

14A.2 OPEN AND INTEROPERABLE NWS GEOSPATIAL DATA FROM NOAA IDP NEXTGEN IT WEB SERVICES

Ryan L. Solomon^{1*}, Luis Cano², Matthew Peroutka³, Steven Olson³, Kolly Mars⁴, Peter Pickard⁵,
Chris MacDermaid^{6,7}, Kenneth Ward⁸, Willow Marr⁹, Aaron Braeckel¹⁰, Benjamin Schwedler^{6,1}

¹NOAA/NWS NCEP Aviation Weather Center, Kansas City, MO

²NOAA/NWS NCEP Central Operations, College Park, MD

³NOAA/NWS Meteorological Development Laboratory, Silver Spring, MD

⁴NOAA National Weather Service Internet Dissemination System, Kansas City, MO

⁵NOAA/NWS Office of Science and Technology, Silver Spring, MD

⁶Colorado State University Cooperative Institute for Research in the Atmosphere, Boulder, CO

⁷NOAA Earth System Research Laboratory Global Systems Division, Boulder, CO

⁸NOAA National Ocean Service

⁹M2 Strategy, Inc.

¹⁰National Center for Atmospheric Research, Boulder, CO

1. INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA) Integrated Dissemination Program (IDP) is fielding NextGen IT Web Services (NGITWS), a web-based data dissemination service that will revolutionize the accessibility, discoverability, and machine-to-machine communication and processing of National Weather Service (NWS) data sets. Focused on Open Geospatial Consortium (OGC) standard services and data formats for maximum interoperability, initial operational capabilities will be available from two geographically-diverse state-of-the-art data centers in College Park, Maryland, and Boulder, Colorado. While the initial deployment will focus on aviation-centric data sets to support the Federal Aviation Administration (FAA) Next Generation Air Transportation (NextGen) system, others are preparing to take advantage of this new service including the NWS Advanced Weather Interactive Processing System (AWIPS) and Aviation Weather Center (AWC) Web Services. Leveraging sound project management principles and a highly skilled team with experience fielding successful operational systems ensures the delivery of a scalable and robust system poised for broader NOAA-wide data dissemination services. This paper provides an overview of the NOAA IDP, outlines the factors driving the need for open access to geospatial data, and describes the

capabilities being delivered by the NGITWS Project.

2. NOAA INTEGRATED DISSEMINATION PROGRAM

In 1970, NOAA was formed from the merger of the United States Coast and Geodetic Survey, the Weather Bureau, and the Bureau of Commercial Fisheries, established in 1807, 1870, and 1871, respectively (National Oceanic and Atmospheric Administration n.d.). From its inception, NOAA has been providing data to a wide and varied customer base. Over the years, in order to meet the needs of the vast user base, NOAA data dissemination systems have become equally wide and varied. Informal estimates in 2013 indicated NOAA had over 170 web sites and at least 20 dissemination services that were considered operational (Miller 2013). Implemented under many different programs with different funding lines, these specialized non-standard services were operating with no centralized support or governance structure. This paradigm has led to an infrastructure made up of stovepipes, many with overlapping capabilities. These non-standard data exchange services are difficult to manage and sustain.

The NOAA IDP is one component of the NWS' Dissemination Portfolio Services. IDP was created to transform NOAA's dissemination capabilities from a collection of stovepipes to an integrated, enterprise-wide dissemination service. The timely and reliable dissemination of data is a critical component in supporting the NWS' mission to

* *Corresponding author address:* Ryan L. Solomon, Aviation Weather Center, 7220 NW 101st Terrace, Room 101, Kansas City, MO 64153; email: ryan.l.solomon@noaa.gov

“provide weather, water, and climate data, forecasts and warnings for the protection of life and property and enhancement of the national economy.” Furthermore, IDP centralizes the management and governance of these many services under one umbrella, leveraging shared resources at two state of the art data centers, and merging similar capabilities to provide a more consistent and sustainable solution. While IDP includes support for many dissemination services, the three core initiatives listed below drive many of the Program’s Projects and their funding.

- NWS Ground Readiness Project: This Project is upgrading the NWS telecommunications and computing infrastructure to ensure readiness for the next generation of satellite, radar, and high resolution model data. Progress is being made to deliver a reliable and robust telecommunications network with end-to-end management.

- NWS Telecommunications Gateway Re-architecture Project: This Project is modernizing the central NWS data collection and distribution system.

- NextGen IT Web Services Project: This Project is providing a standards-based, net-centric data dissemination system designed to maximize discoverability, accessibility, and interoperability of NOAA data sets.

Currently as of January 2015, the IDP is already paying dividends and providing operational dissemination capabilities, including Enterprise GIS Capabilities: ArcGIS and OpenGeo, Virtual Lab, Satellite Broadcast Network (SBN) expansion, the High Resolution Rapid Refresh (HRRR) model, the Multi-Radar Multi-Sensor (MRMS) system, and the Meteorological Assimilation Data Ingest System (MADIS). IDP will continue integrating new products and services as they emerge, creating a firm foundation for the future of NOAA data dissemination to serve the vast user community.

3. OPEN ACCESS TO GEOSPATIAL DATA

While the explosion of applications that use geospatial data is relatively new—due in large part to the ubiquity of smartphones and other mobile devices—the need for geospatial data is not. In 1953, the U.S. Office of Management and Budget issued Circular A-16 on Surveying and Mapping, calling for the creation of a federal process for assessing and coordinating surveying and mapping

functions across the federal government. This circular was amended in 1990, establishing the Federal Geographic Data Committee whose objective was to build a national digital spatial data resource, which would eventually become the U.S. National Spatial Data Infrastructure (NSDI) (United States Office of Management and Budget 2002). The central tenants of the NSDI include:

- Accuracy, security, and privacy of personal data
- Access for all citizens
- Protection of proprietary interests
- Interoperability of federal information systems

In 2013, the White House issued an Executive Order in conjunction with a new policy from the United States Office of Management and Budget (OMB) establishing a framework to institutionalize effective information management principles that promote interoperability and openness (United States White House 2013; United States Executive Office of the President 2013).

There is a growing emphasis on global partnership and interoperability. According to John J. Moeller and Mark E. Reichardt in the Manual of Geospatial Science and Technology, the “...future promises ... the realization of a global infrastructure with a set of policies, standards, practices, technologies, and relationships to facilitate the flow of geospatial data and information across government organizations...” (Bossler 2010). Moeller and Reichardt go on to say, “...a solid framework of standards for technical interoperability has emerged through the work of organizations such as the ISO Technical Committee 211 Geographic Information/Geomatics, OGC, and other multinational standards organizations and national standards bodies.”

It is an exciting time in the geospatial information arena, one in which we are seeing tremendous benefits being realized. According to the World Wide Web Consortium and the OGC, in the United States alone, geospatial data and services are generating \$1.6 trillion annually (W3C and OGC 2015). Through continued collaboration and partnership between the government, private, academic, and public sectors, these economic benefits can be realized not only in the United States but globally.

4. FAA NEXT GENERATION AIR TRAFFIC CONTROL SYSTEM REQUIREMENTS

One of the most demanding needs for geospatial data in the U.S. federal government is the FAA's NextGen program, the cornerstone of which is a shift from radar-based airspace navigation to Global Positioning System (GPS) based navigation and seamless integration of weather information into flight planning and airspace management. This requires a vast amount of weather data, including everything from high resolution model data to the dense supply of ground-based automated surface observations. The FAA estimates that 70% of flight delays in the NAS can be directly attributed to weather and that 46% of those can be avoided with more accurate, timely, and consistent weather information. The FAA asserts this will save \$19 billion dollars annually (FAA 2014; National Oceanic and Atmospheric Administration 2013).

Together the FAA and NOAA are developing the geospatial data dissemination and processing capabilities needed to serve NextGen. NOAA is building NGITWS, which is described in section 5. The FAA is building Common Support Services-Weather (CSS-Wx), which will connect to NGITWS to retrieve the necessary data and then pass it along to the necessary endpoints within the FAA. Besides CSS-Wx, there are many other components to the FAA NextGen Weather System, including Automatic Dependent Surveillance-Broadcast (ADS-B), System Wide Information Management (SWIM), NextGen Weather Processor (NWP), and the Aviation Weather display (AWD). Figure 1 illustrates the architecture of the NextGen weather system. More details of these components and the entire NextGen system can be found by visiting the NextGen web site at <http://www.faa.gov/nextgen/>.

5. NOAA IDP NEXTGEN IT WEB SERVICES

The NGITWS Project delivering a standards-based, net-centric data dissemination system meant to maximize discoverability, accessibility, and interoperability of NOAA data sets. This section will describe the need and justification for the NGITWS Project, critical management aspects of it, the technical approach being taken, and the schedule for delivering capabilities.

5.1 Project Need

Those that love weather data are on the cusp of exciting times. Investments in supercomputing upgrades, modernization of networking equipment to high-speed/high-capacity, and high-availability state of the art redundant compute farms are just some of the improvements being made to the weather information infrastructure. These improvements are preparing the way for an influx of weather data from new high resolution models, the next generation of environmental satellites offering stunning imagery at never-before-seen fine temporal scales, advances in weather radar technology, more surface observation stations, rapidly increasing private weather data sources, and much more.

This rapidly increasing amount of data coupled with government directives to make it open and easily accessible presents a new challenge for NOAA. This challenge cannot be overcome with conventional data dissemination techniques.

How are users going to discover that these NOAA data sets exist? How are they going to access the data? After they get the data, how difficult is it going to be to interpret and use it? One of the goals of the NGITWS Project is to provide an answer to these questions by maximizing discoverability, accessibility, and interoperability. The intersection of these three target characteristics is where we will find the maximum value for consumers.

5.2 Project Justification

As described in section 2, NGITWS is one of three core IDP Projects. The basis of the funding for NGITWS is to "...provide enhanced weather forecast information for integration into an air traffic management system." This excerpt from the NOAA Budget Estimates for fiscal year 2014 goes on to say, "Capabilities for NextGen will result in a significant increase in weather prediction and dissemination capabilities with wide ranging benefits across NOAA" (National Oceanic and Atmospheric Administration 2013). This Congressional mandate clearly states that NOAA should build services that support the FAA's NextGen program, but not *only* the FAA's NextGen program. Rather, these services should be built in such a way as to have "wide ranging benefits across NOAA."

5.3 Project Management and Centralized Program Support

One of the foundational elements of IDP and its constituent Projects is the use of sound project management principles for the purposes of delivering capabilities within schedule and budget. The IDP Management Office is a central resource for the Program as well as all associated Projects, providing centralized schedule, risk, budget, acquisition, and communications support. The IDP Management Office was established with the sole purpose of supporting the delivery of capabilities and services and has been critical to this Project's success.

Leveraging common standards and processes has also ensured a synergy between all the IDP Projects which provides for opportunities to leverage resources and deliver the most cost effective solutions. For the NGITWS Project, focus on communications both internally within NOAA and with key stakeholders such as the FAA and other partners has been critical and will continue to be a key element for this Project's success.

The IDP Management Office is also a resource for each Project Manager to leverage, providing a Center of Excellence for Program and Project Management Information. The Management Office provides critical support from project standup with development of the project charter through execution and the delivery of capabilities. A results-oriented Management Office, success is based on delivery of capabilities on time and within budget – which is not the common benchmark for Management Offices.

5.4 Technical Approach

To accomplish the goals of building a standards-based, net-centric data dissemination capability, IDP and NGITWS are following a simple approach:

- Adopting common, internationally-recognized standards established by the Open Geospatial Consortium (OGC), the International Organization for Standardization (ISO), and the World Meteorological Organization (WMO).
- Using modern, widely-used and accepted data formats, specifically Network Common Data

Form (NetCDF) and Extensible Markup Language (XML).

- Hosting the services at redundant, geographically diverse, high availability, state-of-the-art data centers managed by teams with operational experience.

5.4.1 Publish-Subscribe

Products will be available via both a Publish-Subscribe (PubSub) service and a request-response mechanism. The PubSub service is being built as an enterprise level service in order to fulfill the needs of all IDP projects, not just NGITWS. As the PubSub system is early in the design and development phase, the technical details continue to evolve towards delivering a best-of-breed solution. The PubSub development team is consulting with the OGC PubSub Standards Working Group (<http://www.opengeospatial.org/projects/groups/pubsubswg>).

5.4.2 Web Feature Service and Web Coverage Service

NGITWS will utilize the OGC Web Feature Service (WFS) and Web Coverage Service (WCS) standards. These standards are becoming more widely adopted. The WFS standard has been adopted as a standard by the ISO (reference ISO 19142:2010). More information about WFS and WCS, including the technical specifications, can be found on the OGC Standards web page: <http://www.opengeospatial.org/standards>.

5.4.3 Data Format

To disseminate gridded data, NGITWS will use the Network Common Data Form 4 (NetCDF-4) format, following the Climate and Forecast (CF) conventions. For more information on NetCDF visit the Unidata NetCDF web page: <http://www.unidata.ucar.edu/software/netcdf/>. For more information on the CF conventions, visit the following web page: <http://cfconventions.org/>.

Non-gridded data will be disseminated in XML adhering to standard weather exchange models, including the ICAO Weather Information Exchange Model (IWXXM), the United States extension (IWXXM-US), and the Weather Information Exchange Model (WXXM). Due to the relatively small size of these XML data sets, in contrast to the

gridded data, the non-gridded payloads will be delivered as part of the PubSub messages.

5.4.4 Metadata

NGITWS will expose a comprehensive suite of data-based and service-based metadata records to enhance the discoverability of NOAA data sets, the underlying services supporting the data, and comprehensive metadata information about the data. NOAA metadata records will adhere to OGC-based and ISO-based standards including ISO 19115 Geographic information – Metadata.

5.4.5 Security

As with any outward-facing web service, security will be an important consideration. One of the benefits of standardized web services comes in the form of security capabilities. The web services community has developed extensive and capable state-of-the-art standards for authentication, authorization, and encryption. From the infrastructure perspective, a “defense-in-depth” approach will be used in designing NGITWS security, to both protect itself as well as data consumers. Interconnection and interface planning is currently underway, and an emphasis will be placed on a secure exchange of data.

5.4.6 Handling of Restricted Data

As with security, data protection is paramount. Some classes of data are purchased and owned by an entity and therefore proprietary. The owner of that data has the right to restrict access to that data. Other data may be sensitive (such as real-time aircraft locations). This data will have an extra layer of protection.

5.5 Schedule

The NGITWS Project has an aggressive schedule and is delivering services in a phased approach to demonstrate capabilities as early as possible. The goal is to expose services early, gather user feedback through testing and evaluation, and use those lessons learned to improve existing services and subsequent services. Table 1 below shows the major milestone releases for the NGITWS Project in fiscal year 2015.

Table 1. NGITWS release of capabilities in FY2015.

Date	Capability to be delivered
Jan 2015	Development release of METAR WFS (internal partners only).
Mar 2015	Development release of METAR WFS (external testing) and development release of PubSub with at least two NetCDF gridded products (National Convective Weather Detection and Current Icing Product).
Jun 2015	Operational release of METAR Web Feature Service. Development release of TAF, SIGMET WFS. Operational release of PubSub for NCWD and CIP. Development release of other gridded data sets via PubSub, possibly GFS, NAM, and RAP.
Sep 2015	Operational release of METAR, TAF, SIGMET, AMDAR, NCWF WFS. Operational release of GFS, NAM, RAP via PubSub. Development release of WCS.

In fiscal year 2016, the NGITWS Project will turn its attention towards a full-capability WCS, an IDP enterprise discovery and metadata capability, and continue adding more data sets to the PubSub and WFS.

6. SUMMARY

NOAA’s IDP is integrating a plethora of dissemination services and modernizing the way NOAA data sets are delivered to consumers. One of these dissemination systems is a new standards-driven, net-centric data dissemination system called NextGen IT Web Services (NGITWS). Partnering with the FAA’s CSS-Wx Project, NOAA’s NGITWS will be the primary weather data source for the FAA Next Generation Air Transportation System, delivering capabilities based on standards including OGC WFS and WCS. These capabilities will serve not only the FAA, but also the broader consumer base including AWIPS, the NCEP AWC, NWS Weather Forecast Offices and Center Weather Service Units, private industry, academia, and international partners.

With the vast amount of new meteorological data coming online, consumers want only the data they need exactly when they need it. Traditional dissemination systems lack the ability to provide

this sophistication. A modern, standards-based, net-centric approach is the key to unlocking the potential of this data, in turn maximizing return on investment for taxpayers and enhancing the global economy.

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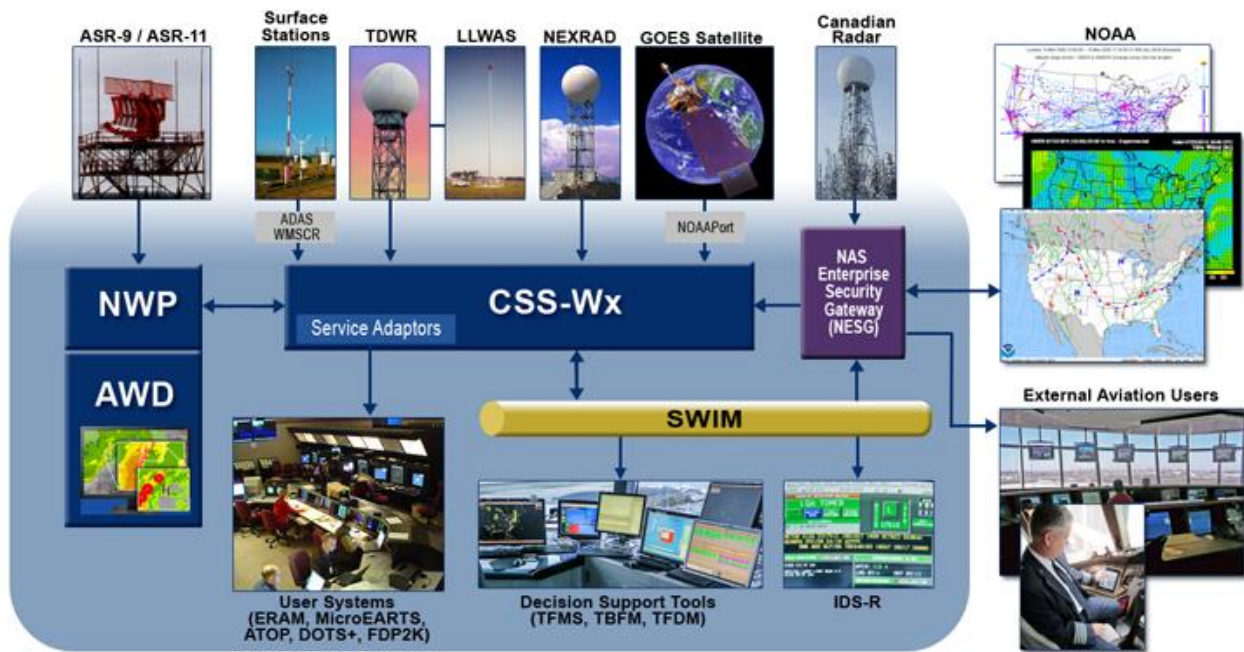


Figure 1 NextGen Weather Architecture Diagram (FAA NextGen Weather n.d.)