1.2 AN UPDATE TO THE FAA'S NATIONAL AIRSPACE SYSTEM WEATHER ARCHITECTURE

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1. INTRODUCTION

The FAA's weather architecture will play an important role in the modernization of the National Airspace System (NAS), as weather information services are critical to both the safety and capacity of the NAS. According to the National Research Council report on Aviation Weather Services, from 1988 to 1992 one-fourth of all aircraft accidents and one-third of fatal accidents were weather-related. The Aircraft Operators and Pilot Association's Nall Report for 2000 states that while general aviation weather-related accidents dropped slightly for 1999, they were more likely to be fatal (75%) than any other accident cause. The FAA Aviation Capacity Enhancement (ACE) plan for 2000 reveals that from 1996 to 2000, adverse weather accounted for 71 percent of system delays greater than 15 minutes. The 2001 ACE Plan indicated it was still a major factor affecting NAS capacity, contributing to 67 percent of system delays. To mitigate these safety and efficiency constraints, aviation weather capabilities in the NAS must undergo major changes.

To that end, the NAS weather architecture has already begun to migrate from its previous state with separate, stand-alone systems, operating independently of one another; to one that is evolving and will eventually become fully integrated into the NAS. This integration will feature the "weather server" concept where single-sourced weather data (from the National Weather Service (NWS) and the National Environmental Satellite, Data, and Information Service (NESDIS)) will be shared with all FAA systems.

2. WEATHER ARCHITECTURE

The FAA began making needed changes two years ago by fielding the second stage of the Weather and Radar Processor (WARP) system, a weather 'server' and workstation for the Center Weather Service Unit (CSWU) meteorologists at each of its Air Route Traffic Control Centers (ARTCC) in CONUS and Alaska, as well as at its Air Traffic Control System Command Center (ATCSCC) in Herndon, VA. Later this year, the FAA begins deploying its terminal weather 'server', the Integrated Terminal Weather System (ITWS). ITWS will provide valuable, user-friendly products (no meteorological interpretation required) to traffic management specialists at 47 of the busiest NAS airports.

WARP and ITWS will be the keystone of the NAS weather architecture enabling the FAA to meet the weather needs of NAS operational decision makers—service providers such as FAA traffic managers, air traffic controllers, and flight service specialists; and users such as airline dispatchers and pilots. This paper will underscore the enhanced capabilities the NAS weather architecture affords the above personnel.

2.1 WEATHER ARCHITECTURE (2002-2005)

Figure 1 provides a generic depiction of NAS facility/subsystem connectivity. The dotted lines indicate a new system being fielded during this time period and interfacing to the system in *italics* within the facility on the right side. In these diagrams, weather data flows from left to right as it enters, and then moves through the NAS. On the left side of the diagram are the multiple sources of weather data and products. In the upper left are the weather sensors that provide raw data or sensor products, while lower left are the line offices of the National Oceanic and Atmospheric Administration (NOAA)—NWS and NESDIS—that provide a crucial portion of the weather information to the NAS.

In the left center are the weather communications switches, the Automated Weather Observing Systems Data Acquisition System (ADAS), the Weather Message Switching Center Replacement (WMSCR), and the FAA Bulk Weather Telecommunications Gateway (FBWTG) that transport weather data through the FAA; the weather servers, WARP and ITWS, are in the right center. Vendors are shown at the bottom as they provide weather products as well. Finally, on the far right side are the

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users of weather information.

That the NAS weather architecture continues to evolve is evident by the fact that the FAA is already exploring new capabilities to provide improved weather services in response to emerging

data from a mix of FAA and NWS radars, as well as lightning data to provide short-term regional forecasts of storm location and movement. The more rapid refresh rate of the FAA radars will be used to detect rapidly growing cells while the NEXRAD provides 3-D

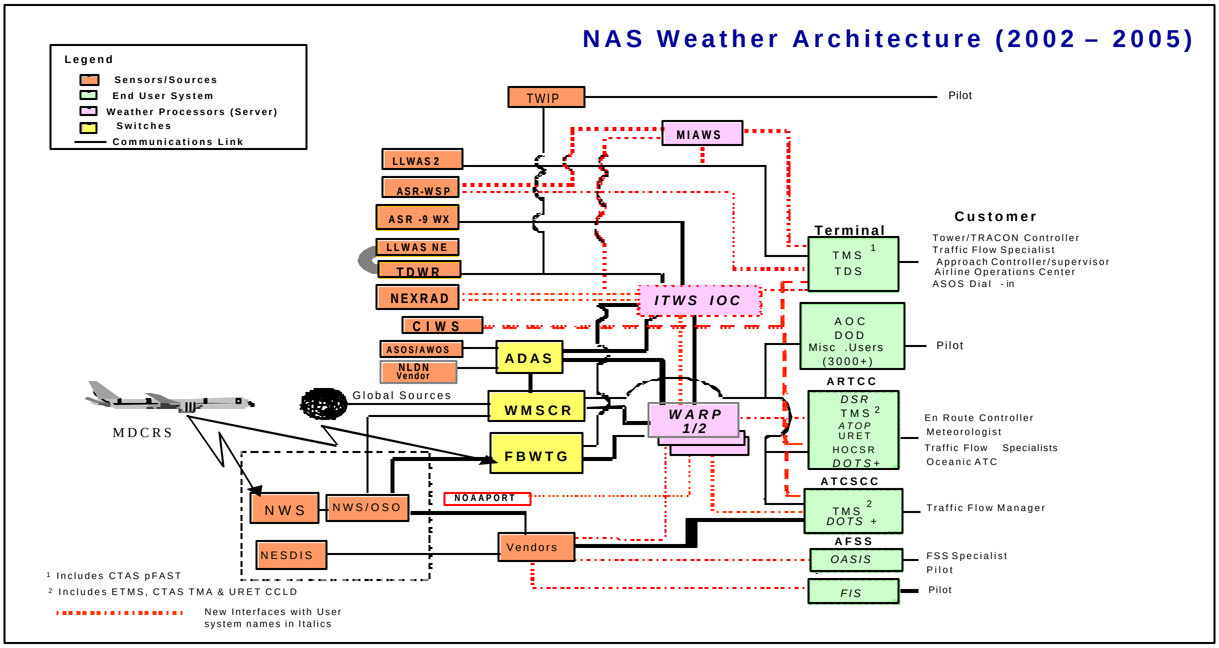

Figure 1. NAS Weather Architecture (2002 –2005)

requirements. Operational capabilities have arisen that require new weather services ranging from improving flight safety at medium-sized airports to enhancing the efficiency of air traffic operations in a large region of the country. For the latter situation, the occurrence of severe weather in a busy air traffic corridor, extending from Chicago eastward to Washington, DC, then up to Boston, has a serious impact on NAS efficiency. Severe weather in this corridor causes a significant disruption to the flow of air traffic, posing a major challenge for FAA traffic managers to resolve via coordination among the FAA's Command Center, several ARTCCs, as well as airline dispatchers.

To ascertain the weather services requirements for these two dissimilar situations, the FAA is conducting a concept evaluation with two programs—the Medium Intensity Airport Weather System (MIAWS) and the Corridor Integrated Weather System (CIWS) depicted in Figure 1. MIAWS will provide tailored weather products of precipitation intensity utilizing radar data from a nearby Next Generation Weather Radar (NEXRAD) and wind/wind shear data from the airport Low Level Wind Shear Alert System to traffic control personnel at 40 medium-sized airports when deployment begins in 2002. CIWS, on the other hand, is unique in that it will ingest weather radar storm information. The concept evaluation for CIWS will likely continue into 2003 with final implementation and the host platform determined at a later date.

Weather service enhancements during this period include: WARP providing NEXRAD precipitation intensity mosaics and thunderstorm attributes information on controller displays; the Automated Surface Observing System (ASOS) receives a processor upgrade, a new dewpoint temperature sensor, and an ice-free wind sensor. An 'open system' upgrade to the NEXRAD radar processor generator (RPG) enables faster processing with new and high-resolution products, tailored radar scans, and more rapid product dissemination. NAS wind shear coverage (safety) is greatly enhanced as the Terminal Doppler Weather Radar (TDWR) receives a new RPG and a 360^{o}-scan for hazards. A microburst prediction capability is added with ITWS, and wind shear coverage is extended as the ASR-9 terminal surveillance radar at 38 non-TDWR airports is modified with the Weather System Processor (WSP).

Both ITWS and WSP increase airport acceptance rates (capacity) with a gust front detection and forecast capability, optimizing runway usage during thunderstorm approach and passage. Weather to the cockpit is realized as Flight Information Services

(FIS) vendors 'datalink' weather and aeronautical information up to aircraft enabling pilots to operate more safely and efficiently.

The NAS weather architecture will continue to meet emerging and unmet weather needs in support of air traffic services as its FAA-funded applied R&D will improve the detection and forecasting of aviation weather hazards. Two of these products, the National Convective Weather Forecast (NCWF) and in-flight icing (called CIP for Current Icing Potential), recently became operational. These and other products will be provided from the NWS' Aviation Weather Center (AWC) in Kansas City, MO, in a gridded format to

Flight Service Station specialists in support of general aviation (GA).

2.2 WEATHER ARCHITECTURE (2006-2010)

During this next period (Figure 2.) CIWS becomes fully operational and greatly aids traffic managers in the Command Center, and affected ARTCCs and TRACONs in mitigating avoidable delays associated with thunderstorm activity as they collaborate with the airlines and each other.

Updates to various systems continue to further improve air traffic services including the completion of the NEXRAD open systems architecture and a

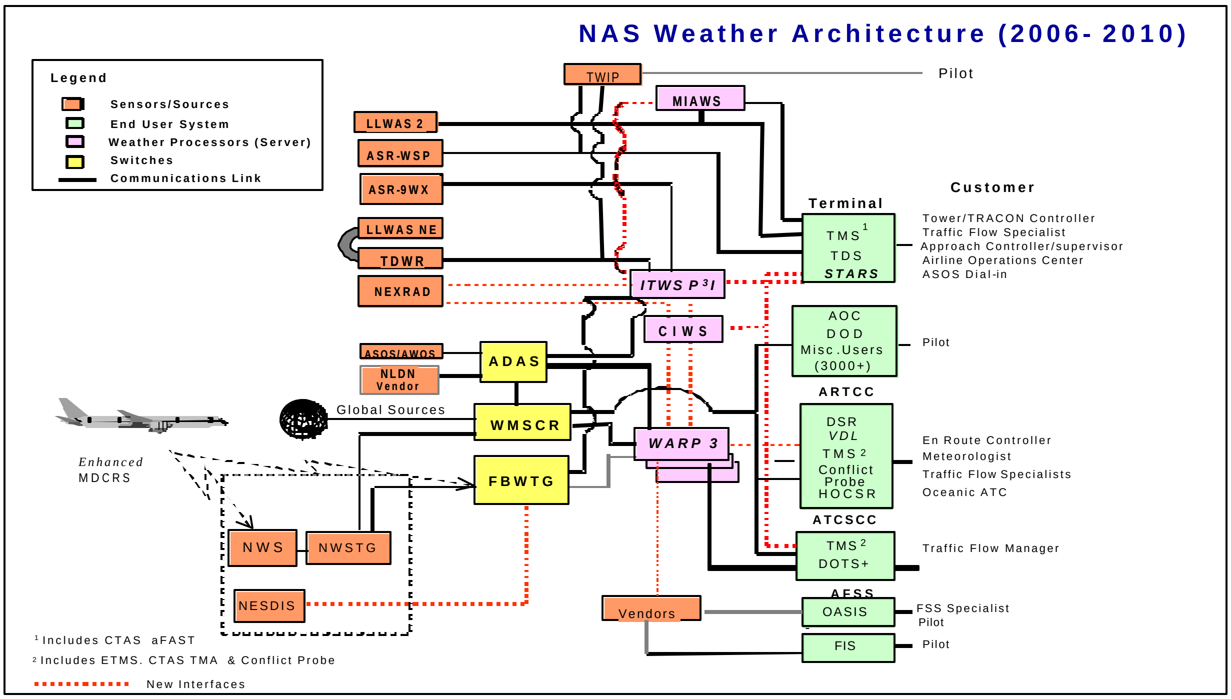

Figure 2. NAS Weather Architecture (2006 –2010)

WARP and ITWS for tailoring and dissemination to traffic managers and controllers as well as their decision-support systems.

NOAA support enhancements include graphical significant meteorological information (SIGMETs), and improved weather models with higher-resolution 3-D computations and increased physics, improving forecast output for wind, temperature, and aviation-impacting variables (i.e., icing, turbulence, convection, etc). These not only aid forecasters but enhance the performance of decision-support systems that assist controllers in various ways, with alerts of possible aircraft trajectory conflicts, or sequencing and merging aircraft into and out of airports. Finally, the Operational and Supportability Implementation Information System (OASIS) is fielded greatly enhancing the service capability of

new antenna that will likely contain a Dual Polarization capability, thereby enhancing the detection/forecasting of areas where in-flight icing poses a hazard. This improves the ability of controllers and flight service specialists to assist air taxi and GA aircraft to avoid those hazards. WARP and ITWS receive both new and improved products, e.g., precipitation products that use vertically integrated liquid for precipitation intensity (vice composite reflectivity) reducing artifacts such as 'bright banding' often noted in winter storms.

ITWS receives the Terminal Convective Weather Forecast product, with a storm cell growth and decay capability that provides traffic managers with an invaluable tool enabling them to optimize runway and terminal airspace usage during storm and gust front passage. ITWS also provides weather data to decision support systems to aid controllers in spacing and metering of aircraft on final approach and advise airport and airline personnel on when to de-ice jetliners or conduct runway snow-removal operations.

ASOS ceiling/cloud measurements are improved (to 25,000') with a new ceilometer, and airborne observations are enhanced as the airlines equip more aircraft with sensors, plus new parameters—humidity and turbulence—become available.

WARP connects to other systems permitting tailored products to be shared by NAS users and service providers. ITWS incorporates new algorithms enhancing its capability to forecast events such as ceiling and visibility, runway winds, and gust front passage, plus it will receive NEXRAD vertically integrated liquid products and improvements to its Terminal Winds forecast product. More than likely, WARP and ITWS will be the source of weather in the cockpit via data link.

3. Summary of Capabilities

The austere budget environment plus the tragic events of September 11, 2001, have forced the FAA to reassess its priorities. Over the next couple of years, delays and/or reductions in preplanned product improvements for weather programs are likely. However, the NAS weather architecture will continue to evolve in meeting the growing needs of NAS users. To enhance its dissemination capabilities, preliminary steps are being taken to allow the weather architecture to exploit an evolving FAA telecommunications infrastructure enabling near real-time access of weather data to FAA service providers and users alike. Subsequently, each of them will have a similar depiction of hazardous weather, thereby facilitating the collaborative decision-making process, allowing timely planning [instead of reacting] to hazardous weather.

As the demand for traffic flow outpaces NAS capacity, tailored convective weather forecast products (out to several hours) will enable terminal, regional and national traffic managers to ameliorate the impact of thunderstorms on NAS efficiency with timely pre-planning for routing/re-routing of aircraft [while en route] and minimize disruption to airport acceptance rates at the busiest NAS airports.

Further evolution of the NAS weather architecture progresses from this "weather server" concept (serving primarily the en route and terminal domains) to one that supports all NAS users, through the maturation of the NAS-Wide Information Services (NWIS). Integration of weather systems into the NWIS allows the FAA to provide near-simultaneous delivery of weather data and products to users and service providers by exploiting planned FAA communications enhancements. As a result, common situational awareness is enhanced, facilitating collaborative decision making. The NAS weather architecture undergoes evolutionary changes over the next 8-10 years, significantly enhancing its capability to provide tailored weather products to NAS users and service providers.

ACRONYMS IN FIGURES:

AOC = Airline Operations Center

ATOP = Advanced Technologies & Oceanic Procedures

AFSS = Automated Flight Service Station

DOTS+ = Dynamic Ocean Track System

DSR = Display System Replacement

DUAT = Direct User Access Terminal

HOCSR = Host and Oceanic Computer System, Replacement

NLDN = National Lightning Detection Network

NWSTG = NWS TeleCommunications Gateway

STARS = Standard Terminal Automation Replacement System

TDS = Terminal Display System

TMS = Traffic Management System

TWIP = Terminal Weather Information for Pilots

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