7.1 FX-NET USE TO SUPPORT THE 2002 OLYMPIC WINTER GAMES AND FIRE WEATHER INCIDENT METEOROLOGISTS

Kevin J. Schrab*, Andy Edman, Jason Burks
NOAA, National Weather Service, Western Region Scientific Services Division
Salt Lake City, UT

Randy Weatherly
NOAA, National Weather Service, Western Region Systems Operations Division
Salt Lake City, UT

Sean Madine
NOAA, Forecast Systems Laboratory and Cooperative Institute for Research in the Atmosphere
Boulder, CO

1. INTRODUCTION

The Western Region (WR) of the National Weather Service (NWS) is employing FX-Net to provide real-time meteorological data to outdoor venues of the Salt Lake 2002 Olympic Winter Games and is testing its use to support incident meteorologists (IMETs) when they are deployed to fires. Western Region has worked closely with Forecast Systems Laboratory (FSL) to implement FX-Net as a remote meteorological workstation. FX-Net was developed at FSL.

By serving the data at WR Headquarters (WRH), data sets not normally available via FX-Net will be available to the widespread venue locations and any possible locations that IMETs may be deployed to. These data sets include specialized satellite imagery, mesonet observations, and other regional and local data sets. The flexibility of FX-Net will greatly simplify the exchange of data during the Olympics and during fire weather IMET operations.

2. FX-NET SYSTEM OVERVIEW

FX-Net was developed by FSL over the last few years (Wang and Madine, 1998). Development continues at the present time as FSL receives feedback from WR, as well as other users, and incorporates requests for bug fixes and improvements in a very timely fashion.

The purpose of FX-Net is to provide a network-based AWIPS-like workstation. FX-Net can operate on a local network, dial-up connection, or dedicated line. The FX-Net server is a modified AWIPS workstation. Data is made available to this server by mounting the data directories from the AWIPS data server. The FX-Net client interface is very similar to the interface used on AWIPS workstations.

* *Corresponding author address*: Dr. Kevin J. Schrab, NOAA/National Weather Service, Western Region Headquarters, 125 S. State St, Salt Lake City, UT 84138; e-mail: kevin.schrab@noaa.gov

2.1 *Client-Server Configuration*

The FX-Net server is a modified AWIPS workstation. This server has additional software that allows the FX-Net client to request data that is resident on the AWIPS data server. The client sends product requests to the server via the FX-Net client interface. The communication between the client and server is via the http protocol. The client uses a client application that mimics the appearance of the AWIPS workstation interface.

2.2 *Client Configuration*

The configuration for the FX-Net client is very basic. The minimum system requirements for the client PC are as follows:

- 256MB RAM
- 400 MHz processor
- Windows NT/2000 OS is preferred
- Windows 98 and Linux OSs will also work
- a connection to the FX-Net server

The client uses a java application for the FX-Net interface. The use of java promotes platform independence. Java also has an available network Application Programming Interface that is needed to set up the interface.

2.3 *Server Configuration*

The FX-Net server is basically a modified AWIPS workstation. The additional software allows the FX-Net server to convert the client requests for data into requests to the AWIPS data server and then convert the data into a format that the client can display.

The hardware that the server runs on can be either a Linux PC with 1GB RAM and 1 GHz processor or an HP workstation of the J or C series.

More information on the client-server communications can be found in Wang and Madine, 1998 and Wang and Madine, 1999.

2.4 *Design Drivers*

There are two very important design drivers that affect how the FX-Net software is developed and implemented. These are:

1) Maximize functionality to make FX-Net client as similar to the AWIPS interface as possible, and
2) Bandwidth limitations govern how much data can be transmitted from the server to the client.

Therefore, the full AWIPS data set cannot be sent from the server to the client in its native format. These two design drivers actually can complement and compete with one another. For example, to add additional client functionality may require more bandwidth than is available.

The bandwidth limitations are critical since the timely delivery of products is critical to the usefulness of FX-Net. To reduce bandwidth requirements:

1) Some functionality of the server is handled on the client,
2) Information sent from the server to the client is optimally compressed, and
3) The server pregenerates products that are time sensitive to create.

The functionality that is handled by the client includes animation control, overlay, toggle, zoom, color table editing and loading. This allows local control so that communications of these simple tasks do not have to go to the server and back. The client also maintains a simple cache of previously loaded products. When a previously requested product is loaded only new frames are requested from the server and the others are loaded from the cache.

Compression of products that are sent from the server to the client is critical to the success of FX-Net. There are 2 basic types of products: vector graphics and pixel images. Compression is needed to reduce the size of these products before they are sent from the server to the client. JPEG compression was experimented with but resulted in too much data loss. Wavelet compression was found to be the most efficient method to reduce product sizes, while maintaining product resolution. Compression ratios for model images are on the order of 100:1, while compression ratios for satellite images varies from 1:1 to 50:1 (Wang and Madine, 1998). The wide range of compression ratios for satellite images results from the fact that satellite data generally has large and variable dynamic ranges. The wavelet compressions tend to be computationally intensive. As a result, the satellite products are compressed in a pregeneration mode. As soon as the AWIPS data server ingests the data, the FX-Net server compresses and saves the satellite images so they are ready for access by the client. A similar process is not used for model imagery since the possible number of products is almost limitless (whereas for satellite imagery there are a limited number of products available, on the order of 100). The compression ratios for the satellite imagery is also easily configurable to allow different compression ratios for different data types.

The design driver to make the FX-Net user interface as similar as possible to the AWIPS workstation user interface is particularly important for fire weather IMET users, since they use AWIPS in their normal WFO operations. Figure 1 shows the FX-Net client interface and Figure 2 shows the AWIPS workstation interface. This design driver is less critical for the Olympic use since the users will not be NWS forecasters. In order to accomplish this similarity, the FX-Net server needed to be created by making minor changes to the baseline AWIPS workstation. The FX-Net server provides all data ingest and management software so that the client is free to simply load and display products. Complicated tasks such as time matching and exporting images and graphics are handled by the server so that the client machine can be a lower-end PC.

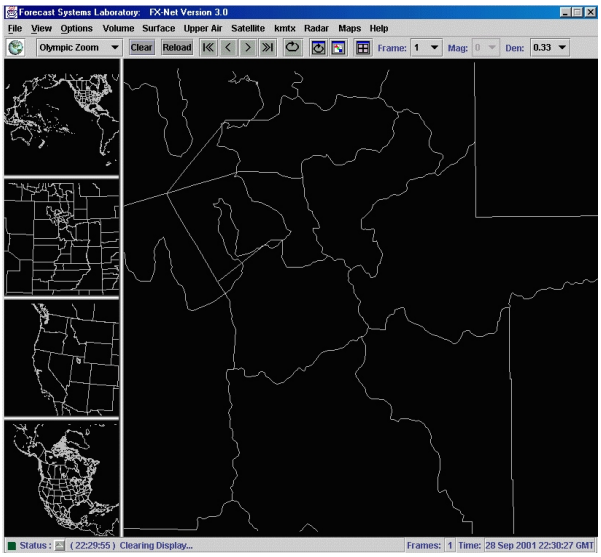

Figure 1. FX-Net client interface.

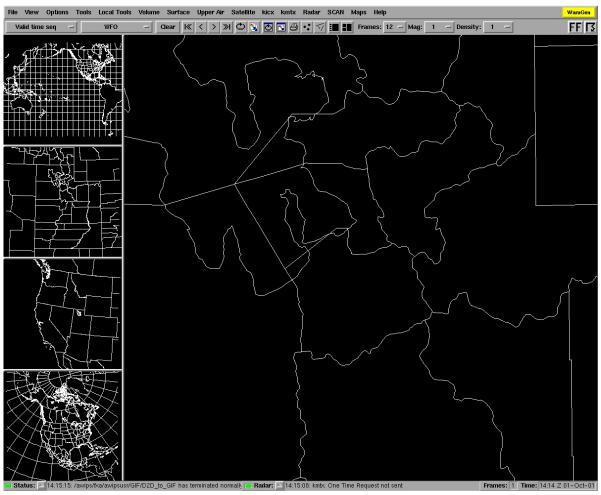
Figure 2. AWIPS workstation interface.

3. FX-Net APPLICATIONS

The FX-Net solution has several possible applications. These include the use as: a remote workstation for Olympic support, a remote workstation for fire weather IMET support, a network of workstations in a classroom setting, a research workstation to deliver data for field experiments.

3.1 *Olympic Support*

FX-Net will provide support to the venue forecasters during the Salt Lake 2002 Olympic Winter Games in Utah. There will be 5 outdoor venues used during the 2002 Winter Olympic Games and weather support needs to be provided. The forecasters at each of these venues are private sector forecasters that have been hired for this task by KSL-TV (the chosen venue weather forecast provider for the 2002 Olympic Winter Games). In order to adequately support the venue forecasters a reliable data feed is necessary. During the 2002 Olympic Winter Games it is expected that Internet will be extremely busy, which would hamper any attempt to use Internet to access weather data necessary to support the venue forecasters. FX-Net can provide the data that is necessary to support the venue forecasters. To make the data feed reliable, dedicated communications lines will be setup between each venue and the NWS WRH AWIPS. This allows the data path to bypass Internet and give very high reliability to the data feed for the venue forecasters.

The configuration of the FX-Net system to support the 2002 Winter Olympic Games includes putting an FX-Net client at:

- each of the 5 outdoor venues (Deer Valley, Park City, Soldier Hollow, Utah Olympic Park, and Snowbasin; see Figure 3 for venue locations)
- KSL-TV (management control center for venue forecasters)
- Hill Air Force Base (to support the weather needs in support of air traffic control)
- Media Operations Center (to help in any high level briefings to the media).

Each FX-Net client will be connected to the NWS WRH AWIPS via a dedicated 256Kbps communications line. This line connects only to the FX-Net client (which is a stand-alone workstation not connected to any other network) and the WRH AWIPS system to ensure security to the AWIPS network. The FX-Net client will run on a PC configured with Windows 2000, 512MB RAM, and a 850MHz processor. The FX-Net server configuration will be 2 FX-Net servers on the WRH AWIPS network. A load balancer will be placed in front of the servers in order to provide better system stability and robustness.

To enhance the support to the venue forecasters for the 2002 Olympic Winter Games numerous changes to the default FX-Net configuration have been made. These changes are referred to as localization. The 2002 Olympic Winter Games localization includes:

- an added scale (map background) that is centered on the venues (see Figure 4)
- tailored background maps to include venue locations and other important features such as highways
- fixed points for numerical model time/height sections and soundings at venue locations and other pertinent locations
- added 1km ADAS centered over northern Utah
- ability to view MesoWest mesonet
- ability to view MM5 output

The added scale centered on the venues makes it easy for the venue forecasters to quickly view information close up. A 1km version of ADAS (ARPS Data Assimilation System) developed at the University of Utah is also available to the venue forecasters via FX-Net. Figure 5 shows a view of the temperature and wind field from the 1km ADAS. The ADAS incorporates the extensive MesoWest mesonet that the University of Utah also collects and processes (see Figure 6). These two data sets are critical to the forecasters at the venues. MM5 model output provided by the University of Utah is also available on the FX-Net client. This mesoscale model output will be essential in forecasting on the fine scale needed at the venue locations. Figure 7 shows a sample of MM5 output on FX-Net.

FX-Net was tested at 4 of the 5 outdoor venues during the winter of 2000/2001. These tests took place during pre-Olympic test events and proved to be very useful in finding and correcting communications problems and software bugs. The feedback provided by the venue forecasters was very useful to the FSL developers and WRH support staff in modifying the FX-Net system.

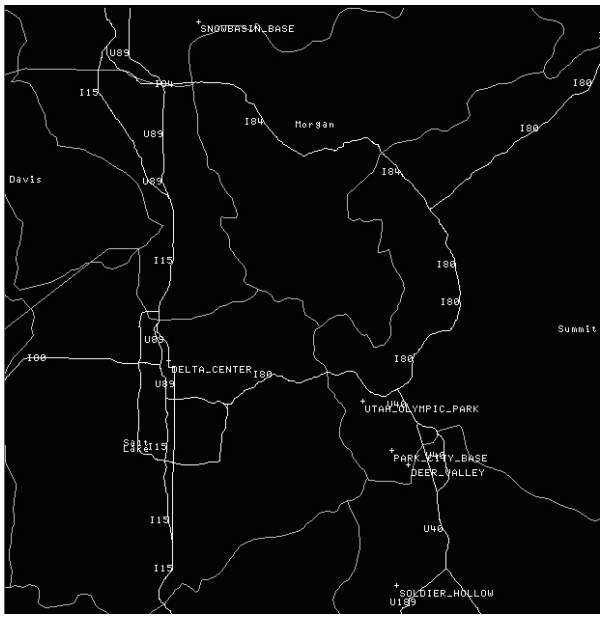

Figure 3. Outdoor venue locations.

Figure 4. Additional scale that is zoomed in on the Olympic venues.

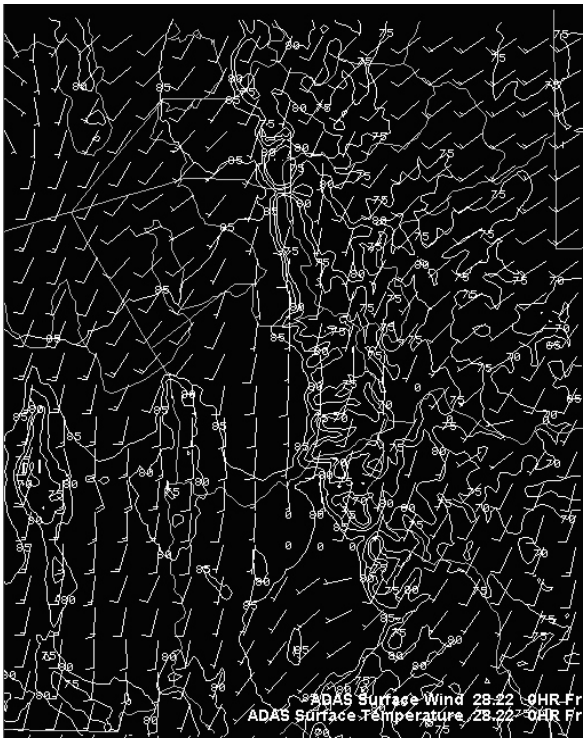

Figure 5. ADAS surface temperature and wind analysis.

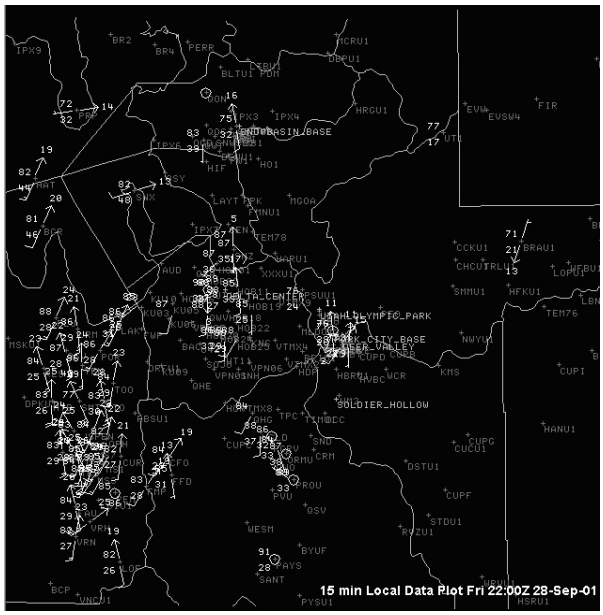

Figure 6. MesoWest mesonet 15 minute surface data plot.

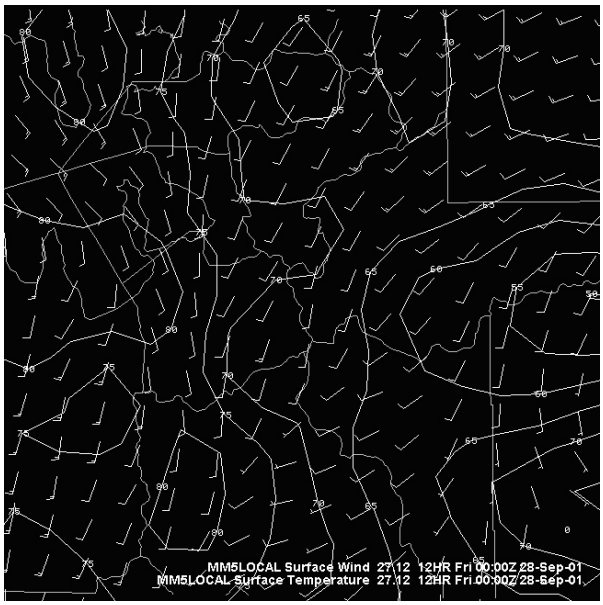

Figure 7. MM5 surface wind speed and temperature forecast.

3.2 *Fire Weather IMET Support*

The WR plans to start using FX-Net to support fire weather IMETs when they are deployed to fires. The system for supporting IMETs is old and hard to maintain. The IMET PC has numerous specialized applications to view all the data that an IMET requires. Data is currently transferred via phone lines or 1-way satellite packet delivery service. The new system which was tested on a couple of fires at the end of the 2001 fire season uses FX-Net. One data stream that comes off of AWIPS is used to feed the data to the IMET PC. The system was tested with phone communications. In the future 1-way satellite with phone and 2-way satellite communications will also be used to deliver the data to the FX-NET IMET client PC.

The PC that IMETs used to test FX-NET was a 750MHz Pentium processor with 512MB RAM,the Windows 2000 operating system, and a 14 inch screen. The FX-Net client used by the IMETs was connected to WRH AWIPS via a Virtual Private Network (VPN) and firewall over phones lines. A special localization was set

up for the fire locations that the IMETs were deployed to. This localization included:

- modified model time/height sections and soundings locations to match fire locations
- modified compression ratios to minimize file sizes to reduce product transfer time
- enlarged the State(s) and Regional scales to cover the entire WR
- made data from all WR NEXRADs available on the State(s) scale

The 2 tests during the 2001 fire season provided very valuable feedback. Some items that were reported included:

- system easy to learn and use (similar to AWIPS)
- load times of products reasonable, even though communications was via phone lines
- suggestions for bug fixes and improvements

The configuration for the future IMET FX-Net PC will include all items from the tested localization plus a local radar viewer that zooms in on any radar.

4. SUMMARY

The NWS WR has been working with FSL to deploy FX-Net to outdoor venues during the Salt Lake 2002 Olympic Winter Games in support of venue weather forecasting operations. Initial testing has also been completed to show that FX-Net is a viable solution to deliver AWIPS-type data to IMETs deployed to fire locations. The FX-Net server and client setup is rather simple and easy to maintain since it is based on the operational AWIPS. FX-Net is easy for forecasters to learn and use since it has a graphical user interface that is similar to AWIPS. Also, the flexibility of FX-Net to be localized and customized greatly aids in its use for the 2002 Salt Lake City Winter Olympics and IMET support.

5. ACKNOWLEDGMENTS

Without the hard work of the team at FSL that works on FX-Net, the support to the Olympics and IMETs would not be possible. This team includes: Sean Madine, Ning Wang, John Pyle, Evan Polster, Renate Brummer, and Dr. Wayne Fischer.

The WRH team was also critical to getting FX-Net working in a smooth and reliable way. The WRH team includes: Randy Weatherly, Jason Burks, Andy Edman, Graham Stork, Dr. Kevin Schrab, Carl Gorski, and Scott Birch.

The 2 IMETs that tested FX-Net in the field are also acknowledged: Todd Carter (NWS Spokane) and Mike Johnson (NWS Missoula).

The Salt Lake Organizing Committee (SLOC) and its weather providers are also thanked for their feedback on FX-Net.

6. REFERENCES

Wang, N. and S. Madine, 1998: FX-Net: A Java-based Internet client interface to the WFO-Advanced workstations. 14th Conf. on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology, Phoenix, AZ, Amer. Meteor. Soc., 427-429.

Wang, N. and S. Madine, 1999: Delivery of meteorological products to an Internet client workstation. 15th Conf. on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology, Dallas, TX, Amer. Meteor. Soc., 356-359.