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Real-time Distribution of WDSS-II Algorithm Information

FY 2005 Proposal to the NOAA HPCC Program

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Proposal Theme: **Technologies for Collaboration, Visualization, or Analysis**

Funding Summary:

Russell Schneider	Joseph Schaefer
Director, Science Support Branch	Director
Storm Prediction Center	Storm Prediction Center

Real-time Distribution of WDSS-II Algorithm Information

Proposal for FY 2005 HPCC Funding

Prepared by: Jason Levit and Russell Schneider

Executive Summary:

The NOAA/NWS Storm Prediction Center (SPC) relies on high resolution radar data to make important decisions regarding the issuance of convective forecast products to the United States. Central to this issue is the need to improve upon and provide more detailed mesoscale weather information in these forecast products using advanced software and data sources. To that end, the SPC has integrated a 4-D radar analysis software system, the Warning Decision Support System – Integrated Information (WDSS-II), into experimental operations using HPCC FY04 funding, and we now seek to extend that successful project to extract more detailed information from the WDSS-II system to further enhance SPC's ability to use the software within a national scope.

This proposed work would continue to involve the National Severe Storms Laboratory (OAR) and the Cooperative Institute for Mesoscale Meteorological Studies/University of Oklahoma, (the principal developers of WDSS-II), and therefore involves multiple line offices. We desire to expand upon the software created with HPCC FY04 funds, which provided SPC forecasters a software system to generate a custom WDSS-II "severe storm" domain in real-time and on-demand. This "severe storm" domain, a data grid of approximately 600km x 600km x 20km, merges live NEXRAD Level II radar data together onto a single analysis grid, and together with other data sources and weather detection algorithms, creates an impressive 4-D atmospheric analysis system through the WDSS-II display client.

The WDSS-II weather detection algorithms generate a great deal of information on the merged data domain, including shear detections, volume integrated liquid water, hail size, hail potential, to name just a few of many. This algorithm detection information can currently only be viewed within the WDSS-II display client, and we propose to develop software that will extract that information and make it available for new uses in WDSS-II, and also to other software systems for research and verification purposes.

This proposed software is important, because it will extend perhaps the most powerful radar data analysis software that currently exists into formats and software systems that can be used by SPC forecasters for researching improved operational services to the public.

Problem Statement:

Several data sources generated by the WDSS-II software are only available via the WDSS-II display client, and access to this data is limited by the size of the domain over which the data is generated, and the ability to search and sort through the data for real-time or research use. *This limits the powerful capability of WDSS-II to provide very detailed, and specific, information from Level II radar data via its library of detection algorithms to only real-time use in the display client and only for a relatively small area covering a few radars.* Therefore, the domain must be expanded using additional compute servers and high-performance software to create a

larger grid so that the detection algorithms can generate information for the larger area needed for national scale forecast and forecast research. Additionally, the data generated from the algorithms must be managed in such a way as to make the data available to a wide range of users via not only the WDSS-II display client, but other software packages as well. *Expanding WDSS-II to include these capabilities would solve the problem of WDSS-II data being confined to a single software platform and a small grid, and would open the door for experimental and prototype SPC projects to use the data both in real-time and in research, and also provide forecasters access to WDSS-II algorithm detection data via methods and software that are currently not available*.

Proposed Solution:

To provide WDSS-II algorithm detection information beyond the WDSS-II display client, we propose to create a data management system using a variety of existing and emerging technologies. First, with an additional compute server, we plan to update the WDSS-II system to create a larger domain over which the algorithms generate data. This upgrade will involve developing software that allows a single WDSS-II domain to run across a network on multiple compute servers, rather than on a single one. The software created here will provide an important upgrade to the WDSS-II system, and allow SPC forecasters to view merged data on a larger domain.

The second component of our proposed software system is to create a custom "collection" algorithm that will collect information from all the severe weather detection algorithms and fold that data into a software paradigm that allows it to be accessed by several different platforms. The current system is flexible enough for this type of C/C++ package to be easily integrated into existing WDSS-II software, and indeed, WDSS-II was designed to be extendable in this fashion. The data collection algorithm will be completely configurable and allow SPC forecasters to turn on and off various components of the algorithm. The collection algorithm will feed data into a new alert message system wrapped into the WDSS-II display system itself, which is another portion of our proposed software system. This upgrade to the interactive display client will allow forecasters to draw a polygon around a specific severe weather threat area, and set thresholds for various components of the severe weather detection algorithms to sound an alert once that threshold is met. For example, an SPC forecaster could draw a threat polygon around a few developing severe thunderstorms within the merged domain, and set the display client to sound an alarm (or send an alert message) once a particular value of shear or hail size is detected within the threat polygon. This experimental system will be tested by SPC forecasters and could help alert to rapidly changing weather conditions for particular threat areas, and as an additional monitor on areas already forecast to experience a specific severe weather threat. The upgrade to the WDSS-II display client will use C/C++ and the OpenGL software libraries, which WDSS-II is already based upon.

The third and final part of our proposed project is to wrap the collection of algorithm detection data into an XML message that will be configured using XSLT (eXtensible Stylesheets Transformation Language) and transmitted via a secure protocol to a remote server, where that data will be parsed by Perl scripts and folded into an SQL database. The SQL database will primarily be used for decoding it into a GEMPAK format for use in National Center AWIPS software (the primary software used by SPC forecasters to display weather data and generate graphical forecast products). Therefore, pinpoint locations of particular algorithm detections

(shear, hail, etc.) will be made available for use in developing forecast products in real-time, though in an experimental and prototype sense. This type of capability will enhance the state-of-the-art software that exists at SPC by extending it to include this new type of data. Additionally, the SQL database will be used in an experimental project to search and sort that data for use in verifying SPC products. This is important, since currently SPC can only verify convective forecast products based on observed severe weather reports that are not always available in real time, are not finalized for months, and could be missed in rural or unpopulated areas. The "algorithm detection database" is an experimental method to aid real-time forecast verification based on algorithm "reports".

The entire suite of proposed software within this data management system will allow for a series of incremental changes to a wide array of WDSS-II and SPC software. The software system builds entirely upon existing software and utilizes emerging technologies to obtain better performance, and to provide enhanced information to SPC forecasters that has not been previously available.

Analysis:

The primary mission of the NOAA Storm Prediction Center is to forecast hazardous weather across the conterminous United States, and therefore protect lives and property. High resolution radar data is a key dataset in these predictions, and a tool such as WDSS-II which integrates NEXRAD Level II data with other data to create an advanced 4-D view of the dynamic atmosphere is a powerful addition to the range of software that exists for SPC forecasters. This software is therefore useful to the SPC as a risk reduction activity experiment, because it allows SPC forecasters to examine state-of-the-art software such as WDSS-II and to begin to use data produced through it. The software we have proposed here will generate a larger data domain, an improved user interface in the display client, and a prototype database for use in verification and research, using existing and emerging high-performance technologies to deliver a powerful system to SPC forecasters for their experimental evaluation.

Performance Measures

The performance of this product will be measured primarily in how the new software integrates into prototype and experimental SPC systems. The most visible measure of performance will perhaps be determined from the prototype SQL database of algorithm detections that will be used in experimentally verifying SPC convective products. We will examine how the algorithm detection database compares with actual severe weather storm reports received by the SPC, and conduct separate verification statistics. Additionally, we expect that SPC forecasters will begin to utilize the database of algorithm detections within the generation of SPC convective products through not only the WDSS-II display client, but through the National Center AWIPS software.

Milestones

- Receive award notification (tentative) – March 15, 2005
- Deploy new, expanded domain software – April 15, 2005
- Integrate system alert capability into WDSS-II – May 1, 2005
- Generate XML algorithm detection database software – May 15, 2005

- Integrate algorithm detections into National Center AWIPS at SPC – July 1, 2005

Deliverables

The software that will be created with this project will provide a powerful upgrade to WDSS-II, and will help create a scalable and flexible software system that can use multiple compute servers for any domain size the user desires (from a few radars to the entire nation, limited only by available computer power). Additionally, we will develop software to collect the algorithm detection information and organize it into XML files that will be broadcast over a network using XSLT. This data will then be parsed into the WDSS-II display system for an alert message capability, into a SQL database for verification and research, and into a GEMPAK file for display in National Center AWIPS using Perl scripts and C/C++. Given the availability of necessary computer equipment (compute servers and a Level II radar data feed) the entire WDSS-II system plus these new software enhancements could be used by anyone who is interested in duplicating this system, from a local Weather Forecast Office to a national center such as the Tropical Prediction Center, or a University.