AWIPS STATUS REPORT

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AWIPS Status Report:

An AWIPS Operations Case Study:

The Advanced Weather Interactive Processing System (AWIPS), is the keystone of the U.S. Weather Service's 15 year modernization program. When fully implemented, AWIPS will provide the primary communications, data ingest, data processing and management, data display and interaction, product generation, dissemination and distribution capabilities for all NWS field office operations.

AWIPS was designed to, among many other things, assist the WFO forecaster during local extreme weather events. It was designed to help the forecaster; 1) manage the massive amounts of weather information an extreme weather event can generate, 2) easily integrate, display and interact with a wide variety of data sets as part of the warning decision process, and 3) quickly generate and disseminate precise, accurate and timely warnings for those in harm's way.

On May 3, 1999, one of the largest tornado outbreaks in U. S. history struck a portion of the central plains of the United States. In less than 10 hours, at least 70 tornadoes were spawned from a dozen supercell thunderstorms over a relatively small area of central Oklahoma and southern Kansas. Many of these tornadoes were F4 and F5 in intensity, and some of the areas hit by these strongest storms were completely devastated (see figure 1). Most of the affected area was within the forecast and warning area of responsibility of the Norman, Oklahoma Forecast Office.

AWIPS was installed and being used operationally in the Norman Weather Forecast Office (WFO) at the time of this major outbreak. Therefore, a logical question to ask is "how did AWIPS do" in helping the forecasters in Oklahoma during the severe weather on May 3?

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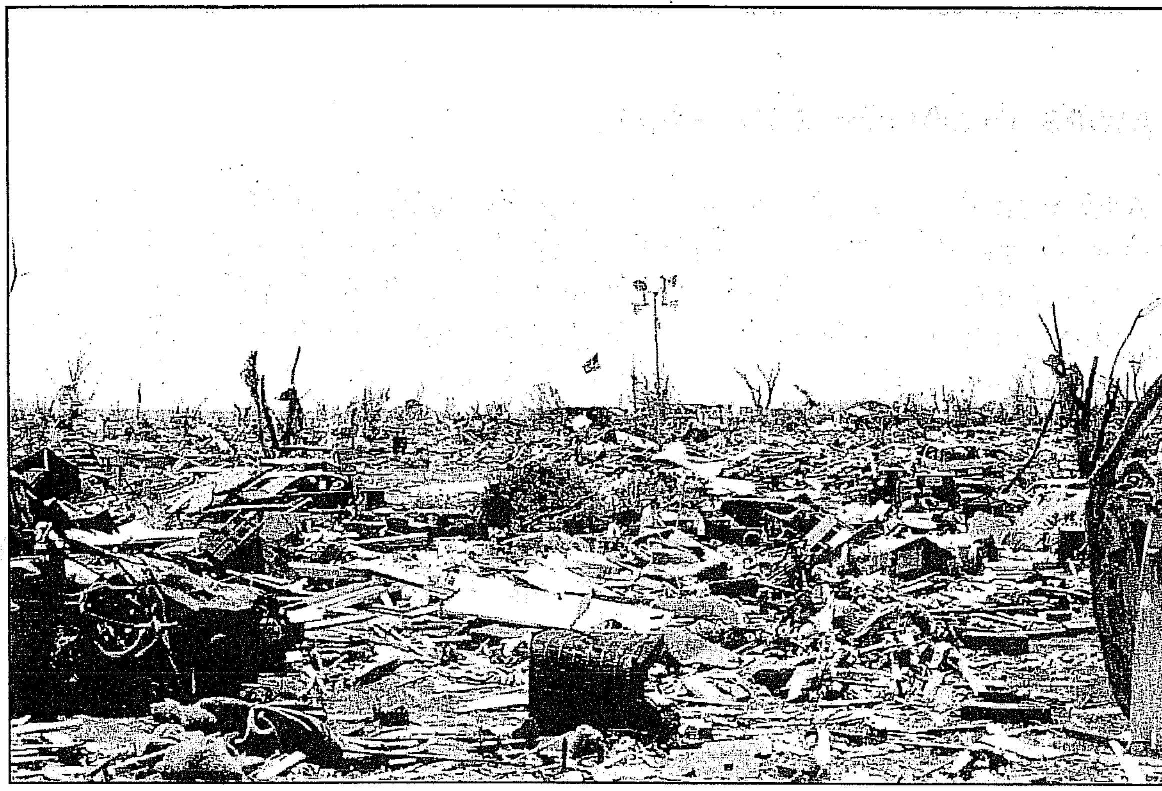

Figure 1. Damage from May 3, 1999 tornado near Oklahoma City, Ok.

The 70 separate tornadoes which were spawned by the storms of May 3, 1999. damaged or destroyed 4 schools, 2 churches, more than 340 businesses, and over 11,400 homes, resulting in well over $1.2 billion in property damage.

Tornadoes are not unusual in Oklahoma, so the Norman WFO staff is typically well prepared to handle most severe weather events. The Norman Science and Operations Officer (SOO) had prepared both the staff and the AWIPS system specifically to deal with large severe weather outbreaks. The staff frequently conducts severe weather drills as part of this preparation, and the local AWIPS system had been highly configured and tuned for such an event as well.

The Norman AWIPS system has 6 forecaster workstations, with one of these workstation normally dedicated to the support of severe weather operations when occurring. On this day, their AWIPS system was fully functional with a pre-commissioning version (v 4.1)of AWIPS software. The Norman office was receiving a continuous data stream from 3 dedicated doppler radars located in the area, and all AWIPS communications systems were operating normally with no significant delays in the receipt or transmission of data or warning products.

A supplemental WSR-88D Doppler radar data analysis system called the "Warning Decision Support System" (WDSS) was also being used at the time, and proved to be valuable. AWIPS was used to produce and disseminate all forecasts and warnings on that day.

What was unusual about May 3rd was both the number and the intensity of tornadoes which occurred in a concentrated area. The most intense and deadliest of the tornadoes was an F5 tornado which moved through Moore, Oklahoma, in the southern suburbs of the metropolitan Oklahoma City area, and just to the north of the Norman forecast office itself.

The staff of the Norman WFO issued 116 tornado and severe thunderstorm warnings during a 10 hour period beginning in late afternoon and evening of May 3. Another 61 storm related products were also generated during this time along with the normal suite of routine forecasts and other weather related products. In the U.S., warnings are issued for counties or parts of counties. A county is a geo-political area of typically a few hundred square kilometers. On this day, the lead time for all warnings generated for the first occurrence of a tornado in a specific county was 32 minutes. The average lead time for all warnings was 18 minutes. (In 1998, the average lead time for tornado warnings in the U.S. was approximately 11 minutes.) For the most severe tornado which struck in the heavily populated Moore area, and which was rated F5 on the Fujuita scale, residents had nearly an hour and 15 minutes advance warning.

The weather on May 3 and 4 was so severe, widespread, and continuous that for nearly the entire 10 hour period, 2 AWIPS workstations in the Norman WFO were used in continuous warning mode. This mode of operations is characterized by extensive display of, and interaction with, doppler radial velocity and reflectivity image loops simultaneously in several display windows of each workstation. Often these data are combined with other types of data on the displays, with frequent updates, zooms, pans, toggles, etc. At times, 4 of the 6 AWIPS workstations in Norman were being used in warning mode.

All of the 177 routine and warning related products produced during this period were prepared on AWIPS, with the 116 warnings prepared using a unique AWIPS graphical warning generation application called WarnGen. On several occasions, multiple workstations were simultaneously generating separate warnings. All warnings were both disseminated and monitored during their valid period using AWIPS functionality. In spite of this extreme stress on the system, there was only one minor system malfunction which was quickly corrected, and which resulted in a delay of less than one minute in the dissemination of only one of the 116 warnings.

48 people were killed from these tornadoes. The tragedy of these deaths is somewhat mitigated by the realization that the number could easily have been very much larger. The tornadoes mostly struck in the early evening after most children were home from school and their parents home from work. Most residents of the region were in their homes. Nearly 5,000 homes, many with the entire families in them, were completely destroyed, yet only 1 person was killed for every 100 homes destroyed. And further, more than 9 of every 10 homes directly hit by a tornado that day did not suffer a single injury. These numbers are amazingly low given the intensity of many of these storms.

In some areas, the destruction from these storms was almost total. Some of the May 3 tornadoes were so intense that they literally stripped paint from automobiles and cleared a swath of destruction across the landscape completely down to bare ground.

Experts from official disaster survey teams who surveyed the incredible destruction of these storms stated that, unquestionably, without the advanced warnings which were issued, and without extensive local planning and preparation for such an event, many more people would have been killed and injured. Some casualty prediction estimates were as high as potentially over 600 killed and many thousands could have been injured from such an severe outbreak. However, from the storms of May 3rd, only 48 people died and fewer than a thousand were injured.

The staff at the Norman forecast office did an outstanding job of staying abreast of the massive severe weather outbreak of May 3, and of keeping the public warned and the media, emergency managers, and other responsible officials fully informed. They gave much of the credit for their ability to handle such a large outbreak to the capabilities and performance of their AWIPS system. As Dennis McCarthy, Meteorologist in Charge of the Norman WFO stated, "AWIPS was the key to our ability to successfully handle such a large severe weather event."

The AWIPS Program

Current Status (Fall, 1999):

Initial deployment of the AWIPS systems to all NWS sites was completed this past summer. This includes 121 Weather Forecast Offices, 13 River Forecast Centers, 8 regional and national headquarter sites, and 8 others sites, including several software development sites. Currently, the system is being used operationally by all WFO's and RFC'c even as it continuously evolves. Both the hardware and site software, as well as most elements of the communications networks, are undergoing upgrades.

Operating in "commissioned mode" means that a site has virtually eliminated any dependencies on legacy systems, and operates almost exclusively using AWIPS. At the current time, 5 sites have already converted to this mode of operations and many more are on the verge. Formal commissioning will not occur until early next calendar year.

AWIPS Communications Architecture:

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The AWIPS Communication Architecture consists of 3 primary components;

(1) The central Network Control Facility (NCF) which is
   a. The central hub and monitor point for all network communications
   b. The link to SBN Master Ground Station via 5 T1 lines
   c. The AWIPS interface to the outside world via the NWS's Telecommunication Gateway

(2) The Satellite Broadcast Network, a C-band point-to-multipoint network which consists of 4 separate T1 data channels with forward error correction modems. A 5th SBN channel will be added in 2001. Currently most WFOs and RFC receive only 2 of those data channels - a GOES satellite data channel and the channel which carries conventional observational data, model grids, and other products. And...

(3) The Terrestrial Wide Area point-to-point and multipoint-to-point Network (WAN) is arranged as a series of star hubs. All hubs are connected to the NCF via 2 PVC links of up to 768 Kbps and a PVC link to one other hub site. Each starred spur is "dual homed" to 2 hubs via 64 kbps PVC links and uses the Open Shortest Path First protocol. This network is used primarily by the sites to disseminate their local observations (including a select set of doppler radar products), forecasts and warnings.

All WAN PVC links are currently scheduled for upgrades within the next year.

Site Architecture:

Each WFO is equipped with redundant data servers (DS); each DS is a dual processor Hewlett-Packard (H-P) D380 computer. One DS is active and the other operates as a "hot" spare. The critical AWIPS data base is mirrored and automatic failover is accomplished via a commercial H-P product called ServiceGuard.

Each WFO site is also equipped with dual H-P D350 Application Servers and up to 6 J-200/210 workstations. Workstation memory has recently been upgraded to 512 Mbytes per machine.

Most site components are interconnected via a 100 Mbps FDDI LAN. For data acquisition, each major data source is interfaced to a dedicated and backup front end processor which provide a variety of protocol handling and preprocessing functions.

Operational Test and Evaluation:

This past summer the AWIPS system underwent a comprehensive Operational Test and Evaluation. This was an extensive 6-week test involving 6 field sites, 4 WFO's and 2 RFC's, and encompassed a variety of weather scenarios and climate regimes. While some problems were identified, the test was considered highly successful. A final OT&E report is available from the National Weather Service.

AWIPS Software Builds:

AWIPS functionality is evolving incrementally via periodic software upgrades called "Builds". Each major build adds significant new functionality or infrastructure while "Point" releases may add limited new functionality, infrastructure upgrades, urgent fixes, etc.

The U.S. National Weather Service has currently fielded Build 4.2.5, which has a number of minor upgrades and fixes from the Build (4.2) used to conduct the OT&E this past summer. Build 4.3 is now undergoing formal testing for deployment targeted for next February (2000). Some highlights of 4.3 include additional gridded data sets (including some global grids) and better ways of displaying them, improved radar displays, and new tools for managing locally acquired data. Build 5.0 is now in development, and the contents of AWIPS Builds beyond that are still being defined.

The major new functionality to be delivered with Build 5.0 include:

(1) Interactive Forecast Preparation System,

(2) a WEB-based dissemination capability,

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(3) several additions to support the National Centers (Global data sets, new scales, etc.),
(4) the usual addition of new data sets and functionality.

Summary:

The AWIPS system deployment has been completed nationwide. While some sites are still adjusting to the newness of having AWIPS installed and are still learning how to efficiently use the system, other sites which have used the system longer have become both quite proficient in its use and operationally dependent on it. It has been extensively tested operationally both in a very controlled field environment and under extreme fire, and has proven to be powerful, flexible, and robust. Upgrades to system hardware, software, and communications components are ongoing, and will likely continue for the foreseeable future. Formal commissioning of the AWIPS system will begin early in 2000.