2015 UNIDATA COMMUNITY EQUIPMENT AWARD PROPOSAL

Expanding Unidata Visualization and Data Analysis for Innovative Meteorological Education at Western Kentucky University

Date: 5 March 2015

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Signature of Official:

Amount Requested: $14,770

1 Project Summary

The B.S. Meteorology Program at Western Kentucky University (WKU), housed within the Department of Geography and Geology, is the only meteorology program in Kentucky and Tennessee that meets all Federal Civil Service requirements (GS-1340) for employment by the National Weather Service and enables broadcast meteorologists to immediately pursue the "Certified Broadcast Meteorologist" program of the American Meteorological Society upon graduation. The Meteorology Program serves numerous first-generation college students, particularly from rural populations and other socio-economically disadvantaged groups. The program is comprised of four full-time tenured faculty, one full-time research faculty, one full-time tenured State Climatologist, and two full-time instructors. The rapid growth of the Meteorology Program (established in 2007) currently leads the department with 70 enrolled majors. The emphasis of the program is on advanced theoretical and applied coursework, coupled with student engaged hands-on active learning with meteorological instruments, Unidata (e.g., IDV, GEMPAK, McIDAS) and other software, and fieldwork. Consequently, undergraduate students are involved with various faculty-sponsored research efforts that have resulted in numerous national professional conference presentations (e.g., American Meteorological Society, National Weather Association, among others) and peer-reviewed journal articles (e.g., Bulletin of the American Meteorological Society, among others). Further, the B.S. Meteorology Program at WKU boasts a greater than 95% success rate with respect to post-graduate employment with the National Weather Service, funded graduate assistantships, and private sector positions.

Given the rapid and sustainable growth of the Meteorology Program at WKU, the objective of this proposal is to request funding to expand Unidata visualization and data access to continue to provide innovative instruction and opportunities for students seeking careers in meteorology. *Specifically, this proposal requests funding to acquire a dedicated AWIPS II server with three CAVE clients to expand Unidata visualization and data analysis for innovative meteorological education at WKU*.

2 Project Description

2.1 *Background and Goals*

The mission of the B.S. Meteorology program is to promote high-quality undergraduate learning and advancement of meteorological knowledge using innovative infrastructure and technology. WKU has established the Kentucky Mesonet, a statewide high-resolution weather and climate-observing network that is only the second of this type in the entire world. This in-situ mesoscale observation system provides world-class, research-grade surface and sub-surface data from 65 stations and provides near real-time analysis output at up to five-minute time scales (http://www.kymesonet.org). The Kentucky Mesonet collects data on temperature, precipitation, solar radiation, relative humidity, wind speed and direction at all sites, as well as soil moisture and soil temperature at five locations.

The Kentucky Climate Center (KCC; http://www.kyclimate.org/) is recognized as the State Climate Office for Kentucky by the American Association of State Climatologists as part of the National Climate Services Partnership. The KCC is an applied research and public outreach initiative that disseminates information on climate variability and change, human impacts on the natural environment, and promotes understanding and appreciation of the natural environment and its importance to sustainability and society. Both of the Kentucky Mesonet and the KCC reside within the Department of Geography and Geology under the direction of the State Climatologist and serve as integral

components to the B.S. Meteorology Program at WKU.

The College Heights Atmospheric Observatory for Students (CHAOS) provides a monitoring, prediction, and research facility for upper-level meteorology majors, as well as a learning and applications laboratory for over 400 introductory meteorology students (mostly non-majors) each academic year. CHAOS utilizes an in-house NOAAPORT system, the Unidata software suite, the Kentucky Mesonet, a university weather station, a live-streaming video camera, and drone copter surveillance to provide in and out-of-classroom applied meteorological student learning engagement experiences with the primary focus on local weather conditions. CHAOS features output visualization via a 100-inch computer projection system, along with 55 and 65-inch televisions, and 25 and two Windows and Unix-based (Apple) systems, respectively.

The Department of Geography and Geology has two devoted climate research laboratories, which feature nine Linux workstations with one 16-node (32 cores) computer cluster, along with a NOAAPORT ingest system and Unidata Local Data Manager (LDM). Lastly, the university maintains the High Performance Computing Center (HPCC; http://hpc.wku.edu/home/) that consists of three clusters with 128 nodes each (+3,000 total computing cores) and one expandable cluster with 7,000 GPU cores. The clusters are fully networked and connected to a high-speed network to address the needs of faculty, researchers, and students.

The Unidata software suite has served as a vital tool in the meteorology curriculum. Students are required to conduct many assignments, forecast discussions, and research projects using Unidata software. The overarching goal of this request is to enhance meteorological education and training at WKU by expanding the current Unidata infrastructure to include sufficient, dedicated hardware necessary for handling both, AWIPS II software and the growing number of students who require access to these workstations. With this system expansion, we will develop a student-run real-time weather monitoring and prediction web site via CHAOS that will showcase Unidata output and compliment the Kentucky Mesonet data visualization and Kentucky Climate Center outreach efforts.

2.2 *Equipment Request*

The requested funding for WKU's 2015 Unidata Community Equipment Award proposal will be used to purchase an EDEX server/CAVE and three CAVE clients. The configuration of the EDEX server is based on Unidata recommendations. The CHAOS facility operates on a three-year equipment update cycle. The next update cycle is slated for the 2017 summer in preparation for the fall semester. The requested CAVE clients will supplement the current off cycle to immediately offer student access, as well as set the stage for necessary hardware specifications in the next update cycle in 2017. The new machines from the 2017 update cycle will be dual-boot enabled for Windows and Linux, which will introduce the Linux environment as a permanent fixture in the undergraduate curriculum. Below is the itemized equipment request for this proposal:

Microway Xeon WhisperStation is proposed for the EDEX server / CAVE:

- 2 x Intel Xeon E5-2620 processors (2.4GHz, 16-Core)
- 64GB RAM (DDR4 2133MHz)
- 512GB Samsung 850 Pro Series SSD (Operating System)
- 4 x 2TB Toshiba Enterprise SATA Drive (Storage)
- LSI 9361 4 port hardware RAID

- EVGA GeForce GT 750 (2048MB GDDR5 5400 MHz memory)
- LITE-ON 24x DVD/CD Burner
- COOLMAX 1000W Quiet Power Supply
- CentOS 6.5

Microway Xeon WhisperStation Thin Client is proposed for the CAVE client:

- Intel Xeon E5-1620 processors (3.5GHz, 4-Core)
- 16GB RAM (DDR4 2133MHz)
- 2TB Toshiba Enterprise SATA Drive (Storage)
- EVGA GeForce GT 750 (2048MB GDDR5 5400 MHz memory)
- LITE-ON 24x DVD/CD Burner
- 650W Quiet Power Supply
- Asus 23" Widescreen LED Backlight LCD Monitor
- Dual Boot Windows / CentOS 6.5

2.3 *Benefits to Atmospheric Science Education at WKU*

There are a multitude of positive education, and ultimately professional outcomes given the implementation of the proposed expanded hardware and Unidata software suite. Post-graduate career paths for B.S. Meteorology students at WKU have been dominated by employment with the NWS, followed next by graduate school attendance, and finally with private sector forecast and/or technical positions. CHAOS is a student-centered interactive and applied learning facility whereby students engage in data collection, analysis, and interpretation via computer visualization. Further, the students frequently communicate with the NWS Louisville and Nashville offices and local emergency managers on current observations and forecasts, and disseminate this information via public diagnostic and prognostic weather discussions, online web content, and social media (Figure 1). The backbone of CHAOS starts with our curriculum, which heavily utilizes Unidata technology in the classroom on a daily basis. Below is a listing of courses and brief activities that rely on this infrastructure:

- *Weather Analysis and Forecasting*: 2nd year students are introduced to and taught Unidata visualization and data analysis (IDV) for use in daily forecast discussions and homework assignments.

- *Synoptic Meteorology*: 3rd and 4th year students are required to use Unidata visualization and data analysis (IDV) for use in daily forecast discussions, assignments, and semester research projects.

- *Mesoscale Meteorology*: 3rd and 4th year students are required to use Unidata visualization and data analysis (IDV) for use in daily forecast discussions, assignments, and semester research projects.

- *Dynamic/Thermodynamic Meteorology*: 3rd and 4th year students use Unidata visualization and data analysis for assignments (IDV).

- *Satellite and Radar Meteorology*: 2nd and 3rd year students are required to use Unidata visualization and data analysis (IDV and McIDAS) for use in daily forecast discussions, assignments, and semester research projects.

- *Atmospheric Modeling*: 3rd and 4th year students use Unidata visualization and data analysis (IDV and GEMPAK) for assignments and semester projects.

- *Field Methods in Weather Analysis and Forecasting*: Each May, students in this intensive capstone field course use Unidata visualization and data analysis (IDV) for use in daily forecast discussions of severe convective storms.

- *Independent Research course*s: Students are required to use Unidata visualization and data analysis (IDV, McIDAS, and GEMPAK) and output of research for dissemination of research findings at professional research conferences and peer-reviewed manuscripts.



Fig. 1. An image showing an out-of-classroom student/faculty forecast discussion in the CHAOS forecasting facility. Here, the student was using IDV to explain predicted surface patterns from a recent RAP model run.

In summary, by expanding Unidata infrastructure for education and training in the B.S. Meteorology Program at WKU, students will be equipped with enhanced technical skillsets and better prepared for their intended career paths.

2.4 *Benefits to Research*

The Meteorology faculty and students at WKU conduct observational, case study, and modeling research. These efforts are largely supported by external agencies (e.g., National Science Foundation, United States Department of Agriculture, National Aeronautics Space Administration, among others) and internal programs (e.g., Research and Creative Activities Program, Faculty-Undergraduate Student Engagement Program, among others). A recent example of peer-reviewed published Unidata-based research output from a faculty/student collaboration may be seen in figures 6-8 and 10b in the Durkee *et al.* 2012 *Bulletin of the American Meteorological Society* article, "A Synoptic Perspective on the Record 1-2 May 2010 Mid-South Heavy Precipitation Event". This research was a case study analysis that focused on the morphology of large-scale atmospheric circulation and moisture anomalies that aided in the development of record rainfall and devastating floods across Kentucky and Tennessee. For the aforementioned figures, the authors used IDV to calculate and provide visualization of composite standardized moisture and upper-air height anomalies to help explain the synoptic influence of the event (http://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-11-00076.1). Further, we are particularly interested in observational coupling of AWIPS II with the Kentucky Mesonet for real-time and post-event analysis. Expanding the Unidata research technology infrastructure would enhance these types of research abilities, quality, and output within the program, and promote greater leverage for research production with potential funded opportunities.

2.5 *Benefits to Unidata*

The Unidata software suite is an invaluable asset for all faculty and students, who teach, learn, and research various atmospheric and geoscience phenomena. Part of what makes Unidata successful is feedback from the end users that is later used to improve software and data access in subsequent renditions. The B.S. Meteorology Program at WKU has been using the Unidata software suite ever since its inception and has continued to provide feedback to Unidata. By expanding Unidata infrastructure to include an AWIPS II implementation, our faculty and students will continue to provide important feedback on this system as it continues to set the stage as the leading data visualization and analysis software system. We are also interested in designing a test-bed configuration that will allow students to use non-Linux workstations to operate the AWIPS II environment through virtualization and windows-based X Window systems (e.g., Cygwin).

Our department is also equipped a Tobii X2-60 Eye Tracker, with pending funding for a Tobii Glasses 2 Live View Eye Tracker. Eye-tracking technology provides the ability to quantitatively measure an individual's points of interest and precise eye movements when viewing 2D or 3D visualizations. Specific eye movements can be statistically correlated to the attention path demonstrated by an observer. With this in mind, we are especially interested in coupling eye-tracking techniques with advanced GIS spatial data analysis to investigate effective instructional data visualizations using AWIPS II. Our department also has five certified GIS professionals (GISP) who may assist in innovative education analysis such as eye tracking. This technology and analysis will allow quantifiable education feedback for Unidata on the overall effectiveness of AWIPS II visualization for B.S. Meteorology students at WKU.

Finally, the B.S. Meteorology Program at WKU offers a weather camp each summer. The WKU Weather Camp (http://wkuwxcamp.weebly.com/) is part of the National Weather Camps Program and provides a weeklong immersive learning experience for children ages 11-14, with the goal of promoting and exciting interest in the atmospheric sciences at an early age. These young campers get

an abundance of hands-on active learning experiences that range from basic demonstrations and experiments to operating and interpreting professional-grade software, including the Unidata software suite. With the implementation of AWIPS II, we plan to offer a NWS training workshop during the event, whereby campers get to emulate the day in a life of a professional meteorologist at the NWS.

3 Proposed Budget

In order to enable B.S. Meteorology Program at WKU to become fully capable of utilizing AWIPS II software, the following servers will be purchased at the following cost:

Quantity	***Item***	***Unit Price***	***Total Price***
1	Microway AWIPS II server	$5,240	$5,240
3	Microway CAVE client	$2,237	$6,711
		Indirect Costs (42% on $6711)	$2,819
		Grand Total Requested	$14,770

WKU's Facilities and Administrative rate agreement (modified total direct costs) does not include overhead on individual items exceeding $5,000. The above costs include a two-year parts warranty. While there will not be any direct cost sharing by the university for the above equipment, WKU will provide a 4th CAVE client with equivalent specifications and with a hardware RAID with 5 TB of usable storage. In addition, the university will donate time for the Co-PI and the departmental IT support for the installation, configuration, and maintenance of the system. 0.25 months of time is anticipated for each. An additional 0.33 months time will be used by the PI to train faculty and students in the use AWIPS II and its incorporation into the undergraduate coursework.

4 Project Milestones

- End of May 2015: Notice of award.
- End of July 2015: Acquisition and installation of the AWIPS II server and CAVE clients.
- End of August 2015: Configuration and testing. Late July though August 2015 will provide ample time for configuration and testing prior to the students arrival for the fall semester.
- Fall 2015 semester: Initial implementation and testing in a classroom setting. As the observation intensive courses are during the spring semester, Fall 2015 will provide additional time for students and faculty to develop skills in using AWIPS II for lectures, homework assignments, and weather discussions.
- Spring 2016 semester: Full implementation. Intensive use in METR 324, Weather Analysis and Forecasting.

APPENDIX I

Microway, Inc.
12 Richards Road
Plymouth, MA 02360
Phone: 508.746.7341
Fax: 508.746.4678
http://www.microway.com

QUOTATION

Quote # MWYQ19123-04
Date: 2/27/2015
Microway Confidential

Quote To:
Western Kentucky University
Eric Rappin

(305)542-3288
eric.rappin@wku.edu

Ship To:
Western Kentucky University
Eric Rappin

(305)542-3288
eric.rappin@wku.edu

Sales Rep.
Eliot Eshelman
508-732-5534
eliote@microway.com

Qty	Description	List Price	Your Price	Extended Price

Microway is a small business, woman owned and operated. We are building many clusters at any one time and have built thousands of custom clusters for universities, government research labs and agencies, and corporations. Microway has been in the scientific computing business since 1982.

1 **Microway Xeon WhisperStation** $6,818 $5,240 $5,240

Chenbro Mid-tower for Xeon/Opteron (Black)
Dimensions: 20.1" D x 16.7" H x 7.8" W
Exposed Drive Bays: (3) 5.25" (3.5" bracket available)
Internal Drive Bays: (4) 3.5" (hot-swap optional)
Two front-mounted USB 2.0 ports
One front, one rear and one hard drive cooling fan



Coolmax ZP-1000B Bronze Certified 1000W Quiet Power Supply

NumberSmasher Dual Intel Xeon Motherboard (X10DAi)
Supports up to two Intel Xeon E5-2600 Socket R3 processors
Intel C612 chipset
Intel QuickPath Interconnect (QPI) with system bus up to 9.6GT/s
Sixteen slots for up to 1024GB Reg. ECC DDR4-2133/1866 memory (Quad Channel)
Dual Integrated Intel I210 Gigabit Ethernet ports
Integrated RealTek ALC888 7.1 High Definition Audio
Integrated SATA controller with ten SATA3 6Gb/s ports
PCI-E Slots Support EITHER:
(3) PCI-E x16 3.0 slots, (2) PCI-E x8 3.0 slots, (1) PCI-E x8 3.0 slot (with x4 signal), all single width OR
(3) PCI-E x16 3.0 slots (double width), (1) PCI-E x8 3.0 slot (with x4 signal, single width)
Internal headers: USB 3.0, USB 2.0
Rear Connectors:
Serial, Ethernet, Audio
Four USB 3.0, Two USB 2.0

(2) Intel Xeon E5-2620v3 Haswell-EP 2.40 GHz Six Core 22nm CPU
with 15MB L3 Cache, DDR4-1866, 8.0 GT/sec QPI, 85W
Supports Hyper-Threading and Turbo Boost up to 3.2 GHz

(8) 8GB DDR4 2133 MHz ECC/Registered Memory (Single Rank, 1.2V)

(64GB Total Memory @ 1866MHz)

(2) Ultra-Quiet Active Xeon Socket Workstation Heatsink

512GB Samsung 850 Pro Series 2.5" SATA III MLC Solid State Drive
SATA 6Gb/s Interface (Supports 3Gb/s)
Solid State Disk (SSD), 2 Million Hours Mean Time Before Failure (MTBF)
Sustained sequential read: up to 550 MB/s
Sustained sequential write: up to 520 MB/s
Random 4KB Reads: Up to 100,000 IOPS; Writes: Up to 90,000 IOPS
(Operating System)

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Qty	Description	List Price	Your Price	Extended Price

(4) 2 TB Toshiba MG03ACA200 3.5" Enterprise SATA Drive
64MB Cache, 6Gbps, NCQ, 7200RPM, 1.2 million hours MTBF
(Hardware RAID5; ~6TB Usable)

LSI 9361-4i Internal 12Gbps SAS/SATA Low Profile PCI-E x8 3.0 RAID Controller
LSI SAS3108 ROC
1GB DDR3 1866Mhz Cache
RAID levels 0, 1, 5 and 6
RAID spans 10, 50 and 60
Supports up to 128 SAS or SATA RAID Devices
One internal Mini-SAS HD SFF-8643 connector
(Flash Backup is Optional and Not Included in Base Price)

EVGA GeForce GTX 750 Ti PCI-E 3.0 2048MB
1 DVI, 1 HDMI, 1 DisplayPort
2048MB GDDR5 5400 MHz Memory (128 bit)
Core Clock: 1020 MHz
CUDA Cores: 640
Memory Bandwidth: 86.4 GB/sec
Supports NVIDIA CUDA
Max Power Draw: 60 W (1 x 6-pin)
Double PCI slot form factor

LITE-ON Dual Layer 24X DVD/CD Burner (Black) SATA
DVD-R/+R: 24X, DVD+RW: 8X, DVD-RW: 6X
CD-R: 48X, CD-RW: 32X

Noise Dampening Material and Silent Fans

CentOS 6.5 Linux installed, configured and tested.

3	**Microway Xeon WhisperStation Thin Clients**	$2,891	$2,237	$6,711

Chenbro Mid-tower for Xeon/Opteron (Black)
Dimensions: 20.1" D x 16.7" H x 7.8" W
Exposed Drive Bays: (3) 5.25" (3.5" bracket available)
Internal Drive Bays: (4) 3.5" (hot-swap optional)
Two front-mounted USB 2.0 ports
One front, one rear and one hard drive cooling fan



650 Watt High Efficiency Quiet Power Supply

NumberSmasher Single Socket Intel Xeon Motherboard (X99 Extreme4)
Supports one Core i7 or Intel Xeon E5-1600 or Xeon E5-2600 Socket R3 Processor;
Eight slots for up to 128GB ECC Unbuffered/ECC Registered DDR4-2133/1866 memory;
PCI-E expansion supports either:
Two PCI-E x16 3.0 Slots (GPU support, double-wide), One PCI-E x8 3.0 Slot); OR
One PCI-E x16 3.0 slot (x8 signal), Two PCI-E x16 3.0 Slots (with x8 signal, double-wide), One PCI-E x16 2.0 Slot (x4 signal), One PCI-E x1 2.0 slot;
Intel X99 chipset
ATX form factor;
One Intel Gigabit Ethernet Ports;
7.1 CH HD Audio with Content Protection (Realtek ALC1150 Audio Codec)
10 SATA3, 1 eSATA, 1 Ultra M.2 (PCIe Gen3 x4 & SATA3)
6 USB 3.0 (2 Header, 4 Rear), 8 USB 2.0 (4 Header, 4 Rear)
1 COM Port Header, 1 Thunderbolt AIC Connector

Intel Xeon E5-1620v3 Haswell-EP 3.5 GHz Four Core 22nm CPU
with 10MB L3 Cache, DDR4-2133, 140W
Supports Hyper-Threading and Turbo Boost up to 3.6 GHz

(4) 4GB DDR4 2133 MHz ECC/Registered Memory (Single Rank, 1.2V)

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APPENDIX I

Qty	Description	List Price	Your Price	Extended Price

(16GB Total Memory @ 2133MHz)

Quiet Active Xeon Socket 2011 Workstation Heatsink

2 TB Toshiba MG03ACA200 3.5" Enterprise SATA Drive
64MB Cache, 6Gbps, NCQ, 7200RPM, 1.2 million hours MTBF

EVGA GeForce GTX 750 Ti PCI-E 3.0 2048MB
1 DVI, 1 HDMI, 1 DisplayPort
2048MB GDDR5 5400 MHz Memory (128 bit)
Core Clock: 1020 MHz
CUDA Cores: 640
Memory Bandwidth: 86.4 GB/sec
Supports NVIDIA CUDA
Max Power Draw: 60 W (1 x 6-pin)
Double PCI slot form factor

LITE-ON Dual Layer 24X DVD/CD Burner (Black) SATA
DVD-R/+R: 24X, DVD+RW: 8X, DVD-RW: 6X
CD-R: 48X, CD-RW: 32X

Noise Dampening Material and Silent Fans

CentOS 6.5 Linux installed, configured and tested.

Asus 23" Widescreen LED Backlight LCD Monitor
1920 x 1080 Resolution
250 cd/m2 Brightness
170H 160V Degree Viewing Angle
2 ms Response Time (average)
0.2655mm Pixel Pitch
D-Sub (VGA), HDMI, and DVI-D Input Connectors
Tilt Adjustment
Power Usage: 27W On, .5W Power Save/Off
(Black)

Logitech MK120 Deluxe KB and Optical Mouse Combo

Microway Testing Procedure:

Each computer system is network booted to execute low-level memory tests for 12+ hours.

Once passed, operating systems are loaded and Linux stress tests are executed for 48+ hours. These tests include processor and memory intensive applications that have been shown to cause faults in the field. A separate set of tests accesses all sectors on each hard drive and runs filesystem-intensive applications to ensure drive and filesystem reliability.

Shipping Included

Total (Academic Pricing) **$11,951**

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Qty	Description	List Price	Your Price	Extended Price

FOB: Destination

Ship Date: 3 - 4 Weeks after receipt of order and documentation

Warranty: Two years offsite with replacement components typically cross-shipped within 24 hours of problem determination by Microway Tech Support.

Technical Support: Lifetime technical support via telephone, fax, or email.

Terms: Net 30

Shipping Method: Best Way

The Buyer is responsible for any sales taxes or duties related to the purchase.



Since 1982 Microway has been a leader in providing high performance computing solutions. Microway specializes in building complex clusters, servers, and workstations. We are unique in having Linux expertise throughout our organization to provide testing of all systems at our assembly and integration center at our headquarters in Plymouth, Massachusetts. Our validation suite includes a number of MPI applications and Microway proprietary software, including MPI Link-Checker and InfiniScope.

Microway is classified as a small business - woman owned and operated.

Microway welcomes our customers (and potential customers) to personally visit our manufacturing facility. We value the opportunity to share our understanding of the systems we build, and to demonstrate our dedication to quality in our design, fabrication, final testing and technical support. Please contact me if you plan to be in or near Massachusetts and would like to make an appointment.

Prices subject to review at time of order due to potential short term memory and hard drive price volatility.

GSA quotes are available upon request. Microway's GSA Contract Number is GS-35F-0431N.

This quote is valid for 30 days.

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