INCREASING ACCESS TO AWIPS-II IN THE UNIDATA COMMUNITY AND AT THE UNIVERSITY OF MISSOURI

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Project Summary

The dedicated computing facilities in the Atmospheric Science Program at the University of Missouri-Columbia (UMC) consist of 3 Windows XP or Windows 7 PCs and 16 Linux machines (including 1 Dell Precision T7500 server, and a Dell PowerEdge T620 which is currently research-dedicated). Most of the Linux machines have been organized into the Weather Analysis and Visualization (WAV) laboratory. The DELL T7500 is the network server. Another machine is dedicated to running the Local Data Manager (LDM) and allowing users to access real-time and archived data via GEMPAK and the *ntl* suite (NMAP, NSHARP, GARP, etc.), as well as the Integrated Data Viewer (IDV). Other software available on the network includes NCAR Graphics, WDSS-II, and MatLab. The Windows XP PCs are mostly grouped together in a separate laboratory.

This proposal requests funding to purchase one high-end machine capable of being an EDEX server, and eight high-end student workstation PCs running Linux compatible with UNIDATA software; the latter represents replacement of machines that are well past their sunset date (4-6 years old). Our current situation has posed a significant instructional problem for our faculty; internal funds for system replacement have not quite kept pace with the need for upgrades. Over the last three years, we have received funds (~$7,000.00) from MU to replace our Linux server (the Dell T7500), the teaching PC in the WAV Lab (which also uses X-Win 32 to tunnel into the Linux cluster for access to UNIDATA software and data) as well as our web server machine (http://weather.missouri.edu). However, these "backbone" needs have consequently delayed the replacement of student workstations, and prohibited our lab from moving forward to AWIPS-II.

The machines that we intend to acquire would allow continuity in our Linux environment and software offerings. They would also enable rapid access to the AWIPS-II on newer computing platforms that are far less expensive. The overarching theme of this proposal is to broaden local ***and*** community access to AWIPS-II as well as reinvigorate MU student use of our WAV lab workstations in both teaching and research modes.

1. PRESENT SITUATION

The Atmospheric Sciences Program (ASP) resides in the Department of Soil, Environmental and Atmospheric Sciences (SEAS) and the School of Natural Resources (SNR) at the University of Missouri (MU). Within the ASP is housed the Missouri Climate Center (MCC). The ASP was founded in 1961 and grants Bachelor of Science, Master of Science, and Doctor of Philosophy degrees in Atmospheric Science. Currently, there are 90 undergraduate students majoring in atmospheric science as well as 12 graduate students (8 M.S., and 4 Ph.D.); these numbers have remained relatively constant over the last decade. MU is a charter member of the University Corporation for Atmospheric Research (UCAR). With 4 full-time tenured faculty lines and a part-time instructor, the ASP is a moderately sized program.

The Weather Analysis and Visualization (WAV) laboratory is comprised of 16 Linux machines, which are fed data by the Local Data Manager (LDM). Observed data and model output are available in the WAV lab through GEMPAK, the *ntl* suite (NMAP, NSHARP, GARPetc), the IDV; NCAR Graphics, WDSS-II, and MatLab are also available. Lastly, 3 Windows-based PCs are available for generic use and IDV access.

We also note that one of the machines is dedicated to our departmental web server (http://weather.missouri.edu), which exists largely for the dissemination of student forecasts, American Meteorological Society-National Weather Association student chapter information, student web pages, and graduate student research results. Additionally, real-time output from National Centers for Environmental Prediction (NCEP) model simulations in *isentropic* coordinates and GEMPAK-format files is available (from a previously funded UNIDATA proposal)

2. A DEVELOPMENT PLAN FOR THE UPGRADE OF COMPUTING RESOURCES

Becoming fully functional in terms of AWIPS-II will require upgrades to our present cluster. It is proposed that the following hardware be purchased for this upgrade:

- **1 Dell T620 server running on Intel® Xeon® E-26XX Processors / 64GB RDIMM, 1600MT/s, Low Volt, Dual Rank, x8 Data Width / 5 x 1TB 7.2K RPM SATA 3Gbps 3.5in Hot-plug Hard Drives in a RAID 5 configuration / NVIDIA® Quadro® K4000 GPU / Dell 27" Monitor, P2714H**
- **8 Dell T1700 computer systems running on 4th Gen Intel® I7-4770 Processor (Quad Core HT, 3.40 GHz, 8MB, w/HD Graphics 4600 / 8.0GB 1600MHz DDR3 Non-ECC / 500 GB 3.5inch Serial ATA (7200 Rpm) Hard Drive**

The equipment specified by this proposal would modernize a significant portion of our Linux laboratory and provide an EDEX server that would facilitate AWIPS-II access both on the MU campus (through use of the CAVE client on the 8 Dell computers) and to the larger UNIDATA community, thus contributing to UNIDATA community capabilities and broadening community scope.

2.1 Contributions to Education

We envision a significant impact of the proposed hardware/software in our teaching. The WAV Lab is an interactive classroom, where students can view diagnostic and prognostic meteorological fields. Our courses typically have about eight to twelve students, which means one to two students per computer in class. Over the course of the academic year, students will have ample time to use the workstations in an unstructured environment in order to explore the particulars of AWIPS II. The following courses in our Program will greatly benefit from the new equipment in the manner described below.

a. Synoptic Meteorology I/II (Junior level)

For real-time map discussions, skew-T analysis, isentropic analysis, Q-G theory interpretation, calculation of convective parameters, comparing numerical models, satellite imagery analysis, and the like, the *ntl* suite (especially NMAP, NSHARP, and GARP) and the IDV are used extensively.

b. Dynamic Meteorology, Thermodynamics, and Numerical Methods (Senior levels)

Students will have a greater freedom to calculate vertical motion, vorticity tendencies, and other diagnostic quantities. Finite differencing techniques are studied in detail. GEMPAK remains an ideal framework for the exploration of these topics.

c. Mesoscale Meteorology and Dynamics (Senior / Graduate level)

In addition to in-class examples and homework sets, students are required to perform a detailed case study of a given mesoscale event as a part of their grades, beginning at the synoptic scale with conventional data and progressing downscale to the analyses of individual storm cells using radar (reflectivity and velocities) and satellite imagery. The IDV and WDSS-II provide the ideal tools for the analysis of these observed data.

d. Weather Briefing (Freshman / Sophomore level)

An introduction to surface and upper air analysis, satellite imagery, and RADAR will be made to this class using the IDV and GARP, which are particularly well-suited to incoming freshmen, as data are readily accessed using mouse-driven icons and pull-down menus. The proposed hardware for the WAV Lab would be invaluable to this course, as it reinforces the idea that students are in a laboratory setting analyzing data, and not merely surfing the web looking at pictures. Although Web access of rasterized images is convenient and expedient, students do not manipulate data in the process, which sets low expectations on them as students and scientists at the outset of their academic careers.

e. Radar Meteorology (Junior/Senior level)

The IDV and WDSS-II allow students to view radar data in its natural orientation giving them a better understanding of where the atmosphere is sampled by the radar relative to the surface. It will also allow them to explore the how the radar observations are related to other meteorological fields produced by model. For example, Doppler velocity fields can be compared to model winds to illustrate differences in sampling and structure scale.

The introduction of more high-end hardware which can take full advantage of the features in the *ntl*/IDV suite will also benefit continued development of a weather forecasting laboratory, which will use both "canned" and real-time case studies for forecast analysis and exploration of forecasting techniques. It is important also that students integrate lecture material with actual data and modeled output in order to help them visualize atmospheric processes in two and three dimensions. Moreover, it is critical that students learn how to use modern "tools of the trade" in meteorology, software that they may be using in many aspects of the profession. This is where the requested EDEX server becomes especially valuable, as **students will finally gain substantive access to AWIPS-II**.

The ASP will continue to illustrate conceptual models and ideas using the requested workstations. Finally, it is expected that students will continue to want to explore the use of this equipment outside of class time.

2.2 Contributions to Research

One of the PI's existing NSF-funded collaboration with the NOAA/NWS/Weather Prediction Center would benefit from the enhanced ability to exchange data. Market is a recipient of a National Science Foundation grant, the design for which demands extensive student forecasting, using the *ntl* software suite as well as the IDV to access data along with NCEP and local model simulations. Adding the proposed hardware will permit broader access to all of the available data by a greater number of student and faculty researchers.

2.3 Increasing UNIDATA Community Capability and Scope

The University of Missouri has been involved with UNIDATA since the early 1990's. The University is also a UCAR member. With the acquisition of new equipment, the Program representatives will need to attend UNIDATA or UCAR sponsored workshops in order to more effectively understand and use AWIPS-II. The EDEX server will also allow us to participate in data exchange with other UNIDATA member institutions. Through this process, we can also relate our experiences using UNIDATA products in the classroom with our fellow institutions and UNIDATA. Our program will continue to support UNIDATA's efforts in whatever capacity (and in an expanded capacity) is available to us.

We will disseminate the results of our projects and UNIDATA activities via the following avenues:

a. Real-time and archived isentropic data sets

We continue to serve as an outlet for web-based analyses of model-derived isentropic fields (http://weather.missouri.edu/isen). Many professors teach their students about the benefits of isentropic analysis techniques. Yet, after a few "canned" case studies, students rarely have an opportunity to continue with the practice of analyses in θ-space. Our web portal hosts real-time analyses of NAM model fields in isentropic coordinates, as well as archived isentropic files from the NAM and GFS model solutions in GEMPAK format.

b. Preprint and journal articles

Those that are published by the AMS or NWA. It is likely that we will produce a poster for an NWA meeting or AMS Education conference where we discuss our early experiences with AWIPS-II.

c. Laboratory manuals

These manuals show our students how to use the Linux environment and access meteorological data in an X-window or similar display environment. Also, our program will gladly share any similar products (esp. for AWIPS-II) we develop with other institutions. Our program will also make available our datasets to other institutions via the EDEX server.

d. Script files

Our program has developed GEMPAK script files to make teaching and research applications much easier. For example, we have developed many scripts, which create regional satellite analyses, pressure-space analyses, isentropic-space analyses, and isentropic versions of GFS and NAM model gridded output files. We have shared these with the UNIDATA community in the past, and will continue to do so as we continue to develop more.

3. SYSTEM MANAGEMENT COMPETENCE

Dr. Bohumil Svoma, the principal investigator of this proposal, and Drs. Patrick Market, Anthony R. Lupo and Neil I. Fox, project co-directors, are all well acquainted with Linux-based systems and peripherals. The investigators also possess considerable experience using various X-window environments in their research. They also have considerable expertise in using the IDV, GEMPAK, and the *ntl* suite, and have developed GEMPAK scripts in their research work. Dr. Market supervises the existing WAV Lab network, while training students and other faculty in the use of the machines, their windowing environment, and the UNIDATA software suite. He has considerable experience with the implementation and use of mesoscale models, as well as various visualization packages (esp. LDM, GEMPAK and IDV). Dr. Lupo has been the UNIDATA contact point for the University of Missouri since 1998. Dr. Fox has an extensive background in the processing of remotely sensed data in a Linux environment. Their resumes are found at the end of this document.

The School of Natural Resources, of which the Atmospheric Sciences Program is a part, has a computer systems engineer who provides maintenance, largely for the Program PCs. Additionally, the services Mr. Shawn Riley, MU alumnus and now system engineer for Baron Services, Inc., are retained by the MU ASP on a contract basis because of his years of experience with meteorological computing applications in a Linux environment.

In closing, we have complete confidence that the proposed hardware will be well-deployed and facilitate a necessary upgrade to our present computer resources. This proposal will enhance the computing environment at the University of Missouri as well as add to the larger UNIDATA community in its fledgling AWIPS-II efforts.

4. BUDGET AND JUSTIFICATION

A breakdown of the actual computer equipment and peripherals follows and includes a 20% discount available to our educational institution:

1	**Dell T620 server running on Intel® Xeon®E-26XX Processors / 64GB RDIMM, 1600MT/s, Low Volt, Dual Rank, x8 Data Width / 5 x 1TB 7.2K RPM SATA 3Gbps 3.5in Hot-plug Hard Drives in a RAID 5 configuration / NVIDIA® Quadro® K4000 GPU / Dell 27" Monitor, P2714H**	$7,377.00
8	**Dell T1700 computer systems running on 4th Gen Intel® I7-4770 Processor (Quad Core HT, 3.40 GHz, 8MB, w/HD Graphics 4600 / 8.0GB 1600MHz DDR3 Non-ECC / 500 GB 3.5inch Serial ATA (7200 Rpm) Hard Drive (*$970.00 each*)**	$7,760.00
	Total Direct Costs	**$15,137.00**
	Indirect Costs (30% of modified total)	$2,328.00
	Total $17,465.00	

Indirect cost for on-campus other sponsored activity is 30% of the modified total direct costs. For this project, any unit item over $5,000.00 may be considered equipment, and not subject to indirect cost charge. Thus, the total direct cost to which the indirect may be applied ($7,760.00) yields an indirect cost of $2,328.00. Drs. Market, Svoma, Lupo, and Fox have volunteered their time as-needed, respectively, as contributions to the oversight of the upgraded facilities.

We believe that the requested computer hardware are justified for a program of our size, and that the proposed additions would represent a major upgrade to our present networked system. The machine upgrades will allow our outdated machines to retire; we may thus keep pace with other institutions in making the AWIPS-II available to our students for educational and research activities.

5. PROJECT MILESTONES

Equipment from these funds will be purchased and deployed immediately. We anticipate these upgrades to be complete within 1-2 months of funds receipt. More involved teaching with the AWIPS-II will ensue in the following semester. There are no dependencies that will delay the project milestones.