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## 1. Introduction

The Warning Decision Training Branch (WDTB) develops warning decision making training for all offices across the National Weather Service (NWS). Training development on this magnitude requires a diverse set of data for case building and operationally relevant software for display. WDTB has configured an effective data ingest, display, and archival system to accomplish the following objectives:

- Establish a central hub for training case datasets to be viewable by the Advanced Weather Interactive Processing System (AWIPS) Display 2 Dimensions (D2D)
- Allow trainers to view data in real time from any County Warning Area (CWA)
- Provide archiving functionality to capture real-time data for training case creation
- Install multiple AWIPS builds, including alpha and beta builds, allowing trainers to develop experience with the latest software in support of AWIPS training
- Integrate the AWIPS-based capabilities to the new java-based AWIPS-II, allowing for the viewing of both AWIPS-I and AWIPS-II during the transition

Cooperative Institute for Mesoscale Meteorological Studies (CIMMS) scientists in collaboration with WDTB have successfully accomplished these objectives using publically available components. The main components used in data ingest include Unidata's Local Data Manager (LDM) (Unidata 2008), the Next Generation Radar (NEXRAD) program's Common Operations and Development Environment (CODE) (Ganger et al. 2002), and AWIPS components available through The Weather Event

Simulator (WES) (Magsig et al. 2004). The AWIPS software also serves as the visualization backbone of the system which is organized through the WDTB Weather Case Browser (Yu et al. 2005). The system has evolved from a single AWIPS build with basic satellite, grid, point, and limited radar data to multiple AWIPS builds including full radar product creation for any WSR-88D. A dedicated live data feed for the TOKC Terminal Doppler Weather Radar (TDWR) has also been established and the system supports other unique data sources, like Dual-Pol radar and the expansive surface observations of the Meteorological Assimilation Data Ingest System (MADIS). While the foundation of the ingest and display is AWIPS-I software, AWIPS-II capabilities have also been added using preliminary AWIPS-II task orders to prepare for the major upgrade to AWIPS-II in 2010 (Stricklett et al. 2008).

This paper will give an overview on each of the system elements along with examples of collaborative activities in which this system is used.

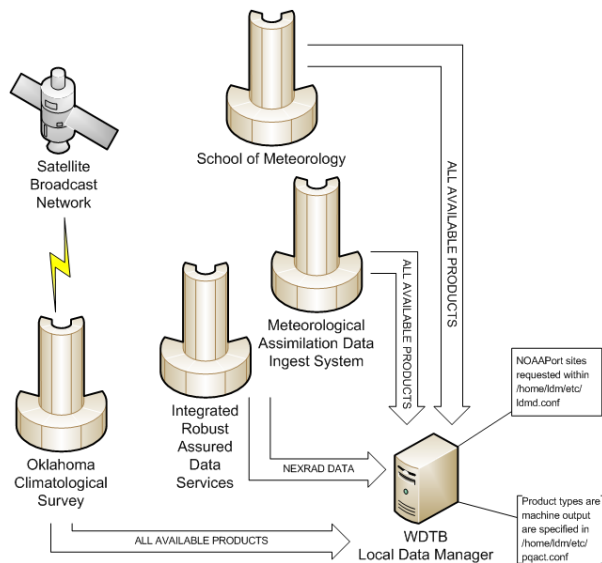
## 2. Local Data Manager (LDM)

In order to replicate NWS operational data processing, a server dedicated to the LDM was built to act as the primary request and re-routing application of raw meteorological data. The raw data are requested from data assimilation centers specified in the LDM configuration file (ldmd.conf). The Oklahoma Climatological Survey (OCS) provides WDTB access to the NWS operational data sets transmitted through the Satellite Broadcast Network (SBN). WDTB also receives data from other data sources including raw radar data from the Integrated Robust Assured Data Services (IRADS), and surface observations from MADIS. Other data are provided by The University of Oklahoma School of Meteorology (SoM), which acquires its data from Unidata. All possible data products are requested from each of these sites as a failsafe mechanism in the event of an outage. Figure 1 shows a graphical depiction of the data flow in this portion of the system.

The product acquisition configuration file (pqact.conf) in the LDM system requests the raw data types and routes them to their respective

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**Figure 1: Data Transfer Process to the LDM**

server for processing by the AWIPS decoders. Data are requested using regular expressions syntax. Data types are either relayed directly to the decoding servers for processing or can be piped through additional scripts for formatting and syntax manipulation before being sent to the decoders.

At WDTB, the raw data routed from the LDM server are placed in the /data/fxa directory tree on the AWIPS decoding servers. This directory tree is a mount point, making it visible to client machines. Figure 2 diagrams out the data flow from LDM to the data mount point and what the clients can view.

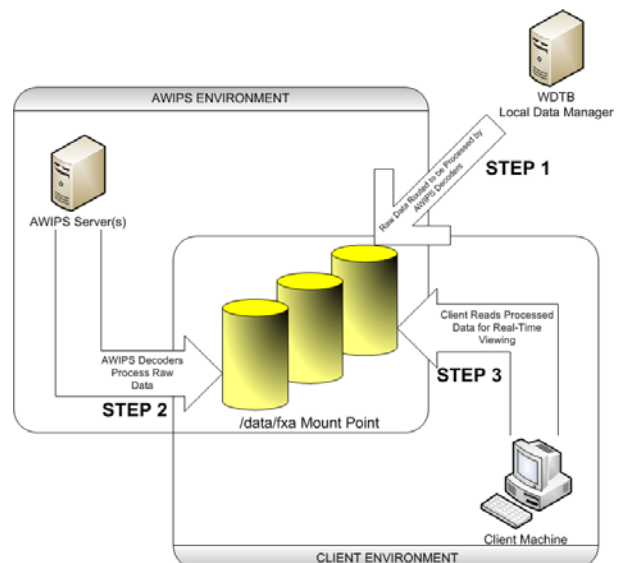
Data are also being fed to an AWIPS-II environment for processing. This allows WDTB WES developers to observe how data will be managed in the future AWIPS-II environment. The AWIPS-II environment will also be critical for the development of AWIPS-II training.

More information about the LDM can be found here: <http://www.unidata.ucar.edu/software/ldm>

### 3. Common Operations and Development Environment (CODE)

The public version of CODE includes a WSR-88D Radar Product Generator (RPG) clone. At a NWS forecast office, the RPG ingests the raw Level II radar data to create Level III base data and algorithm products. In our environment, Level II data are brought in from the LDM server to the RPG, and the RPG feeds product data to the AWIPS decoders on the /data/fxa mount point.

Multiple instances of the RPG are run on a single machine with the following configuration:



**Figure 2: Data Flow from LDM to AWIPS Environment**

1. Each RPG must have its own account (e.g. rpg1, rpg2, rpg3, etc.)
2. The RMTPORT environmental variable is unique for each account (i.e. 50210, 50220, 50230, etc.)
3. The TCP port number specified in the tcp.conf file is unique for each account (i.e. 4495, 4496, 4497, etc.)

At WDTB, a server is dedicated to running 8 RPGs. The 8 RPGs are run simultaneously on a 3GHz quad core server with 4GB of RAM without any system performance issues. A system with a higher memory capacity could potentially run 10 to 20 RPGs.

The line of communication between the RPGs and the AWIPS decoders is created under the AWIPS ORPGCommsMgr process. Once connected, the user can dynamically send Routine Product Set (RPS) lists for each of the RPGs through the ORPGCommsMgr for display in D2D in real time.

Archived data from past events can also be replayed through the RPG. With a connection through the ORPGCommsMgr, the Level III data are displayable through D2D, and product creation can be controlled through RPS list creation and transmission.

More information about the CODE can be found here: <http://www.weather.gov/code88d>

#### 4. Advanced Weather Interactive Processing System (AWIPS) and The Weather Event Simulator (WES)

##### a. The Decoding Process & AWIPS Environment

Portions of the AWIPS system available through the WES are used for the decoding and displaying of the data fed in from the LDM and ORPG servers. The AWIPS decoders are started through a single script, and all AWIPS decoders are restarted on a daily basis through cron jobs. In a NWS forecast office, new data notification occurs automatically as the data are processed. In this real-time system, most of the data notification pings are mimicked through individual scripts with specified ping commands while others are handled through LDM event driven notifications. These ping scripts will check for new data and then sleep for a specified amount of time, usually 30-60 seconds.

All AWIPS decoders are run from an AWIPS home environment located on a mount point visible from the client machine. This allows the client machine to use either the mounted home or a local version of AWIPS included with WES as the environment for viewing real-time or archived data. Having mounted AWIPS home environments also facilitates using multiple operational builds of AWIPS. This allows WDTB training developers to preview the next operational build of AWIPS to establish proficiency with new tools and ultimately create more effective training. Currently, operational builds OB8.2, OB8.3, and OB9.0 of AWIPS are available for usage by WDTB employees for training and professional development.

##### b. Modifications for Integration with CODE and National Real Time Viewing

For flexibility as to where real time data can be displayed, localizations are built for every County Warning Area (CWA) site in the nation. This takes approximately ~27 GB of disk space. When dealing with multiple operational builds, new localizations are constructed for each build. WDTB has a repository of localizations which can be called upon for every operational build dating back to OB8.2. The AWIPS decoding ingest can only be run for one CWA, so some modifications are made to allow connection to any WSR-88D radar site through the RPG:

1. The portInfo.txt and radarsInUse.txt files in the ingest localization directory contain entries for every radar that will be viewed through the RPG.

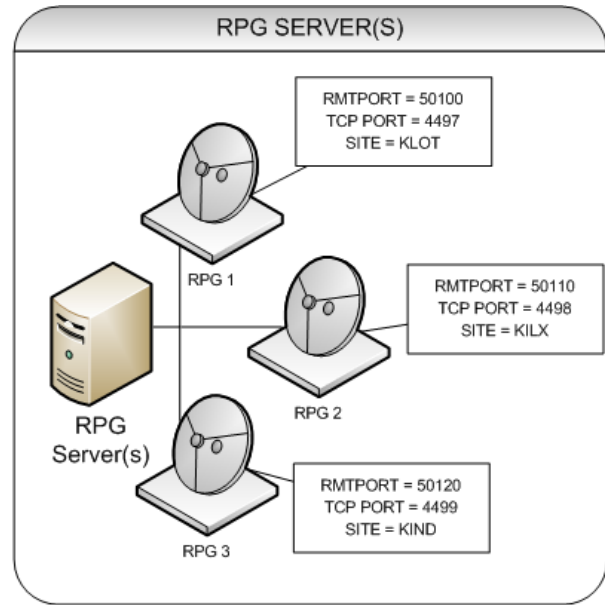
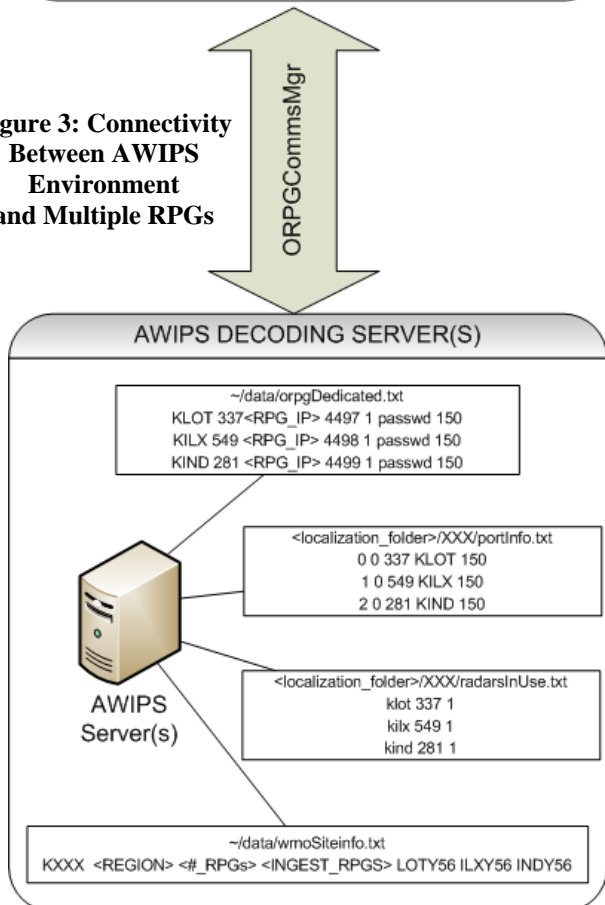


Figure 3: Connectivity Between AWIPS Environment and Multiple RPGs



2. The wmoSiteInfo.txt file in the AWIPS home data directory has entries for the RPG radars currently active.
3. The orpgDedicated.txt file in the AWIPS home data directory contains entries for only the currently running RPG sites in order for successful

connectivity with the ORPGCommsMgr.

At WDTB, the AWIPS decoding ingest is OUN (Norman, OK), so the portInfo.txt and the radarsInUse.txt files are modified in the OUN localization directory. The wmoSiteInfo.txt and the orgpDedicated.txt files are updated dynamically and the ingest is restarted every time a radar is changed. An example of RPG to AWIPS connectivity is seen in figure 3.

### 5. The Weather Case Browser (WCB)

The Weather Case Browser is a WDTB application providing a graphical user interface (GUI), written in Tcl/Tk, as the front-end for user selection of either archived case playback or real-time data viewing. Archived cases are organized and selectable by date, hazard type (severe, winter, etc.), and CWA. For real time data viewing, a map allows the user to visualize the CWA areas spatially before making a selection. The GUI code also integrates map coloring if certain CWA specific products are available, such as Local Analysis and Prediction System (LAPS) data.

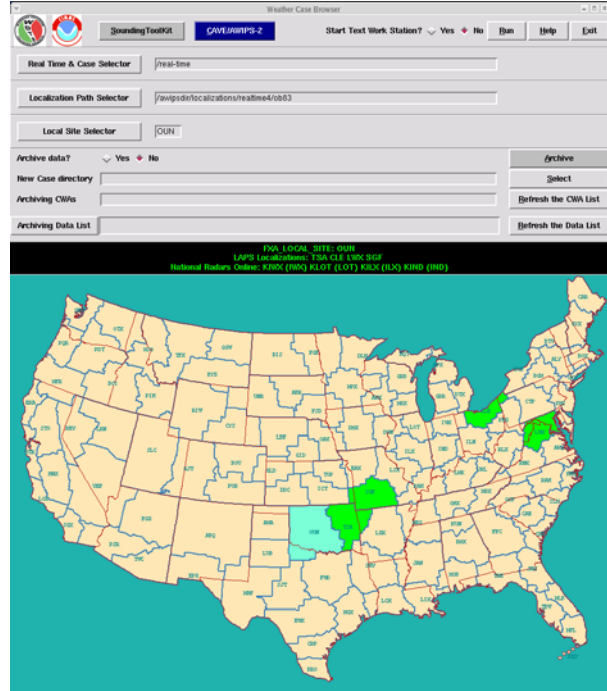


Figure 4: Weather Case Browser

As seen in figure 4, recent modifications

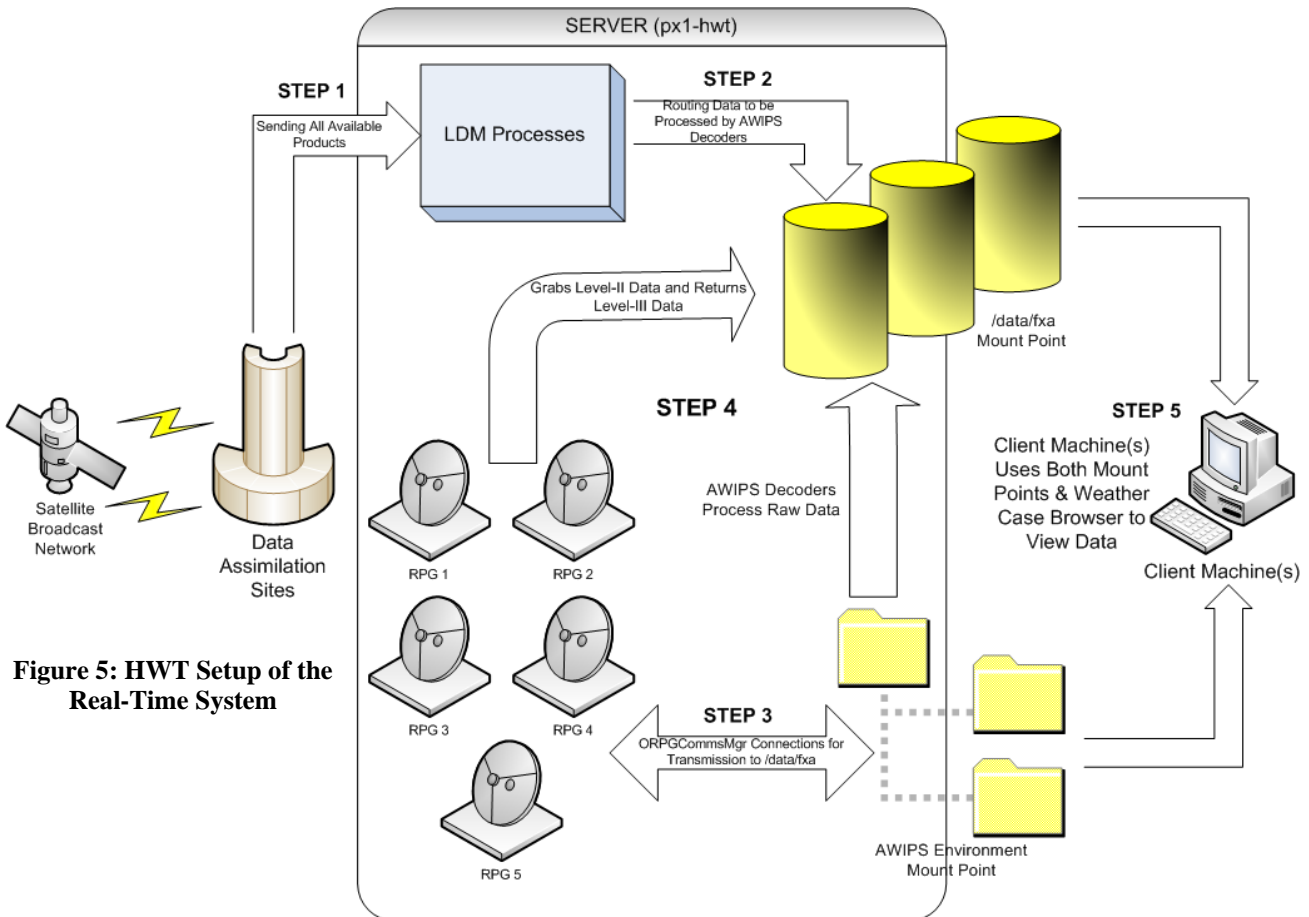


Figure 5: HWT Setup of the Real-Time System

include a Common AWIPS Visualization Environment for AWIPS-II (CAVE) button at the top of the GUI, providing the user with an opportunity to view the data processed in the AWIPS-II environment.

The GUI also contains tools for the archiving of real time data for future case creation. The user has the option to archive all or select types of data (grid, satellite, point, radar) for any number of CWAs.

## **6. Collaborative Activities With The Real-Time System**

### **a. The Experimental Warning Program (EWP) 2008 Spring Experiment**

The EWP 2008 Spring Experiment provided an opportunity for forecasters to evaluate new forecasting technology in a testbed environment (Stumpf et al. 2008). In order to provide a familiar forecasting environment for the visiting scientists, the real-time system was condensed and implemented into the Hazardous Weather Testbed (HWT). The LDM, 5 RPG accounts, and the AWIPS decoders were configured to run all ingest processes on a single machine (px1-hwt). Both the AWIPS home and AWIPS data mount points were made visible to all applicable client machines for access to the Weather Case Browser. Figure 5 shows a graphical flow of data used in HWT operations. Most of the restart operations were automated, allowing for minimal interaction by the HWT weekly coordinator.

For the duration of the experiment, RPGs were easily switched to sites of favorable severe weather. This, combined with the Weather Case Browser, provided an easy to use and familiar operational data analysis system for use in the experiment.

### **b. Collaboration with the Norman, OK Weather Forecast Office (WFO)**

A client to the WDTB real time system is also established on a laptop for usage by WDTB observers in the Norman Forecast Office. During severe weather operations, WDTB trainers view the event through D2D on the laptop while observing forecast operations.

## **7. Summary and Future Considerations**

This system, comprised of publically available components, provides a flexible and operationally relevant environment for the viewing of current or archived NWS weather data. The LDM processes bring in and re-route all data to the AWIPS decoders. The CODE environment processes Level II radar data and returns Level III radar

products for the AWIPS decoders. The AWIPS decoders are a part of the standard WES distribution, Lastly, the WCB is the front-end GUI for launching the displays and archiving data.

In future development of this system we intend to migrate to AWIPS-II as the primary ingest and display while keeping AWIPS-I intact for the remainder of its lifecycle. Collaboration with HWT activities and other partners will also be pursued. The impending release of AWIPS-II in 2010 will provide for a new era of collaboration between NWS and its partners. This may be a unique opportunity for expanding and sharing these types of capabilities in easy to manage ways.

## **8. Acknowledgements**

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