

# Building a 4-D Weather Data Cube for the NextGen Initial Operating Capability (IOC)

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# Overview

- This presentation will detail the effort underway to have an operational 4-D Weather Data Cube ready for the NextGen IOC in 2013
  - Definitions of the 4-D Weather Data Cube and the 4-D Weather Single Authoritative Source
  - Details of *System* and Infrastructure Requirements
  - Planned Demonstrations before IOC
  - JPDO Sponsored Teams, plans, roadmaps, and schedules

## Goal

- Establish the initial operating capability (IOC) of the *System* by the end of FY13
  - IT infrastructure in place
  - Cube contents includes state variables such as temperature, dew point, surface winds, etc...
  - Enhanced forecasting capabilities for icing, turbulence, convection, ceiling and visibility, winds aloft

# Definitions

- *4-D Wx Data Cube*: A shared, 4-dimensional (three spatial dimensions and time) database of weather information viewed as a conceptually unified source distributed among multiple, physical locations and suppliers\*. The cube 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
    - Winds aloft
    - Wake vortex
  - The 4-D Wx Data Cube of the future will contain “all” environmental information in addition to aviation parameters

\* JPDO NextGen Weather Policy Findings and Recommendations, Version 0.1, October 31, 2007

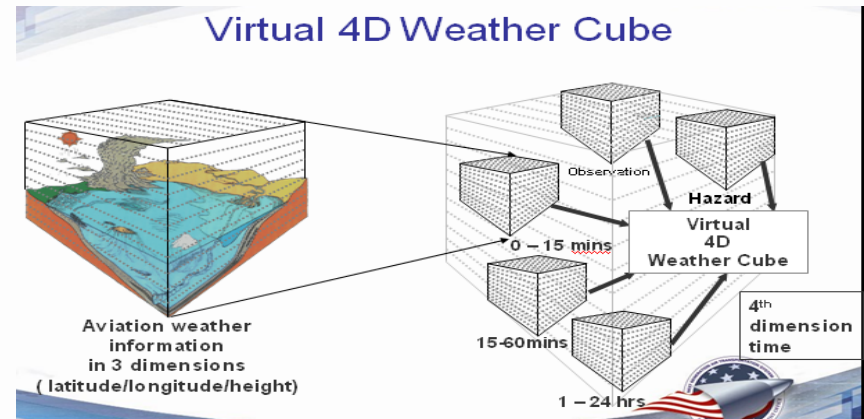
# Definitions

- *System*: The 4-D Wx Data Cube and the infrastructure required to facilitate and maintain its use
- *4-D Weather Single Authoritative Source (4-D Wx SAS)*
  - The seamless, consistent common weather picture that is needed by and available to all ATM decision makers for integration into collaboratively made operational decisions. \*\*
  - SAS data:
    - Will be Network-enabled, machine-readable, geo- and time-referenced
    - Includes current observations, interpolated current conditions (analysis fields), and predictions of future conditions
    - Supports probabilistic decision aids
    - Is only a portion of the 4-D Wx Data Cube
    - Is formed by merger of model data, automated gridded algorithms, climatology and observational data, and meteorologist input/data manipulation to ensure consistency and accuracy

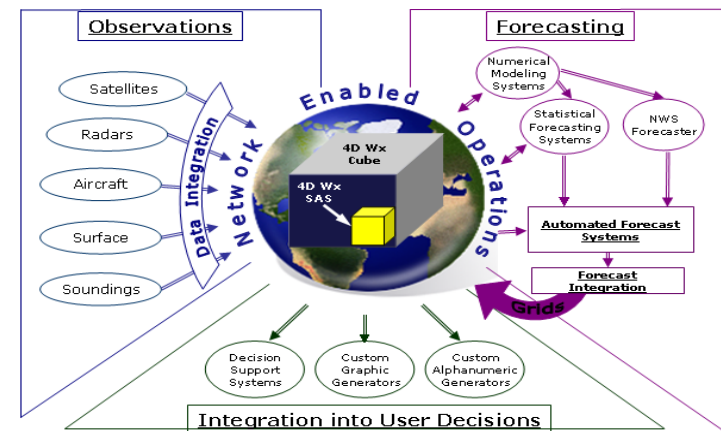
\*\* Derived from the 4-D Weather Functional Requirements for NextGen Air Traffic Management, Version 0.1, Jan 18, 2008

# The 4-D Wx Data Cube and the 4-D Wx SAS

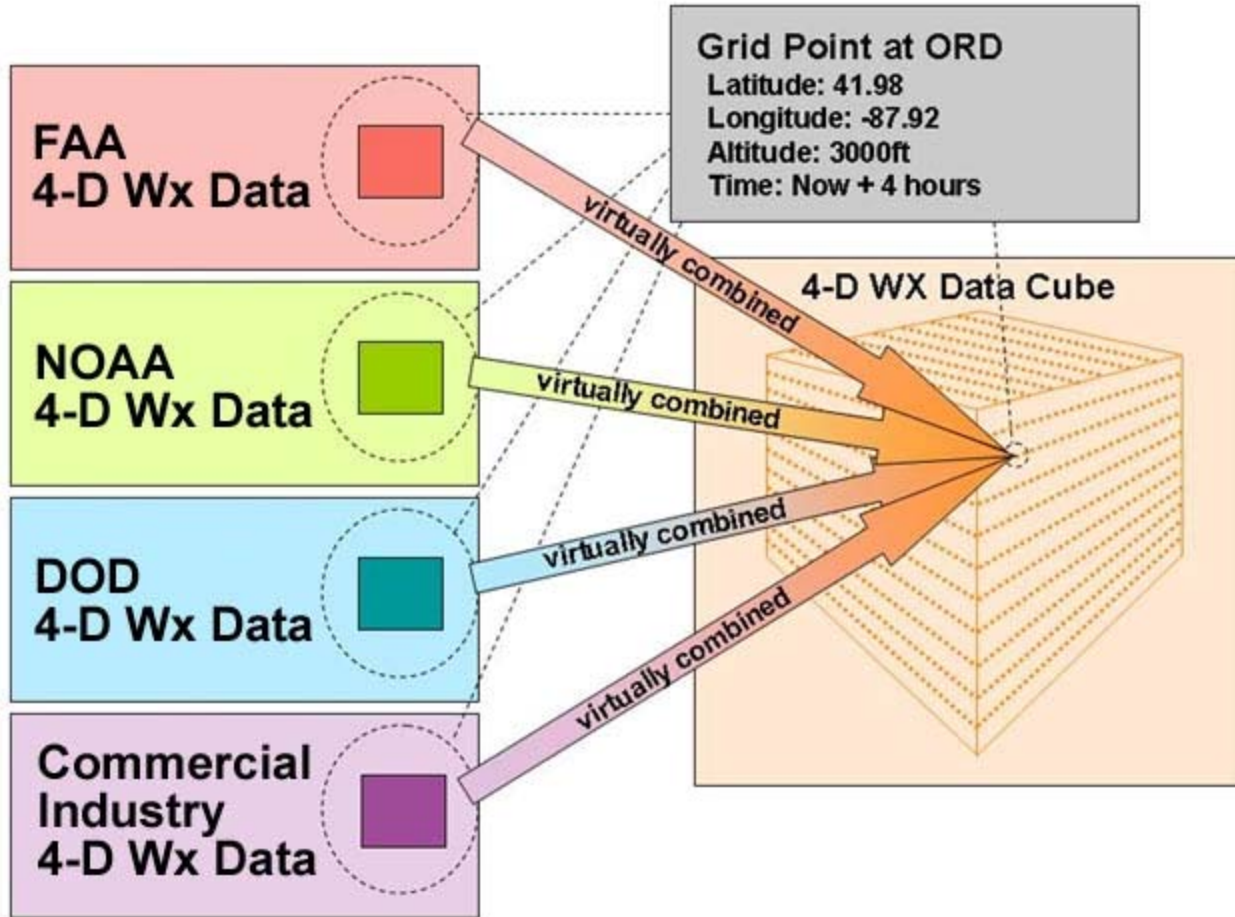
- The Virtual 4-D Wx Data Cube contains weather data from many government sources as well as approved commercial providers
- A portion of the cube contains the 4-D Wx SAS...the fused, merged, consistent set of observed, analyzed, and forecast weather to be used in all ATM decisions
- Much R&D is needed to develop the process which moves the 4-D Wx Data Cube data into the 4-D Wx SAS. This will not be finalized by IOC



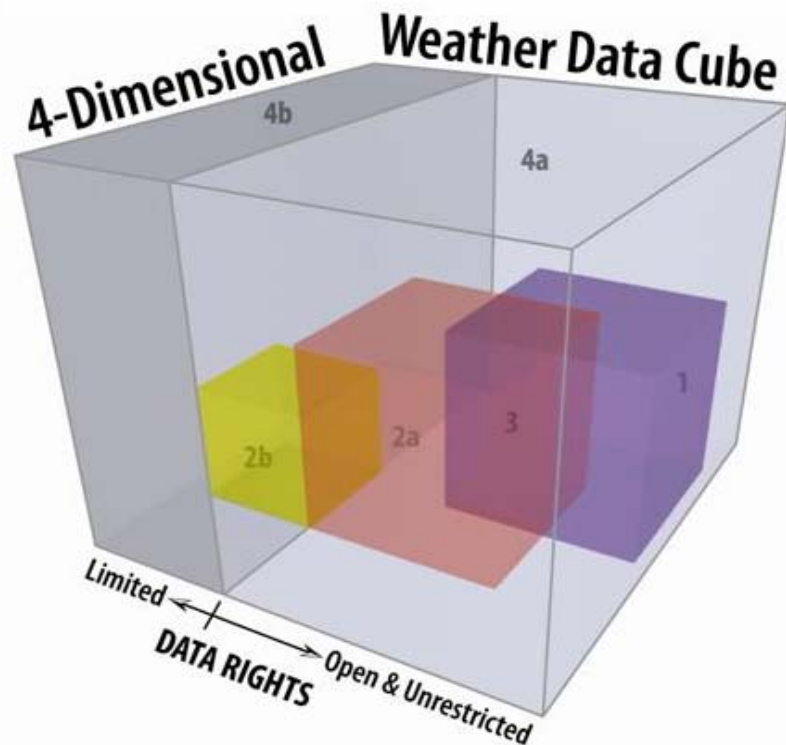
## Conceptual Model



# 4-D Wx Data Cube Concept



# 4-D Wx Data Cube Domains



## 4-D Weather Data Cube Domains

**Domain 1:** Weather information used by the operator of the NAS for air traffic management decisions in the civil-use airspace portion of the NAS. The data information contained in this domain has open and unrestricted data rights.

**Domain 2a:** Weather information approved for pilots and dispatchers to use in making operational decisions that meet regulatory requirements. The information contained in this domain has open and unrestricted data rights.

**Domain 2b:** Weather information approved for pilots and dispatchers to use in making operational decisions that meet regulatory requirements. The information contained in this domain has limited data rights.

**Domain 3:** Any weather information that meets both of the functional descriptions in 1 and 2a above.

**Domain 4a:** All other weather information used by any NAS participants that has open and unrestricted data rights

**Domain 4b:** All other weather information used by any NAS participants that has limited data rights.

Policy issues will continue to be worked in the upcoming year



# System

- The *System* includes:
  - The 4-D Wx Data Cube
  - Registries/repositories and metadata contained therein
  - Functionality to support net-centric interoperability
  - Functionality needed to respond to data requests, including complex requests like information along a route of flight
  - Necessary telecommunications infrastructure

# Data Format and Service Standards

- Team leveraging two existing data format and service standards
  - Joint METOC Broker Language (JMBL) – an XML based schema
  - Open Geospatial Consortium (OGC) – open GIS based standards
  - Goal is to support both sets of standards and interoperability
- JMBL
  - Over ten years of DoD investment in defining data and metadata standards for exchange of weather and oceanographic data
  - NOAA is planning to adopt JMBL
- Open Geospatial Consortium (OGC)
  - OGC Standards involved are:
    - Web Coverage Services; principally for gridded data
    - Web Features Services; principally for non-gridded data
  - Newly developed standards may use GML -- OGC-compliant extension of XML
- Both OGC and JMBL don't fully meet NextGen requirements
  - Working with OGC and DoD on addressing gaps for NextGen unique requirements
  - Future development will continue to leverage the invested resources in both JMBL and OGC and not focus on one or the other

# IT Demonstrations

- Demonstrations are planned each Fall through 2010
- First Demo conducted by the FAA in 2007
- Next Demo in 2008
  - Use of OGC standards to combine data from 3 disparate databases located around the country
  - Initial testing of federated registries
- Full JPDO participation begins in 2009

# NextGen Test-bed Demonstrations

- Florida has been designated as the NextGen Test-bed
- Yearly NextGen Test-bed Demonstrations are planned through FY12
- FAA, NOAA, DoD and other Federal Partners are planning to support and participate in these demonstrations
- Industry is participating; more partners are welcome

# JPDO Sponsored Expert Teams

- Three teams, with representatives from FAA, DOD, NOAA, NASA, and Industry have been formed within the structure of the NextGen Weather Working Group to meet the IOC 2013 goal.
  - NextGen Weather IOC Development Team
  - NextGen Environmental Information Team (EI Team)
  - NextGen Weather IT and Enterprise Services Team (ITEST)

# NextGen Weather IOC Development Team

- Developing a detailed roadmap and schedule to reach the IOC goal
- Directs/assists the EI and ITEST teams to meet specific deliverables
- Coordinates with JPDO Weather Working Group, and other Working Groups, as needed

# NextGen Environmental Information Team (EI Team)

- Will reconcile the 4-D Wx Data cube contents:
  - For IOC in 2013
  - And beyond
- Will identify R&D needs based on functional and performance requirements
- Will identify R&D needs/methodologies to develop the 4-D Wx SAS
- Works concurrently with ITEST team on issues like data standards, protocols, etc...

# NextGen Weather IT and Enterprise Services Team (ITEST)

- Will reconcile the information exchange requirements:
  - For IOC
  - And Beyond
- Recommend and adopt data standards and protocols
- Develop an IT CONOPS
- Develop 4-D Wx Cube Architecture
- Will identify R&D needs/methodologies to develop the 4-D Wx SAS
- Work concurrently with the EI Team
- Work concurrently with JPDO Net-centric Working Group



# NextGen 4-D Weather Cube Roadmap

| Task Name                           | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |  |
|-------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|--|
| NextGen Weather IOC (2013)          | █    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |  |
| NextGen Weather Intermediate (2016) |      | █    |      |      |      |      |      |      |      |      |      |      |      |      |      |  |
| NextGen Weather FOC (2022)          |      |      |      |      |      | █    |      |      |      |      |      |      |      |      |      |  |

- Initial Operational Capability (2013)
  - Integrated environmental information sources
  - Common data standards and protocols
  - Identify environmental information sources available for integration into decision support tools
- Intermediate Capability (2016)
  - Improved modeling and science enables higher resolution more accurate information
  - Full Network compatibility of environmental information
  - Expand environmental information sources available for integration 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

# Planning

- JPDO and agencies are developing a NextGen weather plan for implementation of the 4-D Wx Data Cube
- Plan to be complete by the end of FY09
  - By 2Q FY09 details of 4-D Wx Data Cube contents will be delivered
  - By 4Q FY09 full integration plan to be added
- Plan will be detailed to support budgeting and execution activities

# Industry Participation

- Industry participation is desired in demonstrations and as part of the 4-D Wx Data Cube IOC
- Industry representatives are co-leads on both the EI and ITEST teams
- Applicants are being evaluated for co-lead on the NextGen Weather IOC team as well
- Additional participation on the EI and ITEST teams are welcome
- Contact the NextGen Institute for details
  - [http://www.ncat.com/ngats/ngats\\_vip.html](http://www.ncat.com/ngats/ngats_vip.html)

# Summary

- A 4-D Wx Data Cube *system* will be available for IOC in 2013
  - Clearly this **initial** capability will not be final
  - Considerable work to meet requirements for 2016 and 2022
- Multi-agency and industry combined efforts are ongoing to develop:
  - Data standards and protocols
  - Service standards
  - Environmental Information

# Summary

- IT and other test-bed demonstrations will continue between now and IOC
- JPDO Multi-agency and industry represented teams are developing the initial 4-D Wx Data cube for IOC. These include:
  - NextGen Weather IOC Development Team
  - NextGen Environmental Information Team (EI Team)
  - NextGen Weather IT and Enterprise Services Team (ITEST)
- Detailed plans and roadmaps have been developed and will be further decomposed in the very near future

# Backup Slides

# BACKUP SLIDES

# 4-D Weather Data Cube Schedule

