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Applying FX Connect to the Prototype Aviation Collaborative Effort at the Fort Worth Air Route Traffic Control Center

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1. Introduction

Adverse weather conditions, especially those associated with thunderstorms, contribute significantly to disruptions in air traffic operations within the National Airspace System (NAS). The effects extend to every sector of the aviation community and take the form of delays, re-routes, trip cancellations, and most importantly, a reduced margin of operating safety. When coupled with the dramatic growth throughout the industry, hazardous weather encounters are severely taxing an already overburdened air traffic management system. Projections are for industry growth to outpace improvements to the traffic management system over the next five years.

In 1978, the FAA and NWS established the Center Weather Service Unit (CWSU) Program, placing NWS meteorologists in FAA Air Route Traffic Control Centers (ARTCCs). This program was initiated by the FAA as a result of an NTSB recommendation based on the findings from a Southern Airways crash in north Georgia. This NWS meteorological support is designed to improve aviation safety and enhance the efficient flow of air traffic by the continual forecasting and monitoring of adverse weather. The effectiveness of this meteorological support is dependent upon the CWSU forecaster maintaining a close coordination with air traffic managers whose decisions affect the flow of traffic through the NAS. FAA personnel need the best available weather information to facilitate their mission of supporting aviation operations. The CWSU program has developed slowly, and not until the latter quarter of the 90's did the CWSUs begin to receive newer technology that would enable the meteorologist to provide higher resolution forecasts and advisories to air traffic decision makers.

Further progress toward achieving a more weather-responsive air traffic system depends upon a joint FAA and NWS commitment that places increased emphasis on emerging science and technology applied to aviation weather forecasting. The FAA is actively working toward establishing a more definitive set of requirements for weather forecast information. Weather information needs of the ARTCC Traffic Management Unit (TMU) are described in a 1999 document (F.A.A., 1999), forming the basis for a formal requirements document anticipated to be completed by 2003. When completed and mutually agreed upon by the NWS and FAA, the resulting weather requirements document will provide a starting point from which the NWS can launch appropriate initiatives aimed at satisfying these requirements.

2. PACE

The purpose of the Prototype Aviation Collaborative Effort (PACE) is to design an operational test for demonstrating and evaluating the effective employment of developing science, technology and computer communication interfaces (N.W.S., 2002). The PACE facility will initially develop a focused range of high-resolution forecast products specifically tailored to the ARTCC air traffic environment. PACE will build upon knowledge and experience gained from ongoing operations and testing, such as the Collaborative Convective Forecast Product (CCFP; A.W.C., 2002). It is anticipated that an initial suite of graphical products will consist of convective forecasts followed by a phased approach to include icing, turbulence, ceiling and visibility products based on requirements to be outlined by the FAA. Fort Worth

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ARTCC and FAA Southwest Region Headquarters officials have agreed to allow the use of their facility in the CWSU workspace to conduct PACE activities, with the condition that PACE activities do not negatively impact CWSU operations. PACE, initiated by NWS Southern Region Headquarters, is a coordinated interagency effort involving the Fort Worth CWSU, Houston CWSU, NWS Southern Region Headquarters, FAA Southwest Region Headquarters, and the Forecast Systems Laboratory. Additional participants may include other adjacent CWSUs, and the Aviation Weather Center (AWC).

The primary goal of PACE is to establish procedures to generate automated guidance products, share common data sets among operational units, and demonstrate how the employment of collaborative forecasting methodologies can lead to improvements in aviation forecast products. This process will begin with the development of thunderstorm forecast products formatted for use by the TMU.

The specific objectives of PACE are 1) Define a methodology, and produce automated forecast products. 2) Establish a methodology for state-of-the-art collaboration technology, for promoting an exchange of meteorological information among several operational elements. 3) Demonstrate the utility of collaboration to achieve more accurate and consistent forecast products. 4) Establish methodology for use of the collaboration technology from FX Connect. 5) Verify results of the forecast products for use in an air traffic management system.

Initial PACE exploratory development will be directed to prototyping graphical thunderstorm forecast products combining the National Convective Weather Forecast (NCWF; Mueller, et. al., 2000), the Convective SIGMET, and the CCFP. The NCWF provides an analysis of convective hazards with a 1-h forecast of storm positions updated every 5 minutes; the Convective SIGMET is a 2-h forecast of significant thunderstorms updated hourly; and the CCFP produces forecasts of significant thunderstorms at 2, 4, and 6 hours, updated every 4 hours. By combining these products in a graphical display, the TMU could be provided with an automated, frequently updated 0-6 hour thunderstorm forecast.

3. FX Connect

FX Connect (FXC) is a real-time meteorological display system with collaborative capabilities, and is a main component of the PACE prototyping environment (F.S.L., 2002). A unique feature of FXC is that it can accommodate the interaction of forecasters at different locations through a graphical user interface. When connected to an AWIPS server, FXC allows the display of D2D data and imagery over which graphics may be created, manipulated, and viewed by remotely located collaboration participants. Although the AWIPS database is the primary and most extensive source of data, FXC can also obtain data (in image form) from Web servers and integrate data from other sources. The local data integration capability is restricted at this time to display of surface data that has been stored in netCDF format. Details of FXC architecture may be obtained in Grote and Golden, 2002.

The FXC system consists of two major components: the client component that allows the user to display and interact with meteorological data, and the servers that are responsible to provide various types of data to the client. In some special cases the client and servers reside on the same machine.

The FXC server comprises a collection of servers: Depictable Server, Scribble Server, Chat Server, Baseline Server, Point Server, Dispatch Server, and File Monitor. The Depictable Server is responsible for interfacing with the AWIPS software and exporting graphic products. It must therefore be hosted on a machine that has direct access to the AWIPS database and is able to run the AWIPS 5.0 (or later) software. The Depictable Server satisfies all user requests for image or graphic products. The location of the Scribble Server and other servers is more flexible and it is anticipated that in the future FXC may actually reassign these servers automatically if the hosts fail. During a collaborative session each server communicates with the clients independently, i.e., it does not broadcast the data to all clients. As a result, some degradation in performance may occur when a large number of clients are connected for a collaborative session.

FXC clients are usually located remotely. In order for a client to connect to a server the user selects the desired server from the FXC menu. Once the connection is made to the server, the client has access to most of the AWIPS database at the host office. Some menu item and table changes are necessary to add additional AWIPS products to the FXC user interface as required by the specific application of FXC.

FXC is a Java 1.3 application that incorporates Remote Method Invocation (RMI) and is multi-threaded. FXC executes on PCs running Win95, Win98, WinNT, Win2000, and Linux; and on Macintosh G3 Powerbooks running Yellow Dog Linux. Recommended machine attributes include 1 GHz cpu speed, 1 GB RAM, and 20 GB or larger disk. A network connection (DSL, ISDN, or Ethernet) is also necessary. FXC is able to retrieve processed data from an AWIPS database, web server, and local databases. The performance of the software varies with the hardware configuration and operating system. The Java VM implementation for Windows appears to be the most efficient and dependable.

FXC has three basic operational modes: local, remote, and collaborative.

- Local Mode - In local mode, the client is not connected to any AWIPS server. However, the user does have access to selected data from remote Web servers and possibly some local data. This mode is useful for preparing briefing displays that do not require real-time data.
- Remote Mode - In remote mode the user is connected to an AWIPS server that the user has selected from the FXC menu. This allows the user to access real-time meteorological data at the remote server. The user can display a variety of data and perform such functions as zooming, panning, changing colors, overlaying graphics, and animation on the client. The FXC server can accommodate a number of concurrent and independent clients. The maximum number of clients is controlled from a menu on the server.
- Collaborative Mode - In collaborative mode, the user can perform all of the same functions as in remote mode with the added capability of simultaneously updating or controlling the screen of other users. An extensive drawing capability is available that allows the user to annotate the screen and share the annotation with the other collaboration session participants. There is also a chat capability that allows users to exchange text messages. Only one collaborative session can be held at a time. All users connected to a common server are part of the same session. The session can remain active although all clients have disconnected from the server. This allows users to rejoin the session at a later time.

FXC features include the conventional capabilities of:

- Display of diverse data sets (images, observations, and text);
- Interactive display manipulation (zoom, pan, toggle overlays, overlay color);
- Interactive display generation (cross sections, time series, time/height, model soundings);
- Extensive manual graphic and annotation tools;
- Display procedures.

Advanced capabilities of FXC include:

- Slide creation and presentation;
- Chat capability;
- Internet access to WWW products
- Display of radar data from any WSR-88D radar;
- Creation and display of JPEG images;
- Local (independent) or collaborative mode of operation.

FXC will be used in PACE to explore methodologies for promoting an efficient exchange of meteorological information and collaboration in the development and production of new briefing products for TMU decision makers. One of the key features of FXC is the ability to annotate meteorological displays. This feature will play a crucial role in enhancing communications between collaborators, as well as in supporting prototyping and routine briefing product generation.

NWS Warning and Forecast Offices, CWSUs and the AWC all have aviation forecast responsibilities, yet utilize different operational workstations and data streams; AWIPS at the Forecast Offices, WARP (Harris, 2002) at the CWSUs, and N-AWIPS at the AWC. Forecasters with overlapping or intersecting regions of forecast responsibility will gain a shared situational awareness through collaborative analysis and diagnosis using FXC's collaboration capability.

Another advantage of FXC in PACE is that the Depictable Server and AWIPS data server being used reside at AWC, outside of their operational firewall and local area network, and outside of the operational AWIPS configuration management system. This arrangement allows exploratory development and prototyping to occur with no impact to AWC's operational systems. It also allows the display of new operational products

(NCWF and CCFP), which are not currently available on operational AWIPS displays. Additionally, the FXC Client computer at the CWSU is isolated from the ARTCC operational systems, with a commercial DSL connection to the Internet, thereby having no impact to that operational environment. In this implementation, FXC meets or exceeds current government security standards.

4. Acknowledgments

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