UNIDATA COMMUNITY EQUIPMENT AWARD PROPOSAL

Enriching Meteorological Education in Undergraduate Courses Using Real-Time, High Resolution Datasets at Metropolitan State University of Denver

Date: 3-10-2014

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Requested Amount: **$19,938.22**

Enriching Meteorological Education in Undergraduate Courses Using Real-Time, High Resolution Datasets at Metropolitan State University of Denver

Sam Ng, Department of Earth and Atmospheric Sciences,
Metropolitan State University of Denver

1 Project summary

The Earth and Atmospheric Sciences Department at Metropolitan State University of Denver (MSU-Denver) has been offering a Bachelor of Science in Meteorology since the early 1980s. This established meteorology program attracts local and out-of-state students from various ethnic and socioeconomic backgrounds. The department mission statement is to educate through effective, student oriented teaching and research to prepare students for successful career. Specifically, the meteorology program's mission is to establish an environment based on operational meteorology concepts.

As of the fall of 2013, over 7,300 students out of 22,000-plus undergraduates have a minority background at MSU-Denver. Metropolitan State University of Denver remains the least expensive of Colorado's largest four-year universities offering undergraduate degrees, providing an opportunity for underprivileged students to seek a valued education. As the only Bachelor of Science Meteorology degree in the state of Colorado, MSU-Denver's administrators strongly support the meteorology program. The Meteorology Program has also been a member of the UCAR (University Corporation for Atmospheric Research) since 2009. The program consists of 3 full-time meteorology professors (two tenured and one tenure track), several affiliate professors (from National Center for Atmospheric Research, NCAR) and a part-time UNIX system administrator. The MSU-Denver meteorology curriculum (see Appendix A) follows the guidelines and recommendations suggested by American Meteorological Society (AMS) and National Weather Service (NWS).

The MSU-Denver weather computer server has been serviceable, but with the demand of larger datasets and more data to choose, the computing load within the meteorology network is inefficient. Currently, the department's server utilizes various Unidata products to retrieve and visualize meteorological dataset for educational purposes. A Local Data Manager (LDM) has been setup and has been actively running for 10-plus years. The Meteorology program has 30 Linux-based (Red Hat 6.0) PCs that are spread across two classrooms, independent of the school's network. The first room is a traditional lecture-based classroom that houses one PC for instructor use during lectures, while two other PCs with dual-boot capability are for students to use freely. The remaining computers are located next door in the meteorology lab. In the lab, two of the PCs are assigned to a projector and a 42" LCD TV exclusively for the use of weather discussions. Unidata software running on these Linux machines includes GEMPAK,

NTL, and IDV. The School of Letters, Arts and Sciences has in the past upgraded the computers in the lab on a 3 to 5 year cycle. The meteorology lab's PCs are approaching the end of their lifecycle and should be upgraded within the next 24 months. Last summer, the PCs were upgraded from 4 to 8 gigabits of RAM in order to handle IDV more efficiently, but as it appears, a standalone graphics card will provide a better user experience for the students. The meteorology program anticipates the next PC upgrade to include a higher capacity of RAM in the machines along with a standalone graphics card to handle IDV even more efficiently.

The objective of this grant proposal is to request an AWIPS II EDEX server and 15 NVIDIA Graphics cards with 2 GB video RAM. With the ever-growing size and countless choices of meteorological datasets, incorporating an AWIPS II EDEX server will create a smoother, seamless, user-friendly experience for students who are trying to display current and archived data for student presentations and undergraduate research. Having a local EDEX server will create a shorter lag time during the data fetching and processing steps, which are the top complaints from current and past students. The upgraded server and new graphics cards will allow faculty and students to analyze a new dataset such as the GOES-R products when they become operational through AWIPS II or IDV combined with RAMADDA.

Receiving funding to upgrade the MSU-Denver meteorology lab will ensure students are kept up to date with the latest meteorological datasets by improving how the datasets can be used and manipulated. This will be a vast improvement compared to searching for static weather information/graphs/charts online. Students and faculty will be able to analyze and plot meteorological data to reinforce concepts and theories that are discussed in classes.

2 Project description

2.1 Equipment requested

The AWIPS II EDEX server and standalone Dell PC have the following configurations:

AWIPS II EDEX Server

- HP ProLiant BL460c Gen8 E5-v2 10Gb FlexibleLOM Blade Server
- HP ProLiant BL460c G8 Server Blade
- 2 x Intel Xeon E5-2650v2 (2.6GHz/8-core/20MB/95W) FIO Processor
- 32GB (4x4GB) Single Rank x4 PC3-14900R (DDR3-1866) Registered CAS-13
- HP Smart Array P230i/512 6Gb FIO SAS Controller
- 2 X146GB 6G SAS 15K rpm SFF (2.5-inch) HP RAID 1 Drive 1 FIO Setting (requires matching 2 hard drives)
- HP FlexFabric 10Gb 2P 554FLB FIO Adapter
- 2 x HP D2200sb Storage Blade
- HP Smart Array P410i / 1GB FBWC Controller
- HP 600GB 6G SAS 10K rpm SFF (2.5-inch) Dual Port Enterprise
- RedHat 6.0

15 x NVIDIA Graphics Processing Unit (GPU, Video Card)
- 2 GB video RAM
- OpenGL support

Based on the recommendation suggested by the Unidata staff on a minimal configuration of an EDEX server and CAVE clients, the specifications of the proposed server will ensure a smooth, seamless integration into the meteorology-computing network. Moreover, half of the lab's computers (15) will be upgraded to become CAVE clients.

2.2 How the equipment will help meet the overall goals of the project

The requested hardware will allow students to efficiently visualize and understand advanced concepts in meteorology while utilizing high-resolution, spatial and temporal weather data. In several courses, real-time data are necessary to convey the conceptual importance of the topic. Using the AWIPS II software will enable students to learn meteorology in a way that has not been available to them in the past. GEMAPK and N-AWIPS programs are excellent meteorological display software, but they are outdated and are only used at National Centers, while AWIPS is the weather analysis software of choice in the NWS. Since the MSU-Denver program focuses on operational meteorology in its curriculum, having a system like AWIPS II will be beneficial to students as they prepare for a possible future in the forecasting sector. The EDEX server will act as a high-powered, data-processing machine to push the final products out to the CAVE clients. Half of the meteorology lab PCs will be converted into CAVE clients in order for students and faculty to access AWIPS II dataset in real-time. With the integration of GEMPAK into AWIPS II, students can also customize their data with some simple programming.

The second part of the proposal calls for a purchase of 15 graphics processor units in order to display the data from the EDEX server and to visualize 3-D atmospheric processes on IDV. The meteorology program will still use IDV along with RAMADDA as a tool to visualize the 3-D nature of atmospheric motions along with incorporating it for case study diagnostics. The cases will be stored and freely distributed to students through the RAMADDA system. The MSU-Denver meteorology program has a series of case studies made for GARP stored on the current server. New cases will be added using data ingested by the EDEX server to create comprehensive case studies of past weather events.

The courses that will benefit from the grant include Forecasting Lab I, II & III (MTR4210, 4220, & 4230), Synoptic Meteorology (MTR3410), Weather Analysis Techniques (MTR3410), Mesoscale Meteorology (MTR4500) and Advanced Synoptic (MTR4400). These classes have lab contact hours written into their master syllabus; therefore, utilizing AWIPS II data along with the RAMADDA system will be an integral part of teaching. By analyzing the latest meteorological datasets from AWIPS II, students would be able to combine concepts and theories and apply them in an user-friendly, laboratory environment.

2.3 How the equipment will impact the Unidata community

The proposed equipment will enable Metropolitan State University of Denver to be an early adopter into the AWIPS II weather analysis display system. There have been talks around the academic community on how the EDEX server could be burdensome for smaller programs, similar to MSU-Denver, due to its rigorous minimal requirements and specifications. Being a small, under-funded, undergraduate program, a successful grant proposal can show the Unidata community along with the rest of the weather enterprise that these concerns can be overcome. Building and sustaining an EDEX server can be quite beneficial for any atmospheric science program that is serious about joining the 21st century in meteorological analyses and visual displays of data.

Moreover, the meteorology program will make our data available to any students or programs outside of the MSU-Denver meteorology network via IDV and RAMADDA. Several universities have successfully shared their data through the Community Data Server within IDV, the meteorology program is trying to follow in these Universities' footsteps.

2.4 Relationship of proposed hardware to departmental hardware

The additional hardware will allow the MSU-Denver meteorology program to speed up its data processing of real-time data along with adding a smooth, 3-D visual display in IDV.

Currently, the MSU-Denver weather server (wx.msudenver.edu) that also houses the LDM has the following specification:

- 8 Core Intel E5630 Xeon processor @ 2.53GHz
- 8 GB RAM
- 120 GB Local Storage
- 1.5 TB Network Storage (iSCSI)
- RedHat 6.0

While the lab workstations have the following configuration:

- Intel Duo Core2 E8400 @ 3.0 Ghz
- 8 GB RAM
- 250 GB Local Storage
- 250 MB On-board Graphics
- RedHat 6.0

The current weather server should be able to perform in the same capacity while interacting with the new EDEX server. An imminent PC upgrade to the meteorology lab will enable faster processing to run the CAVE clients faster. Before the actual school upgrade period, the meteorology program would like to add 15 GPU cards into one-half of our lab workstations to make some of our workstations functional with AWIPS II. When the lab upgrade date arrives, the program will request from the school of LAS that the rest of the PCs be replaced with new workstations with new video cards. Once the

school upgrade has been completed, the meteorology lab will be a fully serviceable CAVE client lab for AWIPS II.

2.5 Feasibility of attaining the proposal goals

The meteorology program has a part-time UNIX person that works closely with the full-time faculty. Chris Kimmett, the co-PI on this grant, will set up all the hardware and compile all the necessary programs that require the EDEX server to run properly under the supervision of the Dr. Sam Ng, the lead PI. Mr. Kimmett has been the meteorology computer administrator for the last 4-plus years. He has worked closely with Dr. Ng in maintaining and upgrading the meteorology lab hardware and software since his appointment. The school of LAS has given close to 50% of Chris' work time to be solely invested in the meteorology program. He has taken upon himself to learn more about the different Unidata software packages by attending the summer 2011 Unidata workshop on GEMPAK, IDV, and LDM. The PIs will be working closely together to ensure this portion of the proposal project gets accomplished in a timely manner.

Once the EDEX infrastructure is in place, the utilization of the multitude of datasets will be up to the instructors to implement in their courses. Dr. Ng teaches most of the courses that would benefit from this proposal; therefore, he will introduce the new data and AWIPS II program to students and faculty. Dr. Ng has worked with GEMPAK exclusively for his research and is quite capable in GEMPAK programming. He has attended an IDV and LDM workshop during the summer of 2011. In addition, in the last 1.5 years, Dr. Ng has moved almost exclusively to using IDV in his lab courses. He uses the IDV YouTube tutorials regularly to understand the software more in depth. Lastly, Dr. Ng has had some exposure to the first AWIPS software. He was one of the lab instructors for an international hydrology course held at COMET in 2008. Dr. Ng wrote a short AWIPS tutorial for the international students since they were using AWIPS extensively during the 3-week course.

The PI and Co-PI have established a strong working relationship. They have the expertise to see the project to completion and beyond. They have built and maintained a solid infrastructure in the current weather lab.

3 Budget

The grant proposal is for hardware only. Under the supervision of the PI, Chris Kimmett will install and configure the hardware. All quotes are from the IT purchasing group at MSU-Denver, which should have the education discounts. The quotes include extended warranty to cover for any possible failure after the initial warranty expires. Cost sharing is not a part of the proposal since it is over $5,000; however, the School of LAS has always maintained the solid computing structure in the weather lab with PC upgrades on a regular cycle. Our next scheduled upgrade is within the next 24 months; therefore, the newer PCs can serve as a CAVE client as well for the proposed EDEX server.

1 EDEX server with the previously specified configuration: $13,938.22 x 1 = $13,938.22
15 NVIDIA Graphics Processing Unit with 2 GB video RAM and OpenGL support :
$400 x 15 = $6,000.00

Total Cost **$19,938.22**

4 Project milestones

Hardware purchase will take place immediately after verification of funding during the summer of 2014. The EDEX server will be housed in a climate controlled data center. Additionally, the campus IT department is constantly backing up all the school's server data. The video cards will be purchased during the summer of 2014 as well. The installation of the necessary hardware and software in order for the EDEX server running on RedHat 6.0 will begin when the hardware is delivered along with the GPU video cards.

The EDEX server will be the top priority. During the fall of 2014, the PI and Co-PI will be diagnosing and testing the EDEX server on several machines with the new video cards to test the speed and responsiveness of the AWIPS II and IDV software. The PIs anticipate a completion of the installation and testing of the EDEX server by the winter of 2014. The students should be able to use the AWIPS II system by the spring of 2015. In the meanwhile, students can take advantage of the faster IDV graphics rendering provided by the video card upgrade. During the spring of 2015, the PI will be giving a general overview tutorial on the AWIPS II system to the students at a local AMS meeting to get them familiar with the software. AWIPS II will be used exclusively in Dr. Ng's MTR 3410 and MTR 4210 course during the spring semester of 2015, since these courses have an operational meteorology component in their curriculum. During the summer of 2015, selected datasets from the EDEX server will be placed in RAMADDA repository for students to access from their home or away from the meteorology lab.

APPENDIX A

The Meteorology Program and Curriculum at Metropolitan State University of Denver

The program meets both National Weather Service and American Meteorological Society guidelines, preparing students for graduate school or careers in the National Weather Service, private industry, or public broadcasting.

Meteorology Major for Bachelor of Science

Required Core – 35 hours			**Credit Hours**
MTR	1400	Weather and Climate	3
MTR	2020	Weather and Climate Lab	1
MTR	2410	Weather Observing Systems	3
MTR	3330	Climatology	3
MTR	3400	Synoptic Meteorology	4
MTR	3410	Weather Analysis Techniques	3
MTR	3430	Atmospheric Thermodynamics	3
MTR	3440	Physical Meteorology	3
MTR	3450	Dynamic Meteorology	3
MTR	4400	Advanced Synoptic Meteorology	3
MTR	4500	Mesometeorology	3
MTR	4600	Senior Research Seminar	3
Approved Meteorology Electives - Select at least 8 hours			
MTR	3100	Air Pollution	3
MTR	3420	Radar and Satellite Meteorology	3
MTR	3500	Hazardous Weather	3
MTR	3710	Meteorological Co-op. Education I	3-6
MTR	4210	Forecasting Laboratory I	1
MTR	4220	Forecasting Laboratory II	1
MTR	4230	Forecasting Laboratory III	1
Required Mathematics Minor – 24 hours (3 hours apply to General Studies, Quantitative Literacy)			
MTH	1410	Calculus I	4
CS	1050	Computer Science I (with Java)	4
MTH	2410	Calculus II	4
MTH	2420	Calculus III	4
MTH	3210	Probability and Statistics	4
MTH	3420	Differential Equations	4
Physics and Chemistry - 14 hours (9 hours apply to Gen. Studies, Natural Science)			
PHY	2311	General Physics I	4
PHY	2321	General Physics Lab I	1
PHY	2331	General Physics II	4
PHY	2341	General Physics Lab II	1
CHE	1800	General Chemistry I	4

Additional Course Requirements (General Studies) - 24 hours

Global Diversity Requirement – 3 Hours

Multicultural Requirement – 3 Hours

General Electives – 15 hours

Total for Meteorology Major…… **120**