacted Time (100-40nmi)</th>
<th>Overall Mean Flight Time Good Weather Days (100-40nmi)</th>
<th>Arrival Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-ITWS</td>
<td>18.19</td>
<td>12.79</td>
<td></td>
</tr>
<tr>
<td>Post-ITWS</td>
<td>15.73</td>
<td>12.02</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td>2.47 min</td>
<td>.77 min</td>
<td>1.7 min</td>
</tr>
</tbody>
</table>

Illustration of Assessing Operational Performance - ITWS
Illustration of Assessing Operational Performance - CIWS

Meteorology assessment of NCWD data to capture sufficient set of sample days with convective weather

<table>
<thead>
<tr>
<th>Date</th>
<th>Time (Z)</th>
<th>ZKC</th>
<th>ZMP</th>
<th>Intensity 1-4</th>
<th>Echo Top Opp.</th>
<th>Date</th>
<th>Time (Z)</th>
<th>ZKC</th>
<th>ZMP</th>
<th>Intensity 1-4</th>
<th>Echo Top Opp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/8/2004</td>
<td>1400-1800</td>
<td></td>
<td>X</td>
<td>2 to 3</td>
<td>Yes</td>
<td>6/28/2007</td>
<td>1000-1600</td>
<td>X</td>
<td></td>
<td>2</td>
<td>Yes</td>
</tr>
<tr>
<td>7/14/2004</td>
<td>1000-1700</td>
<td>X</td>
<td></td>
<td>3 to 4</td>
<td>Maybe (late)</td>
<td>6/30/2007</td>
<td>1300-1700</td>
<td>X</td>
<td></td>
<td>2 to 3</td>
<td>Yes</td>
</tr>
<tr>
<td>7/16/2004</td>
<td>1000-1500</td>
<td>X</td>
<td></td>
<td>2 to 3</td>
<td>Maybe (late)</td>
<td>7/3/2007</td>
<td>1100-1600</td>
<td>X</td>
<td></td>
<td>2 to 3</td>
<td>Yes</td>
</tr>
<tr>
<td>7/21/2004</td>
<td>1000-1300</td>
<td>X</td>
<td></td>
<td>3</td>
<td>Maybe</td>
<td>7/8/2007</td>
<td>1100-1400</td>
<td>X</td>
<td></td>
<td>3 to 4</td>
<td>Maybe</td>
</tr>
<tr>
<td>7/23/2004</td>
<td>1000-1800</td>
<td>X</td>
<td></td>
<td>2</td>
<td>Yes</td>
<td>7/18/2007</td>
<td>1800-2300</td>
<td>X</td>
<td></td>
<td>2 to 3</td>
<td>Yes</td>
</tr>
</tbody>
</table>

OBJECTIVES – 1) to capture *data driven change* in airborne metric from pre-implementation to post-implementation for identifying change in airborne performance at ZMP and ZKC with CIWS, 2) compare with discrete-event simulation modeling outputs

![Graph showing Nbr. of O-D Pairs by Distance Reduction (nmi) and Improvement](image)

<table>
<thead>
<tr>
<th>Year</th>
<th>Airborne Delay (min)</th>
<th>Flts. Eval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-CIWS (2004)</td>
<td>1.84</td>
<td>1529</td>
</tr>
<tr>
<td>Post-CIWS (2007)</td>
<td>1.06</td>
<td>1441</td>
</tr>
<tr>
<td>Difference</td>
<td>-0.78</td>
<td></td>
</tr>
</tbody>
</table>
Illustration of Our Challenge

Airborne Time From ORD to DCA

This 500+ nmi flight, which flies through an average of 7 en route sectors, has averaged between 81.5 to 82.9 minutes of airborne time over a 12-year period. In 2010 there was a very wide range between the actual airborne time and the of Filed ETE. Can better usage of the forecast close the gap and improve the predictability of the flight??

<table>
<thead>
<tr>
<th>Month</th>
<th>Airborne</th>
<th>FP ETE</th>
<th>FP ETE-Airborne</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>81.5</td>
<td>85.9</td>
<td>4.4</td>
</tr>
<tr>
<td>Feb</td>
<td>81.8</td>
<td>85.3</td>
<td>3.5</td>
</tr>
<tr>
<td>Mar</td>
<td>84.8</td>
<td>88.8</td>
<td>4</td>
</tr>
<tr>
<td>Apr</td>
<td>80.6</td>
<td>85.6</td>
<td>5</td>
</tr>
<tr>
<td>May</td>
<td>82.4</td>
<td>87.1</td>
<td>4.7</td>
</tr>
<tr>
<td>Jun</td>
<td>80.7</td>
<td>86.6</td>
<td>5.9</td>
</tr>
<tr>
<td>Jul</td>
<td>82</td>
<td>87.6</td>
<td>5.6</td>
</tr>
<tr>
<td>Aug</td>
<td>81.7</td>
<td>88</td>
<td>6.3</td>
</tr>
<tr>
<td>Sep</td>
<td>81.1</td>
<td>92.8</td>
<td>11.7</td>
</tr>
<tr>
<td>Oct</td>
<td>81.2</td>
<td>92.6</td>
<td>11.4</td>
</tr>
<tr>
<td>Nov</td>
<td>82</td>
<td>85</td>
<td>3</td>
</tr>
<tr>
<td>Dec</td>
<td>81.5</td>
<td>84.2</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Source: ASPM
User Benefit Perspective
What is Needed to Ensure Defendable Measure of Success?

Legacy Weather Programs

Methodology 1
ITWS BENEFITS
*Short-term forecast*

Methodology 2
WARP BENEFITS
*NEXRAD mosaics*

Candidate DSTs Expected to Integrate Weather Forecasts

Methodology 3
CATMT WP2 BENEFITS
*CIWS Integration on TSDs*

Methodology 4
TBFM BENEFITS
*Metering during convective weather*

NextGen Programs

Methodology 5
NWP BENEFITS
*Improved short-term and long-term forecasts*

Methodology 6
CSS-WX Benefits
*Dissemination of Forecasts*

Methodology 7
CATMT WP4 Benefits
*Improved Weather Forecast translation impacts Airport Acceptance Rates (AARs)*

CONSISTENT METRICS that Measure Incremental Change from Today’s State are CRITICAL!!

- En route distance savings
- More efficient capacity utilization
- Increased throughput (surface and airborne)
- Reduced variance in flow separations
- Fewer missed departure slots

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Federal Aviation Administration
What Should the FAA be Doing?

• Develop a historical multi-year baseline that captures key measures to track the operational performance in various weather conditions
  – Winter precipitation, IMC, convective weather (terminal, TRACON, en-route), terminal winds, etc.

• Integrate various databases and data sets into a relational database/warehouse that can quickly address the “contribution of the forecast” questions
  – Utilize the National Traffic Management Log (NTML) and sector activity and arrival fix/departure fix measures better
  – Take advantage of current Weather Impact Traffic Index (WITI) and WITI-Forecast Accuracy (WITI-FA) Toolset and flight data sets, e.g., ASPM, ASQP, OPSNET, PDARS

• Use post-analysis modeling tools to identify opportunities to measure events

• Quantify the impact of enhanced weather capabilities through a portfolio based Operational Assessment
  – Provide portfolio views that capture contributions of multiple programs contributing to the success of the flight as well as the individual program view
  – Helps assess the results of NextGen Operational Improvements
Questions?