A Proposal to the

2014 Unidata Community Equipment Awards

for Support of

Improving Visualization and Access to Radar Data using Unidata Tools for Flood Prediction and Management

3/12/2014

Principal Investigator

Dr. Ibrahim Demir
Assistant Research Engineer, IIHR
Adjunct Assistant Professor, CEE
IIHR Hydroscience & Engineering
University of Iowa
300 S. Riverside Dr.
Iowa City, IA 52242
Phone: (319) 335-5780
Fax: (319) 335-5238
ibrahim-demir@uiowa.edu

Co-Investigator

BongChul Seo
Assistant Research Scientist, IIHR

Institution Official

Dr. Daniel Reed
Vice President for Research
University of Iowa
2 Gilmore Hall
Iowa City, IA 52242
Phone: 319-335-2123
Fax: 319-335-2130
dsp@uiowa.edu

Paul Below
Acting for Daniel Reed

Dr. Daniel Reed
VP for Research and Economic Development

Ibrahim Demir
Principal Investigator

Project Summary

The Iowa Flood Center (IFC) is a research and educational organization in which undergraduate and graduate students at the University of Iowa can participate in a variety of activities related to flood mitigation in Iowa. The IFC has been developing a web-based prototype flood information system called Iowa Flood Information System (IFIS), which is open to research and education communities (Demir and Krajewski, 2013). IFIS provides statewide radar-rainfall maps in near real-time using the Unidata Local Data Manager (LDM) software over the Internet Data Distribution (IDD), and the generated rainfall maps are fed into a physically-based hydrologic model for flood predictions. However, researchers and students need an interactive tool to better analyze and visualize radar data and products (e.g., Level II and III data) and to improve user understanding of IFIS generated rainfall maps and predictions. Expansion of the current LDM storage is also needed, due to the rapidly growing capacity and increase of radar volume file size (e.g., dual-polarization upgrade).

Although AWIPS has been widely used in meteorology and atmospheric science communities, its usage in the hydrology field has been rather limited. Collecting, decoding, and analyzing precipitation information using radar data and products are essential for flood prediction and management, and can be accomplished using the Advanced Weather Interactive Processing System (AWIPS) and LDM/IDD. The AWIPS is a primary tool to navigate all capabilities of NEXRAD radar data and offers an opportunity for hydrologists to enhance the quality and accuracy of radar-rainfall estimates; this is a driving factor for the IFIS flood prediction. In this proposal, we request funding to purchase new equipment for a prototype AWIPS II stand-alone Environmental Data Exchange (EDEX) server and Common AWIPS Visualization Environment (CAVE) client, coupled with the Unidata LDM to test data ingest and display locally, and using the CAVE thin client to connect to remote severs. This equipment will also be used in several courses at the University of Iowa to demonstrate the effective use of radar and meteorological datasets in hydrology and hydrometeorology, and to expand use of AWIPS and CAVE to students in non-traditional disciplines.

Project Description

In 2008, Eastern Iowa in the United States faced record flooding events described as a 500-year flood for some locations. To mitigate the effects of similar disasters in the future, a real-time regional flood forecasting system (IFIS) is being developed by the Iowa Flood Center, an academic research center at the University of Iowa. IFIS provides the “state-wide rainfall intensity and accumulation maps” in near real-time, generated by combining data from seven WSR-88D radars (two located in Iowa and five in nearby states). The radar (Level II) data are ingested into the IFIS system using the Unidata LDM/IDD and then further processed into rainfall products using algorithms developed by IFIS researchers.

IFIS uses the latest web technologies and graphical process unit (GPU) to visualize large-scale radar and rainfall data on a web-based map environment (Demir and Krajewski, 2014). These rainfall products offer high-resolution radar-derived rainfall information in time and space, capturing key features of rainfall fields. The data are then fed into a physically-based flood-forecasting model that uses landscape decomposition to process the information into hillslopes and channel links. The model predicts the hydrologic response of the landscape to rainfall inputs and provides predictions for the entire state without the need for extensive calibration.

The performance or reliability of model prediction without calibration (without using observed stream-flow data) is often subject to the quality or accuracy of rainfall inputs. Despite vigorous efforts to use radar-rainfall estimates for hydrologic and environmental applications, several important issues regarding the uncertainty of the estimates still remain unresolved. Fortunately, recent upgrades of dual-polarization in the WSR-88D data provide a new opportunity to mitigate some error sources in precipitation estimation, which are not yet implemented in the IFIS rainfall product. The use of AWIPS II enables easy access to the radar Level II and III data, allows researchers and students to explore the new dual-polarization capability, and offers many ways to comprehensively analyze and compare them with IFIS-created rainfall products. This analysis and comparison can facilitate testing of AWIPS II capabilities, as well as improved rainfall algorithm development in the IFIS system.

While the generated IFC rainfall and prediction data are published and accessible through a website open to general public and researchers, with a standardized NetCDF format the data will be available through the LDM for Unidata communities as well. The proposed equipment will allow us to set up an AWIPS II server to enhance the potential capabilities of IFIS to serve a broader community of researchers from the current Unidata community, as well as research communities outside the atmospheric sciences and general public. IFIS provides real-time and historical stream-level data and rainfall products using a web-service shared with many organizations, including the National Weather Service. IFIS also contributes to the education of graduate and undergraduate students by providing an interactive environment to access the IFIS-created products.

The equipment will be used to demonstrate the effective use of radar and meteorological datasets in several undergraduate and graduate courses in the Department of Civil and Environmental Engineering at the University of Iowa, including Introduction to Earth Science, Hydrology, Hydrometeorology, Remote Sensing, and Fundamentals of Atmospheric Science. This will allow students to interactively analyze and visualize massive geoscience datasets using Unidata tools through term projects and informatics labs for PI Dr. Demir's Information Systems for Resource Management course, which is cross-listed in seven departments at the University of Iowa. Notably, the LDM and AWIPS II will help students

obtain hands-on practice in manipulating and interpreting real-time data with their own knowledge and diagnostics.

Our research investigations have been cited in a number of research papers. The historical radar-rainfall products generated by Hydro-NEXRAD, a well-known cyberinfrastructure (Krajewski et al., 2011; Kruger et al., 2011; Seo et al., 2011), have supported various research purposes: flash-flood prediction for Iowa State University; scaling of peak flows in Kansas for the University of Iowa; calibration of distributed hydrologic models for New Mexico Tech; uncertainty propagation in hydrologic models for the University of Louisiana at Lafayette; spatial data representation in databases for Drexel University; and unban flooding and hydrometeorology for Princeton University. Moreover, real-time rainfall product feeds (Krajewski et al., 2013) have been provided for the University of Illinois at Urbana-Champaign, and the University of North Carolina.

Although AWIPS has been widely used in meteorology and atmospheric science, its usage in the hydrology field has been limited. This funding could encourage researchers in the hydrology community to experience for themselves the cutting-edge data display and analysis system and to take advantage of its potential benefits. The IFC is housed at IIHR—Hydroscience & Engineering, which is a research institute within the College of Engineering of the University of Iowa and supports many graduate and undergraduate students who participate in a variety of activities to understand flood-related physics and to mitigate effects from meteorological and hydrological hazards. Thus, this effort to test and navigate AWIPS capabilities will significantly contribute to the education of many students.

Proposed Equipment

IIHR provides support for several large-scale data harvesting and processing systems related to hydrological and meteorological analysis and modeling for the Iowa Flood Center. The IFIS system collects LDM and other weather data and builds a sequence of products for subsequent modeling. Raw data packets are ingested on one system and passed to another system for processing and storage in a database. A third system provides web-based access to these data products. Similarly, a network of bridge-mounted stream-stage sensors supply data to servers where the information is handled in a manner similar to the IFIS network. This architecture has proven scalable and reliable.

IIHR's professional dedicated Research Computing staff maintains a diverse array of information technology resources and facilities. We propose purchasing a new server (see configuration in the budget section) to set up AWIPS II to enhance the capabilities of the Iowa Flood Information System to serve a broader community of researchers. The new equipment will be located with the existing IT infrastructure within the Iowa Flood Center

and will be maintained by IIHR Research Computing staff as a component of the IFIS system.

Personnel Expertise

PI Dr. Ibrahim Demir is a Research Faculty Engineer at the Iowa Flood Center, University of Iowa. He is the architect and lead developer of the Iowa Flood Information System, a one-stop web-based platform to provide access to flood-related data, information, maps, and visualizations. Dr. Demir is a member of the CUAHSI (Consortium of Universities for the Advancement of Hydrologic Science, Inc.) Informatics Committee and the NSF EarthCube Workflow Steering Committee. CUAHSI is working to define the scope and requirements of a modeling platform to develop, disseminate, and support community modeling tools and simulation models. NSF EarthCube is an effort to develop transformative concepts and approaches to create integrated data management infrastructures across the geosciences. Dr. Demir teaches courses in informatics for engineering and science students. Dr. Demir is also active in the design and development of environmental information systems, novel scientific visualization interfaces for hydrological and meteorological data, and web-based information communication.

Co-PI Dr. Bong Chul Seo has been an Assistant Research Scientist at the Iowa Flood Center since 2010. He is a radar hydrologist and has used his expertise in hydrometeorology and atmospheric science to process NEXRAD radar data and generate quality-rainfall estimates. He participated in the research project, Hydro-NEXRAD ITR, when he was a Ph.D. student at the University of Iowa. He has been using the Unidata IDD/LDM technology to acquire radar Level II data in real-time and is also familiar with NetCDF and associated Unidata tools. He attended the Unidata training workshop (LDM session) in 2012.

Budget

The total requested funding for this proposal is $11,629. This will provide a system dedicated to data access and computational modeling. IIHR will provide system administration support, including backup, power, networking, and rack space in its data center.

The proposed system is comprised of:

Silicon Mechanics Rackform nServ A422.v4

CPU:	4 x Opteron 6376 (2.3GHz, 16-Core, G34, 16MB L3 Cache) 115W TDP
RAM:	128GB (16 x 8GB DDR3-1600 ECC Registered 2R DIMMs)

NIC:	Dual-Port Intel 82576 Gigabit Ethernet Controller - Integrated
Management:	Integrated IPMI 2.0 & KVM with Dedicated LAN
SAS:	Integrated LSI 2008 8-Port SAS2 HBA
RAID:	LSI 9271-8i (8-Port Int, PCIe 3.0, 1GB cache, Dual Core) CacheVault incl.
Boot Drive:	400GB Intel 910 Series MLC PCIe 2.0 x8 SSD
Storage:	5 x 3TB W. Digital RE SATA (6Gb/s, 7.2K RPM, 64MB Cache) 3.5-inch SATA
Fixed Drive:	500GB W. Digital VelociRaptor (6Gb/s, 10K RPM, 64MB Cache) 3.5" SATA
Optical Drive:	Low profile SATA DVD Drive
Power:	Redundant 1400W Power Supply with PMBus - 80 PLUS Gold Certified
Warranty:	Standard Three-Year Warranty

Equipment Cost:	$11,629
Total Direct Costs:	$11,629
Total F&A Costs:	$0 - (no F&A for equipment over $5,000)
Total Project Costs:	$11,629

Project Milestones

We expect to purchase the equipment to set up AWIPS II within one month of the award. A list of actions and milestones are as follows:

- May 2014 – Notification of award
- July 2014 – Acquire and install equipment
- September 2014 – Set up and configure AWIPS II
- November 2014 – Servers online and operational
- January 2014 – Integrate AWIPS products to Iowa Flood Information System

References

Demir, I, Krajewski, W., 'Towards an integrated Flood Information System: Centralized data access, analysis, and visualization,' *Environmental Modeling and Software*, 50, 77-84, 2013.

Demir, I, Krajewski, W., 'Interactive Visualization of Large-Scale Radar and Rainfall Data using Graphical Processing Unit and Latest Web Technologies,' in *Proceedings* of 30th

Conference on Environmental Information Processing Technologies, 2014 AMS Annual Meeting, February 2-6, 2014, Atlanta, Ga., USA.

Krajewski, W.F., Kruger, A., Smith, J.A., Lawrence, R., Gunyon, C., Goska, R., Seo, B.-C., Domaszczynski, P., Baeck, M.L., Ramamurthy, M.K., Weber, J. Bradley, A.A, DelGreco, S.A., Steiner, M., 'Toward better utilization of NEXRAD data in hydrology: An overview of Hydro-NEXRAD,' *Journal of Hydroinformatics*, 13, 255-266, 2011.

Krajewski, W.F., Kruger, A., Singh, S., Seo, B.-C., Smith, J.A., 'Hydro-NEXRAD-2: Real time access to customized radar-rainfall for hydrologic applications,' *Journal of Hydroinformatics*, 15, 580-590, 2013.

Kruger, A., Krajewski, W.F., Domaszczynski, P., Smith, J.A., 'Hydro-NEXRAD: Metadata computation and use,' *Journal of Hydroinformatics*, 13, 267-276, 2011.

Seo, B.-C., Krajewski, W.F., Kruger, A., Domaszczynski, P., Smith, J.A., Steiner, M., 'Radar-rainfall estimation algorithms of Hydro-NEXRAD,' *Journal of Hydroinformatics*, 13, 277-291, 2011.

Silicon Mechanics
22029 23rd Dr SE
Bothell, WA 98021-4410
(425) 424-0000

Quote

Date	Quote #	Confirmation #
03 / 12 / 2014	265480	1840825726

Bill To:
Mark Wilson The University of Iowa 423A Stanley Hydraulics Lab IIHR - Hydroscience & Engineering Iowa City, IA 52242 mark-wilson@uiowa.edu

Ship To:
Mark Wilson The University of Iowa 423A Stanley Hydraulics Lab IIHR - Hydroscience & Engineering Iowa City, IA 52242 mark-wilson@uiowa.edu

Description	AWIPS Refresh 3-12-14
Notes	

Quantity	Description	Price Each	Amount
1	**Rackform nServ A422.v4 "IIHR AWIPS op"** CPU: 4 x Opteron 6376 (2.3GHz, 16-Core, G34, 16MB L3 Cache) 115W TDP, 32nm RAM: 128GB (16 x 8GB DDR3-1600 ECC Registered 2R DIMMs) Operating at 1333 MT/s Max NIC: Dual-Port Intel 82576 Gigabit Ethernet Controller - Integrated Management: Integrated IPMI 2.0 & KVM with Dedicated LAN SAS: Integrated LSI 2008 8-Port SAS2 HBA NOTE: No Item Selected LP PCIe 2.0 x16 - 1: LSI 9271-8i (8-Port Int, PCIe 3.0, 1GB Cache, Dual Core) 6Gb/s SAS/SATA - CacheVault incl. LP PCIe 2.0 x16 - 2: 400GB Intel 910 Series MLC PCIe 2.0 x8 SSD LP PCIe 2.0 x8 - 1: No Item Selected Hot-Swap Drive - 1: 3TB Western Digital RE SAS (6Gb/s, 7.2K RPM, 32MB Cache) 3.5-inch SAS Hot-Swap Drive - 2: 3TB Western Digital RE SATA (6Gb/s, 7.2K RPM, 64MB Cache) 3.5-inch SATA Hot-Swap Drive - 3: 3TB Western Digital RE SATA (6Gb/s, 7.2K RPM, 64MB Cache) 3.5-inch SATA Hot-Swap Drive - 4: 3TB Western Digital RE SATA (6Gb/s, 7.2K RPM, 64MB Cache) 3.5-inch SATA Hot-Swap Drive - 5: 3TB Western Digital RE SATA (6Gb/s, 7.2K RPM, 64MB Cache) 3.5-inch SATA Fixed Drive: 500GB Western Digital VelociRaptor (6Gb/s, 10K RPM, 64MB Cache) 3.5" SATA Front Panel: Front USB / COM Port Panel Optical Drive: Low-Profile SATA DVD Drive Power Supply: Redundant 1400W Power Supply with PMBus - 80 PLUS Gold Certified Rail Kit: Quick-Release Rail Kit for Square Holes, 19 - 26.6 inches OS: No Item Selected Warranty: Standard 3-Year Warranty	11629.00	11629.00

Subtotal	11629.00
Sales Tax (0%)	0.00
Total	USD 11,629.00

Silicon Mechanics
22029 23rd Dr SE
Bothell, WA 98021-4410
(425) 424-0000

Quote

Date	Quote #	Confirmation #
03 / 12 / 2014	265480	1840825726

Bill To:	Ship To:
Mark Wilson The University of Iowa 423A Stanley Hydraulics Lab IIHR - Hydroscience & Engineering Iowa City, IA 52242 mark-wilson@uiowa.edu	Mark Wilson The University of Iowa 423A Stanley Hydraulics Lab IIHR - Hydroscience & Engineering Iowa City, IA 52242 mark-wilson@uiowa.edu

Orders shipped to WA and TX are subject to the appropriate tax rate. The quoted tax amount is subject to change.