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STREAMLINING THE FAA'S WEATHER ARCHITECTURE TO MEET FUTURE NAS NEEDS

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1. INTRODUCTION

Weather information services are critical to both the safety and capacity of the National Airspace System (NAS). Previous reports on aviation weather services indicate that approximately one-fourth of all aircraft accidents and one-third of fatal accidents were weather-related (National Research Council). Additionally, weather continues to be a major factor adversely affecting NAS capacity, contributing to approximately 70% of system delays (15 minutes or greater) year after year according to the FAA Aviation Capacity Enhancement plan (2003). With air traffic activity approaching pre-September 11, 2001 levels, the NAS is beginning to show signs of stress in terms of having the airspace capacity to meet that demand.

The RTCA NAS Concept of Operations (CONOPS) and Vision for the Future of Aviation (December 2002) stated that access to real-time weather information for decision making supports efficient national airspace operations when capacity limitations and safety restraints both impact the system. The FAA's weather architecture serves as the enabler to providing such weather capabilities and plays an important role in the modernization of NAS services. However, in order to mitigate these constraints, the weather architecture must evolve effectively over time to support the growing needs of the NAS.

2. WEATHER ARCHITECTURE ROADMAP

The FAA's System Engineering Office developed and continually updates views of the NAS weather architecture from the current out into the future. These views are depicted in "wiring diagrams" to show the flow of weather data from source (sensor, National Weather Service (NWS), vendor, etc.) to the end user (Pilot, Traffic Flow Management (TFM), Air Traffic Control (ATC), etc.). Also shown in these views is the connectivity to/from the NAS domain weather servers, WARP (Weather and Radar Processor) and ITWS (Integrated Terminal Weather System). Since NAS Architecture Version 4.0 was published, all documentation on the evolution of systems of the weather architecture has been contained in a database. However, there has been minimal documentation regarding not only *how* the weather architecture might best accomplish a migration of functionality to provide weather capability out into the future, but also *why* specific changes will be made. To address this lack of information, a NAS weather architecture "Roadmap" was recently drafted under the direction of FAA system engineering. The intent of the Roadmap is to show how the weather architecture realizes the goals of the RTCA NAS CONOPS while addressing the gaps specified in the Aviation Weather Mission Need Statement (MNS #339) within the construct of the draft weather CONOPS.

The Weather Roadmap emphasizes key elements of the weather architecture that as an enabler allow it to:

- Ensure a wider dissemination of weather information to NAS operational decision-makers, both internal (i.e., controllers, traffic managers, and flight service specialists) and external to FAA (i.e., pilots and dispatchers)
- Integrate emerging weather research products into weather servers and ATC/TFM decision support systems
- Improve data accessibility and the integration of appropriate data into automation systems
- Tailor weather information to the end-user
- Implement advances in information management including data integrity and security, as well as data handling (communication techniques and related infrastructures)

As the FAA envisions needed capabilities for the future, the Weather Roadmap identifies architectural interdependencies that must be considered in providing weather support to that capability. It also traces functionality to documented needs and presents the rationale for why a certain capability is achievable in a particular future timeframe. Finally, it identifies implementation of functionality in a manner with the highest likelihood for success. This ensures that as

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incremental changes are made to the NAS, the weather architecture continues to evolve as well and meets each user's future needs for weather information.

This paper presents important components of the Weather Roadmap in timeframes, first describing the current architecture (2004-2005) as an established baseline, then future architectures in two increments, 2006–2010 for the Mid-term and 2011–2018 for the Far-term. These timeframes establish a common thread of improved capabilities that can be traced directly back to NAS initiatives and weather gaps specified in MNS #339. The Far-term includes the Target System Description (TSD), a snapshot of NAS capabilities (or services), which the FAA believes it can reasonably deliver in the 2015 to 2018 timeframe in the current budget environment.

3. WEATHER ARCHITECTURE - CURRENT

The current NAS weather architecture describes the existing weather architecture and incorporates all near-term projected expenditures to achieve both tactical and strategic benefits through 2005. This section focuses on those changes achieved since the last update (2002).

Figure 1 depicts the current facilities and subsystems as well as data flow connectivity. Weather data flows from left to right as it moves into and through the NAS. Multiple sources of weather data and products are shown on the left. Sensors are shown on the top left. Government agencies and vendors are shown on the bottom left. Weather communication switches are shown left center. The WARP and ITWS weather servers are shown right center. Weather information users are shown on the right. Dotted lines indicate new system fielding and associated interfaces.

At the present time, the NAS weather architecture has begun the migration from separate, standalone systems to one that features a weather server concept. For example, the FAA recently fielded the second and third stages of the WARP system. The WARP functions as an "en route weather server" and meteorologist's workstation at the Air Route Traffic Control Centers (ARTCC) and Air Traffic Control System Command Center (ATCSCC). WARP's new functionality enables the system to create NEXRAD mosaics for display on controllers' screens, and to integrate new products that are sent to en route controllers and traffic managers, as well as increasing the number of systems to which it sends data.

The FAA also began implementing its "terminal weather server" ITWS. When fully deployed, ITWS will provide traffic management with tailored products that depict impacting weather at 46 of the busiest NAS airports, where the majority of NAS delays occur. FAA-sponsored aviation weather R&D efforts also provide both safety and capacity benefits with the emergence of new forecast products such as in-flight icing and turbulence products in digital, gridded format.

In the NAS, thunderstorms contribute the most to weather-related delays and focused aviation weather research has enabled the FAA to develop a prototype capability to generate thunderstorm forecasts for terminal use. While not yet used for operational purposes, these forecasts (called the Convective Weather Forecast (CWF)) are viewed in numerous air

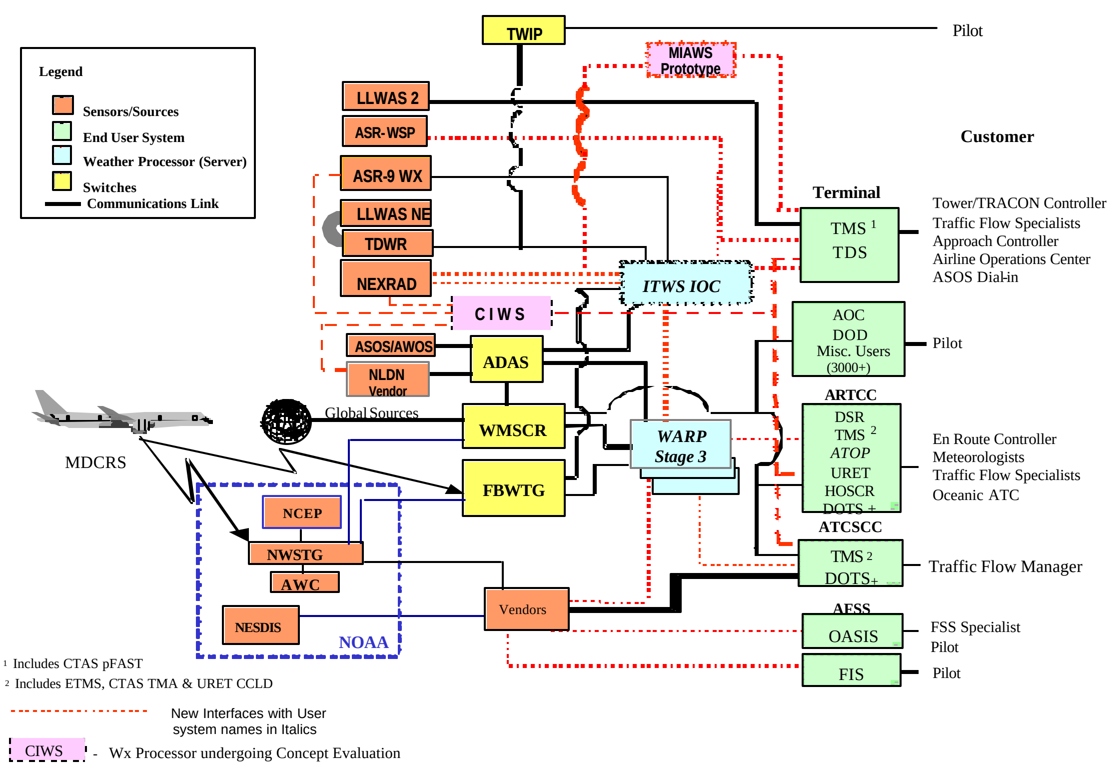

Figure 1 NAS Weather Architecture (2004-2005)

traffic control facilities as part of a "concept of operations" phase. The FAA tested the CWF at its three ITWS prototype sites: Dallas/Ft. Worth, TX; Orlando, FL; and Memphis, TN. The CWF was also on the Port Authority prototype at New York. A quantitative benefits assessment for New York attributes about half of the convective avoidable delay reduction to ITWS' storm growth and decay capability (found in the CWF). The FAA's Joint Resources Council approved funding for fielding 22 of the 34 ITWS systems with the CWF capability. Funding for the remaining 12 systems will be sought later if proved to be cost beneficial.

The FAA has two prototype systems, primarily developed to provide enhanced convective information, undergoing proof of concept. The Corridor Integrated Weather System (CIWS) supports traffic flow managers by providing a 2-hour Regional Convective Weather Forecast (RCWF) and an echo tops forecast to six ARTCCs, six large Terminal Approach Control (TRACON) facilities, and the ATCSCC. This capability is undergoing investment analysis to determine the most cost effective acquisition strategy. The Medium Intensity Airport Weather System (MIAWS) provides convective information to terminal controllers at locations with fewer operations. The FAA deployed MIAWS prototypes at three airports to provide controllers with a real-time display of six-level precipitation intensity and storm position and short term storm-extrapolated forecasting. The FAA Air Traffic Organization (ATO) Executive Council recently examined the proposed MIAWS solution and acquisition of this capability has been canceled until a more cost-effective solution is developed.

During this time period, the FAA upgraded the system processor and added a new ice-free wind sensor to its 569 Automated Surface Observing Systems (ASOS). The ice-free wind sensor provides accurate wind measurements during winter storms. The FAA continues to improve ASOS Data Acquisition System (ADAS) reliability and sustain its capability to collect automated surface observations from its Automated Surface Observing Systems (ASOS) and 180 Automated Weather Observing System (AWOS). The agency is evaluating the inclusion of total lightning (e.g., adding in-cloud and cloud-to-cloud lightning) into ADAS (and thereby to ASOS and AWOS) to provide more lead-time to NAS service providers and users of convective activity near airports.

NEXRAD was upgraded to an open-system architecture enabling FAA weather systems to receive improved FAA-specific radar products such as digital velocity and high-resolution precipitation intensity. Replacing processor components of the Radar Product Generator subsystem also resulted in quicker delivery of products, addressing ATC concerns on data latency.

<u>Development and Deployment Issues</u>

The Operational and Supportability Implementation System (OASIS) program, originally planned for deployment to 61 Automated Flight Service Station sites, has encountered delays and funding shortfalls, resulting in only 14 OASIS systems being deployed by the summer of 2004. Twelve additional systems to be deployed by December were delayed pending the results of a FAA study to determine if flight services were inherently governmental. The FAA is currently evaluating proposals to outsource the provision of flight services, either commercially or by a separate Government solution.

For some time the FAA has been questioning the proliferation of weather systems. This has resulted from the past practice of allocating requirements to each domain, resulting in domain-optimized solutions rather than NAS optimized solutions. An area that is a prime candidate for streamlining or consolidation is thunderstorm forecasting, as both terminal and en route/traffic flow products have been developed. Also, aviation weather R&D efforts have been ongoing for several years and generated different thunderstorm forecast products in various states of use, while others are emerging at this time. With the FAA's acquisition budget decreasing and additional emphasis on cost-beneficial decision making, analysis is ongoing to determine if a single thunderstorm forecasting capability could satisfy both the terminal and en route/traffic flow requirements. Details of those efforts are described in another paper at this conference by the present authors.

4. WEATHER ARCHITECTURE – MID-TERM (2006-2010)

The Mid-term includes several major changes that enable the architecture transition to enhanced capabilities needed to support NAS decision-makers to 2018 and beyond. These changes (Figure 2.) primarily improve the capability of the NAS "domain weather servers."

- ITWS completes deployment at 22 sites with the CWF and emerging enhanced R&D products
- The capability to provide regional forecasts of convective activity (RCWF) in high-activity NAS corridors becomes operational
- The WARP is replaced providing new functionality enabling improved support from the Center Weather Service Unit (CWSU) meteorologist with upgrades to processing power, storage, etc., and connectivity to NWS databases
- ASOS and NEXRAD undergo sensor enhancements

The ITWS capacity enhancing gust-front prediction algorithm, which provides controllers with lead-time to reconfigure the runways during wind-shift passage, is improved.

The one-hour terminal CWF enables TRACON controllers to anticipate storm passage near gates. Late in the period, ITWS receives an automated 2-hour forecast of convection (line thunderstorms only) that depicts storm position and movement. ITWS Pre-

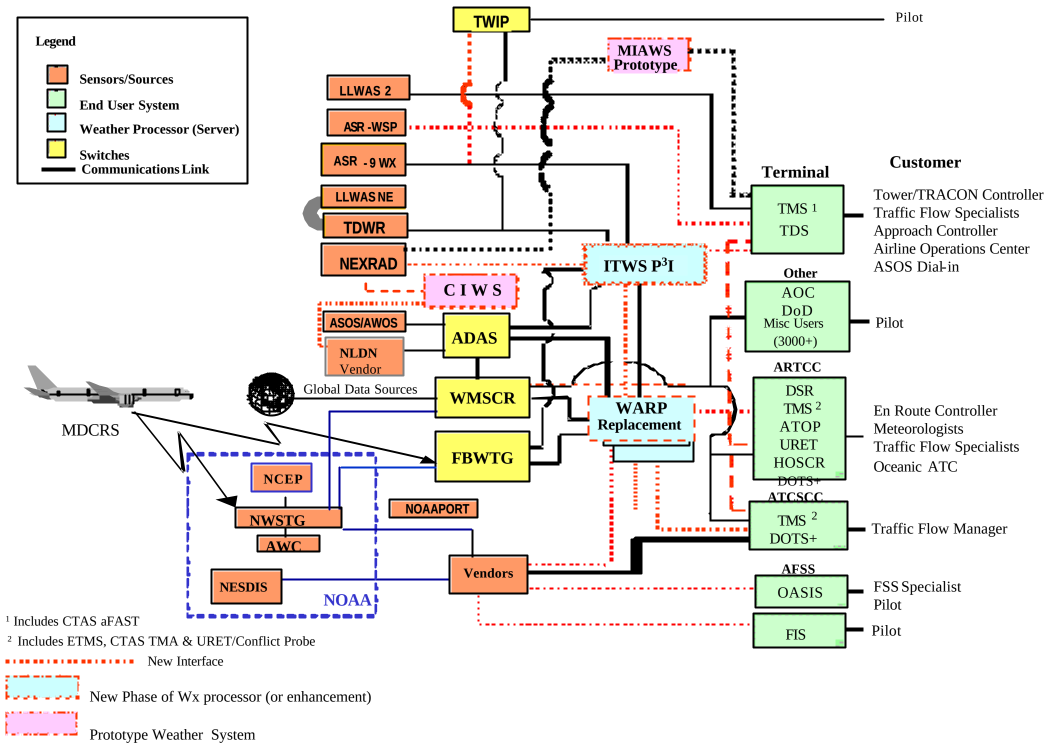

Figure 2 NAS Weather Architecture (2006-2010)

Planned Product Improvements also include a Vertically Integrated Liquid (VIL)-based thunderstorm mosaic for large TRACONs, which provides increased coverage and enhanced resolution of convection. At snow-susceptible airports, ITWS incorporates an advanced version of the Weather Support to Deicing Decision Making (WSDDM) software (including improved data from NEXRAD and ASOS). ITWS provides 2 km, 30- and 60-minute forecasts of gridded wind products to automation systems (e.g., Center TRACON Automation System (CTAS)/active Final Approach Spacing Tool) to optimize performance. It also interfaces with the Standard Terminal Automation Replacement System (STARS) or other Information Display Systems (IDS) enabling controllers to see weather impacts on terminal operations.

Of major importance during this timeframe is the interface between ITWS and WARP, which enables a two-way product exchange between terminal and en route domain weather servers. This enhances dissemination of weather-impacts at NAS pacing airports to both terminal and en route traffic managers, bolstering common situation awareness and also helps consolidate display systems in crowded ATC/TFM workplaces.

WARP receives a major upgrade by mid-period to sustain its functionality as well as provide enhanced forecasting tools for the CWSU and an interface to the NWS Advanced Weather Interactive Processing System for database exchange and retrieval.

Medium-level airports without an ITWS or Airport Surveillance Radar (ASR-9) Weather System Processor WSP likely receive an IDS to display CIWS-generated thunderstorm forecasts via WARP. As IDS become more prevalent, output/images from other systems (i.e., ASR-WSP, Terminal Doppler Weather Radar (TDWR), Low-Level Wind-Shear Alert System (LLWAS), ASOS, and Digital Altimeter Setting Indicator) in each facility are consolidated into the IDS display, eliminating unnecessary monitors.

Changes in the weather architecture also take place in the en route domain:

- Support for Traffic Flow Management Modernization (TFM-M) initiatives
- Support migration to centralized weather processing.

TFM-M includes new products from weather research for both TM display and integration into TFM traffic flow decision support tools. WARP improves support to TFM-M initiatives as it provides higher-resolution weather products (e.g., in-flight icing, turbulence, and convection) for integration into the algorithms of automation systems and tools (e.g., Enhanced Traffic Management System (ETMS), and routing tools (CTAS/TMA (Traffic Management Advisor) and CTAS/DA (Descent Advisor), etc.)

The WARP Replacement takes full advantage of NEXRAD improvements including new VIL-based products to provide better coverage and resolution of convection and faster volume scans (VCPs) to update controller and TM displays more quickly. In addition, dual polarimetric scans enhance detection of precipitation type (i.e., liquid vs. solid) and in-flight icing conditions.

The WARP provides oceanic ARTCC specialists with convective diagnostics, nowcasts, and 1- to 2-hour forecasts as inputs into automation systems via improved Aviation Weather Center products. Late in the period, volcanic ash and turbulence products are made available.

During this timeframe the CIWS capability is fielded (most likely at the ATCSCC) with an interface to the WARP to exploit the existing dissemination infrastructure. This enables RCWF products of position/movement out to 2 hours (plus echo top forecasts) to reach TM at the ATCSCC, ARTCCs, and TRACONs, and large Towers/airports, where they will be displayed on user systems, as well as to Airline Operations Centers (AOCs). CIWS expands to other FAA designated high traffic/weather impact corridors near the end of this timeframe.

Meteorological Data Collection and Reporting System (MDCRS) or in situ aircraft observation density increases due to broader equipage. Water vapor sensor installation is increased and more aircraft have a turbulence algorithm installed in the flight management system. Additional MDCRS observations are also collected during ascent and descent, providing valuable lower altitude data.

NWS model data also evolves during this timeframe, as the WRF (Weather Research and Forecasting) model replaces the Eta and Rapid Update Cycle models in 2005 and 2007 respectively. The FAA evaluates the need to move from 40-km model output resolution to a higher (20-km) output resolution for some or all parameters. The FAA Bulk Weather Tele-communications Gateway (FBWTG) receives more bandwidth and data compression algorithms to handle the anticipated increased throughput.

Interfaces between the WARP Replacement, CIWS, ITWS, and the flight service platforms improve dissemination of data and products between Terminal and En Route traffic specialists facilitating CDM, which sets the stage for domain weather server centralization. By the end of this period, the architecture evolves into a framework that begins to freely exchange data across traditional NAS domains. This entails implementing a new telecommunications network, which moves the NAS from a point-to-point system to one that is net-centric. It uses data flow streamlining, compression techniques and the initial phases of the System Wide Information Management (SWIM) to consolidate interfaces to sensors and provide advanced dissemination capabilities late in the period. In essence, the weather architecture becomes less “domain-centric”.

Architecture Critical Path and Considerations

All changes to the weather architecture must enhance the ability of NAS operational decision makers to make informed decisions in advance to mitigate the impact of adverse weather. This requires:

- Developing “open systems” with expandability that permits easy incorporation of new, tailored algorithms/products as they mature
- More accurate weather information for display and integration into decision support systems
- Improved collaboration between service providers and users by providing each with a similar depiction of impacting weather

The third element is virtually unobtainable without the first two, as they form a “critical path” to achieving improved collaboration. Studies show that the NAS will net the greatest potential benefits from improved identification and prediction of weather and its impacts **on the terminal area.** This is because most weather-related delays and accidents, as well as safety-related incidents occur there. The associated “ripple effect” of NAS delays from the terminal **outward** as a result of delays at pacing airports is incontrovertible.

Expedited deployment of ITWS facilitates many of the perceived benefits to Terminal. The deployment is not only a major critical-path event for the Terminal domain, but for the entire NAS as well

5. WEATHER ARCHITECTURE – FAR-TERM (2011-2018)

Centralized processing of weather information begins in earnest during this timeframe. With this transition, it is essential to ensure that legacy platform functionality is not ”lost” when a new platform subsumes its functionality. Technologies emerge that enable a single system to provide weather information and ATC Advisory Services to users (e.g., decision-makers requiring weather) in all domains. Given that weather transcends all domains, this evolving architectural concept of providing weather services for all domains from a single source is not only technically feasible, but logical as well.

The WMSCR and FBWTG functionalities are subsumed by SWIM, which allows for the elimination of most direct connectivity between sensors and processors as well as end user display systems (See Figure 3). Information technology modules of SWIM greatly facilitate this exchange of weather data, products, and information, including priority plus “communications intelligence” to enable perishable weather information to reach the most remote user in accordance with the most stringent NAS latency requirements (i.e., the timely transfer of ITWS short-term terminal convection and Obstruction to Vision (OTV) forecasts).

An automated graphical product replaces the text icing AIRMET. A Wake Vortex prototype sensor is developed and deployed to detect and track wake vortices based on earlier research efforts. Late in the period, integrated icing products are available with aircraft-specific and preflight planning information.

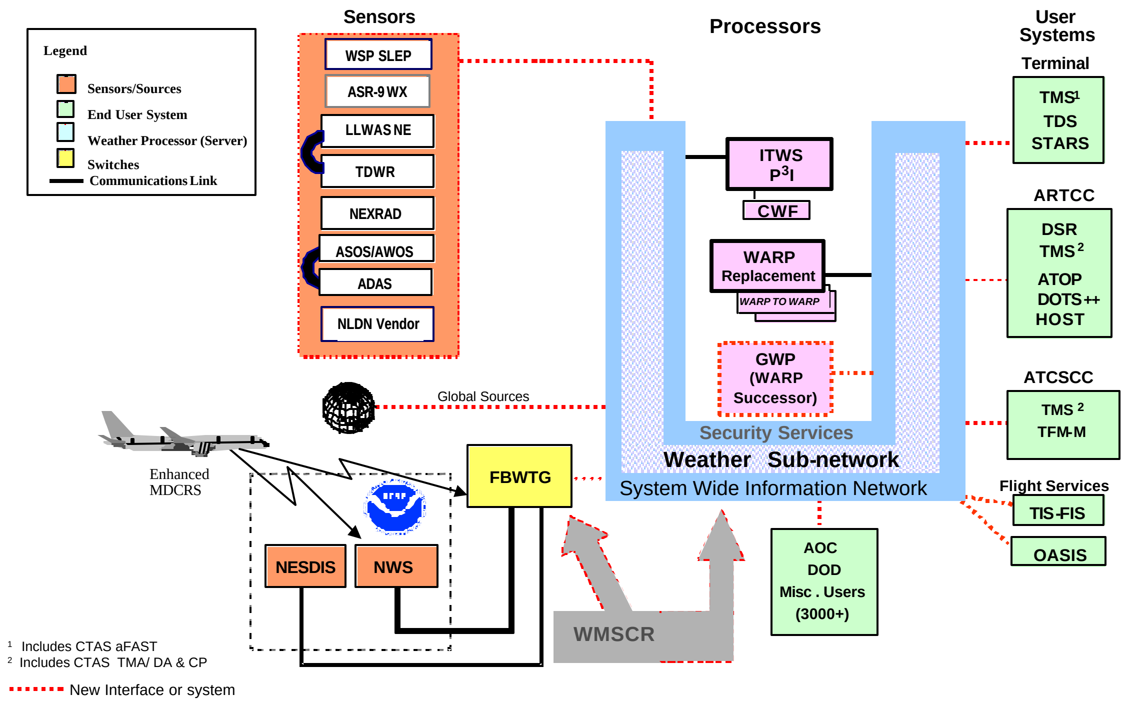

Figure 3 NAS Weather Architecture (2011-2018)

ITWS receives a crucial technological refresh early in this timeframe to update the processor and software, plus add new product algorithms to sustain its capability to support airports through GWP implementation (at least 2018). New product algorithms include the Machine Intelligent Gust Front Algorithm improvements, data quality alerts for the ASR-9, and a gust front mosaic with longer forecasts (30-60 minutes) of gust front position information for large TRACONs.

Multifunctional IDS replace most ITWS displays, as well as other terminal display systems, which enables FAA service providers to view all necessary information on a single workstation regardless of user location. At the end of the period, the General Weather Processor (GWP) emerges to provide a single automated source of weather information (plus a backup for redundancy). The GWP replaces the WARP at each Center and the ATCSCC and the deployed CIWS. This consolidation of weather processing to a single location is transparent to service providers and users, as an interface to SWIM facilitates near real-time dissemination of sensor input to the GWP as well as dissemination of its products throughout the NAS.

Improved understanding of how to integrate weather information into decision support tools due to:

- Emergence of more accurate weather products/information that quantify measurable effects of weather on an area of airspace (e.g., capacity reduction) or other TFM decision objects (rather than simply provide improved detection and forecast products of aviation-impacting phenomena)
- Improvement in weather product accuracy

Operational decision-makers receive information regarding the impact—what they want—not just improved weather products. The real value of a weather product to operations is that not only must it be accurate, but it must also relate to an operational threshold important to the decision-maker (i.e., tailored).

Confidence is higher regarding forecasts of future atmospheric states due to improved forecast performance. Far-term products contain metrics for reliable accuracy to support TFM decision-making. This means performance metrics are based on aviation (e.g., capacity reduction, route closure, duration, etc.) and not just meteorological thresholds (e.g., severe, moderate, etc.). Thus, decision-makers can effectively judge product or tool performance by what is important to them.

Products for TFM include 1-, 2-, and 4-hour thunderstorm forecasts with 6-hour forecasts possible later in the period; 2-hour Echo Tops forecasts; OTV products, including terminal and regional depictions; thunderstorm-induced turbulence graphics; and improved reflectivity mosaics with higher resolution and total lightning. Other thunderstorm products (e.g., improved CCFP and 4-dimensional arrival/departure gate forecasts) contain higher spatial and temporal fidelity, as the science of meteorology advances and our understanding of weather impacts on capacity improves.

At oceanic Centers, weather products also flow to next-generation Advanced Technologies and Oceanic Procedures/Dynamic Oceanic Track System (ATOP/DOTS++) platform from WARP/CIWS. TMs can plan for and generate flexible routes using integrated satellite/aircraft/ground-based inputs of thunderstorms (including lightning and convection induced turbulence), volcanic ash, in-flight icing, winds aloft, and clear air turbulence.

Advanced data link capability emerges during this timeframe, allowing the flight deck (all classes of users) to receive weather information of value regardless of avionics or data link path. Applications, focused initially for en route, are driven by the benefits of equipage. This technology stems from next-generation TFM applications (that contain integrated weather) as well as the integrated Flight Management System (FMS) and Navigational (onboard) databases, which query databases for updated weather information from MDCRS, Pilot Reports (PIREPS), and NWS databases. In addition, expanded equipage of MDCRS onto more jetliners and commuter/air-taxi aircraft flying at lower altitudes greatly expands this source of automated airborne weather observations. Automated and continuously updated flight optimization techniques provide 20-, 40-, and 60-minute conflict-free trajectories (containing integrated weather) via inputs from en route automation platforms, trajectory tools, FMS, and surveillance tools.

Interfaces to SWIM enhance collection of air-to-ground data (weather and flight data), while aircraft avionics improvements allow for receipt of more tactical-use decision aid products. These products include manual and Electronic (E)-PIREPs for tactical situational awareness, location of thunderstorm activity for tactical reroutes or over flights, in-flight icing for holding altitudes or final approach patterns, non-convective turbulence for convenience/comfort, and wind shear and late in the period, slant visual range for final approach.

Dispatch/AOC maintains access to improved weather products via the FAA Telecommunications Infrastructure (FTI) or FAA-qualified Internet service providers. SWIM eventually replaces the need for FTI-based products sourced directly from the GWP.

Architecture Critical path and Considerations

The weather architecture migration during the Far-term transition must focus on four high-level events to ensure success.

1. Maintaining weather functionality and modular implementation. The recently completed Weather Functional Analysis is decomposed to the platform level (e.g., ITWS, WARP, etc.) to ensure functional conservation. Additionally, if the functionality is modularized, the GWP can “evolve” as fast or as slow as technology or budgetary constraints allow.

2. Ensure that decision-makers continue to receive the type of information that they need to complete mission goals. User-need studies similar to the study, “Center Traffic Management Unit Weather Needs,” FAA, 1999, for pilots and air traffic controllers are expanded and continue to be refined to ensure all users needs are known.

3. Ensure that all system or platform improvements bring value to users and that these value or benefits can be measured. The maximum leveraging of proven capabilities must be focused in ways that bring improved benefit to users and leverage on multi-agency capabilities.

4. Ensure that the NAS can work in an extended “transition state” between the paradigms of today (domain-centric) and the TSD constructs of the future (net-centric). All interim platforms will be open, robust and expandable in case the TSD replacement system is delayed or not implemented.

To facilitate these high-level events, there are four additional considerations/issues based on various assumptions about TSD platforms. Most of these assumptions concern:

- Functionality that must be maintained
- System transition
- Latency issues for time-sensitive data
- Implementation timeframes of TSD platforms

Systems being streamlined through consolidation of processing or display functionality must be carefully tracked to ensure no functionality is lost. Also, extremely limited, if any, processing will be performed by consolidated IDS platforms. So the function of processing weather data (e.g. "fusing" various data sets to generate mosaics and other products) resides first in WARP/CIWS and later in GWP. Only the data output is sent to the IDS or other TSD platforms. With consolidation from multiple sites to a single site, analysis will be performed to ensure that data latency requirements continue to be met. In this timeframe, with future funding unknown, implementation of TSD platforms ensures interdependencies are considered. The transition, however, must be transparent to the end user.

6. CONCLUSIONS

The FAA’s TSD provides insight into how the NAS weather architecture evolves into the next decade. It provides an architectural snapshot of the systems and facilities that will comprise the NAS at a point in time toward achieving the vision of the RTCA NAS CONOPS. In keeping with the theme of the modernization [to consolidate functionality, thereby reducing the number of systems and associated life cycle costs], the TSD shows the consolidation of the functionality of weather product generation. This streamlining greatly reduces the number of weather processors as a single weather processor emerges (GWP) to generate the vast majority of NAS weather information. It will tailor and disseminate products via SWIM to users across traditional NAS domains.

TSD-era systems facilitate the NAS modernization by leveraging off of industry-driven advances in areas such as telecommunications, data compression, and computer processing power. This enables near simultaneous distribution of enhanced weather products and information to NAS service providers and users that greatly aids common situational awareness of hazardous weather. Incorporating weather information into automation systems goes further by providing operational decision-makers with what they really want—a depiction of how adverse weather impacts NAS operations. An example is the integration of weather into traffic flow decision tools so that decision makers view only 'capacity constraints.'

At the same time, the FAA is adopting new paradigms that emphasize the "business case" meaning that new technology must support operations, while reducing operating costs. Also, a commitment has been made to continue supporting NAS services with greater accountability throughout the agency. This translates to the likelihood that new programs will only be started after the requirement is validated, viable alternatives have been proposed, and the selected solution is supported by a sound business case. Also, any solution that optimizes one domain at the expense of another will be unacceptable.

While the full impact of the reduced budget on the weather architecture is unknown at this point, it is reasonable to assume that several weather programs (or program elements) will likely be delayed. An early casualty of this fiscal reality is the ITWS, which has had the fielding of approximately one third of all it's systems delayed.

In summary, the challenge for the FAA is to employ system-engineering principles in order to prudently fund needed improvements to the NAS weather architecture that will harmonize with NAS efficiency (capacity) enhancements that are critical for modernization. Implementation timeframes for FAA weather systems and products have been traditionally and will continue to be driven by factors often beyond agency control—technology and budget appropriations—that complicate an orderly transition of elements of the NAS weather architecture.

ACRONYMS in Text and Figures:

A/D = Approach/Departure Controller

ADAS = AWOS Data Acquisition System

AIRMET = Airmen's Meteorological Information

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

AWOS = Automated Weather Observing System

CDM = Collaborative Decision Making

CCFP = Collaborative Convective Forecast Product

CIWS = Corridor Integrated Weather System

CONOPS = Concept of Operations

CTAS = Center TRACON Automation System

CWF = Convective Weather Forecast (terminal use)

DOTS = Dynamic Ocean Track System

DSR = Display System Replacement

ETMS = Enhanced Traffic Management System

FBWTG = FAA Bulk Weather Telecommunications Gateway

FIS = Flight Information Service

FMS = Flight Management System

FTI = FAA Telecommunications Infrastructure

GWP = General Weather Processor

HOSCR = Host/Oceanic Computer Replacement System

HOST = Host/Oceanic Computer System

IDS = Information Display System

ITWS = Integrated Terminal Weather System

LLWAS = Low-Level Wind-Shear Alert System

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

MIAWS = Medium Intensity Airport Weather System

MDCRS = Meteorological Data Collection and Reporting System

MNS = Mission Need Statement

NAS = National Airspace System

NESDIS = National Environmental Satellite, Data, and Information Service NLDN = National Lightning Detection Network

NWSTG = NWS Telecommunications Gateway

OTV = Obstruction to Vision

OASIS = Operational and Supportability Implementation System

PIREP = Pilot Report

RCWF = Regional Convective Weather Forecast

SIGMET = Significant Meteorological Information

STARS = Standard Terminal Automation Replacement System

SWIM = System Wide Information Management

TDS = Terminal Display System

TDWR = Terminal Doppler Weather Radar

TFM = Traffic Flow Management

TFM-M = Traffic Flow Management Modernization

TIS-FIS = Traffic Information Service – Flight Information Service

TMA DA = Traffic Management Advisor Descent Advisor

TMA CP = Traffic Management Advisor Conflict Probe

TMS = Traffic Management System

TRACON = Terminal Approach Control

TSD = Target System Description

TWIP - Terminal Weather Information for Pilots

URET = User Request Evaluation Tool

VCP = Volume Control Pattern

WRF = Weather Research and Forecast

WARP = Weather and Radar Processor

WMSCR = Weather Message Switching Center Replacement

WSDDM = Weather Support to Deicing Decision Making

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