7.2 A WEB-BASED DISPLAY AND ACCESS POINT TO THE FAA'S INTEGRATED TERMINAL WEATHER SYSTEM (ITWS)

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1. INTRODUCTION†

The Integrated Terminal Weather System (ITWS) is a high-resolution weather information system designed to operate within the TRACONs surrounding the country's major airports (Evans and Ducot, 1994). Targeted for those airports most often adversely affected by convective weather, the system was developed for the Federal Aviation Administration (FAA) by the Massachusetts Institute of Technology's Lincoln Laboratory (MIT/LL) Weather Sensing Group. The ITWS acquires data from Next Generation Radars (NEXRAD), Terminal Doppler Weather Radars (TDWR), Airport Surveillance Radars (ASR-9), Low Level Windshear Alert Systems (LLWAS), the National Lightning Detection Network (NLDN), Automated Weather Observing Stations (AWOS/ASOS), and aircraft in flight. The system integrates the data to provide consistent weather information in a form that is usable without further meteorological interpretation. This information includes six-level precipitation at a number of ranges, windshear and microburst detection and prediction, storm motion and extrapolated position, wind fields, gust fronts, lightning, and storm cell information (hail, mesocyclone notification, and echo tops).

A set of direct users of ITWS (FAA users at TRACONs, Air Traffic Control Towers, and en-route centers) will receive ITWS weather products through FAA-provided Situation Displays (SDs) that are tied directly to the ITWS processor. In addition, the FAA has sponsored development of an ITWS External Users Data Distribution System to provide real-time ITWS products to those users who do not have access to a dedicated SD. The data distribution system is being developed in conjunction with the upcoming deployment of the ITWS (2002-2004) as an operational FAA system serving 47 major airports. The need for a remotely accessible display is strongly supported by draft recommendations recently released by the National Transportation Safety Board (NTSB) that call for U.S. air carriers and all air traffic control facilities to have access to data from FAA terminal weather information systems.

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In addition, the Collaborative Decision Making program (CDM) has highlighted the need to make the information widely available to airlines.

MIT/LL has operated demonstration ITWS systems since 1994, and a demonstration website since 1997. Most major airlines have successfully accessed the ITWS demonstration products in real time via Web browsers and have used this information to improve safety and reduce delays (Maloney, 2000). Benefits specific to airline dispatch include support for decisions made during diversion situations and improvements in hub operations. By sharing a common view of the same operational environment, controllers, dispatchers and other aviation decision makers and stakeholders have been better able to understand and coordinate the decisions that affect air traffic in the terminal area and surrounding en route airspace (Evans 2000).

This paper describes the goals of the ITWS External Users Data Distribution System development project, including a discussion of the system architecture, data distribution and access methods, and the web-based interface.

2. ITWS EXTERNAL USERS DATA DISTRIBUTION PROGRAM OVERVIEW

The primary goal of the ITWS External Users Data Distribution Program is to develop a system to distribute ITWS data to users who have a need for this information, but will not have access to an ITWS SD. An important design goal of the project was to maximize the options available to users of the data while minimizing the cost of establishing the data network infrastructure. The Volpe National Transportation Systems Center in Cambridge, MA (Volpe) was chosen to host the system as they have established high-bandwidth data connections to the majority of TRACONs at which ITWS will be installed. In addition, Volpe has established an infrastructure for distribution of National Airspace System Status Information to air carriers and other aviation users.

3. SYSTEM ARCHITECTURE

Data from each operational ITWS Product Generator (situated at the remote sites) will be made available to the Volpe Hubsite Communications Processor via TCP/IP as shown in Figure 1. This data is transferred over an FAA-managed network (FIRMNet). Once the data arrives at the Volpe Hubsite, it will be made available to users via two different data service applications – the digital data server and the ITWS website display driver (Volpe, 2001). The system is designed to be extensible and will be implemented using a large network of rack mountable Linux computers.

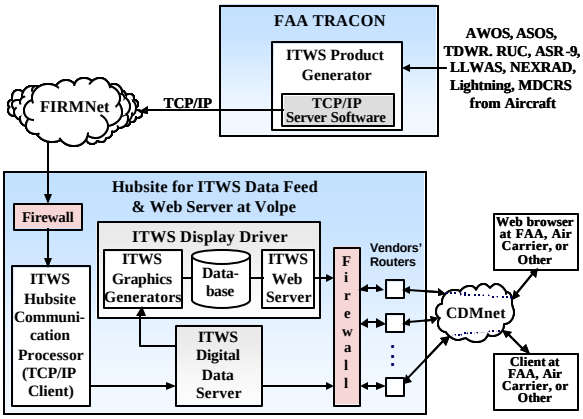

Figure 1. Configuration for ITWS Data Distribution.

4. ITWS DIGITAL DATA SERVER

The digital data server software has been developed by Volpe to provide real-time distribution of ITWS product data, relaying the data as they are received from the ITWS product generation hosts. The data feed provided by this server will allow users such as airlines to utilize the ITWS data in their own data management and display systems. The use of this data feed will require the development of data ingest and processing software. User client applications will connect to the digital data feed over the Collaborative Decision Making Network (CDMnet)* via an individual TCP/IP socket for each ITWS system.

5. ITWS DISPLAY DRIVER

The ITWS display driver has been developed by MIT/LL and interprets the data for the user by processing the raw data and producing interpreted ITWS products for display. It consists of three main parts: graphics generators, databases and web servers. The graphics generators use the data from the digital data server to produce viewable images and formatted text products for each ITWS system and deposit them into an Oracle database for retrieval by the web servers. The web server receives data requests through standard web browsers from users on the CDMnet*, retrieves the data from the database and provides the products to the user using standard HTML. The number of databases and web servers can be increased as needed to meet demand.

6. WEB INTERFACES AND USAGE

A challenge in the design of this website is the large amount of data that needs to be presented at one time. To help the user navigate this information, two overview interfaces were designed, both of which provide the status of all ITWS systems at a glance. The first interface is a national map showing the status of the ITWS system for each airport as a colored icon; the second interface is a text version showing the status and additional information in a table using the same status color scheme as the map. When the user selects the airport identifier using either interface, a graphical product interface window is opened, which displays ITWS product information for the selected airport.

6.1 National Map Interface

The national map interface (Figure 2) shows the ITWS airports superimposed on a map of the United States, with the color of the site icon indicating the status. The color codes are defined in Table 1. This interface depicts the spatial relationship among the ITWS sites, while at the same time showing the status of the individual ITWS airports.

Figure 2. National Map Interface.

6.2 Text Interface

The text interface shows the same status information as the national map, using the color codes shown in Table 1. The information is listed as a table with each line representing a separate airport. Some additional information is available through this interface, including the actual operational mode of the ITWS system (operational, maintenance, or down), the alerts present (if any), a yes/no indication of the presence of storms in the TRACON, and the products currently unavailable (if any). This table can be sorted either alphabetically by airport or by ITWS status (alerted sites appearing at the top). Display of information about systems that are currently non-operational can be suppressed by applying a filter option. Figure 3 shows the text interface with both the filter and status sort options selected.

6.3 Graphical Product Interface

The graphical product interface (GPI) is the interface users will use to view the ITWS external user products. All ITWS products that are used for shared situational

* CDMnet is the data distribution infrastructure for the Collaborative Decision Making (CDM) program. It is used for exchanging data between certain airline operating centers (AOCs) and the FAA. The CDM data distribution system has a hub and spoke architecture, with the hub being located at the Volpe Center. AOCs connect to the CDM hub using communications capabilities provided by third-party vendors.

awareness are available on the GPI. Figure 4 shows an example of the GPI for Dallas Ft. Worth (DFW) TRACON range. The display of ITWS products is the same as the dedicated ITWS situation display although there are some differences in access and product interaction. Each GPI that is opened is a self-contained display, providing all the available alert information, selected product information, and product status information for the target airport.

Table 1.
Status colors used for the ITWS overview interfaces.

Color Code	ITWS Status Description
Black	Not operational (down, under maintenance, or not installed)
Red	Operational and there are active alerts in effect at the airport (microburst, wind shear, tornado, lightning or gust front).
Yellow	Operational and there are level three or greater storm cells present in the TRACON view
Blue	Operational, but there are currently no level three or greater storms within the TRACON view

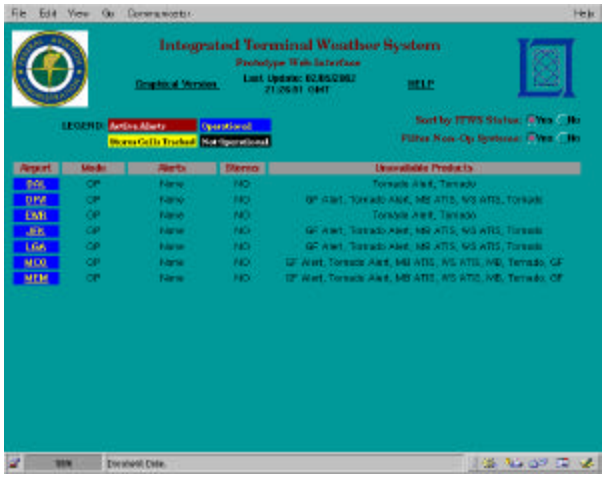

Figure 3. Text Interface.

The interface consists of toolbar on the left hand side, which is used for data interaction and window control, while the rest of the display is reserved for product display. The left hand toolbar consists of the window title showing the current airport and display, the current universal time (UTC), drop down menus for changing the airport and display product, two window control buttons which will apply the airport and display choice, and a group of six buttons for display customization. The data display area consists of an alert panel, on which ITWS alerts are displayed, a product display area where graphical or text products are shown, and a product status panel in which unavailable products are listed (if any).

The airport selection allows the user to choose any ITWS airport, while the display selection determines which product to display. The list of available products is shown in Table 2. A window is activated by selecting one of the window control buttons. If the APPLY button is selected, the existing display will be changed. If the NEW button is selected a new GPI window will be opened to the chosen airport and display leaving the original window unchanged. This will allow for viewing more than one airport and/or display at the same time.

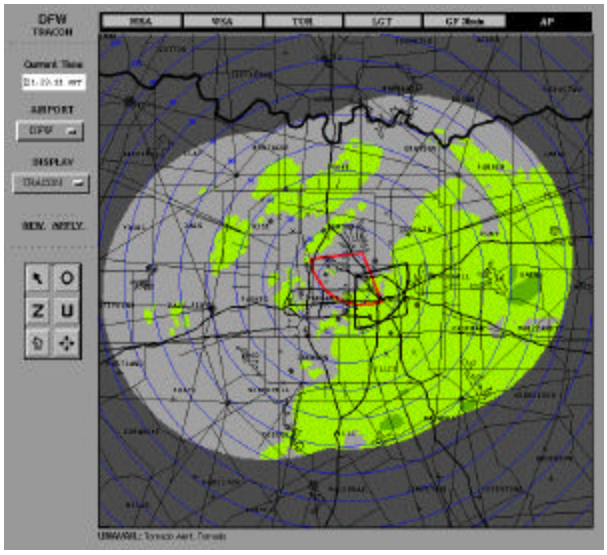

Figure 4. Graphical Product Interface.

The display customization buttons are a set of six buttons below the window control buttons and allow for the customization of the display. The description and use of the buttons are as follows. The arrow is the storm cell selection button which, when clicked, will allow for the selection of storm cells and the display of storm cell information in the lower left corner of the display. The overlay button (O) will allow for the selection of available overlays. The zoom (Z) and unzoom (U) buttons will change the magnification factor of the image. The lower left button is the home button, which will reset the display to the default zoom setting and centerpoint. The lower right button is the recenter button, which will activate a recenter mode, so that the image will be re-centered on the cursor location.

The alert panel at the top of the product display area shows ITWS alerts for the displayed airport. From left to right, the alert boxes are as follows. MBA is the microburst alert box. If there are microburst alerts in effect at the airport, the MBA box turns red. WSA is the wind shear alert box. If there are wind shear alerts in effect at the airport, the WSA box will turn white. Once the microburst and windshear alerts are no longer in effect at the airport, a number will be shown in the respective alert (MBA or WSA) box. This number corresponds to the number of minutes remaining until the ATIS message expires. TOR is the tornado alert box; if this box is black there is at least one NEXRAD tornado vortex signature reported within a certain

distance of the airport. The distance is displayed in the alert box as the number of nautical miles. The LGT box is the lightning alert box, which turns yellow if there is lightning within a certain distance of the airport. The distance is displayed in the alert box as the number of nautical miles. GF is the gust front alert box, which turns purple when a gust front is within a certain amount of time to impact the airport. The time is given in the box as a number of minutes to impact. The last alert box is the AP alert, which, when black, alerts that false radar echoes are being edited out of the TRACON and 30nm precipitation display products.

Table 2.
Display choices on the ITWS Web graphical product interface.

Display option	Description
5nm	5 nautical mile range precipitation based upon TDWR
30nm	30 nautical mile range precipitation based upon ASR-9 mosaic
TRACON	TRACON range precipitation based upon ASR-9 mosaic
100nm	100 nautical mile precipitation based upon NEXRAD
200nm	200 nautical mile precipitation based upon NEXRAD
WindProfile	Winds at various specified locations and altitudes within the TRACON
TerminalText	ACARS aircraft uplinked messages
RDAlerts	Messages displayed on the ribbon display terminal in the air traffic control tower

ITWS graphical and text product data are displayed in the area below the alert panel. This data are depicted exactly as they are on ITWS SD. The first five display options provide a graphical representation of the ITWS products listed below:

- TDWR precipitation on 5nm range, ASR-9 precipitation with anomalous propagation (false echoes) removed on 30 nm and TRACON range, and NEXRAD precipitation on 100 and 200 nm ranges
- Storm motion arrows and storm extrapolated position indicators for areas of VIP level 3 and higher precipitation superimposed on precipitation maps
- Microburst detections*
- Gust front detections and forecast positions*
- Gust front wind shift estimates*
- Storm cell information (echo tops, lightning, hail and severe storm circulation information)

* Only on 5 nm, 30 nm, and TRACON ranges

7. CONCLUSIONS

The safety benefits that accrue from the wide distribution of FAA terminal weather information have been identified by the NTSB. The ITWS External Users Data Distribution System greatly expands the potential for distributing this critical information in real time. In addition to the safety benefits during hazardous weather, there is a significant efficiency and coordination benefit to be gained from the increased shared situational awareness when widely separated users are viewing the same weather display. Airlines have come to depend on the availability of ITWS products. The data distribution system presented here will allow for the real-time access to data at all 47 ITWS airports once deployment is complete. In addition, the ability to simultaneously monitor the status of all ITWS airports nationwide will only be available on the website. This will be of particular use to the FAA's Air Traffic Control System Command Center.

Additionally, the website will allow for a larger group of users to access the ITWS information. Once a connection to the website is established, via CDMnet or an alternate (as yet to be determined) access path, authorized users such as municipal and city emergency management offices, port authorities and Federal, State and local government offices will have access to this data for the first time, allowing for better communication between agencies during periods of hazardous weather.

The ITWS External Users Data Distribution system described here will become available as the ITWS systems are installed and commissioned starting in mid 2002 and continuing through 2004.

8. REFERENCES

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