7.3 THE EVOLUTION OF AWIPS

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1. INTRODUCTION

NOAA's National Weather Service (NWS) has been using the Advanced Weather Interactive Processing System (AWIPS) technology in its forecast offices operationally since 1999. AWIPS has provided a platform for conducting operations, but increasing operational demands are stressing the system in a manner that can not be accommodated by the original hardware, software, and communications architecture. Higher resolution numerical model guidance, increased resolution and number of remote sensing products and introduction of digital services have all contributed to the need for more processing, communications, and display power.

The plans provide a path for AWIPS to evolve towards a modern network oriented architecture that takes advantage of proven industry standards. This paper defines the overall plan and vision for the evolution of AWIPS.

2. WHAT IS AWIPS?

As the integrating element of the NWS Modernization, AWIPS combines data from modernized observation systems, such as NEXRAD, ASOS and GOES into a single processing and display environment. It consists of a suite of hardware, communications and software components.

2.1 *AWIPS Hardware*

There are AWIPS systems at 135 field sites (122 Weather Forecast Offices (WFOS), 13 River Forecast Centers (RFCs)). Systems located a National Centers, headquarters, and training organizations or development and test systems make up the remainder of the 169 AWIPS installations. Each installation has three to six workstations, four servers, network attached storage device and associated peripherals (See Figure 1). The hardware associated with AWIPS has been updated in recent years with the migration to Linux and commodity platforms.

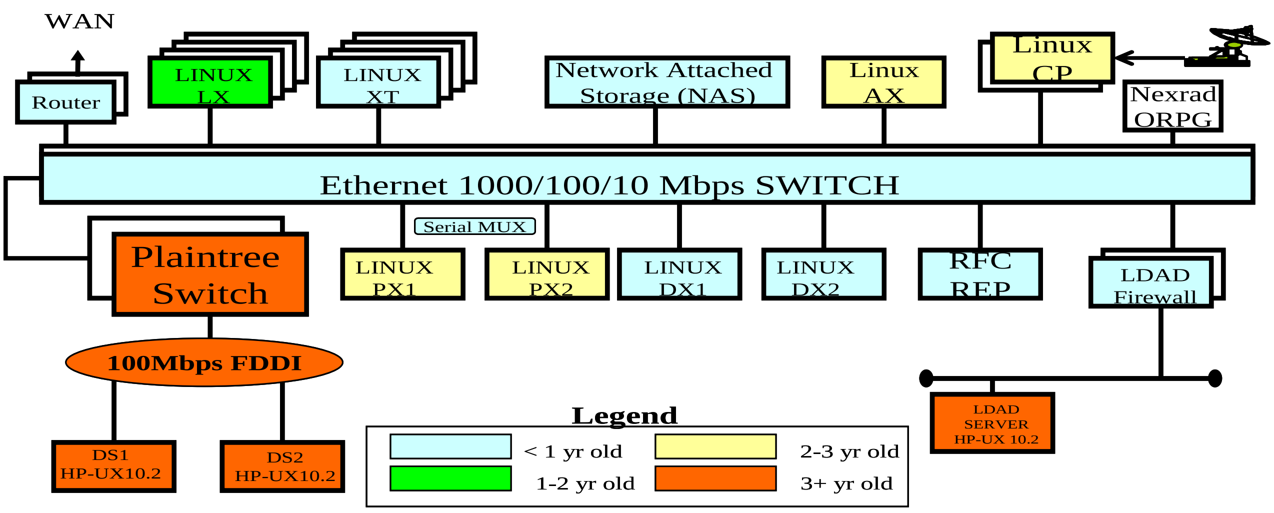

Figure 1: AWIPS Site Architecture

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2.2 *AWIPS Communications*

There are two components of the communications architecture of AWIPS: the Satellite Broadcast Network (SBN) and the Wide Area Network (WAN). The SBN provides reliable multicast data transmission to field sites. It recently migrated to Digital Video Broadcast over Satellite (DVB-S), a single channel solution that is linearly scalable up to 43 Mbps. The WAN is a dual homed, redundant, inter-meshed hub and spoke frame relay network. The WAN carries radar product data from all WFOs for central collection and dissemination over the SBN, retransmission requests for data not received over the SBN, and an increasing amount of inter-site coordination data. Scalability only limited by capacity of the leased bandwidth.

2.3 *AWIPS Software*

The software architecture of AWIPS has not changed fundamentally since it was initially deployed. This architecture is becoming increasingly harder to maintain and increases cost to infusion of new science into the system.

AWIPS software is comprised of more the 5M lines of source code, in a variety of languages (C/C++, Fortran, Python, Java, Perl, Tcl/Tk, X, and Motif). AWIPS has moved away for using Informix® to support the database to the open source solution PostGres. Approximately 95% of the software is Government developed.

Major software components include:

- Visualization environment tool,
- Warning tools,
- Forecast preparation tools for public, marine, fire weather, and aviation forecasts,
- Decision Assistance Tools supporting severe weather, flash floods and maritime, and
- Infrastructure which includes data ingest, decoding, and storage, communication routines, and database access.

3. THE CASE FOR CHANGE

Increasing data volumes, demands for the integration of new science into operations and software maintenance costs were putting a strain on system in 2003-2004. The Office of Science and Technology conducted an analysis of the components of the system against performance, management and control, security, operations and maintenance, product improvement plans, documentation, requirements, funding, and cost effectiveness.

The hardware and communications components of AWIPS were determined to satisfy the criteria defined above. The migration to the Linux operating system, which is targeted to be completed with AWIPS Operational Build 7, enabled the use of commodity hardware workstations and servers. This migration both increased the available performance of AWIPS workstations and servers and decreased the hardware costs. Similarly, the migration of the satellite broadcast network into a single channel DVB-S provides the NWS with flexibility in the communications arena. Any additional improvements in these areas will enhance mission operations.

The existing software architecture was found to be inadequate when evaluated against the criteria. As a result of the size and complexity of the AWIPS software, the number of critical deficiencies reaching the field and the cost of software development and maintenance has increased. Major applications often conflict with each other, use different visualization environments and store the same data redundantly.

The fundamental conclusion from the analysis was that AWIPS had a solid hardware and communications baseline, but was architecturally challenged to meet the increasing data volumes, collaborative requirements, and responsiveness to add new science and functionally.

4. AWIPS EVOLUTION

In August 2005, Raytheon Technical Services (i.e., Raytheon) was awarded the follow on Operations and Maintenance (O&M) contract for AWIPS. Under this five base year performance based contract, Raytheon is responsible for the following core O&M components:

- Network Control Facility Operations,
- Satellite Broadcast Network Operations, and
- Software Integration and Test.

In addition, the Raytheon contract also includes options for sustaining engineering, software maintenance and product improvement which covers hardware, communications, and software.

Raytheon proposes implementing a service oriented architecture (SOA) for the software. Under their proposal, Raytheon plans to implement a J2EE enterprise service bus as the SOA infrastructure. However, an SOA approach will not necessarily address the full spectrum of AWIPS needs.

4.1 *AWIPS Needs*

AWIPS has documented shortcomings and functional needs in four major areas:

- Data Delivery and Information Architecture
- Visualization
- Collaboration, and
- Information Generation.

4.1.1 Data delivery and Information Architecture

AWIPS only has access to data resident locally. Data are delivered to the system via the SBN or through ftp ingest via the Local Data Acquisition and Dissemination. If the data are not resident locally on the system, AWIPS does not recognize it.

The SBN is a cost efficient means of delivery data to a site. However, studies have shown that forecasters only use a small percentage of the data delivered to the site. Thus, on a cost per megabyte used, the SBN may not be necessarily a cost efficient means of delivering data that is actually used by the forecaster. A data pull technology may provide the capability to deliver data that is less frequently used or not mission critical. Davis and Edwards (2006) provide an overview of potential solutions to this requirement. The final technical solution will be driven by both the business case as well as the operational needs of the NWS.

4.1.2 Visualization

AWIPS currently supports a number of different data visualization environments. While the primary visualization environment is Display 2-D, the Graphical Forecast Editor and hydrological software also support their own independent visualization environments. This has led to significant differences in the look and feel of applications as well as inability to display data common to the different environments.

As a result, there is a requirement to create a common visualization environment, with APIs and tools (Grote and McInerney (2006)). By moving in the direction of a common visualization environment the overall look and feel of AWIPS applications will become more standardized. This standardization should lead to a reduction in the training and improved usability of the applications by the forecaster.

4.1.3 Collaboration

NOAA's National Weather Service is moving beyond the WFO-centric mode of operations. There is an increasing emphasis on collaboration with the move to digital services. Our current collaboration tools include a COTS chat package and inter-site coordination of digital grids. The inter-site coordination infrastructure is relatively inefficient.

The new architecture must support an infrastructure for collaboration at three separate and distinct levels:

- Internal NWS collaboration between National Centers, WFOs and RFCs,
- Internal NOAA collaboration between NWS offices and other NOAA entities, and
- External collaboration between WFOs and trusted partners, e.g., Emergency Managers.

4.1.4 Information Generation

AWIPS currently supports a number of applications that are designed to produce unique products and services. Each of these applications employs a different design in order to produce products. As a result, there has been a proliferation of incompatible product templates and inability to adopt emerging dissemination technologies in an integrated fashion. This product and service generation infrastructure needs to be standardized in order to take greater advantage of the web and other dissemination paradigms.

4.1.5 Outcomes of AWIPS Evolution

All of these changes to the underlying architecture are not taken on lightly. Once a new architecture is in place, we anticipate the following benefits:

- Increased integration of AWIPS and National Centers AWIPS

- Improved research to applications throughput
- Increased access to all environmental data for decision making
- Reduction of software O&M costs and reduced tech refresh costs, and,
- Increased flexibility to seamlessly transfer operational functions and responsibilities between WFOs and National Centers for new concepts of operation.

5. CHALLENGES AND RISKS

Making a fundamental change to the underlying software architecture in an operational system is a risky proposition, akin to changing the tire on a car moving 60 miles per hour. This must be managed carefully, so that all critical functionality is preserved and migrated into the new architecture. Most importantly, performance measures will have to be developed against which we will measure the performance of the new architecture.

6. SUMMARY

AWIPS is a solid operational system that currently meets the majority of the needs of the operational forecasters in NOAA's NWS. The shift to the digital services paradigm, increasing data volumes and computational demands has shown that the current architecture can not adequately support future requirements. AWIPS is embarking on an ambitious re-architecture which will allow the migration of the entire system infrastructure to a modern SOA. This re-architecture will leave the NWS better able to take advantage of new science and concepts of operation.

7. REFERENCES

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