



International Civil Aviation Organization

CAR/SAM Regional Planning and Implementation Group (GREPECAS)

**Eighth Meeting of the GREPECAS Aeronautical Meteorology Subgroup
(AERMETS/8)**

Santiago, Chile, 9 to 13 October 2006

AERMETS/8 – IP/04

15/09/06

Agenda Item 11: Other Matters

**METEOROLOGY GROUP OF THE EANPG (METG)
SIXTEENTH MEETING**
(Paris, 18 – 22 September 2006)

Agenda Item 13: Any Other Business

The United States Next Generation Air Transportation System Weather Architecture

(Presented by the United States)

SUMMARY

This paper summarizes the Next Generation Air Transportation System and the vision seen for the weather architecture.

1. Introduction

1.1 The purpose of this paper is to introduce the issues and concepts of the Federal Aviation Administration Next Generation Air Traffic System (NGATS) with a focus on aviation weather issues. This paper is not an exhaustive review and discussion of NGATS.

1.2 The Office of Joint Program Development (JPDO) is overseeing the NGATS program. As stated on the web home page of JPDO, “Today’s aviation system cannot meet 21st century needs. That was the conclusion of numerous studies and blue ribbon panels, including most recently, the National Research Council and the Commission on the Future of the United States Aerospace Industry.... It cannot adequately address more efficient and enlarged capacity and changing market conditions..... Given these challenges, piecemeal solutions or tinkering at the margins will not work. The future demands nothing less than the complete transformation of the U.S. air system”.

1.3 The JPDO has defined eight strategies that are the first steps towards creating the roadmap for NGATS. While the strategies deal with transforming specific areas of the air transportation system, they make up a larger whole and will integrate the sum of the efforts into building the NGATS system as a whole. The transformation strategies are:

1. Develop Airport Infrastructure to Meet Future Demand
2. Establish an Effective Security System without Limiting Mobility or Civil Liberties
3. Establish an Agile Air Traffic System
4. Establish User-specific Situational Awareness
5. Establish a Comprehensive Proactive Safety Management Approach
6. Environmental Protection that Allows Sustained Economic Growth
7. Develop a System-wide Capability to Reduce Weather Impacts
8. Harmonize Equipage and Operations Globally

To make this happen the JPDO created eight integrated product teams which are referred to as Airport Infrastructure, Security, Agile Air Traffic System, Shared Situational Awareness, Safety Management, Weather, and Global Harmonization.

1.4 Similarly, ICAO recognizes the same issue. Recently over the past several years ICAO has been in the process of developing the Global Air Traffic Management Concept. No doubt most of you in attendance at this meeting are aware of this work. So it is not the intent of this paper to delve into this concept but to explore with you the similarities that is being performed under the JPDO for NGATs. They are one and the same, that is to improve the safety and efficiency of Air Traffic Management.

1.5 Weather information is critical to both the safety and efficiency of air traffic management. ICAO recognizes the importance of weather in this arena. Recently, ICAO has been sponsoring Air Traffic Management seminars to further discuss with contracting States the future of the Global Air Traffic Management System.

1.6 This paper will provide a short discussion of the future weather architecture of NGATs.

2. Discussion

2.1 The current NAS weather architecture is designed around a principle that platforms and systems are linked directly to specific sensors/processors to obtain specific data/products to support their operations. While this system has worked effectively for years it can not meet the vision of the future on how weather information is to be provided and disseminated. In the future, the end user will decide what specific data information or product they require to support their operation. The existing system is referred to as point-to-point communication system. Where as the NGATS will be one of net-centric.

2.2 There is a significant difference between the point-to-point vs. the net centric. While it was already stated the user will define the information needed, the information will also be provided in a real time context and a user context format. To ensure that this can be done will require the creation of a four-dimensional (4-D) database. All observations will be sent to a central database, where they are integrated with weather forecasts to provide a single source of authoritative aviation weather for any geographical location and altitude in the NAS.

2.3 The FAA net-centric System Wide Information Management (SWIM) capability subsumes the FAA weather communications systems functionality currently in place.

2.4 One of most significant advantages of this concept is that it will provide common situational awareness to all users. This shared situational awareness of impacting weather facilitates the efficiency of traffic flow and enables traffic managers to minimize delays.

2.5 For a more detail explanation of the weather architecture of the future I refer you to a paper recently presented at the American Meteorological Society 12th Conference on Aviation Range and Aerospace Meteorology. The paper titled “Revolutionary Transformation to Next Generation Air Transportation System & Impact to Federal Aviation Administration’s Weather Architecture” provides an in-depth discussion of the existing NAS architecture and the future architecture of 2015. The paper goes into details showing the roadmap and timeframe of significant milestones to reach the stated goal for 2015. Copy of this paper is attached to this information paper.

2.6 Similarly I refer you to the JPDO web page where you can track developments and the progress of the transformation of the NAS. The URL for JPDO is:

<http://www.jpdo.aero/>

3. **Action**

3.1 The meeting is invited to note the information provided in this paper.

2.5 REVOLUTIONARY TRANSFORMATION TO NEXT GENERATION AIR TRANSPORTATION SYSTEM & IMPACTS TO FEDERAL AVIATION ADMINISTRATION'S WEATHER ARCHITECTURE

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1.0 Introduction

Weather information services are crucial in supporting the safety, efficiency and capacity of the National Airspace System (NAS). The Federal Aviation Administration's (FAA) weather architecture fulfills an important role in enabling the FAA to meet the increasing demand of air traffic on the NAS while maintaining existing high safety standards. To accommodate this increase in demand—expected to triple by 2025—the NAS will transition to the Next Generation Air Transportation System (NGATS) to ensure the future NAS meets air transportation safety, security, mobility, and efficiency needs.

Previous reports on aviation weather services indicate that approximately one-fourth of all aircraft accidents and one-third of fatal aircraft accidents were weather-related (National Research Council (1995) and The NALL Report (2004)). Also, weather continues to be a major factor adversely affecting NAS capacity, contributing to approximately three-fourths of system delays greater than 15 minutes (FAA Aviation Capacity Enhancement Plan (2004)). To address 2025 capacity expectations, weather impact mitigation becomes increasingly critical and current aviation weather capabilities must undergo major changes.

The FAA has determined that the primary gaps in weather information services today are in detection, prediction, and dissemination (FAA Mission Need Statement (MNS) #339, June 2002). Meeting the needs of NGATS requires both eliminating these gaps and meeting the needs of emerging users. New sensors on the ground, on aircraft, and on satellites as well as enhanced algorithms on current ground-based sensors provide significantly improved detection of hazardous weather. Continued aviation weather

research resolves forecasting deficiencies such as 8-hour convective forecasts necessary for efficient traffic management as R&D funding is crucial to attaining the NGATS vision. The transformation of the current point-to-point communications to the NGATS net-centric weather capability ensures service providers and users receive required weather information in real time in a user context format. Moreover, the JPDO has stated that the NGATS vision can only be achieved through revolutionary system-wide transformation, with emphasis on the ability of service providers to focus on the user. However, what are the implications to the NAS Weather Architecture?

2.0 Transformation

The FAA begins a revolutionary transformation of the NAS in all services including weather. The current NAS weather architecture is shown in Figure 1. The NAS transformation occurs in two basic steps—from now until 2015, and beyond that to 2025. Between now and 2015, direct connections to weather sensors will be minimized (except for local display) as data and/or products are routed via a net-centric capability to end-users and to a four-dimensional (4-D) database for later extraction. This reduction of connections between sensors, users, and processors (see Figure 2) enables real time dissemination throughout the NAS as well as communications cost savings without any degradation of data/product availability. Many more aircraft have weather sensors/algorithms to provide weather information to other users directly and/or via the NGATS 4-D database. All observations are sent to this database, where they are integrated with weather forecasts to provide the single source of authoritative aviation weather for any geographical location and altitude within the NAS.

For the FAA, the net-centric System-Wide Information Management (SWIM) capability subsumes the FAA weather communications systems functionality. These systems include the

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Weather Message Switching Center Replacement (WMSCR), two Weather and Radar Processor (WARP) subsystems (the FAA Bulk Weather Telecommunications Gateway (FBWTG) and the Weather Information Network Server (WINS)), and the communications portion of the Automated Weather Observing System (AWOS) Data

User Request Evaluation Tool (URET) and Dynamic Ocean Track System (DOTS). URET uses three-dimensional wind and temperature forecasts to optimize trajectory algorithms for Conflict Probe to facilitate merging of air traffic by controllers, which increases airspace efficiency and capacity. DOTS uses 4-dimensional wind

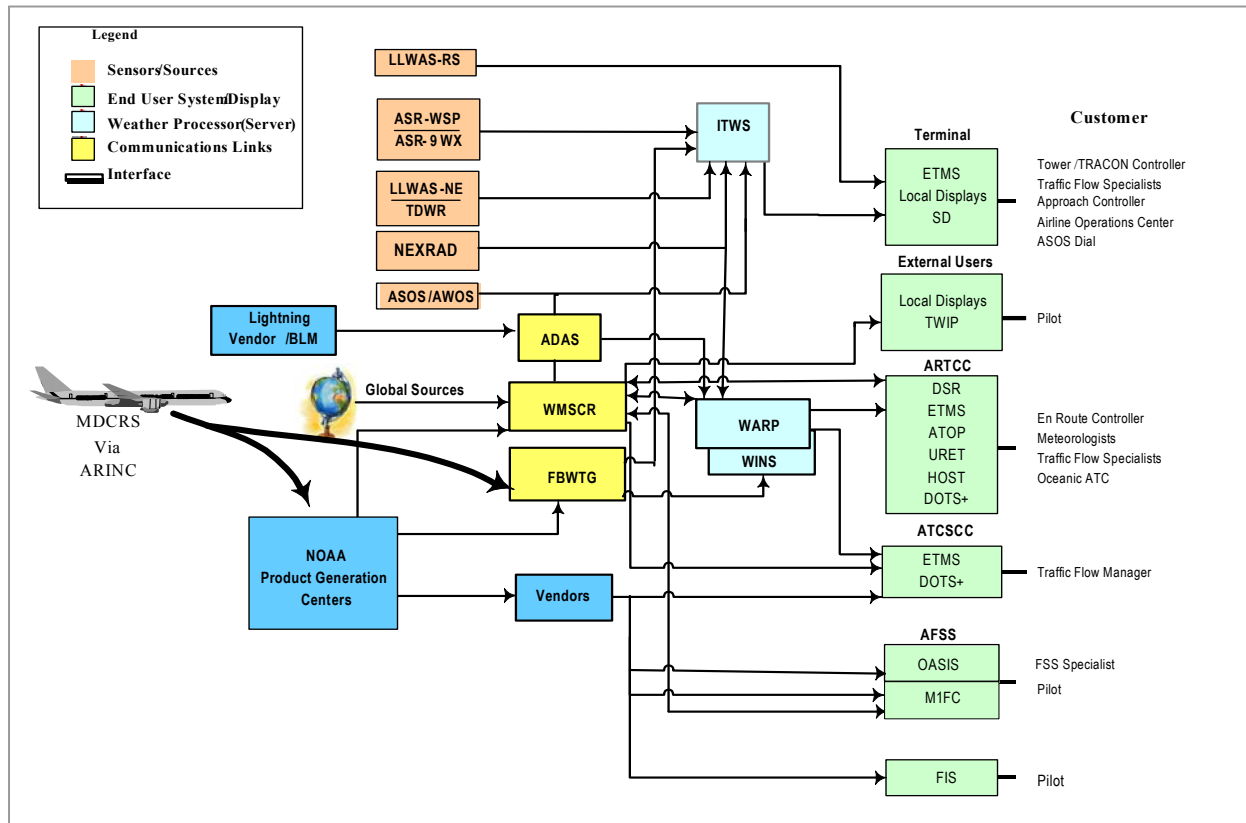


Figure 1 Current NAS Weather Architecture

Acquisition System (ADAS). WMSCR is the primary NAS interface with the National Weather Service Telecommunications Gateway (NWSTG) for exchanging alphanumeric aviation weather products. WMSCR collects, processes, stores, and disseminates aviation weather products and information to various NAS systems, the airlines, commercial users, and international users. FBWTG is the primary NAS interface with the NWSTG for receiving gridded forecast model data.

The FBWTG also receives in situ airborne observations from the Meteorological Data Collection and Reporting System (MDCRS) and gridded hazardous weather products (current and forecast) from the Aviation Weather Center (AWC). WARP disseminates weather products via WINS to NAS automation systems, including the

fields to create wind-optimized flight tracks across the oceanic airspace. The ADAS at each Air Route Traffic Control Center (ARTCC) collects automated surface observations from AWOSs and Automated Surface Observing Systems (ASOS) within the ARTCC boundaries and distributes them locally and nationally.

After 2015, the FAA weather processors, currently optimized by domain (e.g., en route, terminal, and traffic management), converge their functionality, which may be transferred to the NGATS forecasting capability. The convergence of the weather processors, WARP, for En route, Integrated Terminal Weather System (ITWS), and Corridor Integrated Weather System (CIWS), for traffic management, reduces duplicative functions, as well as operations and maintenance costs. The

NGATS forecasting capability (depicted below SWIM in Figure 2) subsumes nearly all weather processing, both of aviation-specific algorithms (e.g., gust front, convection, turbulence, and icing), as well as weather models from the NGATS agencies. However, detection and alerts of

Additionally, the CWSU meteorologist briefs traffic managers and weather coordinators about potential impacts of severe weather on NAS capacity. At the FAA Command Center, former En route Flight Advisory Service specialists use their WARP workstation to examine products for

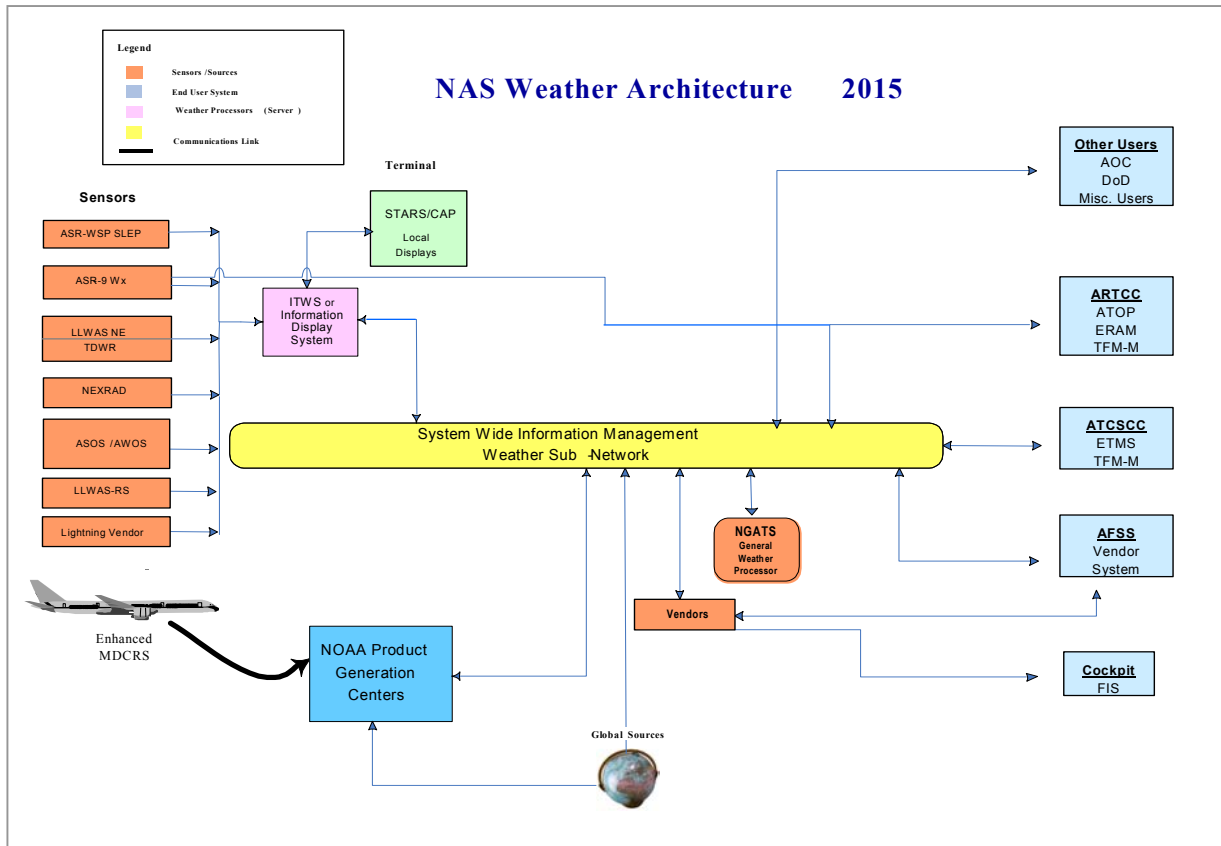


Figure 2 NAS Weather Architecture 2015

microburst/wind shear remain local in the near term until latency requirements to air traffic controllers can be assured, as well as the processing of Next Generation Weather Radar (NEXRAD) mosaics for display to en route controllers.

potential weather impacts on operations at the national scale before briefing traffic management specialists. This shared situational awareness of impacting weather facilitates the efficiency of traffic flow and enables traffic managers to minimize delays.

WARP is the common source for weather information in the En Route domain providing timely weather information to traffic management specialists and area supervisors, Center Weather Service Unit (CWSU) meteorologists, and radar data to air traffic controllers at the FAA ARTCCs. Traffic managers use this information to plan for routing or rerouting of air traffic to increase the efficiency and capacity of the NAS. Air traffic controllers use radar mosaics for more tactical applications, such as advising pilots in their sector of weather hazards along the flight path.

WARP receives aviation observations and products from multiple sources—regional surface observations from ASOS and AWOS via ADAS and from the Harris Weather Data Service (HWDS). WARP also receives radar products from all NEXRADs within the ARTCC boundary and from those radars within 150nm of its boundary. In addition, WARP receives: satellite imagery and alphanumeric products from the HWDS, gridded NWS model forecast data via FBWTG, and tailored aviation products (e.g., National Convective Weather Forecast (NCWF)

and the Current Icing Potential (CIP)) from the AWC via FBWTG. The Forecast Icing Potential (FIP), and the Graphical Turbulence Guidance (GTG) will be implemented on WARP shortly. The FBWTG also forwards RUC (Rapid Update Cycle) gridded forecasts and MDCRS data to the co-located ITWS NWS Filter Unit (NFU) for tailoring and dissemination to individual ITWS systems.

In the Terminal domain, ITWS generates wind shear, microburst, and gust-front alphanumeric and graphic forecast products; storm-cell (location and movement), tornado and lightning information; and high-resolution terminal-area wind data. Moreover, ITWS improves safety by providing the first wind shear and microburst prediction capability. Its high-resolution terminal wind product provides a rapidly updated 3-dimensional wind field of wind speed/direction over ATC terminal waypoints that improves merging and sequencing of aircraft at pacing airports, those with high impact on NAS capacity. In addition, ITWS displays the impact of convective storms and gust fronts on runway usage to terminal controllers, which enables them to optimize runway usage during wind shifts associated with storm passage and assist aircraft in avoiding hazardous weather in the approach/departure corridors, thereby increasing airport efficiency.

ITWS accomplishes this by integrating weather data and products from various sources (e.g., Terminal Doppler Weather Radar (TDWR), ASR-9 terminal radar WX channel, NEXRAD, Low Level Wind Shear Alert System (LLWAS-NE) at 9 sites, and ASOS from the FAA; aircraft in-situ observations from MDCRS-equipped jetliners; lightning data from a vendor; and RUC gridded-weather model data from the NWS. It also processes the ASR-9 six-level weather channel data to remove anomalous propagation and ground clutter from the precipitation intensity on the ITWS situation display. This is essential, as controllers are not trained to differentiate between clutter and actual weather. Additionally, ITWS uses the weather channel of the ASR-9 terminal radar to display precipitation intensity and produces a precipitation-intensity mosaic tailored for TRACON use.

ITWS also enhances overall NAS capacity by displaying storm activity at pacing airports to FAA traffic managers and AOC dispatchers. This provides a common picture of weather impacts between controllers, traffic managers and dispatchers, and facilitates coordination towards

traffic flow impact mitigation in and near affected terminals.

The CIWS prototype enhances the capacity of the NAS by providing traffic managers high accuracy weather products for the high-traffic density Midwest-Northeast corridor (Chicago to Indianapolis to Washington to New York to Boston), enabling them to determine gaps in the convective activity for passage. This area is most susceptible to delays and reductions in capacity during periods of convective weather and any perturbations here cascades into delays throughout the NAS. It generates weather products depicting the current and forecast locations of storms and currently operates displays at eight ARTCCs, the ATCSCC, and six TRACONs.

The common situational awareness the CIWS prototype provides over this wide realm aids collaboration between facilities to implement effective convection mitigation strategies. The CIWS prototype uniquely provides storm forecasts with lead times up to 2 hours and the highest level of accuracy of storm tops measurement. It also provides an indication of whether storms are growing or decaying in intensity, as well as an indication of the recent performance of its predictions. The high reliability and performance of these products enable the FAA and airlines to be proactive at key decisions such as opening routes, rerouting aircraft and identifying situations where planes can safely fly over storms. To enhance capacity, it also covers important Playbook routes in Canada. The prototype uses both TDWR and NEXRAD radar inputs to build current and forecast products.

Also after 2015, the FAA will determine if ground-based wind shear/microburst detection systems need to be replaced or if this functionality can be met through airborne systems, improved NEXRAD algorithms and/or enhanced training. The FAA has three systems that currently produce this information, which will be sustained until at least 2020: LLWAS, ASR-9 Weather System Processor (ASR-WSP), and the TDWR. The LLWAS provides wind shear warnings using a network of anemometers to detect differences in surface winds just beyond the runway thresholds. Processing the six-level Doppler weather channel of the ASR-9 radar, the ASR-WSP provides terminal controllers with information on hazardous weather such as thunderstorms, low-level wind shear and microbursts, and gust fronts. This greatly improves wind shear and microburst

detection capability at the 34 airports with a high wind shear exposure that were previously supported by LLWAS but with insufficient operations to warrant a TDWR. By detecting and displaying microbursts, wind shear, gust fronts, and precipitation intensity, as well as predicting wind shifts—the TDWR increases safety and improves runway/airfield management in the terminal area. Tower and TRACON controllers use TDWR hazardous weather alerts and advance notice of changing wind conditions to redirect air traffic flow and warn pilots of wind shear conditions along approach/departure corridors and on runways. The FAA installed 45 TDWRs that support 46 large (or pacing) airports with the highest wind shear risk.

In summary, the TDWR and ASR-WSP systems provide wind shear and microburst coverage, gust-front prediction, and storm location and movement at 84 of the busiest NAS airports. Factoring in the stand-alone LLWAS-RS network, extended coverage of wind shear and microburst hazards is provided at over 120 airports, which enhances situational awareness between Terminal controllers and pilots.

3.0 Assumptions

The following constitutes the assumptions for transitioning the NAS weather architecture to that of NGATS (Note that some of these assumptions are reflected in Figures 3 and 4):

- Minimal sustainment for weather communications systems (WMSCR, WARP-FBWTG & WARP-WINS) until transition to NGATS net-enabled weather capability
- Current weather sensors are sustained (automated surface observing systems, and TDWR & NEXRAD). In addition, a snowfall rate sensor will be added to ASOS at level B airports to enable removal of contract weather observers
- WARP technology refresh based on sustainability study
- CIWS functionality transfer to NGATS “weather processor”
- Decommission ASR-WSP & LLWAS as low WS accident rates, expansion of WS training, and possibility of WS coverage from NEXRAD via damaging downburst algorithm plus WS detection/prediction capability on jetliners

- Next generation NEXRAD likely needs only radar onsite (no processor) as centralized processing is performed to allow improved tailoring in meeting user needs
- Wake vortex sensors installed & prediction capability available
- In situ weather sensors mandated on aircraft (Part 121 & 135) as well as UAV/UAS
- Cockpit decision support tools use weather information to aid pilots in decision making; tailored weather can also be displayed
- In 2025, nearly all weather data obtained from NGATS 4-D database; however, FAA may retain ability to run some aviation weather algorithms
- Weather research focuses on Safety plus “Business Case” considerations in providing weather impact mitigation to Service Providers and Users

4.0 NGATS Issues Impacting Weather Architecture

The FAA has developed a draft set of roadmaps for depicting the transition from today to NGATS 2025 as the executive view of the Enterprise Architecture. The weather roadmaps for Sensors and for Dissemination, Processing, and Display are depicted in Figures 3 and 4. The primary issues for determining the appropriate transition strategy are discussed in the following paragraphs.

One issue for the future is whether ground-based systems for low-level wind shear detection and alerting will be needed in the NGATS era. Several studies indicate that once the wind shear phenomenon was understood, subsequent actions such as mandatory equipage of onboard wind shear detection systems on jetliners and subsequent airline pilot training were significant factors in reducing wind shear and microburst-related accidents. Similar training for general aviation (GA) might allow the FAA to sustain, but not replace these systems. The combination of wind shear detection systems on airliners, increased pilot training for GA, and enhancement and use of the damaging downburst algorithm on NEXRAD might well provide sufficient wind shear coverage. However, a study is needed to determine if the above could augment or fully supplant the need for ground-based wind shear systems in the NGATS era.

In the NGATS 2025 concept, aircraft must have specified capabilities to use high-density airspace. In the NGATS weather concept of operations it is envisioned that weather sensors and/or algorithms will be mandated for entry into certain airspace in order to provide weather information to other users directly or indirectly via the NGATS 4-D database. There will be two standardized sets of data required, one for jetliners, and one for other aircraft. At a minimum, the airliners will provide winds, temperature, relative humidity, turbulence, and icing information. To capture airborne in situ

on smaller aircraft to fly in highly congested airspace. If the NGATS plan includes mandatory equipage of weather sensors on GA aircraft, there will be opportunities for pre-rulemaking discussion.

Another issue entails conducting Super Density Operations (SDO) at the nation's busiest airports. Today, in the most densely populated areas of the U.S., the air traffic system is barely keeping pace with demand. By 2020, even more major airports are significantly congested as demand on the NAS approaches three times that of today. Conducting

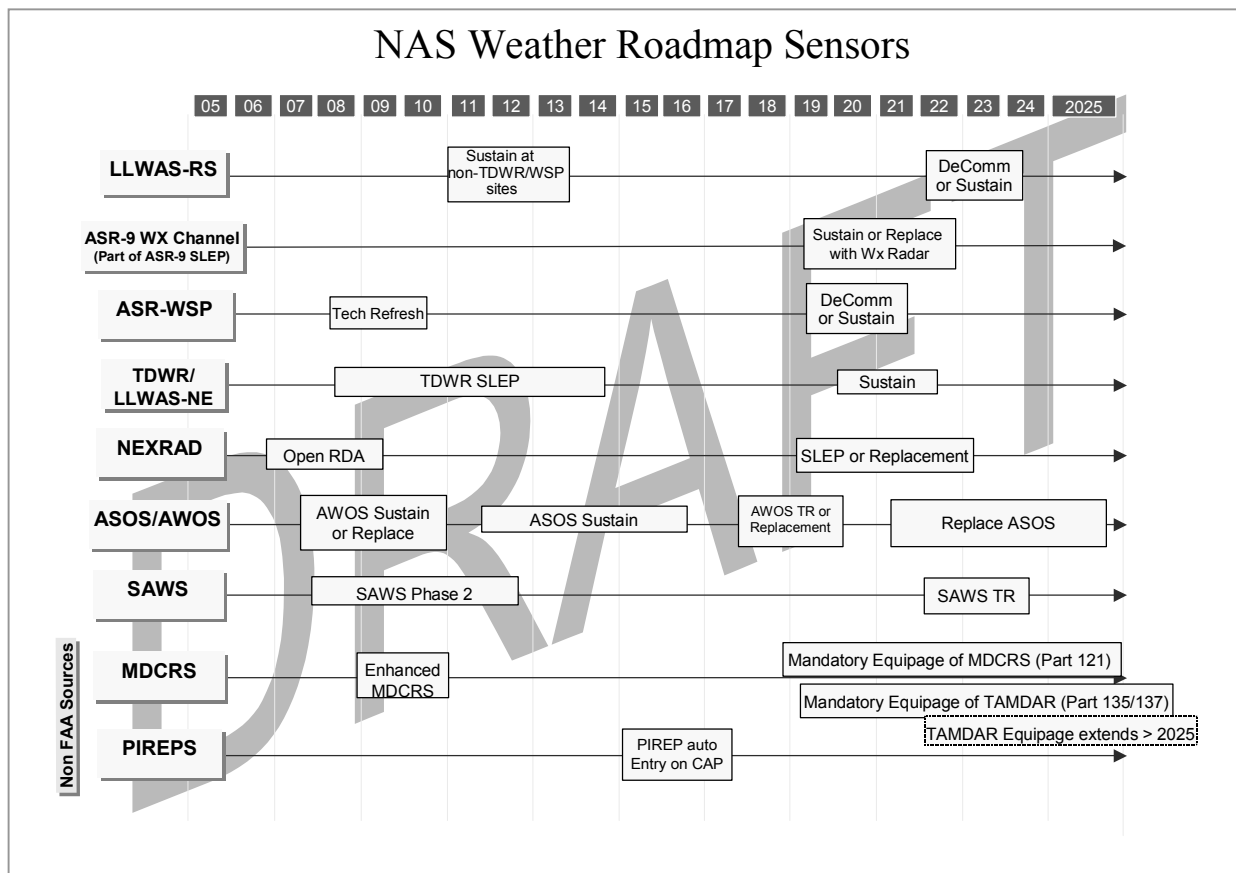


Figure 3 NAS Weather Roadmap to NGATS – Sensors

observations from the mid- and lower-levels of the troposphere, a government-industry initiative called TAMDAR (Tropospheric Airborne Meteorological Data Report) was initiated several years ago. It demonstrated the viability of equipping smaller aircraft (regional jets and turboprops) with an MDCRS-like sensor suite to gather valuable data from these under-sampled regions. To meet the vision of NGATS and the required mitigation of weather on the NAS, the NGATS critical path may require mandatory equipage of a similar, more advanced sensor suite

SDO entails matching land and airside throughput of an airport to meet future NAS demand and requires reduced separation standards and less restrictive runway operations. A major factor impacting airport throughput is wake vortex (WV) considerations, which result in increased separation standards that lowers airport acceptance rates. To ameliorate this reduction in airport capacity, the ability to provide improved wake vortex detection, and predicted location and strength of WV is needed. Currently, both these capabilities are in research and development.

NASA and FAA are collecting data from an airport using a commercial LIDAR to detect and characterize WV, which may lead to modifications to current procedures for separation standards at airports with closely spaced parallel runways. Additionally, efforts are being considered on how to mitigate WV effects on the trailing aircraft. The FAA plans to continue funding research of this capability until it is ready for operational deployment. Close coordination with the airframe modification investigators will ensure integration of efforts into meeting the NGATS vision.

Another of the key elements of NGATS is a common weather picture, created by a fusing of global weather observations and forecasts into a single database that is dynamically updated as

the FAA—whether the convergence of its weather processing capability should be a FAA system or integrated into an NGATS forecasting capability?

This decision depends on several factors including the timeframe this capability is expected to emerge, to what extent it will be decentralized, and the sustainability of the current WARP. The FAA still expects to extract model data from the NGATS database and run aviation-unique applications, e.g., wind shear and microburst algorithms. The NGATS forecasting capability should be capable of incorporating all the current and planned functionality of WARP (except NEXRAD mosaics for DSR), CIWS, and ITWS (except microburst and wind shear). The NGATS dissemination system rapidly moves all required information to

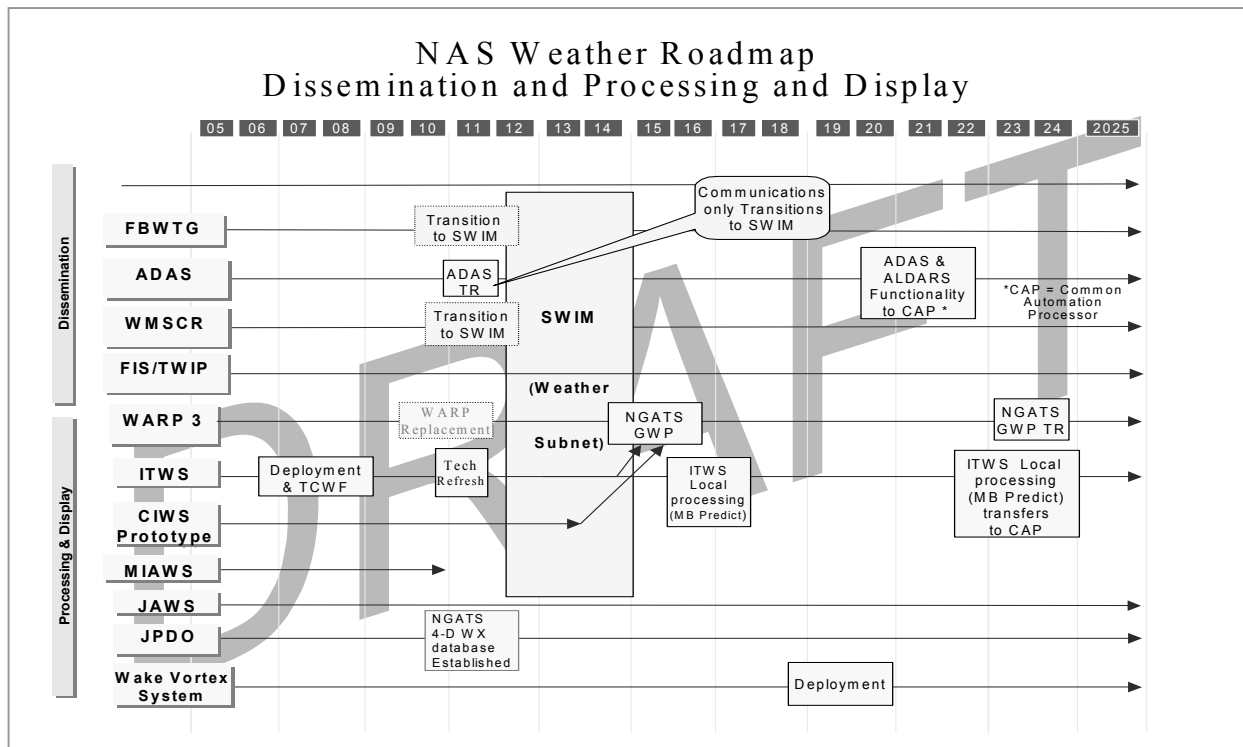


Figure 4 NAS Weather Roadmap to NGATS – Dissemination, Processing and Display

necessary. This database in association with net-enabled information access provides users with context-formatted data. It is currently anticipated that the 4-D database will be centralized so that the observations from tens of thousands of sensors, dozens of multiple forecasts, and government agency tailored products (e.g., ITWS products) can be horizontally and vertically integrated to produce a common picture of weather in the NAS. The FAA does not plan to host this database, but will fund their portion of the costs of its implementation. The key question for

NAS users in accordance with their latency requirements.

One continuing issue for users is the small number of PIREPs that are captured for transmission and assimilated into models. The FAA is evaluating the roles and responsibilities for PIREP capture and considering the addition of a nearly automated capability for controllers to easily enter PIREPs in spiral 3 or 4 development of its En Route Automation Modernization (ERAM) system. At a minimum, this capability will be a part of the

replacement common automation processor (CAP).

In the Surveillance Roadmap, the Terminal Service unit will evaluate the need for terminal radar for aircraft surveillance in the 2016 timeframe. With the transition to automatic dependent surveillance – broadcast (ADS-B) and satellite-based global positioning system (GPS), multi-lateration, and beacons; aircraft surveillance may no longer be ground based. As a result, the weather roadmap specifies a service life extension (SLE) for the ASR-9 to maintain a terminal weather radar capability. TDWR will also have a SLE (main source of radar data to ITWS). If it is determined that ground-based, low-level wind shear systems are no longer needed, the TDWR will be replaced with a less expensive weather radar after 2025.

The JPDO will prioritize weather research and development (R&D) based on the selected NGATS critical path. The FAA then aligns its sponsored aviation weather R&D efforts to attain envisioned improvements. Weather R&D provides improved safety with the emergence of new forecast products such as enhanced in-flight icing and turbulence gridded products, with severity. In terms of capacity, as thunderstorms contribute the most to NAS weather-related delays, aviation weather research continues to develop longer-range thunderstorm forecasts enabling the FAA to meet traffic management needs for forecasts out to 8 hours.

Initially, new weather R&D products are displayed on weather processors and accessible to users. By 2015, however, many of these products are integrated into decision support tools of both FAA service providers and users to optimize algorithm performance for trajectory calculations, and capacity determination, etc. Subsequently, probabilistic forecasts are fully integrated into decision support tools to incorporate both the uncertainty in forecasts and traffic demand to provide traffic managers with enhanced capacity forecasts that minimize the loss of usable airspace.

5.0 Summary

Mitigation of weather impacts on the NAS is crucial to meeting the NGATS vision in 2025. In transitioning the current weather architecture to support the enhanced capabilities of NGATS, there will be impacts to the weather architecture as well, which are discussed below.

FAA efforts to transform toward NGATS begin with the deployment of the net-centric SWIM for the real time dissemination of weather information. SWIM converts the multitude of direct connections between data sources/sensors, processors, and user displays and systems into nodes.

Another architecture impact is the transition to the NGATS weather DB around the 2012 timeframe and subsequent interaction with the NGATS forecast capability when it becomes available (expected by 2016). Both must occur seamlessly and require close coordination and collaboration with the NWS and DoD as well as agency involvement on the JPDO.

Realizing mandatory equipage of weather sensors on GA aircraft will only be successful with aggressive support and sponsorship from the FAA to work through the pre-rulemaking discussions with the GA community. The benefits to model output have shown preliminary but improved model performance. Impacts on the weather architecture mostly entail coordination to ensure that NAS systems and databases can easily ingest TAMDAR data sets and require minimal system modifications.

Additionally, the FAA plans to deploy a wake vortex detection and prediction capability by 2020. It would seem that the culmination of this capability would entail not only a sensor but also a need for data from co-located terminal weather systems (e.g., ITWS and ASOS) to optimize its performance. And, studies would be needed to determine site selection of key pacing airports including those with parallel runways.

However, before we can finalize the critical path of the Air Traffic System from today to 2025, the development of the NGATS CONOPs for weather and its associated requirements are needed in order to perform a gap analysis. In many cases, the functionality does not change, but the entity performing the function changes. Even when the gap analysis is completed, a number of studies are required to determine the critical path. The FAA is currently transforming the gaps determined in the analysis leading to MNS #339 and the associated functional analysis into a baseline set of functional and performance requirements. These requirements will be updated when the current air traffic system to NGATS gap analysis has been completed. Requirements that cannot be met will be allocated to R&D.

Significant weather R&D needs continued to enable NGATS to mitigate the impact of weather

by reducing the number of accidents and helping to reclaim some of the usable airspace that is lost as traffic managers react to insufficiently reliable forecasts. Additionally, investigations must be conducted to determine the possibility of mitigating weather impacts via airframe modifications. In essence, continued funding of weather R&D is absolutely essential to attaining NGATS capabilities.

In order for weather to obtain the funding needed, data-driven business cases must be developed. Classes of studies needed include (1) available benefits, (2) integration of weather into decision support tools (DST), and (3) how does weather really impact the NAS. More importantly, these studies need to be conducted to determine what portions of available benefits can be allocated to weather systems. With the emphasis on improving NAS capacity to meet a demand three times that of today, caution must be exercised to not attribute capacity benefits to weather that may not be realistic.

For example, what portion of the airspace that is currently 'lost' due to inadequate convective forecasts can actually be 'used' in the future with a weather product that permits capabilities such as over-the-top routing, or depicts high-resolution convection spacing that enables safe passage, or has an accurate 8-hour forecast? Full integration of weather into DSTs is a must for the evaluator concept to become a reality.

In the final analysis, benefits must be based on metrics that improve NAS efficiency and capacity. For example, if research can improve in-flight icing forecast accuracy by 12% or turbulence forecasts by 8% due to limited funding, which one has the greatest positive impact on the NAS? It may be that the 8% improvement in turbulence has more impact on NAS capacity, but may not be as great of a safety improvement as the in-flight icing.

The roadmap of the revolutionary changes needed to meet NGATS is still under development. The challenge for the FAA – ensure that sound system engineering principles are adhered to in transforming the NAS weather architecture to the innovative NGATS' visions of 2025.

6.0 Acronyms

4-D = Four dimensional (space and time)

ADAS = AWOS Data Acquisition System

ADS-B = Automatic Dependent Surveillance - Broadcast

AOC = Airline Operations Center

ARTCC = Air Route Traffic Control Center

ASOS = Automated Surface Observing System

ASR-9 = Airport Surveillance Radar

ATOP = Advanced Technology and Operational Procedures

ATC = Air Traffic Control

ATCSCC = Air Traffic Control System Command Center

ATO = Air Traffic Organization

AWC = Aviation Weather Center

AWOS = Automated Weather Observing System

AWSS = Automated Weather Sensor System

BLM = Bureau Land Management

CAP = Common Automation Processor

CDM = Collaborative Decision Making

CIP = Current Icing Potential

CIWS = Corridor Integrated Weather System

CONOPS = Concept of Operations

CTAS = Center TRACON Automation System

CWSU = Center Weather Service Unit

DOD = Department of Defense

DOTS = Dynamic Ocean Track System

DSR = Display System Replacement

DST = Decision Support Tool

ERAM = En Route Automation Modernization

ETMS = Enhanced Traffic Management System

FBWTG = FAA Bulk Weather Telecommunications Gateway

FIP = Forecast Icing Potential

FIS = Flight Information Service

GA = General Aviation

GPS = Global Positioning System

GTG = Graphical Turbulence Guidance

GWP = General Weather Processor

HOSCR = Host/Oceanic Computer Replacement System

HOST = Host/Oceanic Computer System

IDS = Information Display System

ITWS = Integrated Terminal Weather System

JPDO = Joint Program and Development Office

LIDAR = Light Detection and Ranging

LLWAS = Low-Level Wind-Shear Alert System

LLWAS-NE = Low-Level Wind-shear Alert System-
Network Expansion

LLWAS-RS = LLWAS Replace/Sustainment

MIAWS = Medium Intensity Airport Weather
System

MDCRS = Meteorological Data Collection and
Reporting System

MNS = Mission Need Statement

NAS = National Airspace System

NASA = National Aeronautics and Space
Administration

NCWF = National Convective Weather Forecast

NEXRAD = Next Generation Weather Radar

NFU = NWS Filter Unit

NGATS = Next Generation Air Transportation
System

NLDN = National Lightning Detection Network

NWS = National Weather Service

NWSTG = NWS Telecommunications Gateway

OASIS = Operational and Supportability
Implementation System

PIREP = Pilot Report

RCWF = Regional Convective Weather Forecast

R&D = Research and Development

RUC = Rapid Update Cycle

SAWS = Stand Alone Weather Sensors

SD = Situation Display

SDO = Super Density Operations

SLE = Service Life Extension

SLEP = SLE Program

STARS = Standard Terminal Automation
Replacement System

SWIM = System Wide Information Management

TDS = Terminal Display System

TAMDAR = Tropospheric Airborne Meteorological
Data Report

TDWR = Terminal Doppler Weather Radar

TFM = Traffic Flow Management

TFM-M = TFM Modernization

TIS-FIS = Terminal Information Service – Flight
Information Service

TMS = Traffic Management System

TR = Technical Refresh

TRACON = Terminal Approach Control

TWIP = Terminal Weather Information for Pilots

UAS = Unmanned Aircraft System

UAV = Unmanned Aerial Vehicle

URET = User Request Evaluation Tool

WARP = Weather and Radar Processor

WINS = Weather Information Network Server

WMSCR = Weather Message Switching Center
Replacement

WS = Wind shear

WV = Wake Vortex (or Wake Vortices)

7.0 References

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