## A. Title Page

Proposal to

**UNIDATA COMMUNITY EQUIPMENT GRANT**

titled:

**A proposal to upgrade the Creighton University meteorology lab to enhance operational meteorology education**

duration:

**1 June 2014- 31 May 2015**

Total:

**$12,657 in direct and indirect costs**


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## B. Project Summary

The Department of Atmospheric Sciences at Creighton University has a strong history of training operational meteorologists for both civilian and military needs. The department, located in Omaha, Nebraska, is a short drive away from both the Air Force Weather Agency (AFWA) and the National Weather Service (NWS) forecast office in Valley, Nebraska, and both of these agencies have a significant role the department's curriculum and the career path of its graduates. The department is also one of five programs nationwide where the Air Force Institute of Technology (AFIT) sends Air Force officers to get advanced degrees in atmospheric science or meteorology.

As the science and practice of meteorology keeps evolving, it is imperative that the department maintains pace with it. This proposal seeks funding to purchase an Advanced Weather Information Processing System II (AWIPS-II ) Environmental Data Exchange (EDEX) server to enable integration of AWIPS-II into the department's undergraduate and graduate curriculum and facilitate student and faculty research. In addition, this proposal seeks four Common AWIPS Visualization Environment (CAVE) client computers to interface with the EDEX server and provide state-of-the-art systems for students to use in the classroom. The department seeks to be ahead of the curve as the community transitions away from the General Meteorology Package (GEMPAK) and towards AWIPS-II for research and classroom use.

## C. Project Description

*Background and current computing resources*

A fundamental goal of the Department of Atmospheric Sciences at Creighton University is to create an educational experience with ample opportunity for hands-on interaction with real-world data so that students can gain experience beyond what lectures and textbooks can provide. The department has been successful at this goal, with many of its graduates finding employment in the NWS, and students are frequently recruited by AFWA for internships that focus on developing software or training materials for Air Force meteorologists. These internships typically segue into full-time employment upon graduation.

The department is already an avid consumer of Unidata products. Many classes in the department are strongly focused on interactive learning experiences using archived weather data accessed through the McIDAS-V software package (based on Unidata's IDV). Activities include four-dimensional analysis of significant weather events and simulated nowcasting activities in which students are asked to produce watches and warnings as a significant weather event unfolds before them in real time. McIDAS-V is run locally in a laboratory of Apple iMac desktops that date from 2008. On these machines it can take over a minute to load typical datasets like a short series high resolution satellite images or complete radar volume scan, which can limit

the immersive experience of simulated severe weather outbreaks.

An electronic map wall is a focal point of the department, and Unidata is key to its operation. Data from the Unidata Local Data Manager (LDM) are fed into two local servers running General Meteorological Package (GEMPAK) scripts to produce routinely updated charts and maps, ranging from loops of numerical weather prediction (NWP) output to plots of every Next-generation Radar (NEXRAD) station in the continental United States. These data are displayed on a matrix of ten monitors that surround a large-screen television. This central screen is controlled by an adjacent touch screen that allows the user to control the data animations by starting or stopping them, changing the animation speed, or stepping through the animations frame-by-frame. The map wall is used for bi-weekly weather briefings led by students, is available for student use at all other times, and is a common gathering spot for students on severe weather days.

To maintain the department's strong focus on experiential learning of operational meteorology, it has long been a goal to integrate AWIPS into the curriculum. This would enable students to gain experience with the same software packages that they would be using as operational forecasters while they are learning about the atmospheric sciences. The department is well-suited for AWIPS integration. As part of the department's commitment to operational forecasting and its close relationship with the local NWS office, one course each semester is taught by the NWS Science and Operations Officer for the local area. Topics include mesoscale meteorology and radar and satellite. Due to his extensive experience implementing and using NAWIPS/AWIPS-II, the department has an in-house source of knowledge on these systems that it can use to create the best possible experience for its students. In addition, AWIPS-II is being developed in part in the greater Omaha area by the Raytheon Corporation. By having an AWIPS-II installation on campus, it opens opportunities for greater collaboration with local partners in the atmospheric sciences.

*Proposed equipment*

The following computer systems are requested to outfit the meteorology laboratory to run AWIPS-II . Creighton University has a purchasing agreement with Lenovo for Windows and Linux systems, and so faculty and staff in the department are familiar with using and servicing systems like these.

a. AWIPS-II EDEX Server

One Lenovo ThinkServer RD540 with Intel Xeon E5-2620 2.10 GHz six-core processor, 48 GB RAM, two-4 TB hard disk drives for storage set up in a RAID configuration, and a 240 GB solid-state drive for rapid data acquisition and transmission. This system will be the backbone of the upgraded meteorology lab. It will be housed in the university data center and and will handle data ingest and data analysis tasks for the other machines in the laboratory, which

will connect to it via the CAVE client. Tasks for this system beyond serving AWIPS-II to the other systems include handling graphical production for the electronic map wall and transmitting locally-produced data via the IDD to other interested parties.

b. CAVE client systems

Four Lenovo Ideacentre K450 desktop PCs, each with an Intel Core 17-440 3.40 GHz quad-core processor, 12 GB RAM, 2 TB hard disk drive, and a 2GB NVIDIA GeForce GTX 650 graphics card to handle display. Each system will also be equipped with a 21 inch monitor, a mouse, and a keyboard. It is anticipated that students will be working on these machines in small groups, therefore a relatively small number are requested. These systems will come equipped with 64-bit versions of Windows 8 to run the CAVE client, but will be configured to dual-boot into Ubuntu Linux to maintain accessibility to other software packages, thus increasing their overall utility.

*Anticipated benefits to courses*

Should this proposal be funded, the department anticipates using the computing systems in a number of courses, thus bolstering the quality of education that the students receive. This includes the following:

ATS 211: Weather analysis and forecasting. Students in this course gain experience with GEMPAK for basic plotting functions, as for many years this was considered a necessary skill for professional meteorologists. It is clear, however, that the meteorological community is transitioning away from GEMPAK and towards AWIPS-II. Should this proposal be funded, students will gain familiarity with the latest software and require less training once they reach the workforce.

ATS 555: Meteorological remote sensing. Students enrolled in this course currently analyze and interpret radar and satellite imagery mostly through qualitative methods, with some time spent in McIDAS-V looking at quantitative data. As one of the courses taught by an adjunct who works for the NWS, funding of this proposal would be of great benefit to students in this course enabling them to experience hands-on instruction in AWIPS-II use by a professional expert.

ATS 561 and ATS 562: Synoptic Meteorology I and II. A series of labs using McIDAS-V bundles has been developed to augment classroom lectures. These bundles contain data from multiple archives including radar, satellite, surface, and NWP output. Interacting with these bundles is a memory-intensive operation, and the technical specifications limit the detail and duration that these bundles are able to cover. If this proposal is funded,

students will be able to conduct their studies using state of the art hardware and software that will enable broader studies that encompass more data over longer time spans.

Courses that are not part of the atmospheric science degree programs will also benefit. A course in statistical forecasting is taught in service of the college's Energy Technology degree. In this course, students learn to make forecasts of energy production from solar panels and energy consumption by the Omaha area; both of these depend greatly on ambient meteorological conditions. As part of this course, students learn basic weather forecasting. These students, who otherwise have no meteorological training, would benefit greatly by being able to see with greater clarity how the four-dimensional nature of the atmosphere can be analyzed and predicted. Students in the Environmental Science program, which also works closely with the Atmospheric Sciences department, would be able to use the upgraded lab in their environmental remote sensing course.

*Additional benefits to the department and the community*

The department expects benefits outside of direct coursework as well. The map wall, which currently runs GEMPAK at its core, would be upgraded to have an AWIPS-II base. The improved server would reduce the time required to process the data, and the speed and responsivity of the map wall would be improved.

The upgraded systems would also support the research conducted by students and faculty. A significant challenge currently faced by student researchers is the best way to display the output produced by research runs of the department's WRF installation, while other students are dissatisfied with current capabilities for displaying archived radar data. A combined AWIPS-II/CAVE system would allow students to analyze these data in much greater detail on hardware that is much more responsive to what is currently available.

The department produces its own data that may be beneficial to the community as a whole. An iMet radiosonde launching system has been located on-site for over a year, and students are able to launch balloons in advance of significant weather events. The department also manages a high-performance computational cluster that currently hosts an installation of the Weather Research and Forecasting (WRF) model for research use. Plans are currently underway to extend this to include operational high-resolution WRF runs for the greater Omaha area which could then be distributed to local NWS and AFWA forecasters. No current formal distribution network for these data exist, but the successful integration of an EDEX into the department would facilitate the distribution of these data.

*Departmental computing plans*

Creighton University is embarking on a strategic plan that is anticipated to focus university resources more on interdisciplinary programs in the health sciences and away from the traditional natural science programs, especially those in smaller departments. As a result, it is unlikely that the Department of Atmospheric Sciences will be able to obtain funding for this set of systems internally.

The department's current Local Data Manager (LDM) data ingestion server and the server used for GEMPAK graphics creation are both nearing the end of their anticipated lifecycles. These two machines represent nearly all of the computational power afforded both undergraduate and graduate students seeking personal, hands-on experience with meteorological data in support of their education and their personal interests. The system proposed here would allow for a planned and time-appropriate upgrade of machines that need to be replaced within the next two years.

## D. Budget

The budget for the systems outlined above is as follows:

| Item | Quantity | Unit Cost | Overhead rate | Total |
|---|---|---|---|---|
| Lenovo RD540 Server | 1 | $5161 | 0% | $5161 |
| Lenovo KD540 Desktop | 4 | $1288 | 45.5% | $7496 |
| | | | | |
| Total direct costs | | | | $10313 |
| Indirect costs | (45.5% of $5152) | | | $2344 |
| **GRAND TOTAL** | | | | **$12657** |

*Budget justification*

The specific purposes of the requested systems are described above. The specifications of the AWIPS-II EDEX server exceed the minimum requirements for AWIPS-II EDEX servers as determined by Unidata. However, Creighton University does not charge overhead on individual pieces of capital equipment that cost more than $5000. As a result, this much more powerful system is less expensive overall than a barebones system once the indirect costs are taken into account. This also helps future-proof the system and lengthens its upgrade horizon.

Cost sharing will take the form of donated time by the PI and by the departmental client support specialist to install the machines and make them operational. It is anticipated each will spend 0.25 months of time on the setup phase of this project.

## E. Project Milestones

It is assumed that successful projects will be notified of funding in May 2014. Should this proposal be selected for funding, the equipment will be ordered immediately and should be delivered in early summer 2014. This leaves ample opportunity for installation and troubleshooting of the system over the summer months. The summer will also be used to develop new laboratory and classroom activities using the AWIPS II Server and CAVE system so that the Synoptic I and Mesoscale Meteorology courses that meet in Fall 2014 will be able to use the equipment immediately.

Students will be asked to anonymously assess how the new equipment contributed to their learning and will be invited to suggest activities that will be used in future iterations of departmental courses. These responses will be collected and submitted to Unidata as part of the accountability report due a year after successful funding.