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A CONCEPT OF OPERATIONS FOR AN INTEGRATED WEATHER FORECAST PROCESS TO SUPPORT THE NATIONAL AIRSPACE SYSTEM

Kevin Johnston and Judson Ladd
National Oceanic and Atmospheric Administration/National Weather Service

1. INTRODUCTION

By applying the art and science of meteorology, National Weather Service (NWS) personnel provide weather decision assistance to enhance the Federal Aviation Administration's (FAA) extraordinary responsibility of managing a safe and efficient National Airspace System (NAS). Accurate weather predictions enable NAS decision makers to efficiently plan (a strategic function) and direct (a tactical function) traffic flow, especially in and around major "hub" airports. For the NWS to deliver accurate predictions, their services must be efficiently organized, processing and communication systems must be state-of-the-art, and personnel must be highly trained.

A 2003 joint FAA and NWS functional audit of Center Weather Service Units (CWSUs) and a subsequent FAA derived audit assessment identified each of these as areas of needed improvement. In response, NWS leadership established a "Tiger Team" in October 2003 to develop a Concept of Operations (CONOPS) for enhancing CWSU weather services. While primary attention was given to developing a concept aimed at improving the operations of the CWSUs in each of the Air Route Traffic Control Centers (ARTCCs), such improvements must be considered in concert with the important service role other NWS organizational functions play in supporting the overall FAA mission.

Subsequently, the Tiger Team developed a CONOPS titled "Integrated Weather Forecast Process to Support the National Airspace System" which integrates all NWS aviation services into a coherent system that supports all phases of flight operations. This potential CONOPS is currently under review by the NWS and FAA. The intent of this CONOPS, of which an overview is provided in this paper, is to describe a framework for an improved, standardized, and relevant CWSU operation in support of the NAS. The CONOPS serves as a guide for follow-on efforts to establish staffing requirements, specific procedures and directives, as well as determining required changes to appropriate planning, requirements, and training documents. In fact, on-going at the time of this manuscript, a follow-on Tiger Team involving NWS and FAA personnel is working specific solutions using this proposed CONOPS as a guide.

*Corresponding author address: Kevin Johnston, 1325 East-West Highway, Room 13314, Silver Spring, MD 20910-3283; e-mail: kevin.l.johnston@noaa.gov

2. FACTORS DRIVING THE DESIGN OF THE CONOPS

In an effort to improve the overall effectiveness of CWSU operations, program management was re-assigned to the FAA Manager of Air Traffic Tactical (ATT-1) in late 2002. The following year, ATT-1 joined the NWS in completing a functional audit of CWSU operations. Based on information from seven CWSUs, the audit team identified several significant program issues:

Confusion regarding the mission of the CWSU and who its customers are

Limited hours of operation

Non-standardization of products and services

Limited product utility

Lack of system capability and standardization

Lack of communication with auxiliary facilities

Lack of collaboration with other CWSUs and Weather Forecast Offices (WFOs)

Limited funding for training of CWSU meteorologists

Problems with management and oversight

Limited resources to support the program

3. THE INTEGRATED FORECAST PROCESS

ATT-1 in an initial effort aimed at addressing the issues, formulated a new mission statement for the CWSUs

> *"To be cognizant of hazardous weather information covering all phases of flight, participate in strategic planning, and support the transition to tactical operations. The mission is defined by the needs of the national system of traffic management that meet objectives of safety, efficiency, and security."*

This mission statement formed the basis under which the NWS Tiger Team developed their CONOPS.

3.1 *Operations*

Fundamental to the CONOPS is the integration of operational expertise, services and division of labor among NWS offices at national (Aviation Weather Center), regional (CWSU), and local (Weather Forecast Office) scales. This integration is critical to support the new mission calling for cognizance of hazardous weather information during all phases of flight (climb out, en route, and descent).

In addition, the CONOPS calls for new, relevant, and standard products (from one ARTCC to another) to support NAS strategic planning and tactical decision-making. The objective is to ensure safe and efficient flow of aircraft that does not exceed the capacity of the nation's airways and airports. These capacity limits are impacted by certain critical thresholds of weather occurrence which need to be factored into the overall management process. The NWS end-to-end integrated forecast process needs to focus on these criteria to be successful and to have a positive impact on traffic flow management. In addition, the FAA needs high resolution forecasts for the descent and climb-out phases of flight as this is a critical, weather sensitive domain for the transitioning of high-speed air traffic to lower speeds upon descent, and vice-verse for outbound climbing traffic. As an example, inbound or arriving traffic into a TRACON for arrival to a "hub" such as Atlanta International Airport is sequenced through arrival posts positioned roughly 50-70 miles from the airport. These posts are fixed and, in addition to the actual airport terminal, have there own unique weather limitations impacting capacity.

The CONOPS proposes that the CWSU provide a new TRACON area forecast of convection, turbulence, and icing for each of the arrival corner posts and departure corridors. These forecasts will be updated hourly and valid for a 0-8 hour period. More importantly, new standard Tactical Decision Aids (TDAs) *based on known air traffic capacity rules* will be generated from the integration of these forecasts. These TDAs will graphically depict context-relevant weather impact employing a simple color-code scheme (Figure 1).

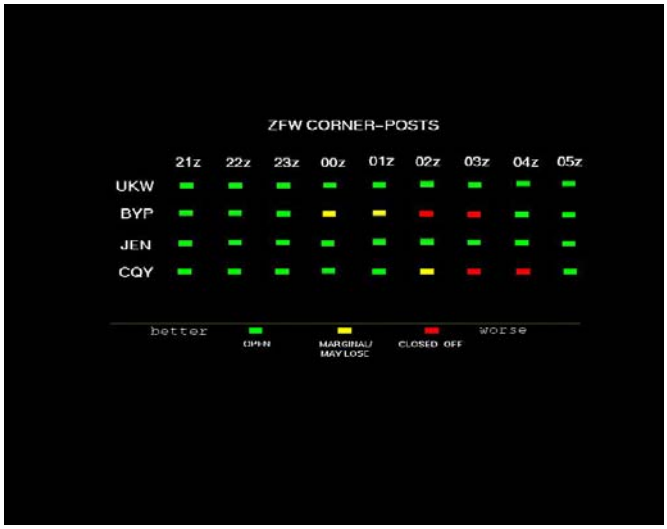

Figure 1. Example of Tactical Decision Aid: TRACON Corner-post forecast.

The integrated forecast process CONOPS for the NAS takes advantage of existing AWC and WFO capabilities. AWC provided area forecasts of convection, turbulence, icing, and low ceilings and visibilities, will support the generation of new standardized TDAs for airway routes traversing the ARTCC airspace, color-coded according to the degree of impact (Figure 2).

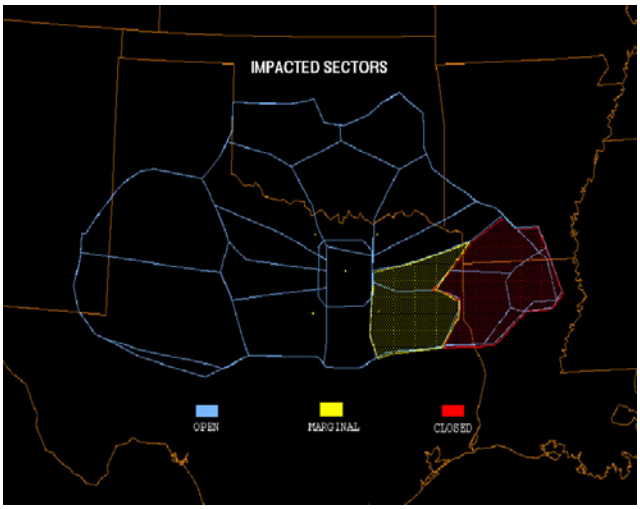

Figure 2. Example of Tactical Decision Aid: Area Forecasts impacting ARTCC Sectors.

Similarly, drawing off of existing WFO capabilities and Terminal Aerodrome Forecasts (TAFs), new TDAs will be generated for specific hub or pacing airport runways. As with other TDAs, these terminal-based aids will allow the TRACON and Air Traffic Control Towers (ATCTs) quick access to information needed to manage capacity and flow sequencing. It is envisioned that the terminal-based TDAs will require frequent issuances (perhaps hourly) and updates every 15 to 30 minutes, depending upon air traffic demands in and around the hub airport. This requires that the TAFs be more timely and accurate to support these TDA temporal resolutions. (See Figures 3 and 4 below).

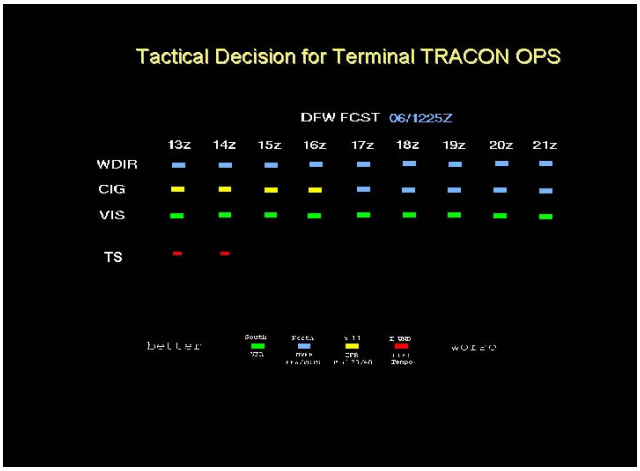

Figure 3. Example of Tactical Decision Aid: Terminal Forecast

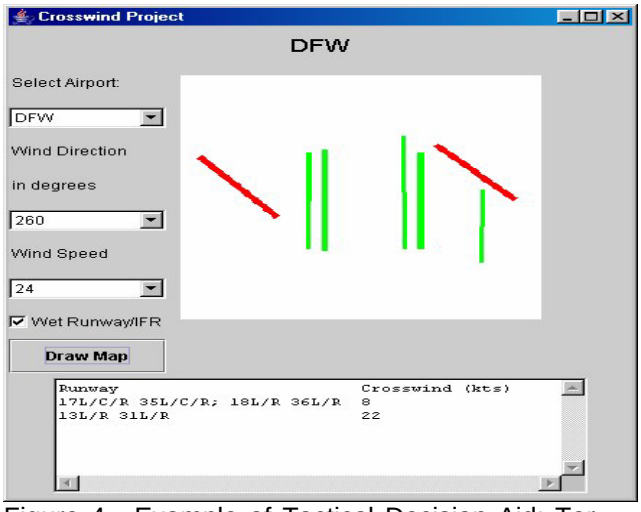

Figure 4. Example of Tactical Decision Aid: Terminal Cross-Winds Exceeding Threshold for Runway

Again, these TDAs will be based on FAA-defined air traffic capacity rules for specific weather elements for both airways and terminals. ***This will enable traffic managers, controllers, dispatchers and other NAS decision-makers to coordinate and develop daily playbook operations for the safe and efficient flow of aircraft based on weather impacts.*** By way of these initial steps, the NWS has begun addressing FAA concerns over non-standardization of products and services, and limited product utility.

It should be noted that these types of TDAs are currently being demonstrated in the Prototype Aviation Collaborative Effort (PACE) at the Fort Worth ARTCC. Traffic management supervisors have responded very positively to the green, yellow, and red coding scheme depicting the increasing degree of weather impacts.

Fundamental to the integrated forecast process is the ability for the CWSU to collaborate with the AWC and applicable WFOs. By collaborating on weather thresholds critical to en route and terminal operations, improved weather services will be generated at the AWC and the WFO.

3.2 *Infrastructure support*

ATT-1 identified three primary contributors to program ineffectiveness of CWSU operations: limited resources to support the program, problems with management and oversight, and limited funding and opportunities for training. In the development of the CONOPS, these contributors were examined in detail.

3.2.1 *Meteorological Workstations*

Currently, the AWC, CWSUs, and WFOs, all have aviation forecast responsibilities, yet utilize different operational workstations and data streams; N-AWIPS (National-Advanced Weather Interactive Processing System) at the AWC, Weather and Radar Processor (WARP) at the CWSUs, and AWIPS at the WFOs. The CONOPS proposed design and implementation of standard NWS meteorological workstations at the CWSUs that include collaborative capabilities and the ability to share a common database. Visual collaboration software will permit real-time, interactive collaboration among the AWC, WFOs, and CWSUs. Standard systems will overcome many of the shortfalls identified in the ATT-1 assessment. As the aviation forecast problem becomes more resolute in spatial and temporal scale, natural bridges of collaboration will develop between the offices based on weather thresholds critical to en route and terminal operations. The standard system also will promote enhanced communications with FAA air traffic customers (TRACONS, ATCTs, and AFSSs), providing them with on-demand dissemination of graphical forecast products and TDAs for all phases of flight through the NAS. In the near future, the standard meteorological workstations will enable CWSUs to migrate into the digital data age, where collaboration with other NWS offices will be crucial to the successful implementation of aviation elements into National Digital Forecast Database (NDFD).

3.2.2. *Manpower Resources*.

The CONOPS-proposed manpower resources required for CWSU operations were based on the following assumptions: Operations 24 hours a day, seven days a week; one ARTCC and one TRACON, with a forecast area (airspace) the approximate size of a current CWSU's forecast area; weather briefings to remote customers, such as multiple AFSS' and TRACONS, can be accomplished through teleconferencing and/or video conferencing; First generation new products produced by the CWSU will not be automated.

The tasks and associated hours required to conduct CWSU operations, considering the above-mentioned assumptions, will minimally require five meteorologists and one Meteorologist-In-Charge (MIC) at each office (a "five-plus-one" staffing profile). Considering increased training and outreach requirements to overcome the ATT-1 assessment deficiencies, the CONOPS proposed a need for the addition of a science and technology person to the staff. This CONOPS can be applied to any operational configuration – expanded (smaller airspace responsibility and fewer TRACONs to support), consolidated (larger airspace responsibility and more TRACONs to support), or existing operations. A commensurate workload analysis would need to be completed to determine the appropriate level or amount of resources for each configuration. The CONOPS proposed the current WFO staffing model as a guide in determining the extent of additional resources needed. In general, for every eight operational meteorologists and MIC, a science and information technology meteorologist and aviation outreach meteorologist should be added to the CWSU staff.

3.2.3. *Budget*:

The CONOPS proposed a cooperative funding arrangement be established between the FAA and NWS to appropriately manage, maintain and operate the CWSUs. This is important considering the need for a standard NWS system to support forecast operations. A budget for operations and management support would directly address several of the identified deficiencies noted in the ATT-1 assessment: an outreach budget for CWSU meteorologists to establish and maintain essential working relationships with the local TRACON, airport tower and Automated Flight Service Station (AFSS) personnel; training to allow CWSU meteorologists to participate in workshops, seminars and conferences aimed at keeping them up-to-date on the latest scientific methodologies; systems support and software/supplies monies will enable CWSU meteorologists to acquire and maintain the technology necessary to keep the program on the cutting edge.

3.2.4 *Management and Oversight*

The CONOPS recommends that the NWS consider shifting management and oversight responsibilities to the Regional Headquarters. Such an arrangement is logical in that ARTCC airspace responsibility spans several (as many as 10) WFO County Warning Forecast Areas, and affords a broader perspective of and quicker response to programmatic matters (e.g. radar issues, equipment problems, etc.). Further, this management configuration better emulates the FAA's recent move toward more "regionalized" management and oversight of the air traffic function.

3.2.5 *Training*

The CONOPS acknowledges that there exists a significant requirement for meteorologists in the CWSUs to be able to understand the needs of the customer, communicate the weather conditions in terms of impacts to air traffic operations, and thus contribute effectively to the operational decision-making process. The CONOPS recommends the FAA establish a comprehensive training course that builds knowledge in air traffic control terminology, air traffic customers, ARTCC airspace navigational aids and identifiers, and Systems (e.g., WARP, Integrated Terminal Weather System [ITWS], etc.).

Similarly, the CONOPs proposed steps for NWS to address training needs of aviation meteorologists, in general, and CWSU meteorologists, in particular. One proposal was to install a Weather Event Simulator (WES) in each CWSU, and to develop aviation-related training scenarios for the simulators, to include collaborative scenarios. Another longer term proposal was for a residence simulator (similar to an aircraft simulator) that can add a high degree of realism and train employees on the skills (both "hard" and "soft") necessary to be proficient in the job functions they perform to include: scientific methodologies and techniques; system knobology; collaboration and coordination; workload management, including delegation, prioritization, and information sharing; and service backup.

3.2.6. *Test-bed*

The CONOPS proposed rapid prototyping to validate key aspects of the proposed concept, such as: estimates of time required for staff (forecasters and Science and Technology Officers) to perform specific tasks; collaboration with AWC and WFOs to ensure high-quality forecasts; automated generation of TDAs from those forecasts and to ensure that the services and TDAs provided by CWSUs will have maximum utility to FAA air traffic operations.

4. CONCLUSIONS

A Concept of Operations has been presented that integrates the entire NWS aviation services delivery process into a coherent system that addresses all phases of flight operations within the NAS. The CONOPS has a number of significant benefits:

- Adaptable to any airspace and facility support configuration.
- Facilitates a "systems" approach to supporting the capacity demands of the NAS and increases overall shared situational awareness.
- Couples the expertise from appropriate NWS forecast operations.
- Supports strong collaboration focused on criteria important to Traffic management decision-making.
- Generates TDAs conveying weather impacts on all aspects of aviation.
- Enables traffic managers, controllers, dispatchers and other decision-makers to better coordinate and develop daily playbook operations for the NAS

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