J12.5 FX-NET NATIONAL : A NON-LOCALIZED INTERNET-BASED METEOROLOGICAL WORKSTATION

Sean Madine*, Ning Wang*, Evan Polster*, John Pyle*, Renate Brummer*
NOAA Research - Forecast Systems Laboratory
Boulder, Colorado

* [In collaboration with the Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, Fort Collins, CO]

1. INTRODUCTION

FX-Net National is the most recent version of an Internet-based meteorological workstation that is being developed at NOAA's Forecast Systems Laboratory (FSL). By leveraging recent AWIPS workstation developments, the FX-Net system is now able to deliver forecasting information for any location in the lower 48 states. As in previous versions, this information includes satellite imagery, model forecasts and observations (Wang and Madine, 1998). Significant improvements to the FX-Net system include access to nationally oriented scales and radar products for each of the WSR-88D sites. More powerful interactive functionality, such as a user-defined vertical cross-section capability, has also been implemented. The client, which emulates the AWIPS D2D interface, runs on readily available PC hardware over network bandwidths as low as phone line based modems. These recent developments have led to an FX-Net server that can now provide relatively low-cost service to a large number of Internet-connected clients.

2. SYSTEM OVERVIEW

FX-Net National is a request based, client-server system intended to be an extension of the D2D capability, not a PC version of the AWIPS work-station. The FX-Net server is primarily responsible for data management (i.e. time matching of products) and for creation and delivery of these product files. Written in C++, the FX-Net server is a modified AWIPS workstation. Rather than support the local display of products, it uses the D2D software to produce and encode files in response to a product request by the client. As is the case for any real-time AWIPS workstation, the server must be collocated with an appropriately localized AWIPS data server (Fig.1).

Corresponding author address:
Sean Madine, NOAA/FSL, Boulder, CO
phone: 303-497-6769;
email:madine@fsl.noaa.gov

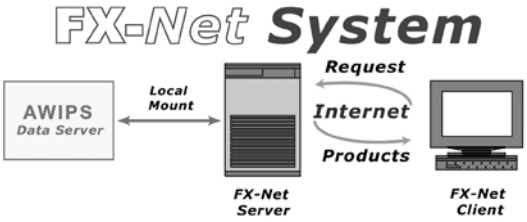

Figure 1: FX-Net System

The client runs as a Java application on a PC. After retrieving products via the Internet, it allows a user to locally interact with the information. Connections to the server are only maintained during the request and retrieval of products.

2.1 Advantages of FX-Net

The Web has become an important resource for meteorological information. Satellite imagery, forecast models, radar, and observations are available on numerous sites. A standard Web browser provides a basic forecasting capability to a meteorologist. FX-Net National provides many improved capabilities.

2.1.1 Interactive functionality and emulation of D2D user interface

The FX-Net client is able to display products from a very large menu of choices. As is the case with D2D, the client can load and overlay products of various types and interact with that information. Functionality includes animation, toggle of overlays, zooming, and swapping of display windows. By emulating the D2D interface, FX-Net is easily learned by those who have AWIPS experience. This is an advantage in applications such as fire weather, where an incident meteorologist would be familiar with both the set of available products and the user interface.

2.1.2 *Product Representation and Compression*

A very important aspect of FX-Net is the appro-priate encoding and compression of meteorological products. The sizes of image files are significantly

reduced, when compared to standard compression formats, through the use of FSL-developed compression programs (Madine and Wang, 1999). When constrained by modest bandwidth, FX-Net is able, in a reasonable amount of time, to deliver products with much better resolution than those that are typically available on Web sites.

2.1.3 User Defined Products

FX-Net National offers some very unique capabilities beyond the features mentioned above. An interface has been developed that allows the user to define an arbitrary baseline from which vertical cross sections of virtually any model parameter can be created and displayed. Similarly, arbitrary points can be defined from which time series of model parameters can be created and displayed. These products are created upon request within a few seconds.

3. LOCALIZATION AND "NON-LOCALIZATION"

One legacy of the original AWIPS design is the concept of localization. Each NWS Weather Forecast Office (WFO) has a localization associated with it. For a given localization, a set of nested scales is defined which progressively zoom in on the area that is relevant to the WFO. This is a very effective approach when forecasting for a specific area. Previous versions of FX-Net servers were restricted by the concept of localization. This limitation required that an FX-Net server and an appropriately localized AWIPS data server be dedicated to each group of users in different locations. Even though the server can handle a large number of users, it was limited in utility due to the localized nature of the products that it could serve. Recent versions on the AWIPS software provide *national-center localizations*. This, in a sense, can be thought of as a "Non-localization". Rather than defining a set of nested scales, the national-center localizations define a set of peer scales that combine to cover large areas. This technique also provides improved resolution over standard scales such as the CONUS view in AWIPS.

FX-Net National supports this "Non-localization". Products, such as satellite imagery, are delivered by the server at a resolution that is appropriate to a given scale. Due to the need to optimize for limited bandwidth, only enough information is sent to support a few zoom operations, depending on the scale. Loading products at the smallest scale relevant to the forecasting needs provides the product at the best resolution. By leveraging the new "Non-localization", a single FX-Net National server is capable of serving many users that are interested in forecasting for diverse geographic locations.

4. RADAR PRODUCTS

Soon after the NWS started disseminating NEXRAD products free-of-charge via NOAAPORT in January 2001, the FX-Net team leveraged this newly opened data stream by adding a software feature to its user interface aptly named the *Radar Chooser.* Closely emulating a related feature in the AWIPS D2D user interface, and operating as an adjunct tool within FX-Net, the Radar Chooser allows users access to 143 of the 154 WSR-88D sites currently producing data. (The 11 sites of Alaska and Hawaii are not yet offered.)

The tool's main display presents a map of the continental United States, and superimposes the locations of the radar sites, allowing the user to select an individual site with the mouse. Once a site has been selected, the application switches into a "radar viewer" mode. In this mode the background map of the FX-Net primary view port changes to reflect the user's selected radar choice, displaying the state/county boundaries associated with that radar site (WFO scale). Radar products can then be loaded, followed optionally by graphic products (i.e., models, point observations, analysis, etc.).

In addition to displaying the radar sites, the Radar Chooser also superimposes the *10 km Radar Coded Message* national mosaic, the contents of which can be toggled visible or hidden. This allows users to see weather activity at sites close by.

Of the radar products being disseminated by the NWS, the following are presently displayed by FX-Net:

- Composite Reflectivity 4 km (0.5 Degree Elevation Angle)
- Composite Reflectivity 1 km (0.5 Degree Elevation Angle)
- Base Reflectivity (0.5 Degree Elevation Angle)
- Base Radial Velocity (0.5 Degree Elevation Angle)
- Storm Relative Mean Radial Velocity (0.5 Degree Elevation Angle)
- Vertical Integrated Liquid
- Surface Rainfall Accumulation

The client also provides the ability to animate some of the above products in angle rather than in time. This capability is supported for Composite Reflectivity 4 km, Base Radial Velocity, and Storm Relative Mean Radial Velocity.

5. CENTRALIZED SCALABLE SERVER

The AWIPS workstation can now be run on a server using the Linux operating system. The FX-Net server has also been ported to this platform so that the system can take advantage of powerful and inexpensive hardware that has recently become

available. In addition, FX-Net servers can now be effectively load-balanced. That is, the system can be effectively scaled to handle more demand by adding more hardware. Recent experience with FX-Net usage in university teaching laboratories indicates that a server under normal operating conditions can handle at least 20 clients. It is difficult to quantify the expense of a client request; different types of requests put different loads on the server. With clients that are not requesting products in a synchronized fashion, initial estimates are that a server can support many tens of clients at any given time. As mentioned, the addition of the nonlocalization and the Radar Chooser makes a single server useful to users in many different locations. By load-balancing many inexpensive servers at a central site, FX-Net National can effectively and inexpensively provide a very good meteorological workstation capability to a very large number of users via the Internet.

6. USES OF FX-NET NATIONAL

The first operational use of FX-Net was at Plymouth State College (PSC) in New Hampshire. It has been almost three years since PSC installed a special meteorological computer laboratory which included 20 FX-Net workstations and a data projector. FX-Net is being used intensively at PSC to teach undergraduate students with a focus on high-tech forecasting tools. In summer 2001 the University of Iowa (UNI) was added to the list of FX-Net clients and is also using FX-Net for undergraduate laboratories. In addition, UNI is also holding special summertime workshops which are part of the STORM Project. The introduction of FX-Net National reduced the problem of an increasing number of localized FX-Net systems to a scalable system set-up. Two national-center AWIPS data servers (prime and backup) and a limited number of FX-Net National servers can provide AWIPS products to a large number of FX-Net clients. The list of products includes the radar products mentioned above. This large choice of radar products makes FX-Net National especially valuable for the university environment. The teaching and studying of severe weather is no longer limited to one location, and therefore can be conducted at any time.

The fire weather research is using the nonlocalized advantages of FX-Net National in the same manner as is done in the universities. Obviously, fire weather is not limited to any one location, and therefore a localized forecaster workstation product limited to one radar would not do the job. FX-Net National will be able to serve fire weather forecasters with the palette of radar products, needed for them to address fires in any area within the lower 48 states.

There are many other nontraditional forecast situations that FX-Net National will be able to serve extremely well. One of these is air quality forecasting. It is no problem for the FX-Net system to ingest and display additional data sets and parameters. Work is presently conducted to try to display air quality data collected in the state of New Hampshire as part of the AIRMAP project. Other air quality parameters can be added in the future.

7. FUTURE ENHANCEMENTS TO SYSTEM

In order to enhance the usability of FX-Net National especially for the fire weather needs work is being conducted to serve additional high-resolution products. In the near future, FX-Net National will serve a very high-resolution visible image. The client will be able to choose an arbitrary view of visible satellite imagery by drawing a “view window” onto the existing CONUS or regional scale visible satellite image. The minimum size of this window will be defined by size of the primary window of the user interface. In addition to the high-resolution satellite image, FX-Net National will also provide arbitrary mosaics of radar products. These new high-resolution products will be complemented with additional high-resolution forecast models, such as the MM5 and the MM5/Chem. On the larger scales additional global satellite products will be served. Presently the global satellite products are limited to GOES-East and GOES-West. Plans are to add products from the Japanese geostationary satellite (GMS) as well as the European counterpart METEOSAT. Mosaics of all four geostationary satellites will allow provision of full hemispheric views of water vapor, infrared, or visible satellite imagery.

8. REFERENCES

Madine, S. and N. Wang, 1999: Delivery of Meteorological Products to an Internet Client Workstation. 15th Int. Conf. on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology, Dallas, TX, Amer. Meteor. Soc., 356-359

Wang, N., and S. Madine, 1998: FX-NET: A Java Based Internet Client Interface to the WFO-Advanced Workstation. 14th Int. Conf. on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology, Phoenix, AZ, amer. Meteor. Soc., 427-429