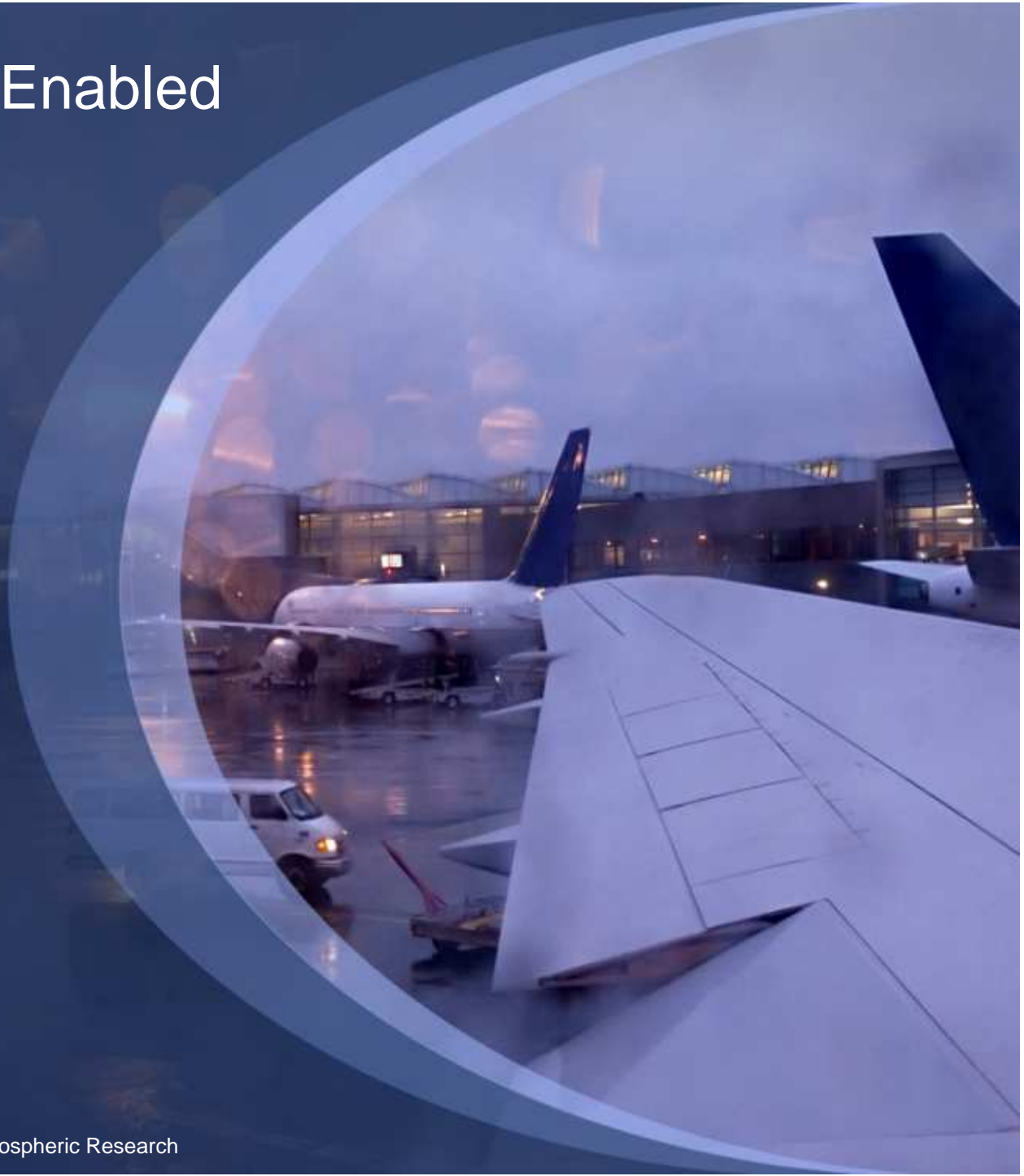# NextGen Network-Enabled Weather (NNEW)

Aaron Braeckel

Briefing to NCAR and NOAA staff
Dec 2009
National Center for Atmospheric Research

Needs and Requirements:

- **Next Generation Air Transportation System (NextGen) – FAA's plan to modernize the National Airspace System (NAS) through 2025.**
  - Increase capacity
  - Increase efficiency
  - Improve safety
  - Reduce environmental impacts
  - Improve user accessibly

"70% of air traffic delays attributable to weather…"

"US air traffic is expected to triple by 2025…"

[1] Information Management and Exchange Strategy (IMEX)
Within the NextGen Environment (January, 2008)

Background and Motivation

Fundamental Concepts:

- An integrated and nationally consistent common weather picture for observation, analysis, and forecast data available to all system users

- "Network Enabled" - available, secured, real-time, useful information

- "Virtual" repository with no single physical database or computer

- Conceptually unified source distributed among multiple physical locations and suppliers, of which NOAA is the primary data supplier

- Direct integration of weather information into operational decision making processes

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The Cube:

•X, Y, Z + time (3-dimensional data products over time)

•**Single Authoritative Source**
A subset of the entire cube. Provides a consistent weather picture

•**Universal Access**
Implies standardized access mechanisms and distributed suppliers

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Virtual 4-D Weather Data Cube
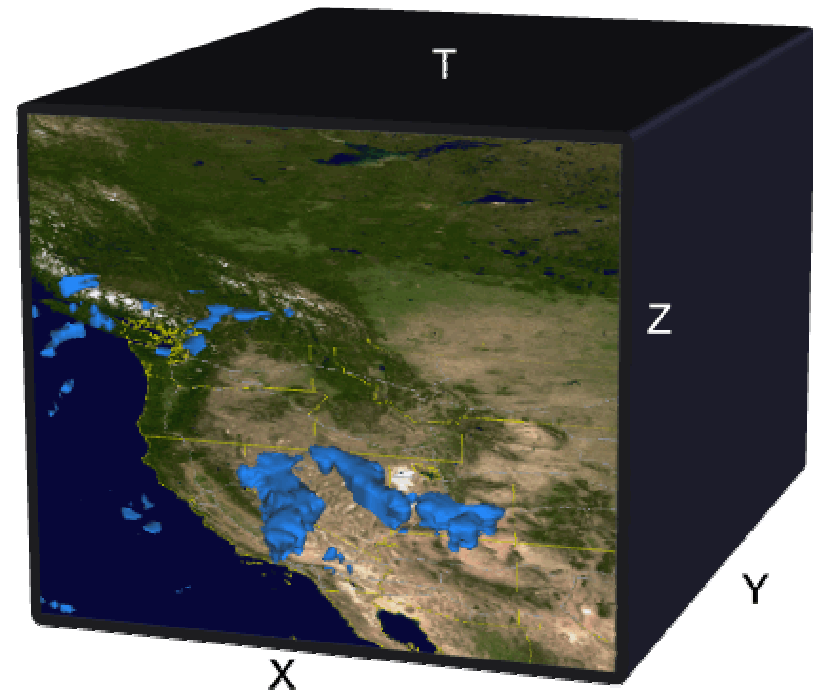
Solution:

Standards-based access
- SOA and Web Services
- OGC Web Coverage Service (gridded)
- OGC Web Feature Service (non-gridded)
- OASIS Registry/Repository
- WXXM
- NetCDF 4/CF
- GRIB 2

Broad community
- Helpful with cross-domain integration (AIM, en-route, etc.)
- Well known to many met groups (!)

MET World Wide Web
- Registry ~= DNS++
- Data access services are functional on their own (bottom up & top down capabilities)
- Extensible & scalable

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Tasks:

- Gather and understand use cases and requirements
- Develop service and data format standards for data exchange
- Develop weather ontologies
- Refine/integrate metadata standards (ISO, OGC, WMO)
- Demonstrations/prototyping
- Coordination with standards bodies and other organizations
  - Open Geospatial Consortium (OGC)
  - National Weather Service (NWS)
  - FAA Programs
  - Eurocontrol
  - OASIS
  - ISO
  - NOAA
  - etc

Design and implement the working system
- Architecture, security, registry/repository, several levels of metadata, data access libraries, and alignment of operational data providers

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Research to Operations

Standards Bodies:

- Investigate potential standards
- Participate in ongoing standards development and discussion
- Prototype the standards and possible extensions
- Take prototyping experience and bring it to the standards bodies

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Reference Implementations:

Complex requirements
- Security
- Monitoring
- Advanced geometrical subsetting
- Unit/measure conversion
- Re-projection, re-gridding
- Publish/subscribe
- Stability and performance
- Horizontal scalability
- Advanced architectural layouts (delegator, repeater, etc.)
- Flexibility to work within different operating environments
- Quality of service assurances
- …

WFSRI and WCSRI
- Open source, freely available
  - Basis for all types of custom use (private industry, government, etc.)
- Other implementations of service standards possible

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Efficient XML:

XML has performance impacts
- 10-100x the size of legacy binary formats[1]
- Non-trivial processing impact

A number of potential solutions
- GZIP
- XML-wrapped binary
- Efficient XML formats

Each with certain characteristics
- In-place editing without decoding (XSLT, etc.)
- Lossless encoding
- Streamable
- Self-described
- Allows schema extensions
- …

[1] Efficient XML – Taking Net-Centric Operations to the Edge. John Schneiders

Efficient XML:

W3C Efficient XML Interchange Working Group
- Analysis
- Characteristics
- Measurement framework
- Recommendation
- Format specification (EXI)

Series of analyses
- FastInfoset with weather XML
- Initial analysis of EXI file sizes
- Efficient XML technology report (WXXM)

NextGen Network Enabled Weather (NNEW)

Exificient/GZIP experiment

```
  92292 Nov   7 01:19 airsigmets.current.xml
   8636 Nov   7 01:45 airsigmets.current.xml.gz
  31357 Nov   7 01:25 airsigmets.current.xml.noschema.exi
  69357 Nov   7 01:25 airsigmets.current.xml.noschema.exi.xml
  34960 Nov   7 01:25 airsigmets.current.xml.schema.exi
  71141 Nov   7 01:25 airsigmets.current.xml.schema.exi.xml
3115084 Nov   7 01:19 metars.current.xml
 240369 Nov   7 01:40 metars.current.xml.gz
 452082 Nov   7 01:24 metars.current.xml.noschema.exi
2595206 Nov   7 01:24 metars.current.xml.noschema.exi.xml
 629403 N
2624926 N
1138217 N
  92103 N
 206086 Nov   7 01:25 pireps.current.xml.noschema.exi
 949420 Nov   7 01:25 pireps.current.xml.noschema.exi.xml
 237590 Nov   7 01:25 pireps.current.xml.schema.exi
 960595 Nov   7 01:25 pireps.current.xml.schema.exi.xml
4520255 Nov   7 01:19 tafs.current.xml
 261229 Nov   7 01:40 tafs.current.xml.gz
 543874 Nov   7 01:25 tafs.current.xml.noschema.exi
3813485 Nov   7 01:25 tafs.current.xml.noschema.exi.xml
 627510 Nov   7 01:25 tafs.current.xml.schema.exi
3833623 Nov   7 01:25 tafs.current.xml.schema.exi.xml
```

GZIP: 0.07 of original file size
EXI: 0.13 of original file size

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Research to Operations

Portrayal/Mapping:

Not yet on the list…
- But of interest

Requirements largely undefined
- On demand
- Formal relationship between data and presentation
  - SLDs appropriate and sufficient?

Technical Participants

MIT/LL

NCAR
Research Applications Laboratory

NOAA
Global Systems Division

FAA Tech Center

National Weather Service

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Demonstrations:

- Proving ground
  - Integration
  - Testing
  - Performance
  - Documentation

Updated/replaced annually
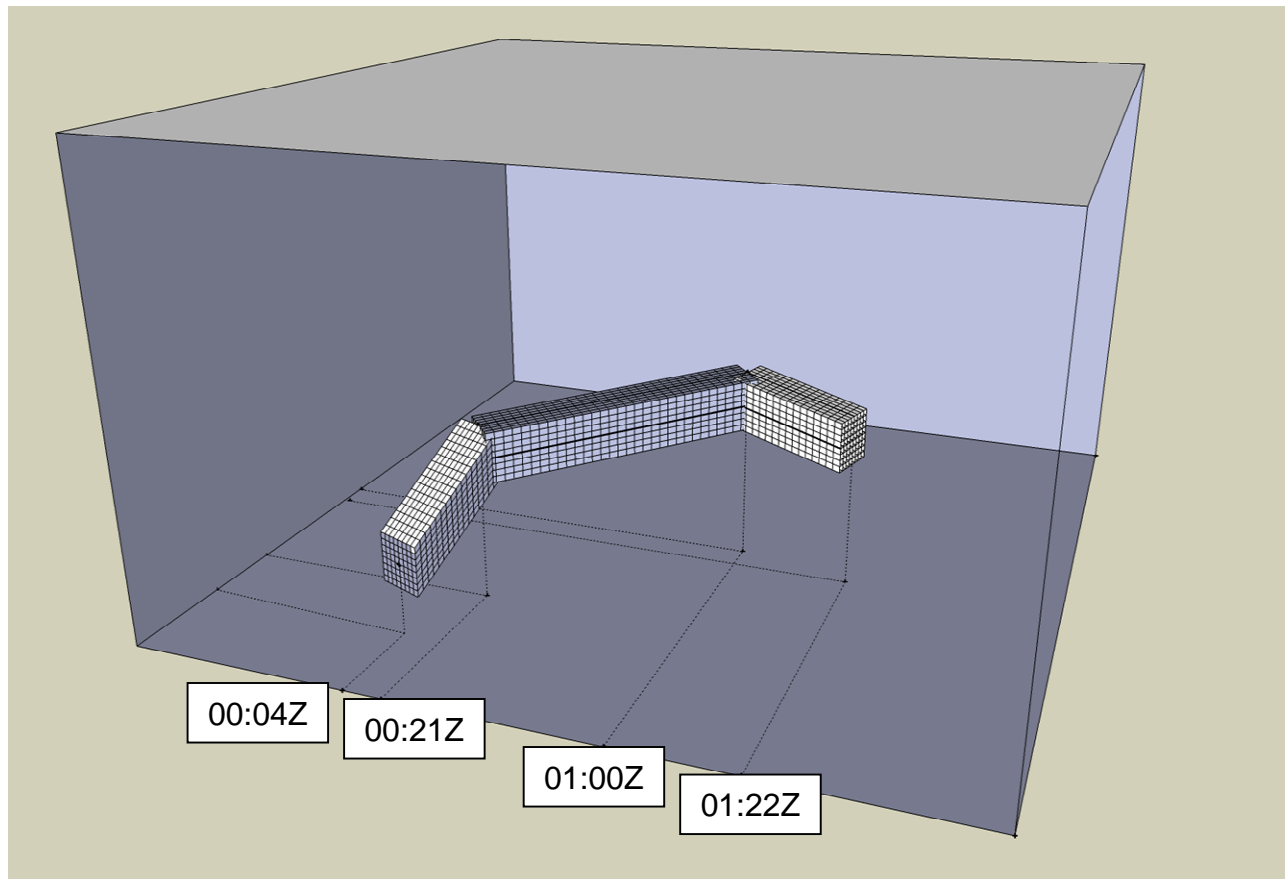
Third annual demonstration just completed (Oct 2009)
- Federal Aviation Administration, National Weather Service, NOAA
- Version 1 WCSRI and WFSRI

Fourth annual demonstration (Oct 2010)
- Additional participants
- Significantly expanded products
- Version 2 WCSRI and WFSRI (with expanded features)
- Commensurate additions to access libraries

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Integration and Interoperability

4-D Trajectories:

NextGen Network Enabled Weather (NNEW)

Resources

Sites:

NNEW wiki – https://wiki.ucar.edu/display/NNEWD
2009 Demonstration Client - http://weather.aero/nnew/fy09/demo
2009 Data Access Information -
https://wiki.ucar.edu/display/NNEWD/NNEW+FY+2009
Official FAA Web Site -
http://www.faa.gov/about/initiatives/nextgen/portfolio/trans_programs/nnew/index.cfm

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Questions:

- Use cases and requirements
- Service and data format standards
- Efficient XML
- Reference Implementations (Reg/Rep, WCS, WFS)
- Weather ontologies
- Metadata
- Demonstrations
- Coordination with standards bodies
- Interactions with other organizations
- Implemetation of the system
- Access libraries