New proposal to
The Unidata Program Center

for

Deployment of AWIPS-II at the University of Wisconsin-Milwaukee

by

Board of Regents of the University of Wisconsin System
for the University of Wisconsin-Milwaukee
P. O. Box 340
Milwaukee, WI 53201-0340

PRINCIPAL INVESTIGATOR: Dr. A. Clark Evans

PERIOD OF ACTIVITY: 1 June 2015 to 31 May 2016

AMOUNT REQUESTED: $13,994

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B. Project Summary

The University of Wisconsin-Milwaukee Atmospheric Science Program is comprised of seven full-time faculty, thirteen graduate students between the M.S. and Ph.D. levels, and approximately forty undergraduate students. Approximately one-third of our graduates pursue post-graduation employment with the National Weather Service, with fifteen of our graduates at all levels achieving gainful employment with the National Weather Service since 2000. An additional one-third of our graduates pursue a post-graduation career in academia.

Existing computational resources do an adequate job of supporting in-class and basic research activities, data ingestion from and data sharing with the Unidata community, and parallelized, resource-intensive research. However, there exist two primary gaps in the computational resources available to our program: the lack of a facility by which our students can acquire training with the next-generation AWIPS-II infrastructure, and the lack of a facility by which large meteorological datasets in both the classroom and research may be effectively visualized.

To address these shortcomings and provide our students with the best-possible training so as to prepare them for their desired careers post-graduation, we request Unidata Program Center funding to support the purchase of one Dell PowerEdge T430 server to serve as an EDEX Data Server, a Dell UltraSharp U2412M 24" monitor to support visualization tasks on this machine, and four Dell Precision T1700 workstations to serve as CAVE clients. The current budget situation within the state of Wisconsin means that, in the absence of this funding, we would not be able to purchase and deploy this equipment for at least two years.

The requested equipment would facilitate student training and development with AWIPS-II; the continued integration of Unidata infrastructure into our synoptic and mesoscale meteorology curricula; and resource-intensive data visualization in both classroom and research activities. Through its integration into the Innovative Weather program, the proposed effort would provide for a unique real-time operational testbed for the AWIPS-II software and for the student-led development of training materials for AWIPS-II that we intend to share with the community. Finally, the requested equipment would integrate our program further with the Unidata community and would in turn expand the community reach of next-generation Unidata offerings.

C. Project Description

a. Introduction

The University of Wisconsin-Milwaukee Atmospheric Science Program is comprised of seven full-time faculty, thirteen graduate students at the M.S. (nine) and Ph.D. (four) levels, and approximately forty undergraduate students. The University of Wisconsin-Milwaukee is a member of the University Corporation for Atmospheric Research, having joined in 1979, and is an active participant in the Unidata community through the Internet Data Distribution program.

The departmental and institutional computational resources currently available to students and faculty in the University of Wisconsin-Milwaukee Atmospheric Science Program are as follows:

- A hybrid classroom-laboratory comprised of twelve iMac machines purchased in 2014. Supported by these machines are the laboratory component of our Synoptic Meteorology I/II course sequence; our Mesoscale Meteorology elective course; our Daily Weather Discussion special topics course; a research-focused weekly weather discussion series; and non-resource-intensive student research.

- A Dell PowerEdge T710 server purchased utilizing Unidata Program Center in 2012. This machine enables our program to participate in the Internet Data Distribution (IDD) program. Operational on this machine are RAMADDA and a THREDDS Data Server, though which both IDD and research data are shared with the community. This machine is further utilized by our Innovative Weather program to produce content, primarily using GEMPAK, in support of forecast operations.

- The University of Wisconsin-Milwaukee *avi* supercomputer, operational since 2009, comprised of 1,136 total computing cores in support of resource-intensive research.

There exist two primary gaps in the computational resources that are available to our program:

- We do not have the computational resources available so as to permit student training with the next-generation AWIPS-II infrastructure. This poses a particular challenge given that the National Weather Service (NWS) is a primary employer of our graduates, with a total of fifteen students across all levels having been hired by the NWS since 2000. Our experience is that the questions that our students struggle most to answer positively on the NWS employment qualification exam are those addressing experience using AWIPS.

- Visualization of large meteorological datasets in both classroom and research settings. In particular, the *avi* supercomputer explicitly does not permit intensive data visualization.

Consequently, so as to ameliorate these shortcomings and, in particular, to better prepare our students at all levels for future employment with the National Weather Service, in the private sector, or in academia, we request the following equipment:

- A Dell PowerEdge T430 server, featuring an Intel Xeon E5-2640 v3 processor running at 2.6 GHz with eight cores and sixteen threads, 64 GB of RAM, and four 4 TB SAS 6 Gbps hard drives arranged in a RAID-5 configuration to serve as an EDEX Data Server.

- A Dell UltraSharp U2412M 24” monitor, for use with the EDEX Data Server, to facilitate server configuration and rudimentary local data display.

- Four Dell Precision T1700 workstations, each featuring a fourth-generation Intel Core i5-4590 processor running at 3.3 GHz with four cores, 16 GB of RAM, a 500 GB SATA

hard drive, an NVIDIA Quadro K620 2 GB video card, and a Dell UltraSharp U2414H 24" monitor to serve as CAVE clients and data visualization workstations.

The above request would constitute roughly one-third of the program's total computational resources. The data drives on the EDEX Data Server would be mounted, utilizing NFS, on each of the four CAVE clients. Two of the requested four CAVE client workstations will be deployed in our hybrid classroom-laboratory alongside the twelve existing iMac machines for in-class and research use. The remaining two CAVE client workstations and the EDEX Data Server will be deployed at our Innovative Weather program for student training and operational product development purposes. Two CAVE clients per location are requested so as to support multiple students at once working with on the machines both individually as well as collaboratively.

The University of Wisconsin-Milwaukee faces a proposed 13% cut in state funding, without the ability to raise tuition revenue to compensate, over the 2015-17 biennium. Further, the Department of Mathematical Sciences utilized its last available discretionary funding in summer 2014 to upgrade the iMac computers within our hybrid classroom-laboratory. Any funding we may receive in the short- to medium-term will, by necessity, be devoted to extending the useful life of our existing equipment. Given the current budget situation, it is highly unlikely that departmental or university funding to support the proposed upgrades will be available for at least two years, if not longer. Consequently, Unidata Program Center funding is requested to support the purchase of the proposed equipment.

b. Contributions to Unidata Community Capabilities and Reach

The University of Wisconsin-Milwaukee Atmospheric Science Program is currently an active participant in the Unidata Internet Data Distribution relay in large part thanks to a Unidata Equipment Grant received in 2012. Through the hardware purchased with this grant, we share both operational and research data with the community, particularly through our RAMADDA server (http://atmo.math.uwm.edu:8181/), and have contributed positively to the education of students who have interacted with this hardware as a part of their internships with our Innovative Weather program. The proposed equipment would further our participation in the Unidata community and would expand the reach of AWIPS-II, EDEX, and CAVE within the community.

The Innovative Weather program annually supports two to three recently-graduated students, chiefly at the undergraduate level, as special projects interns. Representative examples of tasks accomplished by recent interns include the development of applied training materials for junior students; assisting in making the University of Wisconsin-Milwaukee the first *StormReady* University in Wisconsin; and becoming proficient with our Local Data Manager (LDM) feed and GEMPAK so as to expand the range of locally-produced meteorological products. As part of the deployment of AWIPS-II at the University of Wisconsin-Milwaukee, there will be a need to develop training materials so that future students may effectively and efficiently learn to use AWIPS-II themselves. We intend to involve one to two such interns in this process, and we intend to share these materials with the Unidata community at-large upon their completion.

c. Contributions to Education and Student Development

I. Inside the Classroom

Synoptic Meteorology I and II (Atm Sci 360/361; core undergraduate courses), offered every other year, build upon physical and dynamical principles learned in other courses to enable students to gain insight into the formation, structure, and evolution of mid-latitude synoptic-scale meteorological phenomena. These courses incorporate a significant lab component, with ten labs assigned each semester. We propose to utilize the product generation and advanced visualization capabilities afforded by AWIPS-II, Unidata's Integrated Data Viewer (IDV), and the proposed hardware to transform the course lab from one in which students interpret charts provided to them from other sources into one in which students create and interpret their own charts.

Mesoscale Meteorology (Atm Sci 460; undergraduate/graduate elective), offered every other spring semester, is a hybrid lecture/case study course in which students are exposed to topics such as numerical modeling, mesoscale convective systems, and planetary boundary layer processes. Case studies through which students work have been prepared in part utilizing the IDV software package. Deploying AWIPS-II within this environment would provide an additional means of facilitating such case studies, particularly of real-time mesoscale convective phenomena that typically occur during the latter part of the semester.

Daily Weather Discussion (Atm Sci 690; undergraduate/graduate elective), offered every spring semester, provides a formal setting by which students learn to quantify forecast probabilities, identify forecast possibilities, and convey each via oral and written forms of communication. We propose to utilize the product generation and advanced visualization capabilities afforded by AWIPS-II, IDV, and the proposed hardware to transform this course into one in which students generate and discuss their own charts. Thus, the requested hardware is leveraged to provide students with beneficial training in meteorological programming and data analysis.

II. Outside the Classroom

In fall 2014, our program established a weekly, research-focused weather discussion series, modeled after that which has successfully run at the State University of New York, University at Albany for many years. This extracurricular series was quite successful in its first iteration, with five speakers leading a total of nine discussions on topics ranging from California drought to meteotsunamis to tropical-extratropical interactions on the weather-climate interface. The proposed equipment would provide an additional opportunity for the students who lead discussion to gain experience with preparing visualizations in AWIPS-II and communicating their findings to a specialist audience.

The Innovative Weather program, in which approximately two-thirds of our undergraduate students and one-third of our graduate students participate, trains the next generation of meteorologists while providing weather-related services to the community. The Unidata Equipment Award that we received in 2012 enabled three student interns at Innovative Weather

to gain experience with product creation in GEMPAK. The fruits of their labor can be seen publicly on the Innovative Weather webpage (e.g., http://www.innovativeweather.com/forecast-mke.php) and in two Innovative Weather mobile apps – one for clients, one geared toward the community at-large – available for both iOS and Android devices.

The deployment of AWIPS-II at the University of Wisconsin-Milwaukee, and in particular in the Innovative Weather office, would provide a unique real-time operational testbed for the AWIPS-II software. It would do so while providing a means by which our students – a majority of who desire to work for the National Weather Service after graduation – can acquire meaningful experience with the software that they would be utilizing on a daily basis if they were to achieve employment with the National Weather Service. Finally, each year, Innovative Weather supports several recently-graduate students via special projects internships that often serve to extend operation capabilities or provide for training of younger students. We intend to involve one to two such students in the local deployment of AWIPS-II with the goal of developing training materials for both local and community dissemination. In this way, students gain experience as leaders in a tiered mentoring construct, gain invaluable experience utilizing AWIPS-II, and hone their communication skills in preparing these materials.

d. Contributions to Research

Intensive numerical modeling from the cloud- to the climate-scale comprises a significant percentage (~50%) of the research conducted by University of Wisconsin-Milwaukee Atmospheric Science Program faculty and graduate students. Due to the limitations of our existing hardware, however, there does not presently exist a local facility by which output from these numerical simulations – which often ranges into the terabytes – can be interactively visualized and interrogated. The proposed CAVE workstations would facilitate these activities through the use of software such UCAR's Visualization and Analysis Platform for Ocean, Atmosphere, and Solar Researchers (VAPOR), IDV, the Warning Decision Support System – Integrated Information (WDSS-II) and its *wg* display, or other programs. The four-dimensional visualizations that these packages permit would improve data analysis efforts to the benefit of our research as well as potentially lead to the development of new visualization methods, particularly for ensemble numerical guidance of the sort that several of our faculty produces.

D. Budget and Justification

Cost estimates for all requested hardware listed below are derived from quotes obtained from UWM's Dell Premier portal on 28 January 2015.

Quantity	Description	Total Cost
1	**Dell PowerEdge T430 Server** (as EDEX Server) Intel Xeon E5-2640 v3 (8C/16T 2.6 GHz) Processor 4 x 16 GB RDIMM (2133 MT/s) RAM 4 x 4 TB 7,200 RPM SATA 6Gbps Hard Drives PERC H730 RAID Controller, 1 GB NV Cache	$5,160

1	**Dell UltraSharp U2412M 24" Monitor** (for EDEX Server)	$327
4	**Dell Precision T1700 Workstation** (as CAVE Clients) 4th Generation Intel Core i5-4590 (Quad Core 3.3GHz) Processor 2 x 8 GB 1600 MHz DDR3 Non-ECC RAM 500 GB 7,200 RPM SATA Hard Drive NVIDIA Quadro K620 2 GB Graphics Card Dell UltraSharp U2414H 24" Monitor	$5,582

Total Direct Costs:	$11,069
F&A Cost Base:	$5,909
Total F&A Cost:	$2,925
Total Cost:	$13,994

The current Facilities and Administration (F&A) rate at the University of Wisconsin-Milwaukee as applied to federally-funded projects is 49.5% of modified total direct costs per agreement with the Department of Health and Human Services dated 18 June 2014. Equipment, defined as a tangible, nonexpendable piece of property with a useful life of one year or more and a cost of $5,000 or more is defined as a capital cost and is not subject to F&A charges. This applies only to the Dell PowerEdge T430 server listed above. PI Evans, who deployed and currently maintains LDM, RAMADDA, and THREDDS at the University of Wisconsin-Milwaukee, volunteers approximately two weeks of his time during the academic year (approximately 5% effort) to facilitate system deployment and student training on the new hardware.

The hardware specifications for both the EDEX server and CAVE clients meets or exceeds the minimum hardware requirements for each, as outlined at http://www.unidata.ucar.edu/software/awips2/#sysreqs. All machines will be configured with the open-source CentOS 6.6 (x86_64) operating system. Additional disk storage beyond the minimums for the EDEX server will facilitate a two week-plus rotating archive of ingested real-time data so as to facilitate weather discussion and case study analysis, as well as to support the post-processing of research simulations that will subsequently be visualized utilizing the CAVE clients. All requested hardware includes a five-year warranty from Dell, and the expected lifetime of each item is five-plus years.

E. Project Milestones

We expect to purchase and deploy all requested hardware immediately upon receipt of funds from the Unidata Program Center. We expect that the hardware will be ready for testing within one month and deployed in both our hybrid classroom-laboratory and at Innovative Weather within two months of purchase. Student training on the new hardware will commence at the beginning of the Fall 2015 semester. AWIPS-II will be incorporated into the Synoptic Meteorology I/II, Mesoscale Meteorology, and Daily Weather Discussion courses during the next semester in which each is scheduled to be offered.