1.3 THE ROLE OF ITWS IN THE NATIONAL AIRSPACE SYSTEM MODERNIZATION: AN UPDATE

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1. INTRODUCTION

Weather continues to have a major effect on the safety and capacity of the National Airspace System (NAS). According to the National Research Council report (1995) on Aviation Weather Services, from 1988 to 1992, one-fourth of all aircraft accidents and one-third of fatal accidents were weather related. The Federal Aviation Administration (FAA) Aviation 2000 Capacity Enhancement (ACE) Plan reveals that from 1996 to 2000 adverse weather accounted for 71 percent of system delays of greater than 15 minutes, and according to the 2001 ACE Plan was still a major factor affecting NAS capacity, accounting for 67% of 2001 delays (January – September).

2. NAS MODERNIZATION

One of the main goals of the NAS modernization is to improve the efficiency of the NAS, thereby increasing its capacity. Accomplishing this requires increasing the capability of Traffic Flow Management (TFM), which is responsible for the strategic planning and management of air traffic to ensure the smooth and efficient flow through FAA-controlled airspace. Traffic management coordinators at all levels of air traffic control (i.e., Tower, Terminal Radar Approach Control (TRACON), Air Route Traffic Control Center (ARTCC), and Air Traffic Control System Command Center (ATCSCC)) use a combination of automation systems and procedures known collectively as TFM Decision Support Systems. Although strategic in nature, TFM must be able to react tactically to a weather-related disruption at a major terminal, which without adequate monitoring and timely action could cause a cascading effect resulting in numerous delays across the system.

Further exacerbating the impact of weather—NAS traffic is expected to increase. The 2001 ACE Plan projects that aircraft operations will increase by 26 percent by 2012. Increasing the efficiency of the NAS requires providing new and improved services to users. As the NAS is currently near capacity, it is imperative that the adverse impact of weather be mitigated if the modernization goal of increasing NAS capacity is to be realized. The Integrated Terminal Weather System (ITWS) will play a crucial role in realizing this capability. In fact, ITWS is a key element of the NAS weather architecture directly related to achieving demand/capacity related goals stated in FAA's Operational Evolution Plan such as increasing airport arrival/departure rates during adverse weather.

ITWS will increase capacity by providing improved services relative to weather information enabling:

- Reduction of weather-related delays both on-the-ground and in-the-air
- Increased capability of the NAS to respond to hazardous weather
- Increased user access to critical NAS weather information improving common situational awareness and the collaborative decision-making process

To contribute to these goals, weather systems and their displays must be integrated throughout the NAS. A significant aspect of this integration is the creation of new products tailored to terminal users, traffic managers, Airline Operations Centers (AOC), and automation systems.

Convective weather in/around the airport terminal area is a major cause of flight delays and a significant causal factor in aircraft accidents. To improve NAS safety, the FAA has implemented numerous terminal systems to warn of wind shear and convective weather at the nation's larger airports. In the aggregate, these weather systems, Terminal Doppler Weather Radar (TDWR), the weather channel of the Airport Surveillance Radar (ASR-9), and the Low Level Wind Shear Alert System (LLWAS), will significantly improve airport terminal safety, but contribute little to reducing weather-induced delays. ITWS provides that functionality by integrating data from these and other sensors, creating a suite of user-friendly (no meteorological interpretation required), tailored, accurate weather products for terminal air traffic personnel as well as automation systems, not otherwise available from an individual sensor.

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3. DESCRIPTION OF ITWS

The ITWS is an aviation safety and air traffic management decision support system that acquires data from various FAA and NWS sensors and sources, as well as airline sensors. It subsequently generates a number of tailored weather products for dissemination to FAA personnel managing air traffic. Beyond the terminal domain, ITWS will also provide aviation weather information to the transitional en route areas further improving the safety and capacity of air traffic operations.

The ITWS also furnishes weather information to terminal automation systems (e.g., passive Final Approach and Spacing Tool (pFAST)) used by air traffic specialists to improve the merging and sequencing aircraft for accurate spacing on final approach. ITWS will decrease controller workload and increase aircraft safety by transmitting tailored, timely information to pilots directly, first by Terminal Weather Information for Pilots (TWIP) and later via datalink. ITWS will also reduce delays by providing information to FAA supervisors and traffic managers so that they can work more actively to achieve an efficient and orderly flow of traffic during adverse weather.

At many larger airports, planes arrive and depart through transition areas (i.e., 'gates'). A thunderstorm at a gate can significantly disrupt terminal traffic flow even though there are no storms directly over the airport. Consequently, movement of significant storms must be anticipated out to the edges of the terminal area so a safe and orderly traffic flow can be maintained. An ITWS situational display (SD) will be in the ARTCC to provide ITWS information to en route traffic managers. As a result, they'll be aware of terminal or transition area problems and can react in a timely manner to effect a smooth transition between en route and terminal airspace.

ITWS integrates data from various sensors and weather information systems. These include Rapid Update Cycle (RUC II) gridded forecast model data from the National Weather Service (NWS), aircraft observations of wind and temperature from the Meteorological Data Collection and Reporting System (MDCRS), lightning data, as well as WSR-88D (or NEXRAD), TDWR, LLWAS, Automated Surface Observing System (ASOS), Automated Weather Observing System (AWOS), and the ASR-9 weather data. Figure 1 shows the major data sources for ITWS and some principal users of the system.

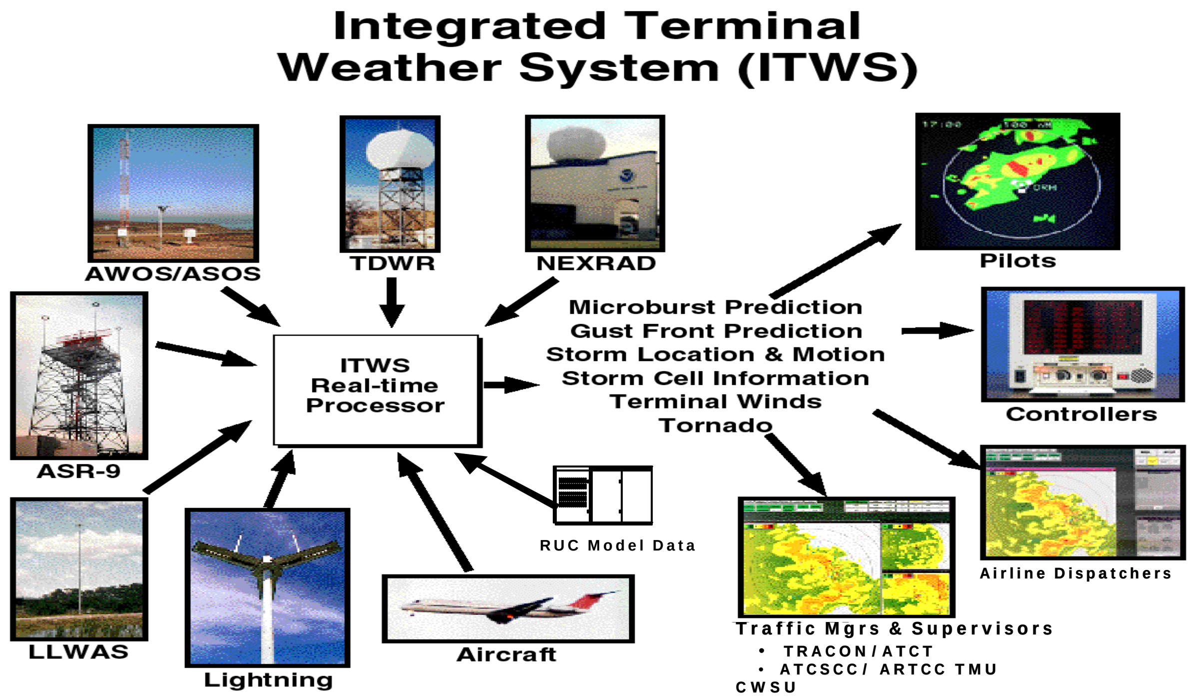

Figure 1. ITWS Architecture

3.1. ITWS PRODUCTS

ITWS contains a robust suite of products/algorithms, which provide a two - three minute predictive warning of a microburst event (before TDWR alert), and gust front detection/prediction. It also provides point location of tornadoes, storm cells, hailstorms, and storm motion and extrapolated position. Table 1 lists the ITWS production products. The primary product not baselined for the production ITWS is the Terminal Convective Weather Forecast (TCWF).

Table 1: ITWS Production Products

Wind Shear Products	Storm Products	General
Microburst detection/prediction	Precipitation products	Tornado detection/alert
Gust front detection/forecast	Storm motion	Airport lightning warning
Wind shift estimate	Storm Extrapolated position	LLWAS winds
Ribbon display Alerts & Microburst Alerts for ATIS	Storm cell information (mesocyclone, hail, echo tops and lightning)	Terminal winds (3-D gridded & wind profiles)
Gust Front Impact Timer for ATIS	Precip with AP flagged & AP Alert	Pilot text/character graphics message
		Airport Lightning warning

All ITWS events are depicted for the TRACON area, 10 nm, 30 nm, and 200 nm ranges. Displayable ITWS products include microbursts and wind shear events. An ITWS window expanded out to 200 nm shows weather at the terminal area transition gates, as many delays result from thunderstorms requiring aircraft to be routed to another gate. Improved knowledge of thunderstorms and their motion near the gates will decrease the time it takes to reroute the aircraft and thereby reduce delays.

4. ITWS AND NAS MODERNIZATION

Functioning as a "weather server" for 47 of the nation's busiest airports, ITWS vastly improves the FAA's ability to monitor and predict aviation-impacting weather in the terminal area. ITWS provides tower and TRACON personnel, as well as terminal automation systems, with enhanced weather data and products. Terminal controllers and traffic managers can more efficiently sequence aircraft in and out of terminal airspace using wind shift or gust front predictions. Furthermore, ITWS SDs located in the ARTCCs and ATCSCC will facilitate coordination between terminal, en route, and command center traffic managers, thereby improving traffic flow management throughout the NAS. Accurate forecasts of wind shifts depicting frontal passage across runways will assist traffic managers and controllers in optimizing runway usage to mitigate weather-related delays in sequencing approaching/departing aircraft.

ITWS will also process weather data from the ASR-9 to remove anomalous propagation and ground clutter. This will be of major significance in assisting terminal and TRACON controllers routing aircraft around hazardous weather. TWIP functionally will be enhanced through the addition of ITWS products. TWIP currently provides airline pilots with a coarse graphical depiction of hazardous weather from TDWR sites such as microburst and wind shear events. ITWS will subsume the TWIP function and also provide enhanced products. The goal is to expand the ITWS predictive capability from 30 minutes out to two hours, which will significantly enhance cross-country traffic flow.

Massachusetts Institute of Technology's Lincoln Laboratory (MIT/LL) currently operates four ITWS prototypes: three for the FAA at Orlando, FL, Memphis, TM and Dallas/Fort Worth TX, and one for the New York Port Authority. ITWS has provided significant reduction in delay. The New York ITWS demonstration system with TCWF has reduced delays by 49,000 hours (equivalent to $150M) annually.

At this time MIT/LL is testing new algorithms on these prototypes that will not be available on the production ITWS. The TCWF will not be available on the production ITWS until the preplanned product improvements (P^3I) are added in the 2004-2006 timeframe (based on current budget estimates).

The ITWS capabilities described in this paper are referring to those of the production systems. The first article ITWS at Kansas City and Houston underwent independent operation test and evaluation in 2001 and was highly praised by all users. As a result, the FAA is ready to field the production systems. The ITWS deployment will begin at Atlanta in May 2002 and be completed with the installation at Orlando, FL in 2004. The FAA is evaluating the priority of interfaces between ITWS and other ATC systems, as well as the NEXRAD open system. Given the austere budget environment the FAA faces the next couple of years, delays/reductions in ITWS can be expected.

The FAA has completed its assessment of the ITWS communication architecture to ensure data is available to all ITWS users. The FAA and the Volpe Center will make production ITWS data available via the Volpe Center's Collaborative Decision Making Network (CDMnet) as each ITWS is deployed. The CDMnet will contain both the ITWS raw data structure and the Product Generator (PG) data as requested by users. Potential users include, but are not limited to the following: airlines, NWS, ATCSCC, Automated Flight Service Stations, Airport/Port authorities, DoD, Police Departments, other Federal agencies (i.e., Agriculture, FEMA, etc.), and FAA satellite air traffic control towers.

5. RECOMMENDED P^3I ENHANCEMENTS

The FAA's highest priority P^3I items are the TCWF and the dry microburst detection and prediction algorithm. The TCWF benefits are estimated to be $350 million per year. Table 2 lists the next highest priority P^3I items.

A major goal of the FAA is to provide capability and user benefits as soon as possible. The production ITWS products were baselined in 1995. In the intervening years, additional ITWS enhancements have been proposed based on new users needs, as well as 'lessons learned' in the real time operation of the ITWS prototypes by MIT/LL. Also, significant improvements in

Table 2: FAA High Priority ITWS P^3I Items
NEXRAD Vertical Integrated Liquid (VIL) product for Large TRACON Mosaic
MIT/LL Radar Growth and Decay Algorithm
MIT/LL Sensor data Quality Algorithms for ASR-9 errors and TDWR radome attenuation
Lightning Data Display
Base Data Port
Terminal Winds Forecast Improvement (vertical interpolation of winds) & Graphic Display
Machine Intelligent Gust Front Algorithm (MIGFA)

weather product generation technology have emerged since the baselining. These improvements, if added to the production ITWS, would significantly delay deployment, preventing immediate safety and user benefits being realized. The FAA has chosen to deploy with 1995 baseline to reduce time to achieving the ITWS associated improvements in capacity and safety.

The FAA will continue to evaluate any necessary changes to the P^3I priority based on user benefits, cost and development efforts, maturity, operations acceptance risk, and implementation risk. The final list will be implemented based on available funding. In fact, the P^3I money for the past several years has been significantly reduced.

6. Medium Intensity Airport Weather System (MIAWS) and Corridor Integrated Weather System (CIWS)

The FAA is evaluating the MIAWS, which is similar to ITWS in that it uses ITWS-like algorithms appropriate for the sensors at these airports. The MIAWS provides a real time display of storm positions and motion based on NEXRAD product data. Warnings of heavy precipitation impacts on runways and final approach/departure paths are provided for controllers to read to affected pilots. A graphical situation display assists in traffic flow management in the terminal area. A MIAWS demonstration system was evaluated at Jackson, MS in 2000. As a result, the FAA will deploy MIAWS demonstration systems at Little Rock, AR and Springfield, IL in 2002, as well as commencing full-scale development at over 35 additional airports

Often passengers at airports with perfect weather have had their aircraft put on a "ground hold" due to weather in another part of the country. One reason for this happening is when a major airport is affected by hazardous weather, the number of aircraft that can land in an hour is reduced. This in turns forces controllers to slow down inbound aircraft, which then affects congested corridors and leads to ground holds at departing airports. To help alleviate the affect of hazardous weather on congested corridors (and thereby further reduce delays), the FAA demonstrated in the summer of 2001, that CIWS, like ITWS, fuses multiple types of data and produces user-friendly products for en route and TRACON air traffic personnel.

7. SUMMARY

To provide existing services more efficiently, weather systems and their displays must be integrated throughout the NAS to improve common situational awareness and collaborative decision-making. When fully implemented, ITWS will vastly improve the ability of controllers and traffic managers to monitor atmospheric phenomena in the terminal domain and take proactive, vice reactive, measures to mitigate the effects of aviation-impacting weather. More importantly, ITWS will significantly enhance the ability of TFM personnel (and supporting automation sys tems) to achieve an efficient and orderly flow of NAS-wide traffic during adverse weather, thereby enhancing safety and improving capacity throughout the NAS.

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