Space Weather in the Next Generation Air Transportation System

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Cecilia Miner
NOAA/NWS/Aviation Services Branch
Overview

- NextGen 101
- NextGen Key Themes
- What are the 4-D Cube and the Single Authoritative Source
- Requirements
- The Roadmap Ahead
NextGen 101

Next Generation Air Transportation System (NextGen)

Aircraft Trajectory Based Operations
Performance-Based Services
Air Navigation Operations and Support
Flight Operations and Support
Super Density Operations
Airport Operations and Support

ICAO
Global Harmonization

DOT
FAA
DOE
DHS
DOC
NASA
OSTP
NOAA

Policy & Regulations
Equivalent Visual Operations

Flight Planning
Flight Data
Aeronautical Information

Surveillance
Layered Adaptive Security

Enterprise Services
GeoSpatial Information
Position, Navigation, and Timing

Communication
Safety

Performance Metrics
Weather

Net Centric Infrastructure Services
Network-Enabled Information Access

Questions/Comments:
Jay Merkle
jay.merkle@faa.gov

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NextGen 101 Documents

http://www.jpdo.gov
>Knowledge Center >Collateral Library >Technical Documents
Conference Examines the Future of TBO

Mar 27, 2009

Collaboration is a key element of any successful organization, and is a driving force of the Joint Planning and Development Office (JPDO). With that said, the Working Group Co-Chairs and their designated team members convened for the first JPDO conference focused on Trajectory-Based Operations (TBO).

TBO represents a critical NextGen capability that uses specific technologies to optimize an individual flight, as well as the overall operations of the national airspace system (NAS).

Held March 24 at the Department of Transportation Headquarters in Washington DC, the TBO Conference—which the JPDO also streamed live via the WebEx platform—offered a unique opportunity to accomplish two goals: 1) develop a common understanding of the TBO vision for the far-term, and 2) identify how the JPDO Working Groups can contribute to that vision.

More>>>

Other News

Full House for JPDO "All Hands" Meeting

A New Paradigm for the 21st Century: Collaboration, Transparency, and Change
NextGen 101

- Weather contributes to 70% of all air traffic delays within the U.S. National Airspace System (NAS)

- "A key finding, based on an analysis of several 2005-2006 convective events, is that as much as two-thirds of the weather related delay is potentially avoidable."

“The total cost of domestic air traffic delays to the U.S. economy was as much as $41 billion for 2007.”

- Air-traffic delays raised airlines' operating costs by $19 billion.
- Delays cost passengers time worth up to $12 billion.
- Indirect costs of delay to other industries added roughly $10 billion to the total burden.

Your Flight Has Been Delayed Again; Congressional Joint Economic Committee; May 2008
### NextGen 101

<table>
<thead>
<tr>
<th>Airlines (Communications) (Loss of flight HF radio communications)</th>
<th>United, Continental, Northwest, American, Lufthansa, Qantas, Virgin, British Airways, FedEx, Air New Zealand, ExecuJet, etc.</th>
<th>Divert polar flights, change flight plans, Change altitude</th>
<th>Cost ~ $100k per diverted flight, $10-50k for re-routes</th>
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| Airlines (Radiation) (Radiation dose on crew and passengers) | United, Continental, Northwest, American, Lufthansa, Qantas, Virgin, British Airways, FedEx, Air New Zealand, ExecuJet etc. | Divert polar flights, change flight plans, Change altitude (even at mid-latitudes) | Cost ~ $100k per diverted flight, Health risks |
NextGen Key Themes

- An integrated and nationally consistent common weather picture for observation, analysis, and forecast data available to all system users
A Net-centric (net-enabled) capability is envisioned:

- "Network Enabled"...
  - An information network that makes information available, securable, and usable in real time
  - Information may be pushed to known users and is available to be pulled by others
  - Weather information sharing is two-way

- "Virtual" repository with no single physical database or computer
  - Conceptually unified source distributed among multiple physical locations and suppliers
NextGen Key Themes

- Direct integration of weather information into operational decision making processes
## NextGen Now and Future

<table>
<thead>
<tr>
<th><strong>Today</strong></th>
<th><strong>NextGen</strong> (new requirements)</th>
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<tr>
<td>- Not integrated into aviation decision support systems (DSS)</td>
<td>- Totally integrated into DSS</td>
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<tr>
<td>- Inconsistent/conflicting on a national scale</td>
<td>- Nationally consistent</td>
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<tr>
<td>- Low temporal resolution (for aviation decision making purposes)</td>
<td>- High temporal resolution</td>
</tr>
<tr>
<td>- Disseminated in minutes</td>
<td>- Disseminated in seconds</td>
</tr>
<tr>
<td>- Updated by schedule</td>
<td>- Updated by events</td>
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<tr>
<td>- Fixed product formats (graphic or text)</td>
<td>- Flexible formats</td>
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What is the 4-D Weather Cube?

The 4-Dimensional (4-D) Weather (Wx) Cube (3 dimensions plus time) will contain:

- Continuously updated weather observations (surface to low earth orbit, including space weather and ocean parameters)

- High resolution (space and time) analysis and forecast information (conventional weather parameters from numerical models)

- Aviation impact parameters
  - Turbulence
  - Icing
  - Convection
  - Ceiling and visibility
  - Wake vortex

- The 4-D Wx Cube of the future will contain “all” weather data, not just aviation parameters.
What is the 4-D Weather Single Authoritative Source?

The 4-D Wx Single Authoritative Source (SAS):

- **Is only a portion of the 4-D Wx Cube**
- **Provides a common weather picture for National Air Space (NAS) participants (Airlines, DoD, FAA, etc.)**
- **Is the basis for all aviation decisions by Air Traffic Management (ATM) in the FAA**
- **Is formed by merger of model data, automated gridded algorithms, climatology and observational data, and meteorologist input/data manipulation to ensure consistency and accuracy**
Virtual 4D Weather Cube

Aviation weather information in 3 dimensions (latitude/longitude/height)
The 4-D Cube: A Conceptual Model

Observations
- Satellites
- Radars
- Aircraft
- Surface
- Soundings

Data Integration

Forecasting
- Numerical Modeling Systems
- Statistical Forecasting Systems
- NWS Forecaster
- Automated Forecast Systems
- Forecast Integration

Integration into User Decisions
- Decision Support Systems
- Custom Graphic Generators
- Custom Alphanumeric Generators

Enabled Network Operations

Grids
The NextGen shall determine the magnitude of solar radiation affecting aviation with an accuracy of plus or minus $0.5 \times 10^{-8} \text{ Watts m}^{-2}$.

The NextGen shall determine \textit{onset of solar radiation affecting aviation} with an \textit{accuracy of plus or minus 5 minutes}.

The NextGen shall calculate the \textit{duration of solar radiation affecting aviation} with an \textit{accuracy of plus or minus 5 minutes}.

The NextGen shall measure those \textit{regions of the globe exposed to high levels (> 10 MeV) of solar radiation} with a \textit{horizontal accuracy of plus or minus 500 miles}.

The NextGen shall determine \textit{latitudinal areas subject to high levels of (> 100 MeV) solar radiation} with a \textit{horizontal accuracy of 300 miles}.

\textbf{Geomagnetic Storm activity}

The NextGen shall determine \textit{regions of the globe affected by geomagnetic storm activity} with a \textit{horizontal accuracy of plus or minus 80 km}.

The NextGen shall determine the \textit{onset of geomagnetic storm activity} with an \textit{accuracy of plus or minus 5 minutes}.

The NextGen shall determine end of geomagnetic storm activity with an accuracy of plus or minus 5 minutes.

The NextGen shall determine end of geomagnetic storm activity affecting aviation with an accuracy of plus or minus 5 minutes.

The NextGen shall determine \textit{duration of geomagnetic storm activity} with an \textit{accuracy of plus or minus 5 minutes}.
The NextGen shall forecast the **arrival time** at the top of the NAS of adverse space weather conditions (e.g., solar flares, coronal mass ejections) with an accuracy of plus or minus 10 minutes out through 12 hours, with an accuracy of plus or minus 20 minutes from 12 hours to 24 hours, and with an accuracy of plus or minus 60 minutes from 24 hours to 48 hours.

The NextGen shall forecast the **ending time** at the top of the NAS of adverse space weather conditions (e.g., solar flares, coronal mass ejections) with an accuracy of plus or minus 10 minutes out through 12 hours, with an accuracy of plus or minus 20 minutes from 12 hours to 48 hours, and with an accuracy of plus or minus 30 minutes from 24 hours to 48 hours.

The NextGen shall forecast the **duration** of adverse space weather conditions (e.g., solar flares, coronal mass ejections) with an accuracy of plus or minus 10 minutes out through 12 hours, with an accuracy of plus or minus 30 minutes from 12 hours to 24 hours and with an accuracy of plus or minus 1 hour from 24 hours to 48 hours.

The NextGen shall forecast solar radiation activity affecting aviation with an accuracy of plus or minus $1 \times 10^{-7}$ watts m$^{-2}$ through 12 hours, with an accuracy of plus or minus $5 \times 10^{-7}$ watts m$^{-2}$ from 12 to 24 hours and with an accuracy of plus or minus $1 \times 10^{-6}$ watts m$^{-2}$ from 24 hours to 48 hours.

The NextGen shall forecast the **regions of high energy (\(> 10 \text{ MeV}\))** solar radiation with a **horizontal accuracy of plus or minus 300 miles**.

The NextGen shall forecast the **regions of high energy (\(> 10 \text{ MeV}\))** solar radiation with a **vertical accuracy of plus or minus 4,000 feet**.

The NextGen shall forecast regions of the globe subject to high energy levels (\(> 100 \text{ MeV}\)) of solar radiation with a horizontal accuracy of **plus or minus 1000 miles**.
The JPDO Weather Roadmap

**Initial Operational Capability (2013)**

- Integrated environmental information sources
- Common data standards and protocols
- Initial integration of diverse weather elements into decision support tools
- IT infrastructure allows access to 4D Cube data by the FAA’s System Wide Information Management (SWIM) network
- Implement NWS forecast processes required to generate, arbitrate and consolidate 4D weather forecast information to populate the 4D Cube with all required weather elements for IOC, including meteorologist oversight of gridded data
- Adapt existing NOAA/NWS observation systems to provide information to the 4D Cube
The JPDO Weather Roadmap

Intermediate Capability (2016)
- Improved modeling and science enables higher resolution more accurate information
- Full Network compatibility of environmental information
- Direct integration of weather into Air Traffic Management Systems

Full Operational Capability (2022)
- All NextGen requirements met and benefits achieved
- High resolution, nested scale forecasts available for all elements
- Full network connectivity ensures consistent information use across service areas and user groups
Backup
Aviation Digital Data Service (ADDS)

- Extremely popular aviation weather web service
- Not just a display capability
- Already has many NextGen data service capabilities
- Data service easily capable of supporting JMBL
  - Has existing capability to support 4D data cube
  - Slices, dices, and returns a subset of data (flight paths or subset cubes)

http://adds.aviationweather.gov/