26 AVIATION WEATHER

Weather information services are critical to NAS safety and efficiency. According to the National Research Council (NRC) report[1] on Aviation Weather Services, from 1988 to 1992 one-fourth of all aircraft accidents and one-third of fatal accidents were weather-related. The 1996 Nall Report[2] states that 69 percent of all weather-related general aviation (GA) accidents resulted in fatalities. The 1997 Aviation Capacity Enhancement Plan reveals that from 1992 to 1996, adverse weather was a major factor affecting NAS capacity, accounting for 72 percent of system delays greater than 15 minutes.

Aviation weather capabilities in the NAS must undergo major changes. The changes will convert today's weather architecture—consisting of separate, stand-alone systems—to one in which future weather systems are fully integrated into the NAS under the weather server concept (single-sourced data shared with all systems). The weather architecture evolves further as it progresses from a "weather server" concept (serving primarily the en route and terminal domains) to one that supports all NAS users, with the implementation of the NAS-wide information service. Integration into this information exchange allows the weather architecture to exploit communications enhancements and provide near simultaneous delivery of weather data and products to both users and service providers.

As a result, NAS providers and users receive the same hazardous weather information (with system-tailored depiction) *simultaneously*, enhancing common situational awareness. This facilitates collaborative decisionmaking for traffic flow managers, controllers, flight service specialists, and pilots. This is accomplished by two new weather systems that convert multiple sources of "raw" weather data into meaningful information: the integrated terminal weather system (ITWS) and the weather and radar processor (WARP). These systems act as weather servers providing information to other subsystems and users. In addition, communications enhancements (i.e., flight information services (FIS) data link) will improve the data exchange between the ground and the cockpit.

26.1 Weather Architecture Evolution

The NAS weather architecture optimizes the capability to collect and process weather data, provide current and forecast conditions of hazardous and routine weather, and disseminate that information in text and/or graphical formats to all NAS users and service providers. NAS users include pilots who receive preflight and in-flight weather information, flight planners, air traffic control (ATC) specialists, airline and vendor meteorologists, and airline dispatchers. Service providers include ATC personnel, traffic flow managers, and flight service specialists. This capability enhances safety and capacity by promoting common situational awareness.

The NAS weather architecture features an evolution to fully integrated systems enhanced by the maturation of the NAS-wide information service (see Section 19, NAS Information Architecture and Services for Collaboration and Information Sharing).

NAS weather architecture systems are categorized as either (1) *sensors* and/or *data sources* or (2) *processing and display systems*. In some cases, a system will process and display data and also be the source of weather data for other NAS systems (e.g., ITWS). The four-step evolutionary process for implementing the NAS weather architecture is discussed in Sections 26.1.1 through 26.1.4.

26.1.1 Weather Architecture Evolution—Step 1 (1998)

The current weather architecture is depicted in Figure 26-1. This diagram and the following weather architecture diagrams are generic depictions of NAS facility/subsystem connectivity. In the upper left section of the diagram are the

1. "Aviation Weather Services, A Call for Federal Leadership and Action," National Aviation Weather Services Committee, Aeronautics and Space Engineering Board, Commission on Engineering and Technical Systems, and National Research Council Report, National Academy Press, Washington, D.C., 1995, p 10.
2. *Nall Report, Accident Trends and Factors for 1995*, The Aircraft Owners and Pilots Association Air Safety Foundation, 1996, p. 13.

PART III

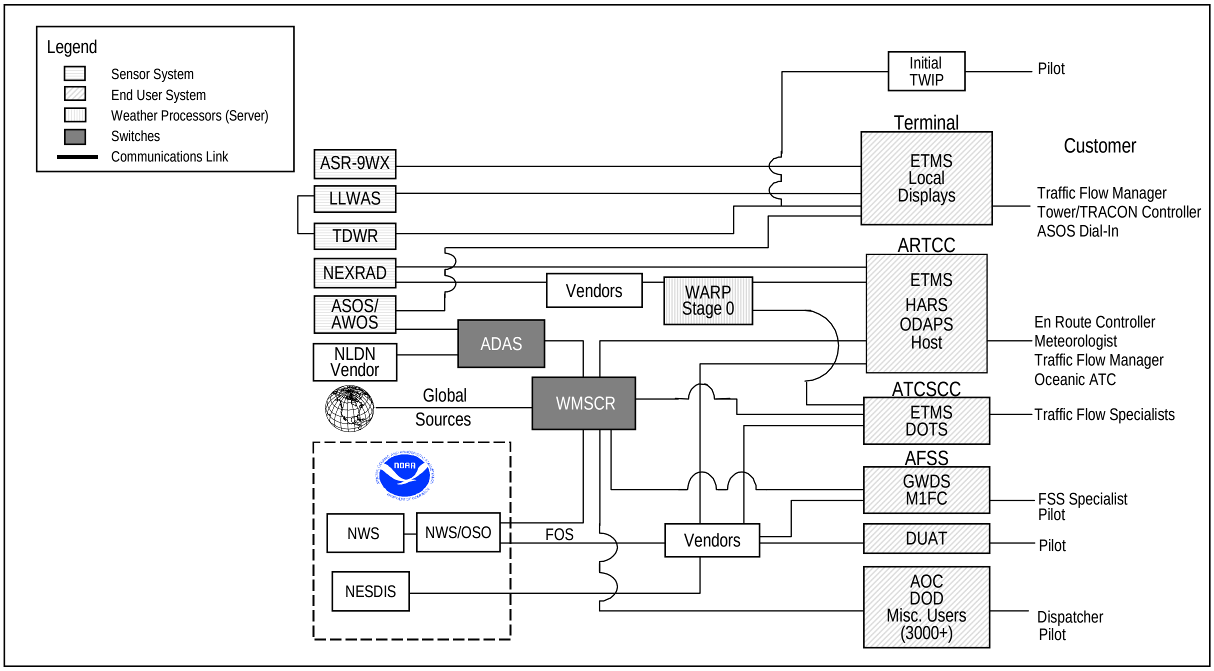

Figure 26-1. Weather Architecture Evolution—Step 1 (1998)

weather sensors that collect the raw data. At the lower left section of the diagram are the outside agencies that provide the majority of weather information to the NAS—the National Weather Service (NWS) and the National Environmental Satellite, Data, and Information Service (NESDIS). The NWS and NESDIS are offices of the National Oceanic and Atmospheric Administration (NOAA). In the center of the diagram are the weather switches, which the FAA uses to transport data. The weather processors are also included in the center section. Finally, on the right side of the diagram is the ultimate user of the data. In the diagrams, the flow of weather data is from left to right as it moves into and through the NAS.

Sensors and Data Sources

Weather data are obtained from ground-based sensors, aircraft sensors, and commercial vendors. Surface observations are generated manually by observers or automatically by the automated weather observing system (AWOS) and automated surface observing system (ASOS). The AWOS data acquisition system (ADAS) collects, processes, disseminates, and archives observations from AWOS and ASOS for local and national distribution. Using data from the National Lightning Detection Network (NLDN), ADAS generates and sends lightning activity messages to AWOS and ASOS for reporting use.

The next-generation weather radar (NEXRAD) provides a variety of weather data, in the areas covered, including layered radar reflectivity data associated with severe weather such as tornados and hail, areas of precipitation, wind speed and direction, and turbulence.

The ground-based low-level windshear alert system (LLWAS) and the terminal Doppler weather radar (TDWR) detect localized windshear phenomena such as microbursts, while windshear detection systems on commercial jetliners provide airborne detection. In the terminal area, thunderstorm information can be inferred from TDWR and by primary airport surveillance radar (ASR), as well as by NEXRAD. In the en route environment, weather radar data from NEXRAD, primary air route surveillance radar (ARSR), and NLDN are used to provide this information.

NOAA support includes observations (surface and aloft), aviation advisories such as significant meteorological information (SIGMET) and airmen's meteorological information (AIRMET), terminal and en route forecasts, radar data, and satellite data. The National Center for Environmental Prediction (NCEP) is a collection of NWS centers that are responsible for atmospheric model development and forecast output. NCEP models provide analyses of current weather and forecast weather parameters such as wind and temperatures aloft, which are required by NAS users. The NWS distributes the data to vendors who provide these data to the FAA.

The NWS's Aviation Weather Center (AWC) uses a computer model to generate forecasts of aviation hazards such as icing. The AWC works closely with both the FAA Aviation Weather Research (AWR) Program and air traffic operations to improve forecasting tools. The AWC's forecasts of aviation-impact variables (icing, turbulence, and convective activity) mitigate the effect of hazardous weather on the NAS. A large portion of weather data used within the NAS is produced or collected by NOAA (i.e., NWS and NESDIS). Additionally, most third-party weather products find their origins in NWS-provided data and models.

The FAA uses terminal weather information for pilots (TWIP) to provide commercial pilots with direct access to limited weather information via the aircraft communications addressing and reporting system (ACARS) data link. This enables pilots of equipped aircraft to view a rough depiction of hazardous weather that is similar to the ones displayed to the tower and the terminal radar approach control (TRACON) controllers, greatly improving common situational awareness. Currently, TWIP is available only from TDWR sites.

Processing and Display

Weather information is processed and displayed in the various ATC facilities through separate weather systems. In air route traffic control centers (ARTCCs), these include the WARP Stage 0 and the NEXRAD principal user processor, which are used by meteorologists in center weather service units (CWSU) and traffic management units. In control towers and TRACONs, information from TDWR, LLWAS, and ASOS are usually provided on separate displays. Some integration of weather data into automation systems currently exists as the host computer processes ARSR weather data that are displayed in two intensity levels to en route controllers (see Section 21, En Route). Additionally, the automated radar terminal system (ARTS) displays ASR reflectivity data to TRACON and tower controllers (see Section 23, Terminal). Three terminals (Dallas-Ft. Worth, Memphis, and Orlando) currently have an ITWS prototype. National implementation of ITWS will begin in Step 2, providing short-term forecasts of terminal-impacting weather to controllers in TRACONs and towers.

At the Air Traffic Control System Command Center (ATCSCC), weather data are obtained from the aircraft situation display (ASD), NEXRAD, and command center WARP briefing terminals. Flight service specialists use the flight service automation system (FSAS), consisting of the Model 1 Full Capacity (M1FC) (see Section 25, Flight Services) plus the interim graphic weather display system (GWDS).

The weather message switching center replacement (WMSCR) is the primary NAS interface with the NWS telecommunications gateway (NWSTG) for the exchange of aviation alphanumeric and limited gridded weather products. WMSCR collects, processes, stores, and disseminates aviation weather products to major NAS systems, the airlines, and international and commercial users.

WMSCR also provides storage and distribution of domestic notice to airmen (NOTAM) data and retrieval of international NOTAMs through the Consolidated NOTAM System. WMSCR receives weather and NOTAM information from the DOD via the Automated Weather Network (AWN); severe weather information from AWC; observations from ADAS and the U.S. Air Force's automated weather information distribution system (AWIDS); international data via the aeronautical fixed telecommunication network (AFTN); and weather information from WARP and FSAS through the aviation weather processor. The WMSCR is also an integral part of the operational alphanumeric product backup for the NWS's automation of field operations and services (AFOS) communications network when the NWSTG is nonoperational.

26.1.2 Weather Architecture Evolution—Step 2 (1999–2002)

The weather architecture completes the deployment of two major systems during this time period, WARP and ITWS (see Figure 26-2). WARP will undergo software upgrades and produce re-

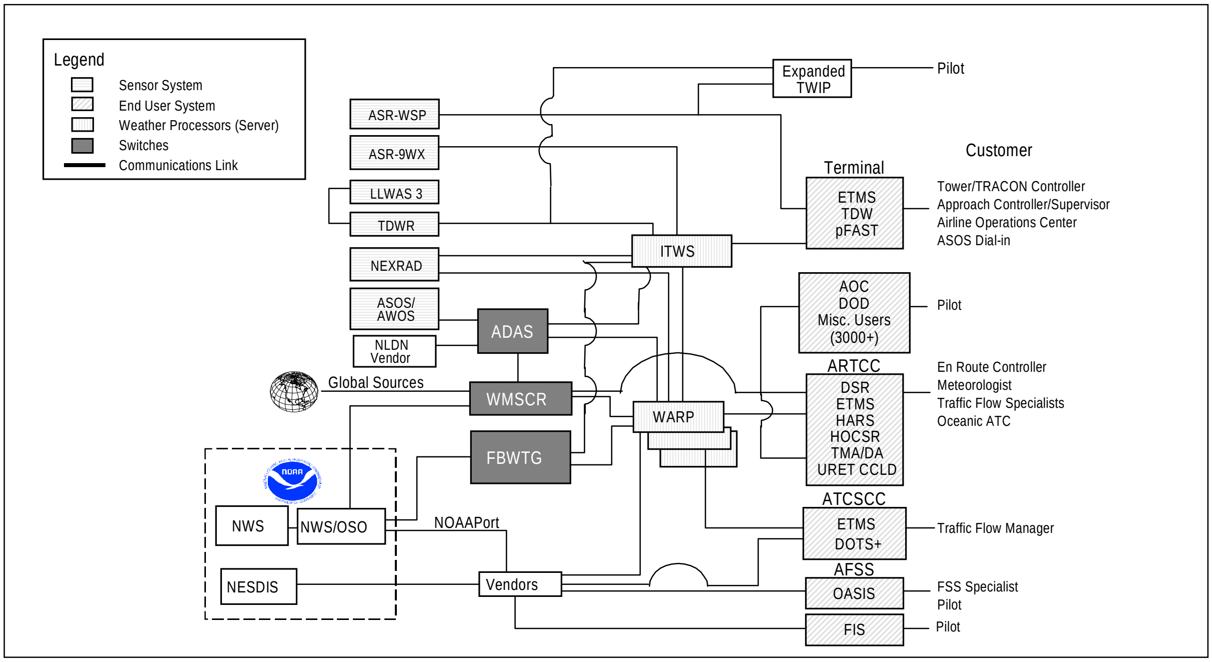

Figure 26-2. Weather Architecture Evolution—Step 2 (1999–2002)

gional and national mosaics of NEXRAD data. These mosaics will be displayed on display system replacements (DSRs) to controllers. WARP will also interface with the Operational and Supportability Implementation System (OASIS) and NAS automation systems, such as the User Request Evaluation Tool core capability limited deployment (URET CCLD) and the Center TRACON Automation System (CTAS) traffic management advisor (TMA). ITWS will be implemented during this period and provide enhanced terminal weather data forecasts to tower and TRACON personnel, as well as to NAS automation systems at 45 TDWR-equipped airports. ARTCC traffic managers will have an ITWS situation display enabling them to track storm activity at major airports and to facilitate coordination with the TRACONs and major hubs.

Other changes include the following: conversion of the NEXRAD radar product generator (RPG) to an open systems architecture; implementation of the FAA bulk weather telecommunications gateway (FBWTG); deployment of OASIS; and fielding of the airport surveillance radar-weather systems processor (ASR-WSP). ASOS and the ASOS Lightning Detection and Reporting System (ALDARS) deployment will be completed. TDWR upgrades include improvements to gust-front algorithms and equipment modifications.

As part of the NAS modernization schedule, the FAA will implement Free Flight Phase 1 Core Capabilities Limited Deployment (FFP1 CCLD) as a risk-mitigation effort for subsequent national deployment of various automation systems designed to provide user benefits. WARP will support URET CCLD by providing forecasts of gridded wind and temperature data fields for trajectory calculations. Other FFP1 CCLD automation systems requiring weather data include the CTAS pFAST used by terminal controllers and traffic managers, and the TMA used by en route controllers and traffic managers. WARP Stage 3 implementation will be accelerated to provide this support.

As part of the FAA's flight information services (FIS) policy, the FAA will approve the basic weather data that a commercial service provider will provide to the cockpit. FIS provides the weather information needed by pilots to operate safely and efficiently. The National Aeronautics and Space Administration (NASA) and industry are engaged in joint research to provide "weather-in-the-cockpit." NASA will expend considerable research funds to develop aviation weather information systems to provide current data to airline and general aviation aircraft.

Sensors and Data Sources

The FAA will continue to obtain weather data from internal and external sources in Step 2. Current FAA sensors will be upgraded or replaced for sustainment. Airborne observations will improve as the airlines equip additional aircraft with weather sensors and increase the number of parameters reported (such as humidity and turbulence). NOAA will be the source of various data, including gridded forecast data from the NCEP (i.e., the Environmental Modeling Center (EMC) and the AWC) satellite data from NESDIS, as well as forecasts and observations from NWS Weather Forecast Offices. Some “value-added” products continue to be provided by vendors. The WMSCR continues to receive and transmit much of the alphanumeric weather information.

The FAA upgrades the basic weather sensors, leading to improved reliability, increased accuracy, and superior maintainability. An example of this refinement is the NEXRAD system upgrade. The NEXRAD network is upgraded to an open systems architecture with new hardware, software, and a modular configuration. The upgrade to the NEXRAD radar product generator (RPG) increases processing capabilities and accuracy and improves both reliability and maintainability. The upgraded system incorporates more complex algorithms. As science advances its understanding of meteorological processes that affect aviation, new products and services will be added to NEXRAD. ASOS will receive sensor and processor upgrades, thereby enhancing its capabilities.

The AWC disseminates forecasts of weather affecting aviation operations to the NAS in a gridded format. This gives NAS systems the capability to display aviation-impact variables, such as icing, in a format that is advantageous to users. For instance, a SIGMET report will no longer be available only in text format with an area location, but will also be provided in gridded data fields. This allows the location and extent of the significant (or hazardous) weather to be displayed graphically in four dimensions (including time). The AWC also provides forecasts of convective activity, icing, turbulence, and AIRMETs as gridded data fields.

There are a number of developmental projects sponsored by the AWR Program that are ready for implementation during this time period.

Processing and Display

Within the weather architecture, ITWS and WARP will function as NAS weather servers—WARP in the en route domain and ITWS in the terminal domain. As weather servers, WARP and ITWS “ingest” NWS computer model output, as well as acquire and process data from sensors such as the NEXRAD and TDWR.

These servers then generate and disseminate weather products to the NAS automation systems, such as CTAS TMA and enhanced traffic management system (ETMS). These systems use 3-dimensional wind and temperature forecasts, as well as convective weather data, to project activity and traffic flow and to allow for a more efficient use of airspace. Wind forecasts are used by URET CCLD to facilitate sequencing of air traffic by en route controller teams.

ITWS will be deployed by the end of Step 2. ITWS improves safety by providing a windshear and microburst prediction capability in the terminal area and improves management of runway resources when convective storms and gust fronts are present. Terminal controllers and traffic managers can more efficiently sequence aircraft in and out of terminal airspace by using wind shift predictions.

ITWS provides information on significant weather associated with severe storms and facilitates routing aircraft around hazardous weather by processing data from LLWAS-3, TDWR, airport surveillance radars (ASR-9), and NEXRAD. LLWAS-2 will continue to provide windshear and microburst information at those terminal sites (about 39) without TDWR and ASR-WSP. ITWS will process the six-level weather data from the ASR-9 to remove anomalous propagation and ground clutter. Removal of anomalous propagation and ground clutter from controller displays is essential, as it is often indistinguishable from actual weather. Initially, ITWS data will be displayed to terminal and tower controllers on separate displays. TWIP functionality will be moved to ITWS and enhanced by adding ITWS data to improve the accuracy of available weather information. TWIP will expand to include ASR-WSP sites at the end of this period.

As the en route weather server, WARP processes and displays NEXRAD data for use by ARTCC controllers and meteorologists. WARP creates a regional NEXRAD mosaic that is also provided to the ATCSCC and other facilities. WARP will incorporate NWS higher-resolution forecast data, which will improve forecast accuracy. Another benefit is the capability to provide controllers with time and position data on moving weather systems for traffic planning and flow control.

The new automation systems being deployed by the FAA require the NWS's improved, higher-resolution forecast data. The FAA is working closely with the NWS to develop the FBWTG. The FBWTG (see Figure 26-2) will enable the high-speed transmission of high-resolution, gridded weather forecasts between the NCEP and the NAS. The planned deployment of the first phase of the FBWTG is early in Step 2.

In addition to the current LLWAS and TDWR sensors, a weather system processor (WSP) enhancement for the existing ASR-9 will be deployed, adding a windshear and microburst detection capability. The ASR-WSP processes the six-level weather data and provides windshear and microburst products similar to TDWR.

ASR-WSP supports airports without a TDWR that need improved windshear and microburst detection capability. Like TDWR, ASR-WSP will provide a TWIP capability, thereby extending the area coverage of windshear systems providing data to pilots.

26.1.3 Weather Architecture Evolution—Step 3 (2003–2008)

Early in Step 3, WMSCR will be upgraded to improve capacity and enhance its capabilities. WARP will provide weather data to Multi Center TMA and DA. The major change in Step 3 will be the interface to the NAS-wide information network, which begins late in this step (see Figure 26-3); for more detailed information, see Section 19, NAS Information Architecture and Services for Collaboration and Information Sharing. This network will allow weather systems in the terminal and en route environments to freely share data and products.

At this time, the FAA will make NAS status and existing weather data available to private data link service providers for the development of FIS products. Commercial providers may make basic

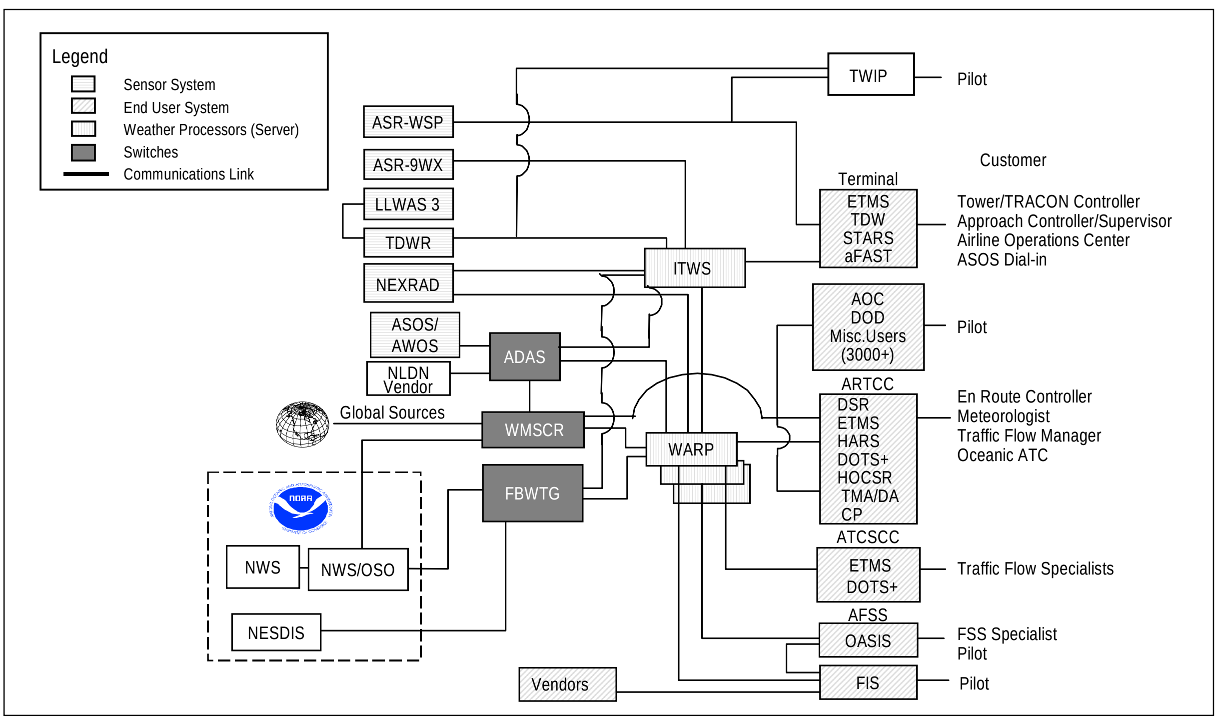

Figure 26-3. Weather Architecture Evolution—Step 3 (2003–2008)

FIS products available, at no cost to the government or the user, and may make "value-added" products available for a fee.

Sensors and Data Sources

NEXRAD will continue evolving to an open systems architecture through the upgrade of the radar data acquisition (RDA) module. The NWS will continue to improve the accuracy of the forecast models used by the FAA. New products, including the predictive locations for hazardous weather, are being introduced into NEXRAD, and improvements in AP removal algorithms continues.

The NWS will continue to upgrade current sensors, thereby enhancing and expanding the capability to automatically provide accurate observations. Lightning detection will be improved to include all forms of lightning, not just the current cloud-to-ground strikes. Aircraft functioning as sensors of weather data will become a key element in improving the accuracy of weather forecast models and will validate new algorithms.

The NAS-wide information service will enable the FBWTG to interface more effectively with the NAS. Weather satellite data will also be available via the FBWTG.

Processing and Display

The ITWS will undergo a technology refresh that incorporates weather satellite data and implements algorithms for vertical windshear, storm growth and decay, icing aloft in the terminal area, in-flight icing, and runway visual range (RVR)/ visibility and ceiling predictions. The goal is to expand ITWS predictive capability beyond 30 minutes (to several hours). The modular design allows ITWS enhancements to be used at more terminals. Some ITWS algorithms could be used at second-level airports running on a local processor or an ITWS variant. ITWS data will be displayed to controllers on the Standard Terminal Automation Replacement System (STARS) workstations in TRACONs and towers as part of the STARS preplanned product improvement (P^3I). ATCSCC traffic managers will receive ITWS data, enabling them to track storm activity at major airports and to facilitate coordination with TRACONs and major hubs.

Weather-in-the-cockpit products transmitted via FIS in this time frame may include improved weather radar information, hazardous weather advisories, observations and forecasts, winds and temperatures aloft, gridded forecast data, and pilot reports (PIREPs). These data are tailored to provide a "high-glance" value display of significant weather along the flight path. Different types of users can still expect varied levels of support; full graphical display of high-resolution data in the cockpit is the ultimate goal.

New algorithms will transition to the NWS for incorporation into their forecast models. A new icing forecast technique is scheduled to be incorporated into AWC's SIGMET and icing forecasts. Additionally, the NAS will receive finer resolution data from the NWS, thereby improving ITWS and CTAS pFAST products.

As the NAS-wide information service is deployed and as new methods of distributing weather data develop, WARP will transition away from its role as an en route weather server within the ARTCC. WARP and ITWS will remain collectors and processors of data, but will require less direct interfaces to user systems with the implementation of the information exchange service. Data will reside on distributed data bases, so it will not always be necessary to directly interface with ITWS or WARP—only with the information exchange network.

26.1.4 Weather Architecture Evolution—Step 4 (2009–2015)

ITWS and WARP will continue to produce new and improved weather products to support other NAS systems (see Figure 26-4). As the demand for products continues to grow and become more complex, these systems will evolve. In addition, the WARP hardware will be replaced and new algorithms will be added, increasing its capabilities. As the NAS-wide information service matures, it will incorporate the WMSCR functionality.

Weather-in-the-cockpit will be improved as new products are able to be transmitted via the FIS data link. These products include freezing level, wake turbulence, ceiling/visibility, and volcanic ash cloud forecasts. The addition of the gridded products from ITWS and WARP will require higher bandwidth data link and advanced avionics

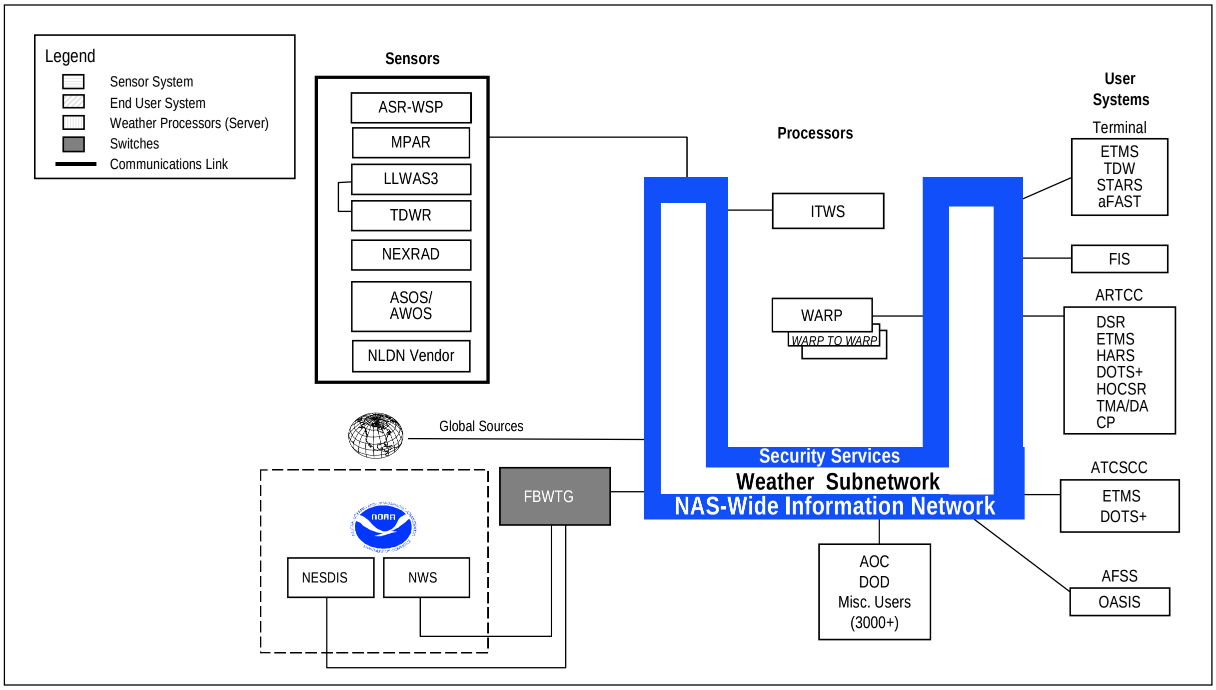

Figure 26-4. Weather Architecture Evolution—Step 4 (2009–2015)

to fully exploit the available information. The flight plan will become a flight object, and the system will automatically inform the pilot via FIS of any significant or hazardous weather. FIS data link and avionics will be more capable and cost-effective during this time frame.

The FAA will continue to use the AWR Program and leverage its affiliation with research agencies to improve the safety and capacity of the NAS by improving algorithms within existing systems. Results from the FAA's wake vortex research program will be implemented, thereby increasing the understanding of vortex behavior, leading to possible reduction of separation standards (see Section 10, Research, Engineering, and Development). Additionally, these algorithms will be ported to processors/systems at airports where it is cost-effective.

Sensors and Data Sources

The next generation of airport surveillance radar will detect both aircraft and windshear events. A multipurpose airport radar (MPAR) will be deployed late in Step 4 that will replace ASR-9s and -11s, LLWASs, and TDWRs. MPAR provides improved maintainability and reliability while reducing spectrum demand and environmental impacts. (see Section 16, Surveillance).

Processing and Display

The NAS-wide information service enables more efficient data searches and queries for all NAS users for any type of data to improve the collaborative decisionmaking process. This information exchange network allows all NAS users to be updated simultaneously, in near real-time when hazardous weather occurs and ensures that all weather products are maintained in a common data base. FIS capability will be improved to transmit enhanced data to the cockpit for display of significant weather. ITWS will receive a technology refresh, allowing it to support multiple terminal sensor configurations.

In the cockpit, the pilots see the same data as other NAS users and can query the weather data base to obtain additional information.

26.2 Summary of Capabilities

The NAS weather architecture will undergo evolutionary changes over the next 5 to 10 years, enhancing its capability to collect numerous types of weather data from internal as well as external sources, then process and disseminate tailored weather products to both NAS users and providers. Figure 26-5 depicts these enhanced capabilities chronologically. In 1997, the first stage of WARP was implemented nationally. CWSU me-

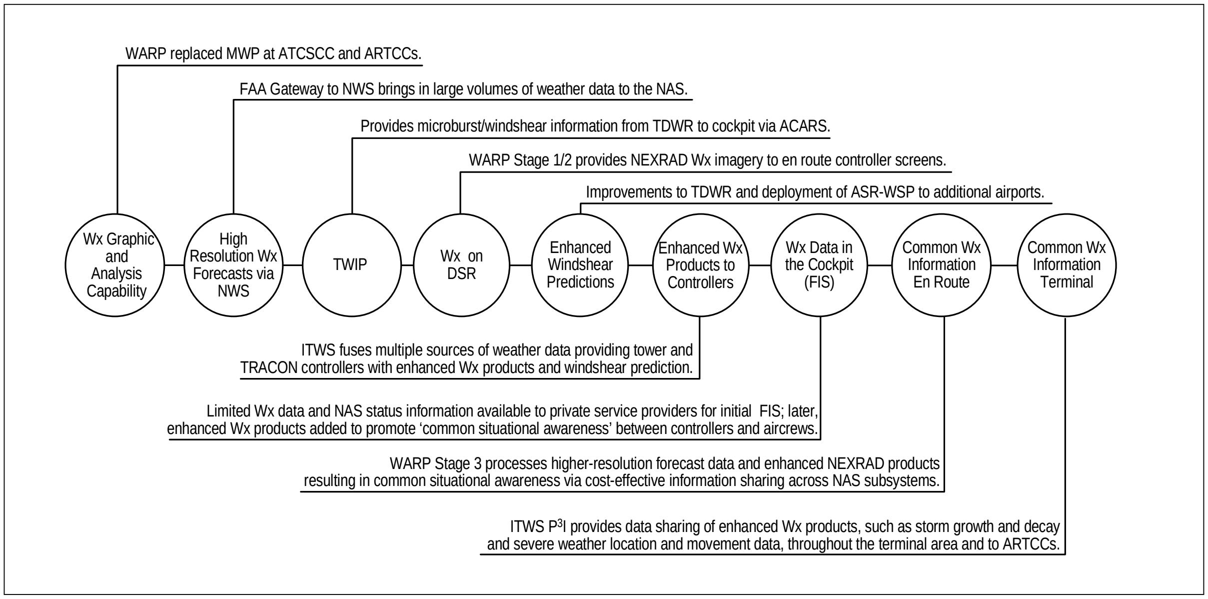

Figure 26-5. Aviation Weather Capabilities Summary

teorologists now have upgraded graphical display and analytical capabilities and can provide better weather support to controllers and traffic flow managers in the ATCSCC and the ARTCCs.

Almost immediately, the NAS will receive high-resolution forecasts of weather data from the NWS. Implementing the high-speed communications link (i.e., FBWTG) between the NWS and the FAA will provide high-definition, high-quality, gridded weather products to the NAS. These high-resolution data sets contain more accurate forecasts of weather information, such as winds and temperature and of aviation-impact variables such as in-flight icing. This enables controllers and traffic managers to plan for aviation-impacting weather.

TWIP currently provides microburst and windshear information from TDWR to commercial aircraft cockpits via ACARS. With the addition of ASR-WSP sites, TWIP coverage will be expanded.

As part of the FAA's FIS policy, the FAA will provide NAS status and existing weather data (including some WARP and ITWS products) to a commercial service provider for data link to the cockpit.

About the same time, en route controllers will see weather from NEXRAD overlaid on their displays as WARP Stages 1 and 2 interface with the DSR. This will help controllers assist aircrews in avoiding hazardous weather. It also eliminates the need for weather data from long-range radar, which allows selected sites to be decommissioned. Traffic managers will use weather information from their WARP briefing terminals for contingency planning. In support of FFP1 CCLD, WARP accelerates Stage 3 interfaces to prototype URET CCLD, ETMS, and CTAS TMA/pFAST sites to provide higher-resolution wind and temperature data.

Early in the modernization process, NEXRAD will be completely converted to an open system architecture, increasing its product generation and dissemination capabilities to fully exploit the radar data. ITWS and WARP will receive improved radar products.

ITWS deployment will be completed shortly thereafter, vastly improving the FAA's ability to monitor atmospheric phenomena in the terminal domain. ITWS provides accurate forecasts of wind shifts associated with frontal passage, thereby mitigating their effect on capacity. ITWS also enhances safety with its windshear prediction capability.

WARP will be connected to other users, completing Stage 3 implementation. This permits tailored products to be shared by NAS users and service providers. Additional algorithms will enhance

NWS forecast data and improve NEXRAD radar products.

ITWS will incorporate new algorithms, enhancing its capability to forecast events such as storm growth and decay, ceiling and visibility, RVR, runway winds, and turbulence.

26.3 Human Factors

The primary focus of human factors related to aviation weather is the efficient and effective presentation of weather products to the meteorologist, dispatcher, controller, and pilot. Of key importance will be determining the informational requirements at various locations and recognizing the possibility that these needs may be different for different classes of aircraft and different service provider locations. To assist aircraft most effectively, controllers will need to know the precise location of an aircraft and which weather products are available to the pilots.

Future systems will move away from separate controls and displays for individual subsystems, therefore, human factors efforts must focus on developing integrated displays and controls, in which weather products are one element of a larger presentation. Human factors will be a major factor in designing integrated workstations. The information needed by controllers must be presented in a timely manner so that workload is maintained within acceptable limits.

Lastly, as the FAA moves toward Free Flight, more information will be needed by the pilot and the controller, particularly for GA aircraft operations. Appropriate training will need to be developed to ensure that pilots and service providers can effectively use the weather information that is presented.

26.4 Transition

The transition schedule for the major components of the aviation weather system is shown in Figure 26-6. The principal transitions include:

- FBWTG Phase 1 deployed
- WARP Stages 1 and 2 deployed (NEXRAD on DSR)
- NEXRAD open system upgrade to RPG
- ITWS deployed
- ASR-WSP deployed
- NEXRAD open system upgrade to RDA
- Satellite data via FBWTG Phase 2
- ITWS products on STARS displays

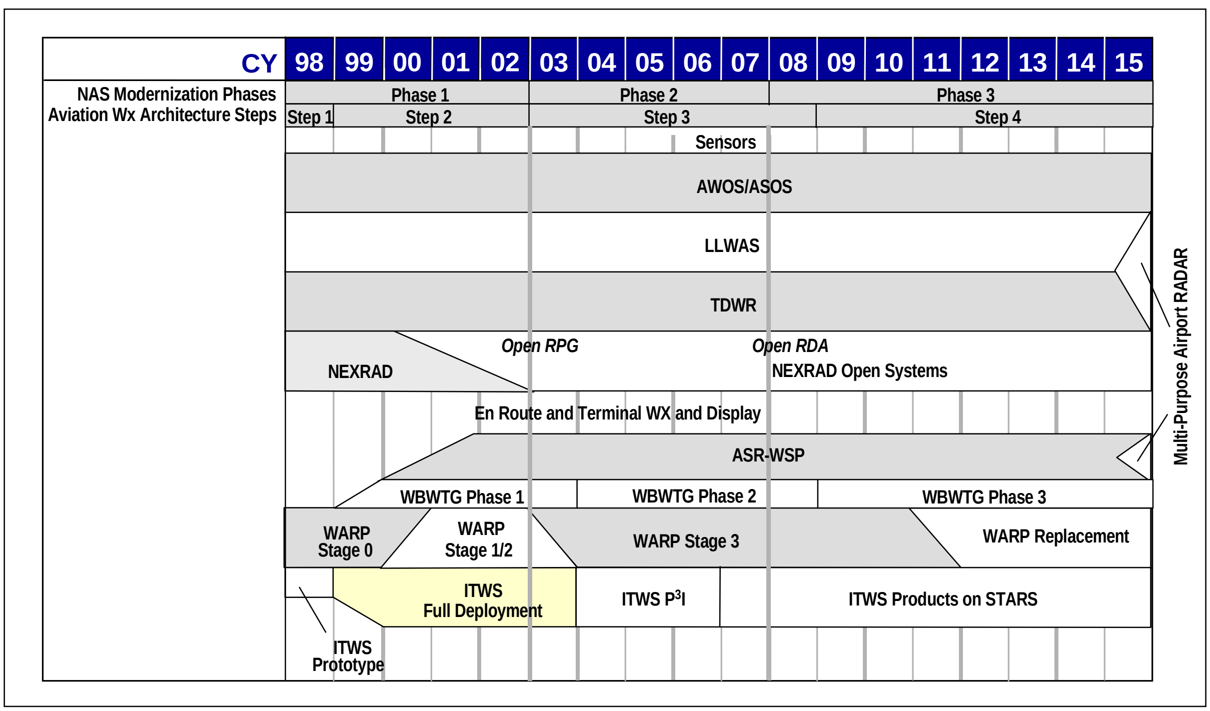

Figure 26-6. Weather Systems Transition

- FBWTG Phase 3 upgrades for NAS-wide information service compatibility
- Consolidated terminal and weather radar deployed (MPAR) (see Section 16, Surveillance).

26.5 Costs

The FAA estimates for research, engineering, and development (R,E&D); facilities and equipment (F&E); and operations (OPS) life-cycle costs for aviation weather architecture from 1998 through 2015 are presented in constant FY98 dollars in Figure 26-7.

26.6 Watch Items

Several items are critical to the aviation weather architecture. These include adequate radio frequency spectrum for ASOS and AWOS, tri-agency funding for NEXRAD upgrades, and implementation of private service provider FIS.

- Without adequate radio frequency spectrum for ASOS and AWOS, pilots cannot receive surface weather observations for new ASOS and AWOS locations.
- Tri-agency (FAA, DOD, and NWS) ability to fund and implement NEXRAD system upgrades in a timely manner, enabling WARP, ITWS, and OASIS to receive FAA-specific products.
- FIS implementation dependent upon available frequency spectrum and commercial service provider participation.

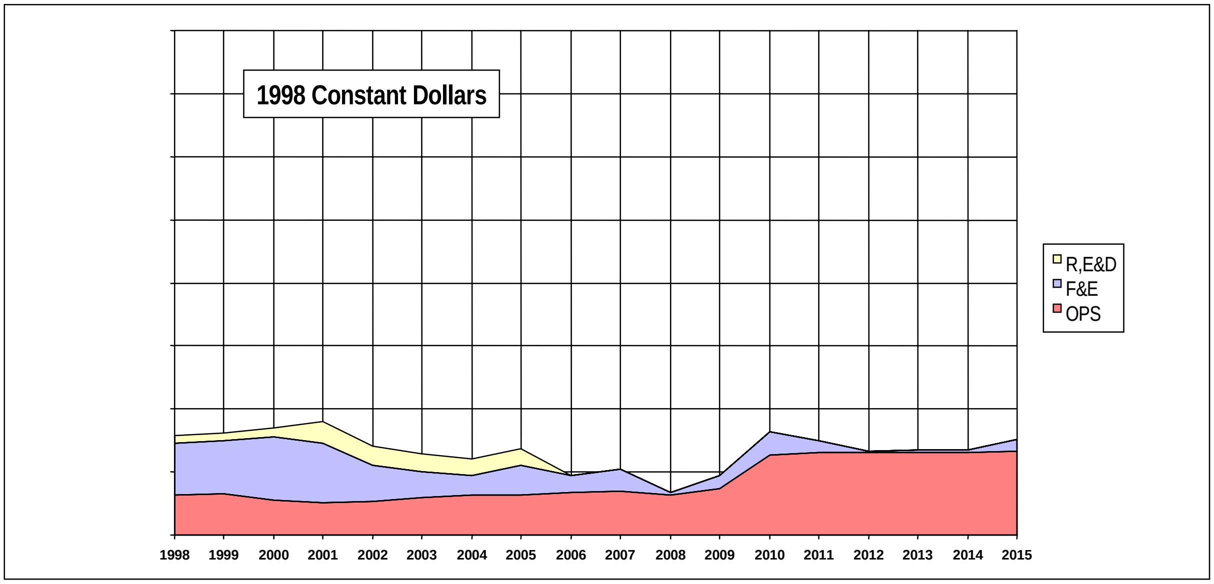

Figure 26-7. Estimated Weather Systems Costs

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