8.A.1 AWIPS Technology Infusion – Status Update

Jason P. Tuell[1], Steve S. Schotz, Ronla K. Henry
NOAA/National Weather Service
Office of Science and Technology

David Plummer
NOAA/National Weather Service
National Centers for Environmental Prediction

1. Introduction

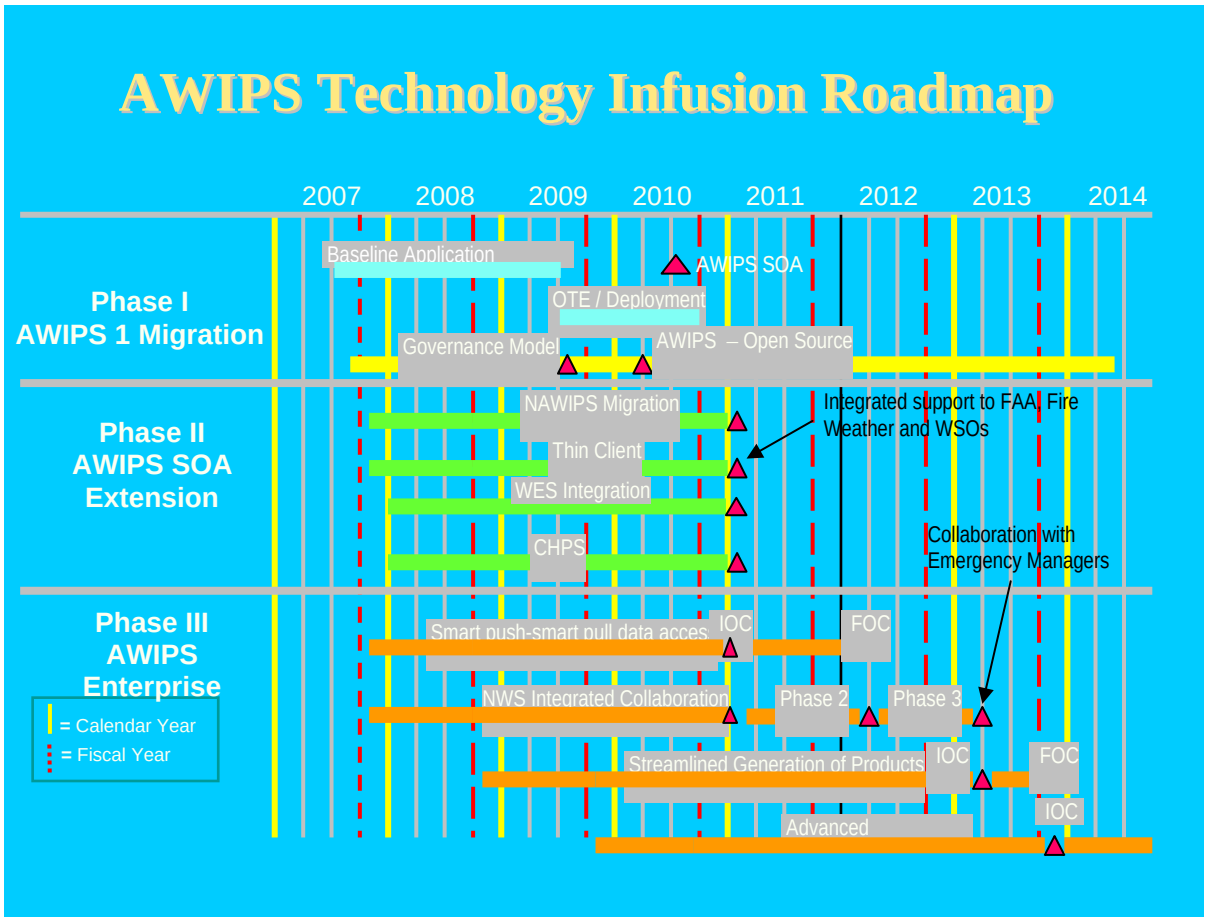
The Advanced Weather Interactive Processing System (AWIPS) Technology Infusion is a multi-phase program that will deliver a modern, robust software infrastructure to the entire National Weather Service (NWS) enterprise and will include a series of major system enhancements to allow the NWS to meet its future mission requirements. The first phase includes a re-architecture of the software infrastructure to a Service Orientated Architecture (SOA) and a migration of the Weather Forecast Office (WFO) and River Forecast Center (RFC) applications to the SOA. The second phase includes extending the SOA to incorporate applications across the NWS enterprise including the migration of National Centers AWIPS (NAWIPS) into the SOA. The third phase includes several major enhancements that will benefit the entire enterprise.

This paper reports on the current status and plans of each phase of the AWIPS Technology Infusion Program. For each phase, key benefits, project status, and plans are described.

2. AWIPS Technology Infusion Projects Summary

AWIPS Technology Infusion is a three phase multi-year program consisting of several projects. The roadmap for AWIPS Technology Infusion is shown in Figure 1.

[1] Corresponding author address: NOAA/NWS 1325 East West Highway, W/OST12, Silver Spring, MD 20910



2.1 Phase I: Migration of WFO/RFC Applications to SOA

The first and most critical phase of AWIPS Technology Infusion is to develop the SOA infrastructure and migrate the current AWIPS baseline functionality into the SOA. The migration paves the way for the NWS to address several key NWS mission challenges including providing uncertainty forecast products and services, developing more effective decision assistance support, and providing the capacity to more effectively exploit new data systems such as advanced weather satellites (GOES-R, NPOESS), and advanced numerical weather and ensemble prediction systems. The SOA infrastructure lays the foundation for many of the follow on projects described in later sections of this paper. In addition, the migration to the SOA will decrease life cycle software development costs by reducing software lines of code and complexity and reducing system down time by over 50% due to software upgrades. It will also provide a better infrastructure than the current AWIPS for shorting the transition from research to operations, e.g., providing the capacity for collaborators to develop plug-ins for new data types.

Raytheon Technical Services (RTS), the prime AWIPS contractor, is responsible for the SOA development and migration of AWIPS baseline applications to the SOA. RTS is delivering incremental AWIPS functionality to the NWS for testing and evaluation through a series of

Task Orders (TO). In 2009, two more task orders are planned to complete the migration of functionality, TO10 and TO11. TO10 will focus primarily on incorporating hydrological functionality into the SOA and additional refinements to the SOA infrastructure. TO11 will complete the migration including adding the necessary communications and product decimation capabilities. The AWIPS SOA Operational Test and Evaluation (OTE) is planned to begin in the Fall of 2009 with deployment targeted for 2010. See, Henry et al 2009, for a more detailed description of the AWIPS baseline migration activities.

2.2 Phase II: AWIPS SOA Extension

The objective of this phase is to extend AWIPS to support forecast operations across the entire NWS enterprise. Four subprojects are included in this phase.

2.2.1 NAWIPS migration

NAWIPS includes a wide spectrum of meteorological applications and support functions for the visualization of meteorological data and generation of products. Used primarily to support NCEP operational forecast production, the system has been in use since the early 1990s. Other users include the NWS Alaska and Pacific Regions for their National Center-like functions and select RFCs to support their quantitative precipitation forecast functions. Additionally, NAWIPS is distributed to the University Corporation for Atmospheric Research (UCAR) Unidata Program that provides NAWIPS to the university community (including about 200 universities) for academic and research purposes.

Incorporating NAWIPS capabilities into the AWIPS SOA will enable more effective collaboration among NWS operational units including NCs, WFOs, RFCs, and Central Weather Service Units (CWSUs). In addition, sharing a common software infrastructure will provide the opportunity for sharing common capabilities across the enterprise, thus reducing software life cycle costs.

NAWIPS functionality is currently being migrated into the AWIPS SOA by the NAWIPS development team, NCEP/Central Operations, in collaboration with the NWS Office of Science and Technology and RTS. During the migration period, incremental deliveries of NAWIPS functionality will be provided to the NAWIPS user community for testing and evaluation purposes. The migration effort is targeted for completion in FY11. See Jacobs et al., 2009 for details.

2.2.2 AWIPS Thin Client

The objective of the AWIPS Thin Client project is to develop and deploy an integrated thin client solution within the AWIPS SOA that will satisfy NWS AWIPS remote access requirements. An integrated thin client solution will allow remote users to access the latest AWIPS baseline capabilities. The thin client capability will be used by the Incident Meteorologists (IMETs) in the field during hazardous incidents such as wild land fires, aftermath of hurricanes and tornados, and oil spills to provide critical decision making support to emergency management officials. In addition, NWS forecasters at Weather Service Offices (WSOs) in the Alaska and Pacific Regions will use the thin client as an

integral part of their forecast and watch/warning/advisory process. WSOs are not directly connected to AWPS for either data receipt or transmission of products. Thus the AWIPS thin client will allow WSO forecasters to remotely access AWIPS capabilities with limited bandwidth. The Thin Client will also support backup and Continuity of Operations Planning (COOP) requirements at RFCs and National Centers, respectively.

Activities are underway for the Thin Client project. In 2008, the concept of operations for its use was defined and technical requirements will be specified in 2009. Development is planned for 2010 with target deployment of the thin client capability in 2011.

2.2.3 Weather Event Simulator (WES)

The current baseline operational AWIPS training infrastructure and tool set does not allow for the comprehensive training necessary to develop fundamental skill in using operational software to provide NOAA/NWS core mission products and services. In response to the lack of operational training capabilities, non-baseline interim solutions have been developed and supported outside of the AWIPS program, such as the Weather Event Simulator (WES). These applications provide basic static playback and simulation capabilities for a subset of AWIPS applications used by Weather Service Forecast Offices (WFOs). While WES has become critical component of NWS significant weather season preparations, it still lacks the comprehensive capabilities needed to fully support the diversity of current AWIPS applications.

The purpose of the WES project is to develop an AWIPS baseline solution to address the comprehensive NWS training requirements. The WES project is multi-phased. In the near term, the current WES is being modified to work in the AWIPS SOA as a bridge until the baseline solution becomes available. This work is being performed by the WES development team who are part of the NWS Warning Decision Training Branch and will be in place when the SOA is deployed. The second phase will develop the more comprehensive training capabilities directly in the AWIPS SOA. Development of the baseline training capability will begin in 2010 with an IOC targeted for 2011.

2.2.4 Community Hydrologic Prediction System (CHPS)

NOAA's NWS River Forecast Centers (RFCs) are key partners in the provision of water resource information. Existing computational infrastructure software - the NWS River Forecast System (NWSRFS) - has been a part of RFC operations since the 1970's. The NWSRFS is a subsystem of AWIPS comprising approximately 800,000 lines of source code. RFCs use this subsystem to model river and stream behavior based on observed precipitation and other data, prior to issuing forecast guidance to customers and partners, and also to the WFOs that issue official forecasts. The NWSRFS system is costly to sustain and is not flexible enough to support future hydrometeorological requirements.

The purpose of the CHPS project is to develop and deploy a replacement system at the RFCs to help NOAA's

Hydrologic Program meet its future goals. CHPS will be interfaced with AWIPS SOA to ensure seamless data and product flows across the enterprise. The realization of the CHPS project will complement other Hydrology activities, in particular the Advanced Hydrologic Prediction Service (AHPS). It will also help to significantly reduce the transition of science to operations.

CHPS is utilizing an open software framework called Flood Early Warning System (FEWS) developed originally by a Dutch hydraulics engineering company WL Delft, now part of Deltares.

The migration from NWSRFS to CHPS will be conducted in a staged manner. In 2008, a Concept of Operations was defined for CHPS. A select group of four RFCs (Front-Runner) RFCs have been selected to evaluate CHPS in parallel with the current system. The evaluation, that will begin in early 2009, will help refine hardware requirements and guide any necessary development to meet IOC requirements. The remaining nine RFCs will run CHPS in parallel with current operations in 2010 with a target IOC for all RFCs in 2011.

2.3 AWIPS Enterprise Enhancements

2.3.1 Data Delivery

Access to data and information is critical to the ability of the operational personnel to support the mission of the NWS. The amount of data provided to and used by the forecaster is rapidly increasing. This growth of data volume is due to improved higher resolution numerical weather prediction models, the need to access model ensemble members to support the creation of uncertainty products, and the addition of new and enhanced data associated with GOES-R, National Polar-orbiting Operational Environmental Satellite System (NPOESS) and radar systems. Many of these areas of data growth are not accounted for within the existing requirements baseline of AWIPS and the existing data distribution and data access infrastructure. As a result, AWIPS needs to be modified to more effectively and efficiently deal with increasing data needs and resultant forecaster data access requirements.

The goal is to develop a data delivery system to enable access to data independent of its location, i.e., provide access to data not resident locally at the Weather Forecast Office (WFO), River Forecast Center (RFC) or National Center (NC). The new data delivery system would not replace existing data distribution mechanisms, e.g., broadcast by the SBN, but rather, augment the existing data distribution systems. The new data delivery system will also have to be compatible with NextGen 4-D Cube requirements.

To meet the objects of the Data Delivery project, the following types of capabilities are envisioned and thus will be explored and implemented:

- Data registry services will provide a means to publish data sources and metadata information and allow for the introduction of new data services.
- Data discovery services will provide for a system that can discover datasets and necessary associated metadata, e.g.,

Extensible Markup Language (XML) schemas, needed to access those datasets.

- "Smart" push/pull technologies that will provide the means to subset the data by user selectable field value, time, space, ensemble member, etc., parameters. Such data set filtering will be done on an ad-hoc user request basis or in a pre-defined way where particular data subsets are known based upon upcoming weather.

Given the challenges of interfacing with a variety of data systems, the strategy envisioned for the Data Delivery project is multi-phase. The Initial Operational Capability (IOC) will likely be limited to developing a more distributed data distribution methodology among NWS systems probably focusing on a limited set of data types for example model data. The methodology will be expanded to accommodate additional data types and interface with systems outside the NWS in the Final Operational Capability (FOC) phase. Given the breadth of the FOC scope, enhancements to the data delivery mechanisms envisioned in this project will provide a foundation for the establishment of a broader NWS Enterprise Architecture (EA).

Activities are underway for the Data Delivery project. In 2008, the initial project plan was defined. In 2009, an evaluation of candidate technologies such as the Joint METOC Broker Language (JMBL) and NOAA National Operational Model Archive & Distribution System (NOMADS) will be conducted to assess their viability. In addition, prototyping using the AWIPS Development Environment (ADE) will be conducted. Development for IOC is planned for 2010 with IOC deployment targeted for 2011.

2.3.2 Collaboration

The NWS operational units including NCEP Centers, Weather Forecast Offices (WFOs), River Forecast Centers (RFCs) and Central Weather Service Units (CWSUs) provide a variety of products and services to partners and customers. Effective collaboration among operational units is critical to ensure that NWS provides a seamless suite of products and services across the enterprise. New AWIPS tools are needed to allow for more effective real-time collaboration between NWS operational units to allow for coordination earlier in the forecast process than is possible today. In addition, there is a growing need for more effective collaboration between NWS forecasters and partners such as emergency mangers to support their decision making processes especially with respect to high impact events. Today's AWIPS provides limited collaboration tools that cannot be utilized across the enterprise and limited capabilities to collaborate with partners.

To support collaboration across the NWS enterprise, baseline AWIPS collaboration capabilities will be developed that can be effectively and efficiently used by all pertinent AWIPS applications. It is envisioned that this project will be conducted in three major phases to allow for refinements as capabilities are developed. The first phase will focus primarily on developing an initial set of capabilities to improve collaboration among NWS

operational units. The second and third phases will improve the initial set of capabilities based upon operational feedback. In addition, the second and third phases will include capabilities to address requirements to more effectively collaborate with trusted partners. Exploratory development, e.g., prototyping, will be included in each phase to aid requirements definition and reduce development risk.

In 2009, operational scenarios and use cases will be developed to support collaboration needs among NWS operational units including National Centers, WFOs, RFCs and CWSUs. Prototypes will be developed to evaluate AWIPS SOA collaboration capabilities and support use case creation. Phase 1 collaboration development is planned for FY10 with deployment targeted for FY11.

2.3.3 Information Generation

AWIPS currently provides a variety of tools for producing tailored products and services to the public, other agencies, and external customers. These products include watches and warnings as well as routine forecasts and reports. The current AWIPS information toolset constrains the NWS's ability to disseminate the full range of information that will be required by its partners, e.g., emergency managers, and external customers in the future.

The objective of the Information Generation project is to develop the necessary infrastructure to support a common set of information generation and tools across the enterprise. The improved information generation infrastructure will allow the NWS to enhance existing products and services faster than is possible in today's AWIPS. It will also establish infrastructure and delivery of services for new product requirements such as GIS and Extended Markup Languages (XML) based formats, e.g., Common Alerting Protocol (CAP) that can be used more effectively to support decision assistance requirements for NWS partners and customers.

It is envisioned that information generation will be a multi-phased project. In 2009, an initial project plan will be defined with IOC targeted for 2011.

2.3.4 Advanced Visualization

The AWIPS SOA employs the Common AWIPS Visualization Environment (CAVE) that enables AWIPS applications to utilize a standard suite of hydrometeorological display techniques. However advanced visualization techniques need to be developed to allow forecasters to fully exploit emerging requirements in several mission critical areas.

New and more data rich observing systems will be deployed in the near future. For example, GOES-R will deploy an additional 11 channels requiring not only individual processing and display of each, but require new image based technique development such as multi-color (or multi-channel) composites. These new channels and techniques will provide forecasters new perspectives never seen which will improve the forecast process, but only if the necessary development is done to incorporate the technology into operations. In addition, new three

dimension/four dimension (3D/4D) radar requirements emerging from the multi-agency (MDL, SEC, NSSL, FLS, University of Oklahoma) Four-Dimensional Stormcell Investigator (FIS) project, otherwise known as Warning Decision Support System – Integrated Information (WDSSII), need to be incorporated into the AWIPS CAVE in such a way that other AWIPS applications can take advantage of the 3D/4D techniques. This will allow 3D/4D techniques to be used by forecasters to visualize other data sets such and numerical weather prediction model outputs.

There is also need to standardize, where warranted, the look & feel of AWIPS applications. Standardizing interface designs will reduce development and maintenance costs between development organizations and will simplify training and increase usability for operational personnel.

It is envisioned that developing advanced visualization infrastructure and techniques will be a multi-phased long - term project. In 2009, an initial project plan will be defined. Follow on exploratory and prototyping will be conducted in the out years with IOC targeted for 2013.

3.0 Summary

The AWIPS Technology Infusion Program will provide the modern, robust infrastructure necessary for the NWS to meet its future, critical mission challenges. The AWIPS I migration to the SOA is well underway with the WFO and RFC applications migration to be completed in 2009. The phase II and phase III projects that extend the SOA to forecast functions across the NWS enterprise and implement major system enhancements are also in progress with implementation for these projects targeted as early as 2011.

The views expressed are those of the authors and do not necessarily represent those of the National Weather Service.

4.0 References

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