J3.19 TRANSFER OF FSL'S AWIPS TECHNOLOGY TO THE CENTRAL WEATHER BUREAU OF TAIWAN

Fanthune Moeng*
NOAA Research–Forecast Systems Laboratory
Boulder, Colorado

Mark Cheng
Central Weather Bureau
Taipei, Taiwan

1. INTRODUCTION

The Forecast Systems Laboratory (FSL) has been in the technology transfer business since 1980, when it was called the Program for Regional Observing and Forecasting Services (PROFS). Over the last two decades, FSL has achieved an extraordinary record of accomplishments and support in the development and implementation of the National Weather Service (NWS) Advanced Weather Interactive Processing System (AWIPS) and other systems.

FSL's technology transfer does not stop at the U.S. borders, but is spread to foreign countries in need of advanced weather information systems. FSL's longest standing cooperative project is the Joint Forecast Systems Project with the Central Weather Bureau (CWB) of Taiwan. Since 1990, FSL and CWB have gone through many phases of weather system development, and both organizations have learned much about information systems, data assimilation and modeling, high-performance computing, and observing systems.

This paper discusses the development and implementation of CWB's current forecast workstation, the Weather Integration and Nowcasting System (WINS), beginning with an overview of the FSL activities leading to AWIPS and the implementation of WINS.

Corresponding author address: Fanthune Moeng, NOAA/FSL, R/FS7, 325 Broadway, Boulder, CO 80305, fanthune.moeng@noaa.gov

2. PROTOTYPE WORKSTATIONS BEFORE AWIPS

In the pioneering days of PROFS, a methodology was established for developing and integrating capabilities with operational potential into an experimental weather forecasting system. During development of the PROFS system, FSL established a design approach that has been successful: build systems, discover their strengths and weaknesses, and rebuild–iterating toward a truly operational interactive system (MacDonald 1985). Running the prototypes in the operational environments brought a faster understanding of the types of systems needed for weather service organizations. For example, the DARE (Denver AWIPS Risk Reduction and Requirement Evaluation) system was tested at the Denver weather office (Bullock and Walts 1991) until it was replaced in 1996 with the AWIPS-like WFO-Advanced prototype (MacDonald and Wakefield 1996).

The WFO-Advanced prototype workstation became the AWIPS workstation prototype not only because it was designed to provide forecasters with a single source of atmospheric data on high-resolution displays but also because it could easily be adapted to run at any NWS site. Before it was officially commissioned as the AWIPS workstation prototype, the WFO-Advanced system underwent major software and hardware changes to accommodate evolving advances in technology (Grote and Biere 1998, Biere 1998, Kelly 1997). This system is a complicated real-time interactive information system (not a black box) for local forecast office use. The dynamic AWIPS workstation prototype system evolves over time to include new requirements and incorporation of new technology.

CWB's meteorological data sources, geographical scales, numerical weather prediction models, and communication systems are much different from FSL's. The CWB headquarters and local weather stations also specify different requirements related to forecast functions and responsibilities. The FSL-CWB joint project establishes necessary communication and training mechanisms in order to customize the CWB system to the many special needs of Taiwan. Indeed, the major challenge for the CWB project has been to customize the WFO-Advanced prototype workstation system into CWB's operational environment, to keep evolving with the ongoing AWIPS workstation development, and to take advantage of new capabilities.

FSL does not deliver turn-key systems to CWB (or any other organization), but works with visiting scientists on identifying critical components of the system and answering specific technique questions. To meet the challenges of system customization, FSL established an exchange visiting scientist program, as part of the long-term technology transfer relationship with CWB. Valuable resources involving training and experimental system development are provided to the visitors. Over the 10-year period from 1990–2000, CWB invested about 24 full-time staff (10 of which stayed at FSL from 6 months to a year) to the task of customizing its advanced forecast systems. Significant efforts involved replacing the whole AWIPS data ingest system with CWB's acquisition system, and defining local data, products, and menu configuration. Other efforts involved developing CWB's own depictables, case archive and review mechanism, remote site dissemination support, and other functions. FSL also trains CWB forecasters onsite (at CWB) to ensure that all users fully understand the functional and meteorological uses of this powerful system.

3. WINS AT THE CENTRAL WEATHER BUREAU

Based on FSL's PC-based forecast workstation system, CWB completed the first-generation WINS workstation during the first three years of the cooperative project. The workstation provided many advanced graphics and image manipulation capabilities that are available on the DARE system. The system is configured with a 486-PC and a special graphics board run on a Unix operating system; it became available in May 1992 to support the Post-TAMEX (Taiwan Area Mesoscale Experiment) forecast exercise. It was the first time that CWB forecasters could view observations and many other weather information integrated in a graphic workstation. The daily volume of all data sets was about 1 GB and over 3 GB for displayable products. The data sets were comprised of satellite, radar, lightning, mesonet, synoptic observations and model forecasts. The first-generation WINS-I was completely replaced by the second generation WINS-II by the end of 1999.

The WINS-II workstation is based on the WFO-Advanced workstation and its prototype became available at the beginning of 1997 at the CWB Forecast Center for further development evaluation. CWB is now getting ready to adopt AWIPS build 5.0. Figure 1 shows the WINS-II system components and data sets. The WINS-II system components include: Communication Gate Way to interface non-TCP/IP data sources, Central Product Generation Server to process and integrate weather information, Display Server to support Display Workstations accessing all products and updating product inventories, Product Service server to disseminate all products to remote sites, and Display Workstations for forecasters to query all kinds of weather information interactively. The meteorological data sets for WINS-II include conventional observations reports (including synop, temp, buoy, ship, and METAR), Taiwan local mesoscale observations (including 300+ raingauge, 36+ automatic meteorological stations, and lightning), numerical models (including ECMWF, NCEP/AVN, NCEP/MRF, JMA/Global, JMA/Regional, CWB/GFS, CWB/RFS, CWB/NFS, CWB/EFS), satellite data (GMS), radar (including 2 conventional radars, 2 Dopplers, 1 NEXRAD, and 2 Gemtromix Doppers); and other products from CGM graphics and raster images. The volume of all data sets is now about 4 GB per day.

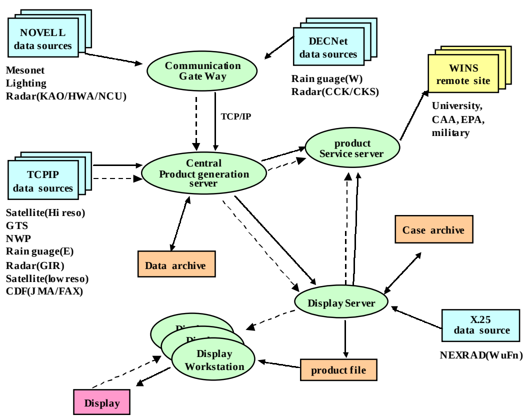

Fig. 1. *WINS Data Flow Diagram*

Figure 2 shows a snapshot of the WINS-II display workstation. The main pane at the right-hand side shows the echo and velocity composite of the Wu-Fan-Shan WSR-88D radar station displayed in Extend-Taiwan scale. The four small panes on the left, from the top are a GMS IR1 color-enhanced satellite image displayed in Asia scale, a Taiwan topographical height image displayed in Extend-Taiwan scale, a surface observations composite with 500-mb analysis and observations displayed in East-Asia scale, and a Skew-t plot of a Taipei upper-air sounding.

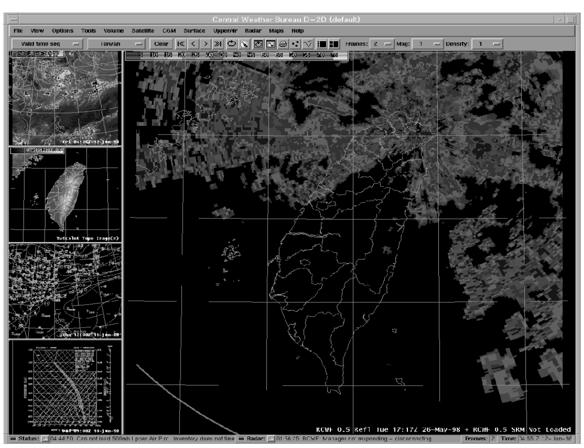

Fig. 2. *WINS workstation display system user interface showing AWIPS-like D2D display system*

4. FUTURE WORK ON WINS AND OTHER DEVELOPMENTS

WINS-II will continue to enhance its data collecting and weather information displaying capabilities, such as generic time-space cross section in volume browser, time height cross section for arbitrarily choosing a sounding station, time-series comparison between model and observation station, and GIS background map display capabilities in order to add another dimension to the weather data viewing capability.

CWB is about to begin a new phase of weather system developments in Very Short-Range weather Analysis and Forecast (VSRAF) in 2002. The major objective of this activity is to improve CWB's very short-range weather forecasts through local model development, severe weather monitoring and warning capability enhancement, and quantitative precipitation estimates. Other new developments are also under consideration for future AWIPS evolution, such as 3D display capability, PC-Linux system, and other new information system technologies.

5. CONCLUDING REMARKS

The Weather Forecast Center at the CWB today is very different from the one 12 years ago. In the modernized office, a projection system hook to the WINS-II display workstation replaces the old paper weather charts that hung on the wall, and the array of individual observation systems display monitor is gone. Now each forecaster has a desktop WINS-II forecast graphical workstation with a text processing workstation to do the forecast process, very much like a typical weather forecast office in the United States.

Before the WINS system became available, CWB forecasters needed to exam various weather data sources, each with an individual presentation medium and style. This made it very difficult for forecasters to digest and integrate all of the weather information quick enough. Forecasters spent too much time "collecting data" instead of monitoring and discerning the weather systems as they occurred in their respective areas of responsibility. Now WINS-II supports CWB's daily forecast operations and provides forecasters with a single, easy-to-use display system. This system also provides forecasters timely and consistent real-time mesoscale weather information so that they can track severe weather phenomena, and the forecast preparation time is significantly reduced.

CWB and FSL have cooperated for over 12 years, with significant accomplishments and mutual benefits. FSL has been successful in transferring workstation systems technology to CWB, and has also had the opportunity to learn from scientists and forecasters who deal with weather situations that are quite different from those in the United States. Moreover, it is quite rewarding to work with many people and organizations to build an operational early warning system that ultimately results in saving lives.

Now that CWB has built a substantial weather observation and forecasting infrastructure, it is ready to move forward into the next phase of development, taking full advantage of these powerful forecasting tools. Its very short-range forecasting will be improved to provide better services to help mitigate natural disasters caused by severe weather.

6. ACKNOWLEDGMENTS

We thanks many individuals from CWB and FSL involved and made significant contributions in this project. We wish to especially thank Director General Shinn-Liang Shieh and previous Director General Ching-Yen Ysay of CWB for their strong support and providing steady funding for this project. We wish to acknowledge Director Adolphus Shen who is the CWB project manager for this project. Finally we also acknowledge the pioneering contributions from the first group of visiting scientists from CWB in the winter of 1990. They are Shih Yun Chou, Chia Ping Cheng, Thomas Huang, Isle Lee and Claudia Lee.

7. REFERENCES

Biere, M., 1998: WFO-Advanced Two-Dimensional Display Software Design. *Fourteenth International Conference on Interactive and processing Systems for Meteorology, Hydrology and Oceanography*, Phoenix, AZ, Amer. Meteor. Soc., 376-379

Bullock, C. and D. Walts, 1991: Considerations for the DARE II design. *Seventh International Conference on Interactive and processing Systems for Meteorology, Hydrology and Oceanography*, New Orleans, LA, Amer. Meteor. Soc., 162-156

Grote, U.H., and M. Biere, 1998: The WFO-Advanced System Software Architecture. *14th International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology*, Phoenix, AZ, Amer. Meteor. Soc., 321–324.

Kelly, S., 1997: The Application Interface for the WFO-Advanced Forecast Workstation D2D. *Thirteenth International Conference on Interactive and processing Systems for Meteorology, Hydrology and Oceanography*, Long Beach, CA, Amer. Meteor. Soc., 328-331

MacDonald, A.E., 1985: Design considerations of operational meteorological systems: A perspective based upon the PROFS experience. *First International Conference on Interactive and processing Systems for Meteorology, Hydrology and Oceanography*, Los Angeles, CA, Amer. Meteor. Soc., 16-23

MacDonald, A.E. and J. Wakefield, 1996: WFO-Advanced: An AWIPS-like Prototype Forecast Workstation. *Twelfth International Conference on Interactive and processing Systems for Meteorology, Hydrology and Oceanography*, Atlanta, GA, Amer. Meteor. Soc., 190-193