Preview of Award 0734825 - Final Project Report

Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
Federal Grant or Other Identifying Number Assigned by Agency:	0734825
Project Title:	CREST-Cyber-ShARE Center of Excellence: A Center for the Sharing of Cyber-Resource to Advance Science and Education
PD/PI Name:	Ann Q Gates, Principal Investigator Paulo Pinheiro da Silva, Co-Principal Investigator Craig E Tweedie, Co-Principal Investigator Aaron Velasco, Co-Principal Investigator Leticia Velazquez, Co-Principal Investigator
Submitting Official (if other than PD\PI):	Ann Q Gates Principal Investigator
Submission Date:	10/31/2013
Recipient Organization:	University of Texas at El Paso
Project/Grant Period:	09/01/2007 - 08/31/2013
Reporting Period:	09/01/2012 - 08/31/2013
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	Ann Q Gates

Accomplishments

*** What are the major goals of the project?**

Goal 1: Create a CI-enabled synergistic environment to advance innovative and interdisciplinary research in STEM and education.

Goal 2: Train and educate a new generation of interdisciplinary, *Cyber-ShARE Scholars.*

Goal 3: Become nationally recognized for its CI contributions to STEM and education community.

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities: Goal 1: The investigators have fostered collaborations by involving cross-disciplinary students and faculty in the funded projects: 1) “Believing and Accepting Cyber-results,” which focused on developing technologies to support collaborations and propagation of knowledge about scientific processes (i.e., provenance), leading to enhanced trust of scientific data and results; 2) “Integrated Analysis for Development of 3-D Models of Earth Structure,” which focused on building more accurate models of Earth structures by advancing mathematical techniques and approaches that integrate geophysics data with varying accuracy and sensitivity, including research in optimization and trust

models (e.g., data assimilation and inversion methods using sensor information); and 3) “Advancing Multi-Scale Environmental Data Capture, Processing, Analysis and Access,” which addressed the characterization of environmental phenomena and processes by collecting, analyzing, and optimizing the quality of data streams and sensor arrays.

Goal 2: Cyber-ShARE has funded 63 student Cyber-ShARE Scholars directly since 2007 and involves an additional 10 students leveraged from other funding sources. 52 of these are citizens or permanent residents. The *ethnicity* of the students who are citizens or permanent residents are as follows: 43 students are Hispanic, 1 student is African American, 2 students are Asian/Pacific Islander, and 6 students are white. Of these students 19 are female and 33 are male. Compared to the national averages for geology, environmental and computer sciences graduate students (NSF 2011), Cyber-ShARE students are 82.7% Hispanic while the national average is 5.0%, and 36.5% female while the national average is 29.0%

The first cohort of PhD students graduated in summer and fall 2011. Dr. Pearl Brazier is a professor at the University of Texas Pan American; Dr. Irbis Gallegos is a Research Assistant Professor at the Regional Cyber and Energy Security Center for Distributed Solar PV Systems; and Dr. Santonu Goswani is a post-doc at Michigan State University. Five Ph.D. students (one of whom is female) from the computer science and computational science programs graduated in spring/summer 2012. The center has graduated 15 Master’s students who are now working at, for example, the Census Bureau, the U.S. Forest Service, the International Studies Abroad program, Microsoft, and Hewlett Packard; three are entering Ph.D. programs. Of the nine undergraduate students, eight have continued to the Master’s program and one is employed as an environmental scientist.

Involvement outside of STEM. In collaboration with UTEP’s Kauffman Campus Initiative and the Institute of Oral History, Cyber-ShARE provided resources to design, develop, and host the website of the Paso del Norte Entrepreneurship Oral History Project, which was selected for inclusion in the American Enterprise exhibit of the Smithsonian's National Museum of American History. The website, which includes multimedia interviews, is used for class assignments for the course "Hispanic Entrepreneurship."

Cyber-ShARE and UTEP's Rubin Center for the Visual Arts are collaborating on development of electronic art for the visualization wall to foster interdisciplinary academic discourse and exchange among individuals from both art and STEM. Artist Francesca Samsel worked with Craig Tweedie and Cyber-ShARE technical staff to interpret into digital, visual form data collected and analyzed from Dr. Tweedie’s environmental research in interconnected physical, biological, and human subsystems. The visualization was presesnted on Sept. 16, 2012 at the preconference symposium for ISEA2012 Albuquerque: Machine Wilderness, the 18th International Symposium on Electronic Art.

Goal 3: Cyber-ShARE established collaborations with the World Wide Web Consortium (W3C), Circumarctic Environmental Observatories Network (CEON), National Ecological Observatory Network (NEON), Geosciences Network (GEON), XSEDE-Extreme Science and Engineering Discovery Environment (formerly TeraGrid) as a Campus Champion, U.S. Department of

Agriculture/New Mexico State University's Jornada Basin Long Term Ecological Research Program, and other renowned research groups. These efforts have led to transformative research and new funding opportunities, as described earlier. Cyber-ShARE has established capabilities in the following areas: knowledge representation (in particular workflows and provenance), collaborative environments and interdisciplinary team collaboration, integrated analysis of multiple geophysical data sets, constraint uncertainty management, data delivery and analysis systems, environmental multi-scale remote sensing, numerical optimization, and visualization data-intensive solutions. Even more notable is Cyber-ShARE's recognition for development of student researchers, in particular those from underrepresented groups. Co-PI Velasco was the 2010 President of SACNAS (Society for the Advancement of Chicanos and Native Americans in Science) and PI Gates leads the Computing Alliance of Hispanic-Serving Institutions (Gates et al. 2011c), a consortium of over twenty institutions and organizations focused on disseminating and implementing best practices for recruitment, retention, and advancement of Hispanic students and faculty in computing. Indicators of the recognition that Cyber-ShARE has received at UTEP and nationally are enumerated below:

- Repsol Energy Company provided support for Cyber-ShARE's geo-computational research by providing funding for a post-doc and for student and faculty efforts.
- At the university, Cyber-ShARE was included in UTEP's Research Strategic Plan as the lead center in UTEP's priority crosscutting area "cyberinfrastructure and collaborative environments."
- An article on the Cyber-ShARE Center appeared in the 2008 issue of "Engineering Research in Texas" published by Texas Engineering Deans for the ASEE Public Policy Colloquium and legislators; Cyber-ShARE's collaboration with TeraGrid and its research were highlighted in NSF's 2009 Performance Report to Congress and NSF's 2012 budget request to Congress, respectively.
- V. Kreinovich was elected to serve on the Board of Directors for North American Fuzzy Information Processing Society and the Board of Governors of the IEEE Systems, Man, and Cybernetics Society for a three year term. He also co-chaired the 2011 International NAFIPS conference held at UTEP.
- C. Tweedie won ESRI awards in 2007 and 2009 for the web mapping application ARMAP and serves on the advisory group to the Advanced Cooperative Arctic Data and Information Service.
- A. Velasco was quoted in an AP news article, "Study: Big Quakes Don't Set off Others Far Away" that reported a study conducted by him and Tom Parsons on the US Geological Survey. T
- L. Velazquez was invited to serve on the American Association for the Advancement of Science Committee on Opportunities in Science 2011-2014. She was also invited to serve on the Extreme Science and Engineering Discovery Environment (XSEDE) Board Council.
- A. Gates received the 2011 Anita Borg Social Impact Award and the 2009 Tapia Achievement Award for Scientific Scholarship, Civic Science, and Diversifying Computing.

Specific Objectives:

Significant Results:

Results for Subproject "Believing and Accepting Cyber-results." This subproject, which has been led by computer scientist Dr. Pinheiro da Silva with involvement of Cyber-ShARE scientists, focuses on developing technologies to

support collaborations and propagation of knowledge about scientific processes (i.e., provenance), leading to enhanced trust in scientific data and results. The outcome of the work is CI support for scientific communities that enable annotation of data collection and transformation with appropriate semantics over the Web to support reuse and sharing of data. This effort has included the design and implementation of the *CI-Server* that provides two important features: a server enhanced with semantics to manage and retrieve resources without dependence on the Website's structure, i.e., the culture of the Website; and the ability to share and reuse applications between scientific communities. A tool called *WDO-It!* has been developed to allow scientists to document their processes in the form of abstract workflows that provide a graphical notation to facilitate authoring and interpretation by users without the need for specialized technical expertise. Another significant outcome is the *Visualization Knowledge (VisKo)* framework to support execution of declarative visualization queries and management of knowledge about visualization, facilitating the construction of visualization pipelines based on standard toolkits. Selected publications: (Gandara et al. 2011a, 2011b; Del Rio et al. 2010; Gates et al. 2007, 2011a; Pinheiro da Silva et al. 2008a, 2009; Salayandia & Pinheiro da Silva 2010; Stephan et al., 2010).

Results for Subproject "Integrated Analysis for Development of 3-D Models of Earth Structure." This subproject, which is led by geoscientist Dr. Aaron Velasco and involves computational and computer scientists Drs. Leticia Velazquez, Miguel Argaez, and Vladik Kreinovich, aims to build more accurate models of Earth structures by advancing mathematical techniques and approaches that integrate geophysics data with varying accuracy and sensitivity, including research in optimization and trust models (e.g., data assimilation and inversion methods using sensor information). This project has developed a novel *model fusion approach* to create more accurate models of Earth structures from velocity models. Results indicate that the fused velocity model, which combines the structural information of all the computed samples, has better root-mean-square residuals per shot point than any of the sample models. An *angular density approach for processing seismic data* uses innovative techniques to quantify spatial resolution of the resulting geophysical model. One challenge in controlled-source refraction experiments is that the horizontal resolution also depends on the angular diversity of the rays that pass through the cell. To assist model resolution evaluation, the research team developed an assessment of coverage by computing and visualizing the coverage angular diversity (CAD). The last significant effort is a joint project that has collected data to determine the *crustal structure of the Rio Grande Rift* (RGR). The research group computed receiver functions and receiver function stacks for 130 USArray and other seismic stations in the region, and interpolated the results using the kriging interpolation scheme. By creating subsurface crustal scale models incorporating receiver functions, gravity, and magnetic information, the team found that the crustal thickness of RGR thins in the south to the east of the current rift, suggesting continuing southern RGR deformation and extension, and an uplifted lower and upper crust that suggests evidence for geothermal activity underneath the central basin of RGR, suggesting that the Rift is likely active. An optimization method under study provides a more robust approximated model in terms of satisfying geophysical constraints, accuracy, and efficiency with respect to one of the most common and current approaches being used. Selected publications: (Ochoa et al.

2010a, 2010b; Ochoa et al. 2011; Pinheiro da Silva et al. 2008b; Hussein et al. 2012; Hussein et al. 2011a. 2011b, 2011c; Sosa et al. 2011; Averill et al. 2008; Rumpfhuber et al. 2008).

Results for Subproject "Advancing Multi-Scale Environmental Data Capture, Processing, Analysis and Access." This subproject is being led by environmental scientist Dr. Craig Tweedie and includes computer scientist Dr. Vladik Kreinovich. It addresses the characterization of environmental phenomena and processes by collecting, analyzing, and optimizing the quality of data streams and sensor arrays. The team has developed ontologies, workflows, software tools, and Web services for interacting with a range of environmental sensors, analyzing collected data and visualizing these in a Web -based environment. Field instrumentation established by the subproject includes automated micrometeorological instrumentation to characterize land-atmosphere exchange of carbon, water, and energy (eddy covariance tower, an 8-node sensor network), and different optical remote sensing technologies to characterize plant species and landscape phenology (robotic tram system, phenocams, Unmanned Aerial Vehicle powered paraglider (UAV), and Kite Aerial Photography (KAP)). Conceptualization, development, testing and maintenance of this infrastructure has led to new approaches for *optimizing site selection*; improving capacities for *data property specification and quality flagging*; innovating methods for *gap filling* using image inpainting, neural network and machine learning; and *optimizing algorithms* for UAV guidance and flight planning. *Error and uncertainty* has been analyzed between digital elevation models derived from terrestrial Light Detection And Ranging (LiDAR), airborne LiDAR, kite aerial photography, and satellite imagery, along with the effect of different types of uncertainty on the results of processing meteorological data, in particular, data from the eddy covariance tower. A range of *ontologies and workflows* were developed along with improved standards for interoperability in Web mapping applications. In addition, a *new spectral index* for understanding interactions between surface hydrology and vegetation greenness in the Arctic called the *Normalized Difference Surface Water Index* (NDSWI) was developed. Nine new software applications were developed or prototyped and include several Web mapping applications with tools for data quality flagging, data web-harvesting and web service publication, image analysis, and scheduling sensor data collection and transmission. Selected publications: Brady et al. 2010; Jaimes et al. 2010a, 2010b, 2010c; Johnson et al. 2011; Gallegos et al. 2011a, 2011b; Gonzalez et al. 2011; Goswani et al. 2011).

Key outcomes or Other achievements:

UTEP Investments. Dr. Deana Pennington was recruited as a strategic hire for Cyber-ShARE in 2010 to conduct research on team science and direct interdisciplinary and collaborative teamwork through involvement in the research groups, and Dr. Natalia Villanueva-Rosales was recruited as a strategic hire in 2012 to conduct research in Semantic Web knowledge representation and data-driven knowledge bases. Other investments by the University include expanded space for a total of almost 19,000 sq. ft. The Computational Science program was given a faculty line in the area of high-performance computing, a program coordinator position, and new office space for the dedicated Computational Science faculty.

Technical and Research Infrastructure. Highlights of the technical and research infrastructure established because of Cyber-ShARE Center efforts are as follows:

- Visualization services: Cyber-ShARE houses a visualization laboratory composed of a 45-monitor tiled display driven by a 360-core Linux cluster interconnected by a high-speed network and supported by technical staff. This lab is used for visualization of scientific data for research, education, and outreach efforts. Cyber-ShARE has developed a tool to manage visualization knowledge and construct visualization pipelines based on toolkits such as Generic Mapping Tools and Visualization Toolkit.
- Digitally enabled sensors and networks: Cyber-ShARE has established: at the USDA-ARS Jornada Basin Long Term Ecological Research Program, an eddy covariance tower and phenocam network to measure land-atmosphere exchange of energy, carbon, and water and a 110 m robotic tram system that collects hyperspectral reflectance data; at UTEP's Indio Mountains Research Station, a remote power supply and wireless communication networks of seven automatic weather stations; and at UTEP's Biology Building, a secure green roof and sensor testing and education facility.
- Knowledge management services to support collaboration: Cyber-ShARE has developed a framework to share and reuse applications and resources between scientific communities. Another in-house developed tool allows scientists to document their processes as abstract workflows to facilitate authoring and interpretation by users without the need for specialized or highly technical expertise.
- Shared repositories: The MetaShare System is being developed to serve as a bridge between independent researchers and small teams without access to community data management infrastructure and large institutional or national data archives by providing services to support three phases of the data management lifecycle: creation of a data management plan, documentation of collected data through metadata, and discovery of data through metadata. Cyber-ShARE supports knowledge and resource sharing across networks to support the diffusion of innovations.
- Scientific computing: Cyber-ShARE is an XSEDE Campus Champion, serving as a focal point for information and access to high-performance computational resources available throughout the XSEDE partner institutions and leaders. These resources complement UTEP's High Performance Computing Center and the University's connectivity through the high-performance fiber optic network of Internet2.

Catalyst for Collaboration and Organizational Change. Cyber-ShARE has supported collaboration through research tools that assist in information exchange and document the research lifecycle, including workflows and ontologies. Serving as the anchor for the NSF-funded Innovation through Institutional Integration (I^3) project, the Cyber-ShARE Center has focused on building a CI and communications-based model to foster collaborations on campus that broaden participation in STEM fields. The project supports three critical components on campus: *technical infrastructure*, including semantically-annotated websites, databases, and collaborative tools (e.g., IBM's SmartCloud and Cyber-ShARE's ontology/workflow tools); *organizational practices*, including policies and procedures and address such things as interdisciplinary research, sustainability of effective practices, and recognition for involvement in

broadening participation efforts; and social interactions that build communities around research topics of interest.

Funded Synergistic Projects. Of the more than 20 funded projects that support Cyber-ShARE efforts, the following synergistic projects are particularly important:

- The NSF MRI program supported the acquisition of a collaborative visualization system (the Cyber-ShARE Collaborative Visualization System or C2ViS), to present high-resolution displays of scientific datasets and other visualizations for exploratory, monitoring, educational, and outreach purposes.
- The NSF I3 program funds Cyber-ShARE as the anchor to a project that aims to establish a university culture that fosters the use of CI technologies and a network of faculty and administrators who maintain and facilitate adoption of effective and creative practices to strategically broaden participation in STEM research and education.
- A three-year NSF CI-Team Diffusion Project in its first year investigates the diffusion of ideas, knowledge, and innovation in research communities through analysis of information exchange and learning in a socially-mediated virtual environment. The Virtual Learning Commons (VLC), the social media site developed through this project, will apply Cyber-ShARE provenance tools to capture the flow of data and information within and across research communities. Secondarily, the VLC will provide a Cyber-ShARE CI-Server-based forum for community learning about the tools of data science.
- A NASA ROSES A-37 Project: Earth, Life and Semantic Web (ELSEWeb) project integrates three innovative technologies to create a new analytical environment for conducting geospatial computational experiments on climate change impacts on regional and global species distributions. These distributions, then, will inform investigations on climate-related human health issues. Cyber-ShARE provenance tools will be integrated into the Web Services of partnering geospatial data providers and species distribution modelers, all of which will be linked through a new extension to the Virtual Learning Commons called SciDesign, which will enable creation of a seamless workflow across these distributed processes, described through provenance.
- An NSF GK-12 program supports minority graduate students as GK-12 Fellows to build their science and teaching portfolios and develop their leadership and teaching skills, ultimately becoming top scholars in environmental, geological, and biological sciences. The GK-12 Fellows will serve as a conduit for exciting the next generation of scientists by serving as role models and instructors in Early College High School (ECHS) classes in a predominantly Hispanic community.

*** What opportunities for training and professional development has the project provided?**

Educational Pathways. NSF Crest funding enabled UTEP to initiate the Computational Science graduate program, a cross-disciplinary program with emphasis in applied mathematics, computing, science, and engineering. This program offers Ph.D., Master's, and Professional Master's options. Cyber-ShARE provides space for the PhD students and two post docs. Cyber-ShARE investigators who are directing and co-directing dissertations include Drs. Velazquez, Argaez, Velasco, and Kreinovich. The program has seen tremendous growth over the last three years (international students not disaggregated): 2008 (6 students; 1 Hispanic); 2009 (11 students; 4 Hispanic, 2

African American (one on army leave since 2010); 2010 (6 students; 4 Hispanic, 1 Asian-American); 2011 (3 students; 1 Hispanic).

More than ten new courses have been developed by faculty across the departments and programs represented by Cyber-ShARE with a focus on preparing students to use, develop, and advance CI. The courses, which typically involve students from multiple disciplines and introduce cross-disciplinary projects, have included such topics as uncertainty, trust, CI applications in geological and environmental sciences, software engineering (working with a scientist to define requirements, design, and implement software), and computer simulation and modeling for science applications.

Over the past three years, *Cyber-ShARE's Distinguished Lecture Series* has exposed students to diverse research perspectives through more than 20 lectures by distinguished researchers such as Drs. Richard Tapia, Ann Zimmerman, Tom Dietterich, Cecilia Aragon, and Barbara Minsker. Students have participated in numerous internships that are aligned with Cyber-ShARE's goals and provide opportunities to share Cyber-ShARE research efforts at sites such as the Data Observation Network for Earth (DataONE), an NSF-funded collaborative focusing on a distributed framework and sustainable CI to provide access to Earth observational data, NASA, as well as the Pacific Northwest National Laboratory, Air Force Research Laboratory, Long-Term Ecological Research Network, United States Geological Survey, and National Center for Atmospheric Research.

Cyber-ShARE has also provided workshops to train students and faculty in various topics, e.g., Linux operating systems, C and parallel programming, computer architecture, data interoperability through ontologies, XSEDE resources, and WDo-It! 101. In addition, Cyber-ShARE has led regional workshops such as the annual UTEP-NMSU Joint Workshop on Mathematics, Computer Science, and Computational Sciences, and the 2007 Summer Southwest Regional CI Workshop to promote awareness of the role of CI in conducting research and engaging scientists in the use of tools in support of CI-based tasks; the Center also sponsored special sessions on CI at the 2010 and 2011 Annual American Geophysical Union meeting. As a member of XSEDE's Campus Champion Program in collaboration with the National Center for Supercomputing Applications (NCSA), Cyber-ShARE offered two consecutive summer workshops (2010-2011) in the Big Data for Science Virtual School of Computational Science Engineering, a Blue Waters Project sponsored by NCSA and IBM. The 2010 course covered cutting-edge techniques and technologies, e.g., cloud computing, semantic web, and visualization, critical for dealing with the large digital data sets generated by research activities in fields such as Astronomy, Bioinformatics, and Earth Science. The 2011 course covered peta-scale programming and tools and algorithmic techniques for many-core processors. XSEDE also provides services for scientific visualization, GPU, and high-performance computing. The Cyber-ShARE staff has provided integral computing resources and technical support for UTEP faculty in physics, chemistry, mechanical engineering, and other departments that require simulations and algorithms running on a cluster.

To develop students' research and professional skills, Cyber-ShARE offers Affinity Research Group (ARG) sessions each semester. The ARG model, developed at UTEP under the leadership of PI Gates, is an evidence-based set of practices built on a cooperative team framework to support the creation and maintenance of dynamic and inclusive research groups in which students learn and apply the knowledge and skills required for research and cooperative work. Findings show that the ARG model operates as a community of practice, i.e., membership in an ARG supports students' growth and development as researchers and their gradual socialization into broader research and professional communities.

Community Outreach. There have been a number of efforts to educate the community and to involve middle to high school students through funded programs and outreach aligned with efforts in the colleges of engineering and science. Principal investigators, senior personnel, collaborators, staff, and research scholars of the Cyber-ShARE Center produced and presented interdisciplinary educational material for diverse audiences in El Paso, located in far west Texas. Outreach to middle and high school students and to college students targeted the El Paso population, which is 82.2% Hispanic, and was carried out with a strong participation of the Cyber-ShARE Scholars. Highlights over the first four years include:

- *Middle to High School Outreach workshops.* Cyber-ShARE staff and student research scholars delivered workshops focused on CI for over 650 middle and high school students and 150 parents through two main programs: Mother-Daughter/Father-Son program, an ongoing initiative that provides workshops, conferences, and other activities to inspire middle school Hispanic student and their parents to build a vision for their future that includes college, and the Excellence in Technology, Engineering, and Science (ExciTES) Summer Institute, which engages high school students in science and engineering hands-on activities that can excite them to pursue science and engineering degrees.
- *High School internships.* Cyber-ShARE provided ten-week and semester-long internships for nine high-school students participating in the College of Engineering Nexus Program; a one-week internship; and a summer-long remote honors semester for students from Canada Community College in California.
- *General Public.* Co-PIs Tweedie and Velasco led the preparation of an exhibit, “To the Ends of the Earth: UTEP at the Poles,” featured at UTEP's Centennial Museum from November 19, 2008 to March 20, 2009. This exhibit, partially funded by NSF’s International Polar Year Research and Education Opportunities in Antarctica for Minorities, was visited by more than 5000 school children and more than 2000 other members of the general public. The exhibit now is a permanent display at the Insights Science Museum, open to the public in downtown El Paso.
- *Female Student Outreach.* Cyber-ShARE participated in both the promotion and application review processes for local participants in the National Center for Women & Information Technology (NCWIT) Award for Aspirations in Computing, the goal of which is to recognize high school girls who work with computers and to encourage them to enter technology-related majors in college. In 2010, the top five regional participants received recognition for their achievements during a ceremony at UTEP. In 2011, Cyber-ShARE participated in the award ceremony for eight local contestants, who, along with their families, toured the Center and participated in scientific demonstrations and poster presentations.

*** How have the results been disseminated to communities of interest?**

CyberShARE's results have been disseminated through its collaborations with the World Wide Web Consortium (W3C), Circumarctic Environmental Observatories Network (CEON), National Ecological Observatory Network (NEON), Geosciences Network (GEON), XSEDE-Extreme Science and Engineering Discovery Environment (formerly TeraGrid) as a Campus Champion, U.S. Department of Agriculture/New Mexico State University’s Jornada Basin Long Term Ecological Research Program, and other renowned research groups. In addition, results have been disseminated broadly through workshops; engagement with NASA and EarthCube working groups; webinars to LTER; presentation at conferences; presentations to faculty and center directors on campus; and on-line courses. Cyber-ShARE has been disseminating tools that support the NSF I3 project through a series of presentations on campus. Presentations are detailed in the Products section of this report. Selected dissemination efforts are highlighted:

- Cyber-ShARE presented a talk at the NSF Research Data Management Implementation Workshop (RDMI) that brought together research computing communities and leading experts in data management to discuss actual implementation architectures. The workshop was a collaboration with the Coalition for Academic Scientific Computation (CASC) and provided an opportunity to share Cyber-ShARE results in data management.
- The visualization effort, Turbulance and Topography, has been disseminated through an on-line article, "Artist in the Lb, Scientist in the Studio," by the Texas Advanced Computing Center that descrbies the digital murals of Francesca Samsel, and how art can engage viewers and inspire interest in larger scientific issues (http://www.tacc.utexas.edu/news/feature-stories/2012/artist-in-the-lab). It was also disseminated in another on-line magazine called International Science Grid This Week that provides an interactive communication platform to discuss digital technologies and culture, and to give visibility to innovative projects of digital art (http://www.digitalmeetsculture.net/article/visualizing-data-as-if-under-a-microscope/). In addition, the work was disseminated at the International Conference on Electronic Art; Texas Art, Science, and Information Technology meeting at the University of Texas at San Antonio; a workshop at the IEEE Visualization 2012; HCI+ISE Conference; SEAD Network Conference; ISEA 2012; invited lecture at Texas A &

M; and a workshop at the College Art Association Conference. Samsel has informally disseminated information about this effort to the National Academy of Sciences.

Products

Journals

Kreinovich, Vladik (2013). Checking Monotonicity Is NP-Hard Even for Cubic Polynomials. *Reliable Computing*. 18 90.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Kreinovich, Vladik (2013). A New Analog Optical Processing Scheme for Solving NP-Hard Problems. *Journal of Uncertain Systems*. 7 238.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Kreinovich, Vladik (2013). Estimating Correlation under Interval Uncertainty. *Mechanical Systems and Signal Processing*. 37 43.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Kreinovich, Vladik (2013). Orders on Intervals Over Partially Ordered Sets: Extending Allen's Algebra and Interval Graph Results. *Soft Computing*. 17 1379.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Kreinovich, Vladik (2013). Brans-Dicke Scalar-Tensor Theory of Gravitation May Explain Time Asymmetry of Physical Processes. *Mathematical Structures and Modeling*. 27 28.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Kreinovich, Vladik (2013). For Describing Uncertainty, Ellipsoids Are Better than Generic Polyhedra and Probably Better than Boxes: A Remark. *Mathematical Structures and Modeling*. 27 38.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Kreinovich, Vladik (2013). Interval or Moments: Which Carry More Information?. *Soft Computing*. 27 1319.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Kreinovich, Vladik (2013). Is It Possible to Have a Feasible Enclosure-Computing Method Which Is Independent of the Equivalent Form?. *Reliable Computing*. 18 1.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Kreinovich, Vladik (2013). Towards Fast and Accurate Algorithms for Processing Fuzzy Data: Interval Computations Revisited. *International Journal of General Systems*. 42 197.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Kreinovich, Vladik (2013). How to Define Relative Approximation Error of an Interval Estimate: A Proposal. *Aplied Mathematical Sciences*. 7 211.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Kreinovich, V., Argaez, M. (2013). Why l1 Is a Good Approximation to l0: A Geometric Explanation. *Journal of Uncertain Systems*. 7 203.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Kreinovich, Vladik (2013). Imprecise probabilities in engineering analyses. *Mechanical Systems and Signal Processing*. 37 4.

Status = AWAITING_PUBLICATION; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Kreinovich, Vladik (2013). In Quantum Physics, Free Will Leads to Nonconservation of Energy. *Journal of Uncertain Systems*. 7 176.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Gandara, A., Villanueva Rosales, N. (2013). Documenting and Sharing Scientific Research over the Semantic Web. *International Conference on Knowledge Management and Knowledge Technologies*. .

Status = AWAITING_PUBLICATION; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Books

Book Chapters

Tweedie, C., Kreinovich, V. (2013). How to describe and propagate uncertainty when processing time series: metrological and computational challenges, with potential applications to environmental sciences. *Departmental Technical Reports* 279.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = No

Kreinovich, Vladik (2013). In the Beginning Was the Word, and the Word was Fuzzy. *On Fuzziness* 337.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = No

Kreinovich, Vladik (2013). Towards Optimizing Cloud Computing: An Example of Optimization under Uncertainty. *Scalable Computing: Theory and Practice* 613.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = No

Thesis/Dissertations

Gandara, Aida. *A Semantic Web-based Methodology For Describing Scientific Research Efforts*. (2013). The University of Texas at El Paso.

Acknowledgment of Federal Support = Yes

Del Rio, Nicholas. *A Declarative Domain Independent Approach for Querying and Generating Visualizations*. (2012). The University of Texas at El Paso.

Acknowledgment of Federal Support = Yes

Salayandia, Leonardo. *Ontologies for Scientific Data Transformation*. (2012). The University of Texas at El Paso.

Acknowledgment of Federal Support = Yes

Conference Papers and Presentations

Salayandia, L., Gates, A. Q., Pennington, D. (2013). *MetaShare: Constructing actionable data management plans through formal semantics*. Research Data Management Implementations Workshop. Washington, DC.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Salayandia, L., Gates, A. Q. (2012). *An Approach to Evaluate Scientist Support in Abstract Workflows and Provenance Traces*. Discovery Informatics Symposium: The Role of AI Research in Innovating Scientific Processes. Arlington, VA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Argaez, M., Tweedie, C. (2012). *Image Inpainting in Micrometereological Analysis*. IEEE International Conference in Image Processing. Orlando, FL.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *Why Complex-Valued Fuzzy? Why Complex Values in General? A Computational Explanation*. Joint World Congress of the International Fuzzy Systems Association and Annual Conference of the North American Fuzzy Information Processing Society IFSA/NAFIPS'2013. Edmonton, Canada.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *Towards a Better Understanding of Space-Time Causality: Kolmogorov Complexity and Causality as a Matter of Degree*. Joint World Congress of the International Fuzzy Systems Association and Annual Conference of the North American Fuzzy Information Processing Society IFSA/NAFIPS'2013. Edmonton, Canada.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *Security Games with Interval Uncertainty*. The Twelfth International Conference on Autonomous Agents and Multiagent Systems AAMAS'2013. Saint Paul, MN.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *Relation Between Polling and Likert-Scale Approaches to Eliciting Membership Degrees Clarified by Quantum Computing*. 2013 International Conference on Fuzzy Systems FUZZ-IEEE'2013. Hyderabad, India.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *Why Inverse F-transform? A Compression-Based Explanation*. 2013 International Conference on Fuzzy Systems FUZZ-IEEE'2013. Hyderabad, India.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *Effective algorithms for computing covariance and correlation based on privacy-protected data*. Abstracts of the College Office of Undergraduate Research Initiatives (COURI) Symposium. El Paso, TX.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *Likert-Scale Fuzzy Uncertainty from a Traditional Decision Making Viewpoint: It Incorporates Both Subjective Probabilities and Utility Information*. The Joint World Congress of the International Fuzzy Systems Association and Annual Conference of the North American Fuzzy Information Processing Society IFSA/NAFIPS'2013. Edmonton, Canada.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *Aggregation Operations from Quantum Computing*. The 2013 International Conference on Fuzzy Systems FUZZ-IEEE'2013. Hyderabad, India.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *Cauchy Problem for the Brans-Dicke Scalar-Tensor Theory of Gravitation May Explain Time Asymmetry of Physical Processes*. The 36th Annual Texas Partial Differential Equations Conference. El Paso, TX.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *Comparing intervals and moments for the quantification of coarse information*. The Mini -Symposium "Engineering Analyses with Vague and Imprecise Information" at the 11th International Conference on Structural Safety and Reliability. New York, NY.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *Data Anonymization that Leads to the Most Accurate Estimates of Statistical Characteristics*. IEEE Symposium on Computational Intelligence for Engineering Solutions CIES'2013. Singapore.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *Estimating Third Central Moment for Privacy Case under Interval and Fuzzy Uncertainty*. Joint World Congress of the International Fuzzy Systems Association and Annual Conference of the North American Fuzzy Information Processing Society IFSA/NAFIPS'2013. Edmonton, Canada.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *F-transform in View of Aggregation Functions*. The 7th International Summer School on Aggregation Operations AGOP'2013. Pamplona, Spain.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *From "I Ching" to Decision Making under Interval Uncertainty*. International Workshop on Applied Mathematics and Statistics. Xi'an, China.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *From p-Boxes to p-Ellipsoids: Towards an Optimal Representation of Imprecise Probabilities*. IEEE Symposium on Computational Intelligence for Engineering Solutions CIES'2013. Singapore.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Velasco, Aaron A. (2013). *Evidence of Active Rifts in The Southwest United States Using Geophysical Inversion of Seismic Data, S34A-05*. AGU meeting of the Americas. Cancun, Quintana Roo.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Zamora, A., Velasco, A. A. (2013). *Thesis defense - Azucena Zamora*. Thesis defense - Azucena Zamora. El Paso, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Velasco, Aaron A. (2012). *Constrained joint inversion of multiple geophysical data sets to characterize crustal and mantle velocity structure*. American Geophysical Union Fall Meeting. San Francisco, CA.

Status = OTHER; Acknowledgement of Federal Support = Yes

Velasco, Aaron A. (2012). *Investigation of potential triggered tremor in Latin America and the Caribbean*. American Geophysical Union Fall Meeting. San Francisco, CA.

Status = OTHER; Acknowledgement of Federal Support = Yes

Velasco, Aaron A. (2012). *On different techniques for the calculation of Bougher gravity anomalies for joint inversion of geophysical data in the Rio Grande Rift*. American Geophysical Union Fall Meeting. San Francisco, CA.

Status = OTHER; Acknowledgement of Federal Support = Yes

Velasco, Aaron A. (2012). *Microseismic study of the insight structure of Menengai Caldera: Geothermal prospect in the central Kenya dome*. 4th African Rift Geothermal Conference (ARGeo-C4). Nairobi, Kenya.

Status = OTHER; Acknowledgement of Federal Support = Yes

Villanueva Rosales, Natalia (2013). *Matching funding opportunities with potential applicants*. Campus Office of Undergraduate Research Initiatives (COURI). El Paso, TX.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Lopez, J. C., Dove, A. K., Berumen, J., Villanueva Rosales, N (2013). *Virtual Geocaching: promoting STEM education through a gaming experience*. Campus Office of Undergraduate Research Initiatives (COURI). El Paso, TX.

Status = AWAITING_PUBLICATION; Acknowledgement of Federal Support = Yes

Dove, A. K., Villanueva Rosales, N. (2013). *Data management for ecological research programs*. Campus Office of Undergraduate Research Initiatives (COURI). El Paso, TX.

Status = AWAITING_PUBLICATION; Acknowledgement of Federal Support = Yes

Del Rio, N. R., Pennington, D., Villanueva Rosales, N. (2012). *Streamlining Data Access Services and Data Analysis Services Integration*. American Geophysical Union Fall Meeting (AGU 2012). San Francisco, CA.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Parra, E., Villanueva Rosales, N. (2013). *Evaluating semi-automatic ontology matching and alignment tools for UTEP's expertise system*. SACNAS National Conference. Seattle, Washington.

Status = AWAITING_PUBLICATION; Acknowledgement of Federal Support = Yes

Laney, C. M., Kassin, A., Dove, A. K., Jaimes, A., Villanueva Rosales, N., Tweedie, C. (2013). *Streamlining data integration and sharing by small ecology labs*. Ecological Society of America 98th Annual Meeting. Minneapolis, MN.

Status = OTHER; Acknowledgement of Federal Support = Yes

Hicks , J. B., Villanueva Rosales, N. (2013). *Matching funding opportunities with potential applicants*. Campus Office of Undergraduate Research Initiatives (COURI) - The University of Texas at El Paso. El Paso, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Dove, A. K., Laney, C.M., Villanueva Rosales, N. (2013). *Data management for ecological research programs*. Campus Office of Undergraduate Research Initiatives (COURI) – University of Texas at El Paso. El Paso, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Dove, A. K., Laney, C. M., Villanueva Rosales, N., Tweedie, C. (2013). *A Scalable Data Management System for Ecological Research*. UTEP Campus Office of Undergraduate Research Initiatives (COURI) 2nd Annual Symposium. El Paso, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Porras, H. D., Villanueva Rosales, N., Pennington, D. (2012). *Provenance Visualization on the Web*. Master's project defense - Hugo Porras. El Paso, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Arora, J., Gates, A. Q., Villanueva Rosales, N., Pennington, D. (2012). *Visualization of Large Ontologies by Iterative SPARQL queries*. Final Project Report - Jitin Arora. El Paso, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Flores, G., Gates, A. Q., Romero, R. A., Tweedie, C., Villanueva Rosales, N. (2012). *The Role of Provenance in Ontology Mapping*. Thesis proposal defense - Guillermo Flores. El Paso, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Lopez, E. Ann., Villanueva Rosales, N. (2012). *An Ontology to describe Micrometeorological Measurements*. New Mexico Celebration of Women in Computing (NMCWiC). Las Cruces, New Mexico.

Status = OTHER; Acknowledgement of Federal Support = Yes

Esparza, P., Villanueva Rosales, N., Gates, A. Q. (2012). *Searching, Sharing, and Connecting Researchers through Semantic Web Technologies*. New Mexico Celebration of Women in Computing (NMCWiC). Las Cruces, New Mexico.

Status = OTHER; Acknowledgement of Federal Support = Yes

Pena, M., Villanueva Rosales, N. (2012). *EON: An OWL ontology to collect, expose, and disseminate UTEP's faculty research areas of expertise*. SACNAS National Conference. Seattle, WA.

Status = OTHER; Acknowledgement of Federal Support = Yes

Parra, E., Villanueva Rosales, N. (2012). *Evaluating semi-automatic ontology matching and alignment tools for UTEP's expertise system*. SACNAS National Conference. Seattle, WA.

Status = OTHER; Acknowledgement of Federal Support = Yes

Villanueva Rosales, Natalia (2012). *El conocimiento digitalizado a través de la red semántica*. Invited lecture - Universidad Politécnica de Aguascalientes. Aguascalientes, MX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Villanueva Rosales, Natalia (2012). *Tutorial sobre la Red Semántica y sus aplicaciones*. Tutorial - Universidad AnáhuacCampus Mayab. Merida,Yucatán, Mexico.

Status = OTHER; Acknowledgement of Federal Support = Yes

Villanueva Rosales, Natalia (2012). *Descubriendo los secretos del conocimiento digitalizado a través de la red semántica*. Invited Lecture - Universidad Anáhuac Campus Mayab. Merida,Yucatán, Mexico.

Status = OTHER; Acknowledgement of Federal Support = Yes

Porras, Hugo D. (2012). *Provenance Visualization on the Web*. Thesis. El Paso, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Samsel, Francesca (2013). *HCI + ISE Conference*. HCI + ISE Conference. Albuquerque, NM.

Status = OTHER; Acknowledgement of Federal Support = Yes

Samsel, Francesca (2013). *Turbulence and Topography*. DASER (D.C. Art Science Rendezvous). Northwest, Washington, D.C.

Status = OTHER; Acknowledgement of Federal Support = Yes

Samsel, Francesca (2013). *Turbulence and Topography, J.D. Talasek, Director of the National Academy of Sciences Director of Cultural Programs*. Turbulence and Topography. Austin, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Samsel, Francesca (2013). *SEAD NETWORK Conference*. SEAD NETWORK Conference. Northwest, Washington, D.C.

Status = OTHER; Acknowledgement of Federal Support = Yes

Samsel, Francesca (2013). *Department of Visualization*. Department of Visualization, Texas A&M University. College Station, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Samsel, Francesca (2013). *Land Heritage Institute 2013 Art Science Symposium*. Art Science Symposium. San Antonio, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Samsel, Francesca (2013). *Collaborative Narrative for Turbulence and Topography, Dr. Hannah Chapellle-Wojciehowki*. Collaborative Narrative for Turbulence and Topography. Austin, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Samsel, Francesca (2013). *ISEA 2012- SARC Panel Discussion*. SARC Panel Discussion. Des Moines, Iowa.

Status = OTHER; Acknowledgement of Federal Support = Yes

Samsel, Francesca (2013). *Two-day symposium on Art and Science Collaborations*. Two-day symposium on Art and Science Collaborations. Santa Fe, NM.

Status = OTHER; Acknowledgement of Federal Support = Yes

Samsel, Francesca (2013). *Los Alamos National Labs Visualization Research Group*. Los Alamos National Labs Visualization Research Group. Los Alamos, NM.

Status = OTHER; Acknowledgement of Federal Support = Yes

Samsel, Francesca (2013). *IEEE VIS 2012, Scherazade's Toolbox*. IEEE VIS 2012, Scherazade's Toolbox. Seattle, Washington.

Status = OTHER; Acknowledgement of Federal Support = Yes

Samsel, Francesca (2013). *Tableau Sponsored Event*. In conjunction with IEEE VIS 2012. Seattle, Washington.

Status = OTHER; Acknowledgement of Federal Support = Yes

Samsel, Francesca (2013). *College Art Association Conference 2013*. Meet the Scientists. New York, New York.

Status = OTHER; Acknowledgement of Federal Support = Yes

Gandara, Aida (2013). *Sharing Scientific Research over the Semantic Web Session 5*. Sharing Scientific Research over the Semantic Web Session 5. El Paso, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Gandara, Aida (2013). *Sharing Scientific Research over the Semantic Web Session 4*. Sharing Scientific Research over the Semantic Web Session 4. El Paso, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Esparza, Patricia (2013). *Deprivation and the Hispanic Health Paradox: Neighborhood effects on children's wheezing*. Association of American Geographers (AAG) 2013 Annual Meeting. Los Angeles, CA.

Status = OTHER; Acknowledgement of Federal Support = Yes

Gandara, Aida (2013). *Sharing Scientific Research over the Semantic Web Session 3*. Sharing Scientific Research over the Semantic Web Session 3. El Paso, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Gandara, Aida (2013). *Sharing Scientific Research over the Semantic Web Session 2*. Sharing Scientific Research over the Semantic Web Session 2. El Paso, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Tweedie, Craig (2013). *Addressing tropical mangrove forest conservation through community-based and remote monitoring of phenology*. American Society of Limnology and Oceanography Annual Meeting. New Orleans, LA.

Status = OTHER; Acknowledgement of Federal Support = Yes

Gandara, Aida (2012). *Sharing Scientific Research over the Semantic Web Session 1*. Sharing Scientific Research over the Semantic Web Session 1. El Paso, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Del Rio , Nicholas R. (2012). *VisKo Demonstration*. Earth Science Information Partners (ESIP) Visualization Cluster Demo. El Paso, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Tweedie, Craig (2012). *Image Inpainting in Micrometereological Analysis*. IEEE International Conference in Image Processing. Orlando, FL.

Status = OTHER; Acknowledgement of Federal Support = Yes

Del Rio, Nicholas R (2012). *VisKo Demonstration*. Semantic Mashups ESDS Working Group Demo. El Paso, Texas.

Status = OTHER; Acknowledgement of Federal Support = Yes

Gandara, Aida (2012). *Documenting and Sharing Scientific Research over the Semantic Web*. Documenting and Sharing Scientific Research over the Semantic Web. El Paso, Texas.

Status = OTHER; Acknowledgement of Federal Support = Yes

Tweedie, Craig (2012). *Improving the understanding and scaling of land-atmosphere carbon, water and energy exchange in a Chihuahuan Desert shrubland at the Jornada Experimental Range, Southern New Mexico*. LTER-ASM. Estes Park, Colorado.

Status = OTHER; Acknowledgement of Federal Support = Yes

Gandara, Aida (2013). *Sharing Scientific Research over the Semantic Web Session 5*. Sharing Scientific Research over the Semantic Web Session 5. El Paso, Texas.

Status = OTHER; Acknowledgement of Federal Support = Yes

Del Rio , N. R., Pennington, D. (2013). *Querying for big data visualization*. SIGGraph 2013. El Paso, Texas.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Esparza, P., Villanueva Rosales, N., Gates, A. Q. (2012). *Searching, Sharing, and Connecting Researchers through Semantic Web Technologies*. New Mexico Celebration of Women in Computing (NMCWiC). Las Cruces, New Mexico.

Status = AWAITING_PUBLICATION; Acknowledgement of Federal Support = Yes

Lopez, E. A., Villanueva Rosales, N. (2012). *An Ontology to describe Micrometeorological Measurements*. New Mexico Celebration of Women in Computing (NMCWiC). Las Cruces, New Mexico.

Status = AWAITING_PUBLICATION; Acknowledgement of Federal Support = Yes

Gandara, A., Villanueva Rosales, N. (2012). *Documenting and Sharing Scientific Research over the Semantic Web*. International Conference on Knowledge Management and Knowledge Technologies. Graz.

Status = AWAITING_PUBLICATION; Acknowledgement of Federal Support = Yes

Villanueva Rosales, Natalia (2012). *EON: An OWL ontology to collect, expose, and disseminate UTEP's faculty research areas of expertise*. SACNAS National Conference. Seattle, Washington.

Status = AWAITING_PUBLICATION; Acknowledgement of Federal Support = Yes

Tweedie, Craig (2012). *Spatial and Temporal Dynamics of Erosion Along the Elson Lagoon Coastline near Barrow, Alaska (2002-2011)*. Proceedings of the 10th International Conference on Permafrost. Barrow, Alaska.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2012). *Algorithmics of Checking Whether a Mapping Is Injective, Surjective, and/or Bijective*. Proceedings of the Fifth International Workshop on Constraint Programming and Decision Making CoProD'12. Novosibirsk, Russia.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *Assessment of Functional Impairment in Human Locomotion: A Fuzzy-Motivated Approach*. Proceedings of the 2012 Annual Conference of the North American Fuzzy Information Processing Society NAFIPS'2012. Berkeley, California.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2012). *Binding Efficacy of Different Polyphenolic Phytochemicals with beta-Lactoglobulin and Human Serum Albumin: Implication for Therapeutics Against Neurodegenerative Diseases*. Abstracts of the Undergraduate Research Symposium COURI'2012. El Paso, Texas.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2012). *Constraint Optimization: From Efficient Computation of What Can Be Achieved to Efficient Computation of a Way to Achieve the Corresponding Optimum*. Proceedings of the Fifth International Workshop on Constraint Programming and Decision Making CoProD'12. Novosibirsk, Russia.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2012). *Decision Making under Interval and Fuzzy Uncertainty: Towards an Operational Approach*. Proceedings of the Tenth International Conference on Application of Fuzzy Systems and Soft Computing ICAFS'2012. Lisbon, Portugal.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2012). *Decision making under interval uncertainty*. Abstracts of the 15th GAMM - IMACS International Symposium on Scientific Computing, Computer Arithmetic, and Verified Numerical Computation SCAN'2012. Novosibirsk, Russia.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2012). *How to Divide Students into Groups so as to Optimize Learning: Towards a Solution to a Pedagogy-Related Optimization Problem.*. Proceedings of the IEEE International Conference on Systems, Man, and Cybernetics IEEE SMC'2012. Seoul, Korea.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Tweedie, Craig (2013). *Spatial and Temporal Dynamics of Erosion along the Elson Lagoon Coastline in Barrow, Alaska (2002-2011)*. Proceedings of the 10th International Conference on Permafrost. Russia.

Status = ACCEPTED; Acknowledgement of Federal Support = Yes

Tweedie, Craig (2013). *The Role of Image Inprinting in Micrometeorological Analysis*. IEEE International Conference on Image Processing. ND.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Other Publications

Kreinovich, Vladik (2013). *A review of "Decision with Dempster-Shafer belief functions: Decision under ignorance and sequential consistency"*. Cyber-ShARE participant(s) funded by CREST Program.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *A review of "Partial metric spaces" by M. Bukatin, R. Koppeman, S.*. Cyber-ShARE participant(s) funded by CREST Program.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *A review of "Universal algorithms, mathematics of semirings, and parallel computations" by G. L. Litvinov, V. P. Maslov, A. Ya. Rodionov, and A. N. Sobolevski*. Cyber-ShARE participant (s) funded by CREST Program.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kreinovich, Vladik (2013). *Special issue on ``uncertainty modeling and analysis with intervals: foundations, tools, applications'' - Editorial*. Cyber-ShARE participant(s) funded by CREST Program.

Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Technologies or Techniques

Algorithms for multi-objective optimization: To properly take uncertainty into account, we used multi-objective decision making, an approach in which, instead of optimizing a single objective function, we produce the set of results corresponding to several possible objective functions -- in our case, objective functions corresponding to different possible values of relative uncertainties. For this, we expanded our previously developed optimization algorithms to the multiobjective optimization case.

Accuracy-Estimating Technique: The new accuracy-estimating techniques have been developed that lead to geophysically reasonable estimates and thus, to more accurate model fusion results.

The “GrantOpportunities” ontology used to automate the matching of grants with potential applicants. It is used for the mash-up of grant opportunities published by Grants.gov and UTEP researchers’ areas of expertise. **Grant opportunities**, available at: http://ontology.cybershare.utep.edu/Expertise/GrantOpportunities.owl.

The EON ontology is used to describe areas of expertise of researchers by means of a hierarchy of disciplines covered in the Catalog of Federal Domestic Assistance (CFDA). **EON**, available at: http://ontology.cybershare.utep.edu/Expertise/eon.owl

The Geocache ontology integrates the definition of services that provide data consumed by the Geocaching game, these services currently include VIIRS true color images and ArcGIS Rest Services. **Geocache**, available at: http://ontology.cybershare.utep.edu/Geocaching/Geocache.owl

The MicroMeasurements ontology describes Micrometeorological measurements, based on the database used to store sensor measurements and observations of the Ecosystems Processes subproject. **MicroMeasurements**, available at: http://ontology.cybershare.utep.edu/Geocaching/MicroMeasurements.owl

The Edac ontology describes OGC-WCS data to be used by ELSeWeb SADI service descriptions. **Edac**, ver 3.0, available at: https://ontology.cybershare.utep.edu/ELSeWeb/master/documents/semantic-web/rdf/ontology/edac-v3.owl

The Lifemapper ontology describes Lifemapper experiments and is used for ELSeWeb SADI service descriptions. **Lifemapper**, available at: https://ontology.cybershare.utep.edu/ELSeWeb/master/documents/semantic-web/rdf/ontology/lifemapper-v3.owl

The RIM ontology uses the Research Influence Model (RIM) to describe the components of a research project and contains properties for asserting relationships between different projects. Also contains rules to infer "influencedBy" relationships based on evidences captured by the VLC. **RIM**, available at: https://ontology.cybershare.utep.edu/VLC/master/ontology/RIM.owl

The VisKo ontology describes different visualizations such as isosurfaces, volumes, and raster maps. **VisKo-View**, available at: http://openvisko.org/rdf/ontology/visko-view.owl

VisKo-Operator ontology describes different kinds of abstract visualization operations, such as converting, filtering, mapping and transforming to be used by Visko. **VisKo-Operator**, available at: http://openvisko.org/rdf/ontology/viskooperator.owl

VisKo-Service ontology associates an abstract visualization operation with an executable OWL-S service. **VisKo-Service**, available at : http://openvisko.org/rdf/ontology/visko-service.owl

The CARP core ontology provides common characteristics, i.e., properties and classes, across scientific collections. By
default, scientific collections can be queried about the basic structure provided by this ontology. **CARP ontology** , available at http:// ontology.cybershare.utep.edu/CARP/carp-ns.rdf

Patents
Nothing to report.

Inventions
Nothing to report.

Licenses
Nothing to report.

Websites

Title: CyberShARE Center
URL: http://cybershare.utep.edu
Description: General Website for the Center.

Title: I3 Website
URL: http://i3.cybershare.utep.edu/
Description: CyberShARE Center serves as the anchor for the I3 project thatis focused on creating the cyberinfrastructure to support knowledge and resource sharing across broadening participation efforts on campus and supporting interdisciplinary research at UTEP.

Other Products

Product Type: Audio or Video Products
Description: VisKo: Enabling Visualization Generation Over the Web. A short demo that illustrates the use of the Visko framework.

Other: Audio or Video Products
Product Type: Virtual Geocache Game Demo. Knowledge subproject. A short demo that illustrates the basic components of the Virtual Geocache game.
Description:

Other: Models
Product Type: Web-Probe. Knowledge subproject. A short demo that illustrates the basic components and use of the Web-Probe tool.
Description:

Other: Audio or Video Products
Product Type: Visualization of 3D seismic tomography models:
Description: http://www.youtube.com/watch?v=5ZI9RG7x2lE

Other: Databases
Product Type: Spectral library (www.spectrallibrary.utep.edu): allows reflectance in the visual and near infra-red spectra to be queried and plotted in an online environment (production). Sharing Information: several conference presentations have featured this site, and it has also been referenced in literature. It is also discoverable via Web searches.
Description:

Other: Software or Netware

Product Type: JOGGLER - a data handling GUI-driven software that harvests, manages, queries and exports data and web services. Sharing Information: This is being used in an ARMAP production-level web mapping application and is the backbone of the Jornada FLEX application and information system, and will also be used in the new BAID grant. Demonstrations have been given to the national snow and ice data center.

Description:

Other: Software or Netware

Product Type: Site choice tool - a Geographic Information System processing routine that uses a series of parameterized decision and optimization algorithms to identify and prioritize site selection for ecological and environmental research and instrument placement (prototype). The tool has been used for situating sensors in Indonesia for a USAID project and will also be heavily used for situating the new sensor network in Barrow as part of a BAID project. Sharing Information: Dispersed through publications, posters, and presentations

Description:

Other: Software or Netware

Product Type: Arctic Research Mapping Application:

Description:

- ARMAP-Internet Map Server - allows GIS-interactivity with more than 750 data and information layers, including more than 10,000 locations associated where US Federally funded research has taken place since the late 1990?s (Production).
- ARMAP for Google Earth (production) - allows ARMAP data to be viewed in Google Earth (production)
- ARMAP for ArcGIS Explorer - allows globe visualization and interactivity with ARMAP data (production).
- ARMAP-Flex application - allows querying and visualization of the ARMAP dataset to show, for example, trends in US federal research expenditure for different fields of arctic research (beta). Sharing Information: The software is discoverable through the website: www.armap.org, and it is widely disseminated through the community.

Other: Databases

Product Type: BAID-Internet Map Server (production) allows GIS-interactivity with more than 646 data and information layers, including more than 9000 research sites dating back to the 1940's.

Description:

- BAID for Google Earth (production) - allows BAID research site data to be viewed in Google Earth.
- BAID Instrument Browser (production) - allows map visualization and interactivity with informational and other data associated with more than 350 instruments in the Barrow area in northern Alaska.
- Barrow SAR viewer (production) - allows map visualization and interactivity with near real time space-borne synthetic aperture radar acquired for the Barrow area.

Sharing Information: Available through www.baidims.org

Other: Software or Netware

Product Type: WDOIt! workflow editor development: Tool for creating work-related ontologies including terminology and workflows. Development, help with design

Description:

of general features and fixes and specifically implemented concept renaming, bookmarking, some drag-n-drop features and workspace support. We are in the process of preparing for first release including development of test cases and software web deployment. Sharing Information: Website (open source access) and presentations at national and international meetings

Other: Software or Netware

Product Type:

Description: Probe-It!: A browser suited to graphically rendering Proof Markup Language (PML) based provenance associated with results derived from inference engines and workflows. Probe-It! consists of three primary views to accommodate the different kinds of provenance information: results, justifications, and provenance, which refer to final and intermediate data, descriptions of the generation process (i.e., execution traces) and information about the sources respectively. Sharing Information: The software will be shared through the portal at http://cybershare.utep.edu/. It currently can be found at: http://trust.cs.utep.edu/probeit/.

Other: Software or Netware

Product Type:

Description: Prospec: A tool for automated development of formal specifications including patterns and scopes. Ordered sequences, non-deterministic sequences, and concurrency can be specified through composite propositions. Sharing Information: The software is being shared through the portal at http://cybershare.utep.edu/.

Other: Software or Netware

Product Type:

Description: Talwani: A 2.5-D gravity modeling tool which is based on the Talwani technique and allows forward modeling of gravity profiles. Subsurface models created with the Talwani software tool can match the pattern of a specific gravity anomaly. Sharing Information: The software is being shared through the portal at http://cybershare.utep.edu/.

Other:

Participants

Research Experience for Undergraduates (REU) funding

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Maria C Barraz	Undergraduate Student	2
Edith Betancourt Marrufo	Undergraduate Student	1
Sergio C Celis	Graduate Student (research assistant)	3
Nicholas R Del Rio	Graduate Student (research assistant)	6
Candice Christine Fierro	Other Professional	6

Name	Most Senior Project Role	Nearest Person Month Worked
Guillermo Flores	Graduate Student (research assistant)	2
Diana Franco Gutierrez	Undergraduate Student	2
Matthew Giandoni	Graduate Student (research assistant)	3
Ashley N Grijalva	Undergraduate Student	3
Ivan Gris	Other Professional	3
Madhulatha Hari	Graduate Student (research assistant)	2
Joshua B Hicks	Undergraduate Student	4
Musa J Hussein	Postdoctoral (scholar, fellow or other postdoctoral position)	2
Ari Kassin	Other Professional	6
Jennifer L Keck	Undergraduate Student	1
Elizabeth Ann Lopez	Undergraduate Student	4
Karla Elizabeth Lujan	Undergraduate Student	6
Loren Ochoa	Undergraduate Student	3
Erika S Ollivier	Graduate Student (research assistant)	4
Franscisco Osuna	Other Professional	12
Edgar Padilla	Graduate Student (research assistant)	3
Marianna Pena	Undergraduate Student	4
Oscar Remirez	Undergraduate Student	2
Norma Rivera	Graduate Student (research assistant)	2
Juan R Rodriguez	Undergraduate Student	4
Uram A Sosa Aguirre	Postdoctoral (scholar, fellow or other postdoctoral position)	7

Name	Most Senior Project Role	Nearest Person Month Worked
Lennox E Thompson	Graduate Student (research assistant)	3
Karina Valtierra	Undergraduate Student	3
Sandra Villarreal	Graduate Student (research assistant)	3
Bertha S Villegas	Undergraduate Student	6
Leonardo Salayandia	Postdoctoral (scholar, fellow or other postdoctoral position)	12
Azucena Zamora	Graduate Student (research assistant)	6
Sergio Armando Vargas	Graduate Student (research assistant)	6
Christian Teran Lopez	Undergraduate Student	6
Jesus Manuel Tabares	Undergraduate Student	2
Hector Adrian Saenz	Graduate Student (research assistant)	5
Geovany A Ramirez Garcia	Graduate Student (research assistant)	6
Hugo D Porras	Graduate Student (research assistant)	5
Julio C Olaya	Graduate Student (research assistant)	5
Geoffrey I Owen	Graduate Student (research assistant)	4
Ezer Patlan	Graduate Student (research assistant)	6
Omar Ochoa	Graduate Student (research assistant)	6
Carlos A Nieto	Undergraduate Student	2
Elba M Nieto	Graduate Student (research assistant)	1
Jesus Roberto Nevarez	Graduate Student (research assistant)	2
Roberto Munoz	Undergraduate Student	2
Mayra Melendez	Undergraduate Student	6

Name	Most Senior Project Role	Nearest Person Month Worked
Naomi R Luna	Undergraduate Student	6
Abdiel F Lopez	Graduate Student (research assistant)	6
Rodrigo A Romero	Staff Scientist (doctoral level)	5
Leonardo O Lerma	Graduate Student (research assistant)	4
Christine Marie Laney	Graduate Student (research assistant)	6
Young-An Kim	Graduate Student (research assistant)	6
Aline Jaimes	Graduate Student (research assistant)	5
Antonio Garza	Graduate Student (research assistant)	5
Julio Cesar Lopez	Undergraduate Student	5
Angel Fernando Garcia Contreras	Graduate Student (research assistant)	5
Javier Eduardo Garza	Graduate Student (research assistant)	4
Ariel Garcia	Graduate Student (research assistant)	6
Aida Gandara	Graduate Student (research assistant)	6
Patricia Esparza	Other Professional	12
Joseph R Aguirre	Undergraduate Student	2
Diego Aguirre	Graduate Student (research assistant)	6
Jitin Arora	Graduate Student (research assistant)	2
Carmen E Avila	Graduate Student (research assistant)	2
Jorge Berumen	Undergraduate Student	5
Cesar R Chacon	Graduate Student (research assistant)	3
Ryan P Cody	Graduate Student (research assistant)	6

Name	Most Senior Project Role	Nearest Person Month Worked
Alla K Dove	Undergraduate Student	2
Deana Pennington	Co-Investigator	12
Miguel Argaez	Co-Investigator	1
Francesca Samsel	Consultant	1
Natalia Villanueva-Rosales	Faculty	12
Leticia Velazquez	Co PD/PI	0
Aaron Velasco	Co PD/PI	2
Paulo Pinheiro da Silva	Co PD/PI	0
Craig E Tweedie	Co PD/PI	1
Rodrigo A Romero	Staff Scientist (doctoral level)	8
Ann Q Gates	PD/PI	2

What other organizations have been involved as partners?

Name	Location
Ameriflux	LBNL
Computing Alliance of Hispanic Institutions	Consortium of HSIs
Los Alamos National Laboratory	Los Alamos, New Mexico
National Ecological Observatories Network	Boulder, CO
New Mexico State University	Las Cruces, NM
Smithsonian Latino Center	Washington, DC
USDA Long-Term Ecological Research Network	Las Cruces, NM
UT Austin TACC Center	Austin, TX
XSEDE	University of Illinois

Have other collaborators or contacts been involved? N

Impacts

What is the impact on the development of the principal discipline(s) of the project?

The Knowledge Subproject research has informed the Computer Science community about methodologies for sharing, reusing and integrating scientific data. Previous results of this project have provided methods, tools and best practices on creation, use and visualization of provenance, in particular using the recently recommended (April 2013) provenance language PROV-O. Current efforts include the investigation of the role of provenance in ontology mapping, an important task in the semantic-based integration of data. Results in the semantic-based choreography of web services for the integration and visualization of scientific data has informed the Computer Science community about the limitations of current techniques as well as proposed extensions. Based on the experience in the training of the next generation of cyberinfrastructure-savvy professionals, an on-line course and a series of workshops have been developed and are offered as part of the Center's training program.

The main objective of the 3-D modeling of Earth sciences subproject centered on developing novel and robust approaches to better determine Earth structure. The impacts of the subproject are as follows:

- Many of the algorithms for processing corresponding datasets are time-consuming, which limits the ability of Earth scientists to process the data in real time. By applying knowledge representation tools and techniques to these algorithms – e.g., to Hole's method for processing seismic data – we have achieved a several orders of magnitude algorithmic speed up, both for sequential and for parallel implementations. This speed-up enables Earth science researchers to get results from data processing in minutes as opposed to days.
- Many data processing algorithms include tuning parameters (e.g., regularization parameters or parameters describing convergence), parameters which need to be properly selected to guarantee convergence to a geophysically meaningful solution. Often, the selection of these parameters is done by a time-consuming exhaustive search: all values are tried, after which an expert looks at final results of computations with different parameter values. As part of the subproject, we developed a tool that visualizes the intermediate results and, thus, enables the expert to stop computations with inappropriate parameter values -- without waiting for the time-consuming iterations to finish.
- Many current techniques for processing Earth science data utilize only one type of data (e.g., seismic or gravity). As part of the project, we developed and tested model fusion techniques that enable us to combine models resulting from different types of data into a single model, which takes all types of data into account. We also used state-of-the-art optimization techniques to define efficient methods for joint inversion that directly processes data of different types. By applying these techniques to the local Rio Grande Rift area, we have discovered new previously undetected geophysical structures, which shows the great potential of joint inversion techniques.

The impacts of the Ecosystems subproject are as follows:

- New methods for measuring environmental variables using low-cost off the shelf technologies have been developed and new software for analyzing data from these systems has been developed. Dissemination of prototype systems has been positive and suggests there is broad support and need for such technologies in the environmental sciences.
- New approaches to data and information management have been developed and tested. Dissemination of preliminary results suggest there is widespread interest in the use of these tools in the environmental sciences.

What is the impact on other disciplines?

Cyber-ShARE has had an impact in Visual Arts through it efforts to visualize the research in environmental science on the Cyber-ShARE visualization wall. Cyber-ShARE's efforts on data quality monitoring is being transferred to the Regional Center on Cyber-Security and Energy Systems for use on electric grid applcations. Cyber-ShARE is working with Dr. Steve Stafford (Metallurgical & Materials Engineering) and Dr. John D. Olivas

(past Astronaut and recently hired to coordinate projects through Cyber-ShARE) on the creation of an ERC Center of Research for Extreme Environment Advanced Material Systems. Cyber-ShARE's is providing support and infrastructure for building high functioning interdisciplinary teams, visualizing data and materials, analyzing and integrating data/knowledge.

Cyber-ShARE's Visualization Cluster resources have been extended to various on-going projects with the Geology and Electrical and Computer Engineering Departments as noted below:

- Jose M. Hurtado, an associate professor for the Geology Department is currently working with Remote Sensing Image Analysis through the use of different Software Applications such as: ENVI, MATLAB, ArcGIS and Google Earth.
- Dr. Richard Langford, also from the Geology Department is working with PetroMod petroleum systems modeling software, which combines seismic, well, and geological information to model the evolution of sedimentary basins.
- Ricardo von Borries, an associate professor from the Electrical and Computer Engineering Department is utilizing the Visualization Cluster in signal processing to predict and quantify the development of muscle fatigue using surface electromiographic signals.

What is the impact on the development of human resources?

The collaboration among members of the three Cyber-ShARE projects results in integration of knowledge from geosciences, computer science, mathematics, environmental science, and engineering. Through these highly interdisciplinary projects, the Cyber-ShARE Center actively prepares the next-generation scientist and engineer who can work on diverse teams with knowledge of using cyberinfrastructure (CI). The professional development workshops provide training in CI middleware, visualization, as well as professional, research, collaboration, and team skills. The outreach components involve students in activities that include technology and science, and the courses that reach future teachers are critical to human resource development. In addition, students are exposed to cutting-edge technologies and concepts that are not typically introduced in the curriculum, and students are able to practice and hone their skills in a real application.

Cyber-ShARE promotes the involvement of students in development workshops, preparation for graduate studies, scientific symposia, and mentoring through experiences at the university and through conferences, e.g., AGU, Computing Alliance of Hispanic-Serving Institutions, and SACNAS. The impact of the Cyber-ShARE Center on expertise development in data analytics and integration at UTEP is reflected in the 2012-2013 strategic hire position that resulted in the hiring of Dr. Natalia Villanueva-Rosales who has expertise in data integration, ontologies and other Semantic Web technologies. Dr. Villanueva-Rosales will have an assistant professor position in the Computer Science Department. In addition, the Computer Science Department hired Dr. Mohamed Hossain who has expertise in big data and visual analytics.

What is the impact on physical resources that form infrastructure?

The Cyber-ShARE Center houses a core facility for visualization. The Cyber-ShARE Collaborative Visualization System (C2ViS) Laboratory supports multidisciplinary scientific collaboration and visualization of scientific datasets for exploratory, monitoring, educational, and outreach purposes. The Cyber-ShARE Center also provides a Testing and Production level development environment through an IBM 3650 M4 server system powered by twelve 2.0GHz Intel Xeon processors, 32GB DDR3 RAM and 12TB of operational storage space. The system infrastructure is laid out into 6 separate virtual Linux servers composed of a Network File System, Network Information System, Web Server, Database Server, Versioning Control System and an Application Server for in-house development. In addition, the center equips a supplementary 12TB of storage space by means of a Dell EqualLogic storage solution.

Other infrastructure includes the following:

- 2009-Present. Eddy tower, robotic tram system, sensor network, phenocam network, remote power supply and wireless communications at the USDA Jornada Experimental Range, New Mexico. This infrastructure has been supported by the NSF funded Cyber-ShARE Center of Excellence at UTEP.
- 2009-Present. Network of seven automatic weather stations at UTEP's Indio Mountains Research Station.
- 2009-Present. A Green roof and sensor testing facility on the roof of the Biology Building at UTEP. This facilitywas catalyzed by the NSF-funded Cyber-ShARE Center of Excellence and was developed with the support of UTEP Facilities.
- 2009-Present. A growth cabinet with a series of 11 microcosms for experimenting with plant and soil monoliths to understand controls of ecosystem processes. This system includes a range of wireless and wired micrometeorological sensors and an open path trace gas analysis system with programmable solenoid valves to control airflow to each microcosm. This infrastructure was built for the IPY-BTF project with support from the Cyber-ShARE Center of Excellence.
- 2009-Present. A paraglider unmanned aerial vehicle (UAV). This remote control UAV is low and slow flying and controlled by line-of site remote control. The aircraft allows for an hour of flight time and a payload of approximately 15 kilograms. This infrastructure was developed through UTEP's Cyber-ShARE Center of Excellence and in collaboration with Industry (Atair Aerospace, http://www.atair.com/).
- 2007-Present. A lab for the design, prototyping, testing and manufacture of sensors, field equipment and other hardware for ecological and environmental research (700 sq ft). This lab includes a walk-in double cold room and a large workshop that houses a range of power and machining tools, systems for the development and testing of electrical circuitry, and a range of building materials and spare parts.

What is the impact on institutional resources that form infrastructure?

Cyber-ShARE provides core facilities and capabilites for research on campus. For example, through its Meta-Share framework, it has been working with faculty on data management plans and data retrieval. Dr. Pennington provides guidance on and contributes to a number of interdisciplinary projects. The Center serves as the anchor for the NSF-funded I3 initiative to build cyber-infrastructure, communication, andconnections to broaden STEM participation. The initiative challenges faculty, administrators, and stakeholders to think strategically about the creative integration of NSF-funded awards. UTEP’s project fosters interdisciplinary collaborations on campus that promote student success, integrate research and education, and result in effective education for a diverse student body with particular emphasis in Science, Technology, Engineering, and Mathematics (STEM) areas. Cyber-ShARE has expertise on building interdisciplinary collaborations. Working with the Office of Research and Sponsored projects, Cyber-ShARE has taken the lead in transferring its Semantic Web technologies to establish an Expertise system that connects faculty through personal profiles, Center profiles, communities, and research stories. This effort connects existing university resources, i.e., Digital Measures, to maintain updated information. The effort has been supported through I3, Cyber-ShARE, and institutional resources.

What is the impact on information resources that form infrastructure?

Cyber-ShARE is having an impact on information resources through its Expertise Connect project. Expertise Connect is a publicly accessible portal for identifying experts on campus and connecting people with centers, communities, and events. The university's Information Resources and Planning (IR&P) Strategic Plan includes the collaborative efforts with the University's Center for Institutional Evaluation, Research, and Planning and Cyber-ShARE to collect, manage, and disseminate data on Student Success projects.

What is the impact on technology transfer?
Nothing to report.

What is the impact on society beyond science and technology?

Cyber-ShARE is developing cohorts of students with 21st century demographics and skills. These students are well prepared to address the scientific challenges facing society through global change, through deep expertise in

their selected discipline and cross-cutting capabilities in the design and use of cyberinfrastructure; teamwork and collaboration; and interdisciplinary research integration. The tools developed by the Cyber-ShARE Center can be used by researchers and educators beyond science and technology. For example, MetaShare, a knowledge-based system that supports the creation of data management plans, can be used to annotate data with metadata and support discovery and retrieval of data and knowledge. Cyber-ShARE's work with artist Francesca Samsel illustrates how visualization can help scientists analyze and communicate their research findings.

Changes

Changes in approach and reason for change
Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them
Nothing to report.

Changes that have a significant impact on expenditures
Nothing to report.

Significant changes in use or care of human subjects
Nothing to report.

Significant changes in use or care of vertebrate animals
Nothing to report.

Significant changes in use or care of biohazards
Nothing to report.