NOAA
NextGen IT/Web Services (NGITWS)

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Topics

• Origins of NGITWS

• NGITWS 101
  – What is NGITWS?
  – Why is NGITWS important?

• NGITWS Architecture
  – Data flow example

• Progress and Timelines
  – What we’ve accomplished and where we’re headed

• Conclusions
The FAA Next Generation Air Transportation System needs accurate, timely, and reliable weather information.

Why does NextGen care about weather?

- ~70% delays in the NAS are due to weather

Through enhanced weather products and services

- ~46% reduction in delays
- ~$19 billion savings annually

That’s where NOAA comes in

NGITWS will “…provide enhanced weather forecast information for integration into an air traffic management system.”

“Capabilities for NextGen will result in a significant increase in weather prediction and dissemination capabilities with wide ranging benefits across NOAA.”

- 2014 NOAA Budget Estimate
Origins of NGITWS (cont)

• NOAA Integrated Dissemination Program (IDP)
  – Enhance NOAA’s dissemination capabilities
    • Reliability
    • Sustainability
    • Integrated, enterprise-level capabilities
  – Core initiatives
    • NWS Ground Readiness – infrastructure improvements, network consolidation, bandwidth upgrades, etc.
    • NWS Telecommunications Gateway Re-architecture – modernizing the heart of NWS dissemination
    • NextGen IT/Web Services (NGITWS)
Origins of NGITWS (cont)

• The culmination of 5+ years of R&D efforts

  4-D Data Cube       Next Generation Network       SE2020
  Enabled Weather (NNEW) prototype

• The fruit of key partnerships

  FAA               National Center for Atmospheric Research (NCAR)
  MIT Lincoln Laboratory

• Leveraging key NOAA resources

  ➢ Aviation Weather Center (AWC)
  ➢ Earth System Research Lab
    Global Systems Division (GSD)
  ➢ Meteorological Development Lab (MDL)
  ➢ NCEP Central Operations (NCO)
NGITWS 101

What is NGITWS?

Legacy data silos

Web-based, service-oriented architecture (SOA)

Platform-specific

Platform-agnostic

Closed systems
What is NGITWS?

- Standard data formats
- OGC compliant services

State of the art data centers
What is NGITWS?

- GRIB2
- NetCDF-4
- IWXXM
- Traditional Alphanumeric Code (TAC)
- Data
- Machine

NGITWS 101 (cont)
What is NGITWS?
Why is NGITWS important?

- Reliability
- Performance
- Interoperability
Why is NGITWS important?

- Reliability
- Performance
- Interoperability

**College Park, Maryland**

Two state-of-the-art, geographically-diverse data centers

**Boulder, Colorado**
Why is NGITWS important?

- **Reliability**

- **Performance**
  - Private high-speed network
    - 100-200 Mbps
  - Redundant high-speed network
    - One-to-many capability - College Park and/or Boulder can feed Atlantic City, Salt Lake City, and Atlanta
    - Quality of service (QoS) - ability to prioritize certain types of traffic over others

- **Interoperability**
Why is NGITWS important?

- **Reliability**
- **Performance**
- **Interoperability**

**Standards-driven**
- OGC Web Coverage Service (WCS)
- OGC Web Feature Service (WFS)
- OGC Web Map Service (WMS)

**Common open-source apps**
- GeoServer
- RabbitMQ
- MongoDB

**International standard data formats**
- NetCDF-4
- XML - IWXXM, IWXXM-US, USWX
NGITWS Architecture

Data Producers (MADIS, ASOS, NWS Forecasters (AWIPS), Pilots, etc.)

Data Consumers (FAA, AWIPS, Public, etc.)
NGITWS Architecture – data flow example

TAF
NWS Forecaster

NGITWS

Message Service

Client Product Queue

Web Service

Web Service

Message Handler

Transcoders

FAA
Progress and Timelines
Data Exchange: Phase 1 - in place now

• Source:
  – NextGen IT/Web Services system on the NOAA IDP Development Tier in College Park, MD

• Destination:
  – FAA SWIM/NEMS Research and Development, FAA William J. Hughes Technical Center, Atlantic City, NJ

• Network:
  – VPN over the Internet

• Message pattern:
  – Publish-Subscribe

• Data:
  – 183 unique gridded numerical model products in NetCDF-4
  – 15 unique XML (IWXXM, IWXXM-US, USWX) products
Data Exchange: Phase 2 - Q3 FY17

• Source:
  – NextGen IT/Web Services system on the NOAA IDP Development Tier in College Park, MD

• Destination:
  – FAA SWIM/NEMS Research and Development, FAA William J. Hughes Technical Center, Atlantic City, NJ

• Network:
  – Private high-speed network

• Message pattern:
  – Publish-Subscribe

• Data:
  – 236 unique gridded numerical model products in NetCDF-4
  – 39 unique XML (IWXXM, IWXXM-US, USWX) products
  – 66 unique image products
Data Exchange: Phase 3 - Q2/Q3 FY18

• Source:
  – NextGen IT/Web Services system, NOAA IDP **Operational** Tiers in College Park, MD, and Boulder, CO

• Destination:
  – FAA SWIM/NEMS Research and Development, FAA William J. Hughes Technical Center, Atlantic City, NJ, and FAA SWIM/NEMS **Operational Centers in Salt Lake City, UT, and Atlanta, GA**

• Network:
  – Private high-speed network

• Message pattern:
  – Publish-Subscribe

• Data:
  – 236 unique gridded numerical model products in NetCDF-4
  – 39 unique XML (IWXXM, IWXXM-US, USWX) products
  – 66 unique image products
Source Origination Efforts

• Project to produce IWXXM from original source
  – AWIPS/TAF
    • Kick Off planning Q4 FY16
      – Start Requirements, Statement of Work
    • Initial Work Phase Q1 FY17
      – Complete Requirements, Initiate Prototyping, Design Reviews
    • Beta Testing Q4 FY17
    • Deploy Software Q1 FY18
Other Internal NWS Efforts

- Review and updating of internal NWS directives and policies that involve IWXXM
- Identify additional Dissemination channels for IWXXM products
- Continued involvement of development of additional schemas (Volcanic Ash and Tropical Cyclone Advisories)
Other Internal NWS Efforts (Cont’d)

• Continued work with UK Met Office on the Met Ocean Application Profile, a newly proposed Open Geospatial Consortium (OGC) standard for Web Coverage Service
• Potential benefits to future IDP Web Services include:
  – New trajectory and getCorridor capabilities
  – Reduction in number of getCoverage requests required over current WCS 2.0 core
  – DescribeCoverage that establishes framework for describing multi-dimensional data cubes with a single identifier
  – Mechanism for quality control using a data mask using the O&M result quality element
  – A rangetype property of the coverage with MetOcean metadata linking to the WMO registries

Bottom Line: New proposed standard better aligns with 4D weather data!
Conclusion

- This work is extremely important!
- Through healthy partnerships and leadership support we’ve made tremendous progress.

Continue to focus on

- Reliability
- Performance
- Interoperability

NextGen IT/Web Services = the foundational capability for providing the critical aviation weather information necessary for decision making in the National Airspace System.
Backup
Goals: Open-source, Proven, Industry-hardened

- **GeoServer**
  - Java-based open-source geospatial software suite
  - Commercial support provided by NOAA-funded contract with Boundless
  - Leverages open standards
  - OGC-compliant implementation of Web Feature Service (WFS), Web Coverage Service (WCS), and Web Map Service (WMS)
  - Global user community

- **RabbitMQ**
  - Open-source message broker that implements the Advanced Message Queuing Protocol (AMQP)
  - Commercial support provided by NOAA-funded contract with Pivotal Software, Inc.
Architecture - technologies (cont)

- **MongoDB**
  - Open-source "Big Data" database
  - Used by industry heavyweights like Facebook, Craigslist, eBay, MetLife, and Adobe
  - Also used by the United Kingdom Meteorology Office (UK Met)

- **Java**
  - Java 2 Platform, Enterprise Edition (J2EEs) Web Services built on Oracle Java 1.8
  - Java Messaging Service (JMS) API
  - Pivotal Spring API - allows for rapid development and prototyping

- **WebHooks**
  - Event/Data Server Push notification system using HTTP technologies
  - Currently being evaluated by the NWS to replace the Family of Services (FoS) system
Architecture - approaches and methodologies

- **Agile development approach**
  - Deliver a working product frequently
  - Anticipate and embrace change

- **Microservices design pattern**
  - Independent, small, modular services
  - Clustered service deployment
  - Easily scalable
  - Improved fault isolation
  - Leverage the power of the virtual computing environment

- **Publish-Subscribe pattern**
  - Message exchange pattern
  - Publishers are decoupled from specific consumers
  - Consumers get only what they need
Architecture - illustration
Points of emphasis (cont)

Performance

• Private high-speed network

  ➢ 100-200 Mbps

  ➢ MPLS-based WAN

    □ One-to-many capability - Either College Park or Boulder can feed all of the FAA endpoints

    □ Quality of service (QoS) - improved service to select traffic
Points of emphasis (cont)

Interoperability

• Standards-driven
  – Open Geospatial Consortium (OGC) Standards
    • Web Coverage Service (WCS)
    • Web Feature Service (WFS)
    • Web Map Service (WMS)

• Commonly available open-source applications
  – GeoServer
  – RabbitMQ
  – MongoDB

• International standard data formats
  – NetCDF-4
  – XML - IWXXM, IWXXM-US, USWX
SOA

Client Application

Internet

Client Application

Services

Components

C1

C2

C3