# **CAREER: Supporting Patterns for Embedded Network Systems**

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| **Award Abstract #1545705** http://www.nsf.gov/awardsearch/images/common/x.gif CAREER: Supporting Patterns for Embedded Network Systems http://www.nsf.gov/awardsearch/images/common/greenline.jpg   |  |  | | --- | --- | | **NSF Org:** | [**CNS**](http://www.nsf.gov/div/index.jsp?div=CNS) [**Division Of Computer and Network Systems**](http://www.nsf.gov/div/index.jsp?div=CNS) | | divider line | | | **Initial Amendment Date:** | June 5, 2015 | | divider line | | | **Latest Amendment Date:** | June 5, 2015 | | divider line | | | **Award Number:** | 1545705 | | divider line | | | **Award Instrument:** | Continuing grant | | divider line | | | **Program Manager:** | M. Mimi McClure CNS Division Of Computer and Network Systems CSE Direct For Computer & Info Scie & Enginr | | divider line | | | **Start Date:** | December 15, 2014 | | divider line | | | **End Date:** | August 31, 2015 (Estimated) | | divider line | | | **Awarded Amount to Date:** | $25,348.00 | | divider line | | | **Investigator(s):** | Jason Hallstrom jhallstrom@fau.edu (Principal Investigator) | | divider line | | | **Sponsor:** | Florida Atlantic University 777 GLADES RD BOCA RATON, FL 33431-6424 (561)297-0777 | | divider line | | | **NSF Program(s):** | COMPUTER SYSTEMS | | divider line | | | **Program Reference Code(s):** | 1045, 9150, 9216, HPCC | | divider line | | | **Program Element Code(s):** | 7354 |   **ABSTRACT** http://www.nsf.gov/awardsearch/images/common/bluefade.jpg Embedded network systems are transforming the planetary compute fabric, changing the way we coordinate with peers, safeguard natural resources, and protect local communities. Ensuring the correctness and performance of these systems has immediate relevance to the health and welfare of the planet. The objective of this CAREER project is to develop the theoretical and applied foundations necessary to ensure these properties and to instill the requisite skills in the next generation of embedded network system engineers. The project relies on a pattern-centric approach motivated by the profound impact of design patterns on software reliability and programmer productivity in other domains and the observation that these benefits can be amplified through the development of formal foundations and supporting software tools.   There are four project components: First, the team is codifying expert knowledge in the form of new patterns for embedded network system design and implementation. Second, the team is developing a specification and reasoning formalism to capture pattern requirements precisely and to validate the correctness of pattern implementations. Third, the team is developing static analysis techniques and supporting software tools to automate the detection of pattern implementation errors. Finally, the team is applying these techniques and tools to reverse-engineering and code generation tasks, extending the benefits of model-based software engineering to this new domain. The dissemination and outreach program includes publication, undergraduate and graduate curriculum integration, undergraduate research involvement, high-school outreach and engagement, academic and dissemination to industry, and mini-workshops for evaluation and promulgation of findings, methods and tools. |

# http://www.nsf.gov/awardsearch/images/common/x.gifCSR: Small: Improving Data Center Water Efficiency via Online Resource Management

**Award Abstract #1423137**  
http://www.nsf.gov/awardsearch/images/common/x.gif **CSR: Small: Improving Data Center Water Efficiency via Online Resource Management**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CNS**](http://www.nsf.gov/div/index.jsp?div=CNS) [**Division Of Computer and Network Systems**](http://www.nsf.gov/div/index.jsp?div=CNS) |
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| **Initial Amendment Date:** | August 5, 2014 |
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| **Latest Amendment Date:** | June 4, 2015 |
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| **Award Number:** | 1423137 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Weisong Shi CNS Division Of Computer and Network Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | October 1, 2014 |
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| **End Date:** | September 30, 2016 (Estimated) |
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| **Awarded Amount to Date:** | $349,495.00 |
| divider line | |
| **Investigator(s):** | Shaolei Ren sren@fiu.edu (Principal Investigator) Gang Quan (Co-Principal Investigator) |
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| **Sponsor:** | Florida International University 11200 SW 8TH ST Miami, FL 33199-0001 (305)348-2494 |
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| **NSF Program(s):** | COMPUTER SYSTEMS |
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| **Program Reference Code(s):** | 7923, 9178, 9251 |
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| **Program Element Code(s):** | 7354 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
A large data center may consume millions of gallons of cooling water each day; in addition, data centers also indirectly consume an enormous amount of water embedded in offsite electricity generation. As a result, water conservation is surfacing as a critical concern for data centers, amid the anticipation of surging water demand worldwide. Left unchecked, the growing water footprint of data centers can pose a severe threat to data center sustainability and may even handicap availability of services, especially for data centers in water-stressed areas. Existing mechanical solutions for conservation, such as using recycled/industry water and directly using outside cold air, are often costly and/or very limited by external factors such as locations, climate conditions, among others.   
  
As part of the integral efforts from both industry and academy to enable data center sustainability, this project uniquely integrates water footprint as an essential part of resource management in virtualized data centers. It exploits the inherent yet little-known characteristics of time-varying water efficiency and optimizes resource management for minimizing operational cost as well as water footprint without compromising service quality. To this end, this project investigates three complementary research thrusts: (i) Online computing resource management for water sustainability in the presence of large unknown dynamics (such as highly volatile outside temperature); (ii) Exploration of the dependency of data center water efficiency on cooling systems, and joint optimization of cooling and computing resource management for water sustainability; (iii) Experimentation and validation based on combined system prototyping and software simulation. In addition to its environmental impacts, this project has large societal impacts for its potential to alleviate the growing pressure on data center water footprint effectively and economically. This project will enhance the understanding of interplay among water consumption, power/energy consumption, and resource management in data centers, and lay a solid foundation for sustainable evolvement of greener data centers. New findings and techniques will be readily incorporated into teaching materials. The project also contains a significant component to promote diversity by inspiring minority students, especially Hispanic students, to engage in computer science research.

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# ****MRI: Acquisition of a High Performance Computing Cluster to Support Multidisciplinary Big Data Analysis and Modeling****

**Award Abstract #1429518**  
http://www.nsf.gov/awardsearch/images/common/x.gif **MRI: Acquisition of a High Performance Computing Cluster to Support Multidisciplinary Big Data Analysis and Modeling**  
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| **Initial Amendment Date:** | August 20, 2014 |
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| **Latest Amendment Date:** | August 20, 2014 |
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| **Award Number:** | 1429518 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Rita V. Rodriguez CNS Division Of Computer and Network Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | September 1, 2014 |
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| **End Date:** | August 31, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $399,038.00 |
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| **Investigator(s):** | Long-zhuang Li Longzhuang.Li@tamucc.edu (Principal Investigator) Feiqin Xie (Co-Principal Investigator) Christopher Bird (Co-Principal Investigator) Ruizhi Chen (Co-Principal Investigator) Lihong Su (Co-Principal Investigator) |
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| **Sponsor:** | Texas A&M University Corpus Christi 6300 Ocean Drive Corpus Christi, TX 78412-5503 (361)825-2177 |
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| **NSF Program(s):** | MAJOR RESEARCH INSTRUMENTATION |
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| **Program Reference Code(s):** | 1189 |
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| **Program Element Code(s):** | 1189 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
This project, acquiring a High Performance Computing (HPC) cluster--the Corpus Christi High Performance cluster (CCHP)--supports large-scale data analysis and modeling research and research training across a broad variety of science and engineering technology disciplines in coastal and environmental studies. The CCHP cluster enables research projects ranging from computer science, life science, geographical information systems (GIS), remote sensing, to atmospheric science. These include:  
  
- Higher order tensor decomposition for big data,  
  
- Population Genomics of non-model species,  
  
- Geospatial crowdsourcing for natural disaster response,  
  
- Large-scale analytics of airborne and satellite remote sensing data and UAS imagery,  
  
- Global weather and climate analysis.  
  
CCHP contains compute nodes, GPU (graphical processing unit) nodes, and shared network storage, connected through InfiniBand switches in a fat tree topology to support high bandwidth low latency data communication (critical for HPC applications) while providing massive parallel computation on graphics processor cores. Moreover, the on-board Gigabit Ethernet ports with switch connection can support large data sets transmission which enables research in real time simulation and modeling.   
  
CCHP enables exploring parallel processing to process real large data sets in the higher order tensor decomposition, which is a basis for many data mining tasks including clustering, trend detection, and anomaly detection. This cluster is a necessary computational tool for biologists to use statistics effectively to realize the promise and power of societally relevant hypotheses in massively parallel nucleotide sequencing. The GIS researchers can utilize the CCHP cluster to advance geospatial crowdsourcing solution in case of natural disaster by providing quicker and more accurate geometric information. The cluster also enables remote sensing scientists to identify the relationship between environmental conditions, including land cover and use and rates of freshwater inflow, and attack the problems caused by the low accuracy of acquired unmanned aerial systems (UAS) images for precision agriculture. Furthermore, processing much longer time series of the global model and satellite data record, atmospheric scientists will be able to easily expand their research projects from regional to global scale.  
  
The impact of the CCHP cluster will be felt in many domains, especially on coastal and environmental studies that impacts society in general, impacting weather and climate model reliability and prediction skills in ecology, evolution, fisheries, conservation, and genetics. Moreover, curriculum materials obtained from the projects serviced by the instrumentation will enhance education and student learning at all levels, including K-12. These will impact existing courses and contribute to the creation of new ones.

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# ****CloudLab: Flexible Scientific Infrastructure to Support Fundamental Advances in Cloud Architectures and Applications****

**Award Abstract #1419199**  
http://www.nsf.gov/awardsearch/images/common/x.gif **CloudLab: Flexible Scientific Infrastructure to Support Fundamental Advances in Cloud Architectures and Applications**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CNS**](http://www.nsf.gov/div/index.jsp?div=CNS) [**Division Of Computer and Network Systems**](http://www.nsf.gov/div/index.jsp?div=CNS) |
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| **Initial Amendment Date:** | August 19, 2014 |
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| **Latest Amendment Date:** | September 16, 2014 |
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| **Award Number:** | 1419199 |
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| **Award Instrument:** | Cooperative Agreement |
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| **Program Manager:** | Joseph Lyles CNS Division Of Computer and Network Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | October 1, 2014 |
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| **End Date:** | September 30, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $4,399,514.00 |
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| **Investigator(s):** | Robert Ricci ricci@cs.utah.edu (Principal Investigator) Kuang-Ching Wang (Co-Principal Investigator) Srinivasa Akella (Co-Principal Investigator) Brig 'Chip' Elliott (Co-Principal Investigator) Michael Zink (Co-Principal Investigator) |
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| **Sponsor:** | University of Utah 75 S 2000 E SALT LAKE CITY, UT 84112-8930 (801)581-6903 |
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| **NSF Program(s):** | INFORMATION TECHNOLOGY RESEARC |
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| **Program Reference Code(s):** | 8002, 9150 |
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| **Program Element Code(s):** | 1640 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Many of the ideas that drive modern cloud computing, such as server virtualization, network slicing, and robust distributed storage, arose from the research community. But because today's clouds have particular, non-malleable implementations of these ideas "baked in," they are unsuitable as facilities in which to conduct research on future cloud architectures. This project creates CloudLab, a facility that will enable fundamental advances in cloud architecture. CloudLab will not be a cloud; CloudLab will be large-scale, distributed scientific infrastructure on top of which many different clouds can be built. It will support thousands of researchers and run hundreds of different, experimental clouds simultaneously. The Phase I CloudLab deployment will provide data centers at Clemson (with Dell equipment), Utah (HP), and Wisconsin (Cisco), with each industrial partner collaborating to explore next-generation ideas for cloud architectures  
  
CloudLab will be a place where researchers can try out ideas using any cloud software stack they can imagine. It will accomplish this by running at a layer below cloud infrastructure: it will provide isolated, bare-metal access to a set of resources that researchers can use to bring up their own clouds. These clouds may run instances of today's popular stacks, modest modifications to them, or something entirely new. CloudLab will not be tied to any particular particular cloud stack, and will support experimentation on multiple in parallel.   
  
The impact of cloud computing outside the field of computer science has been substantial: it has enabled a new generation of applications and services with direct impacts on society at large. CloudLab is positioned to have an immediate and substantial impact on the research community by providing access to the resources it needs to shape the future of clouds. Cloud architecture research, enabled by CloudLab, will empower a new generation of applications and services which will bring direct benefit to the public in areas of national priority such as medicine, smart grids, and natural disaster early warning and response.

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# ****RAPID: Teleoperated Robot Systems in Support of Health Care Workers****

**Award Abstract #1518652**  
http://www.nsf.gov/awardsearch/images/common/x.gif **RAPID: Teleoperated Robot Systems in Support of Health Care Workers**  
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| **NSF Org:** | [**IIS**](http://www.nsf.gov/div/index.jsp?div=IIS) [**Div Of Information & Intelligent Systems**](http://www.nsf.gov/div/index.jsp?div=IIS) |
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| **Latest Amendment Date:** | May 6, 2015 |
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| **Award Number:** | 1518652 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Gregory Chirikjian IIS Div Of Information & Intelligent Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | December 15, 2014 |
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| **End Date:** | November 30, 2015 (Estimated) |
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| **Awarded Amount to Date:** | $79,002.00 |
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| **Investigator(s):** | William Smart bill.smart@oregonstate.edu (Principal Investigator) |
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| **Sponsor:** | Oregon State University OREGON STATE UNIVERSITY Corvallis, OR 97331-8507 (541)737-4933 |
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| **NSF Program(s):** | National Robotics Initiative, INFORMATION TECHNOLOGY RESEARC |
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| **Program Reference Code(s):** | 001Z, 1640, 7914, 8086, 9251 |
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| **Program Element Code(s):** | 8013, 1640 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
The expanded Ebola Testing Unit will allow health care workers to reduce their exposure to highly contagious pathogens, such as Ebola Virus Disease, by creating a physical separation between them and the pathogen. The remote-controlled robot system will allow the health care worker to perform some tasks without having the be physically close to sources of potential infection and will, as a result, dramatically reduce their risks of contracting the disease they are treating. The proposed system will both reduce the risk of infection to health care workers, and will increase the quality of care that patients receive: by reducing the time requirements of donning and doffing protective clothing, health care professionals can concentrate on patient care. Ultimately, the work proposed here will save lives, both in the current Ebola outbreak, and also in future outbreaks of highly-infectious diseases.  
  
The approach will focus on three elements: tele-operated mobile manipulation, protective equipment for easy decontamination of the robot, and a person tracking system for Ebola treatment facilities. A simulated Ebola testing unit will be demonstrated within six months. It will integrate new hardware, address the issues of operation over wireless and identify the robot tasks in consultation with health care professionals. Protection and decontamination systems will be evaluated and the effectiveness of the complete system evaluation. The system will then be integrated in a broader facility in collaboration with WPI.

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# ****SHF: Large: Collaborative Research: Designing the Programmable Many-Core for Extreme Scale Computing****

**Award Abstract #1536795**  
http://www.nsf.gov/awardsearch/images/common/x.gif **SHF: Large: Collaborative Research: Designing the Programmable Many-Core for Extreme Scale Computing**  
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| **NSF Org:** | [**CCF**](http://www.nsf.gov/div/index.jsp?div=CCF) [**Division of Computing and Communication Foundations**](http://www.nsf.gov/div/index.jsp?div=CCF) |
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| **Initial Amendment Date:** | April 24, 2015 |
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| **Award Number:** | 1536795 |
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| **Award Instrument:** | Continuing grant |
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| **Program Manager:** | Hong Jiang CCF Division of Computing and Communication Foundations CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | September 1, 2014 |
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| **End Date:** | December 31, 2015 (Estimated) |
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| **Awarded Amount to Date:** | $274,973.00 |
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| **Investigator(s):** | Samuel Midkiff smidkiff@purdue.edu (Principal Investigator) |
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| **Sponsor:** | University of Illinois at Urbana-Champaign SUITE A CHAMPAIGN, IL 61820-7473 (217)333-2187 |
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| **NSF Program(s):** | SOFTWARE & HARDWARE FOUNDATION |
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| **Program Reference Code(s):** | 6863, 7941 |
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| **Program Element Code(s):** | 7798 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
This work proposes to design a programmable many-core for Extreme-Scale Computing in mobile platforms (netbooks and smart-phones) of year 2020. This work cuts across the architecture, compiler, operating system, and correctness/performance tools areas. A key technology explored is that of cores and all of the software continuously operating in Chunks (i.e., atomic blocks) of instructions at a time --- eliminating the need for in-order, single-instruction-at-a-time commit. The PIs will develop a novel chunk-based architecture that supports the high levels of performance, power/energy efficiency, concurrency, and locality required. They will develop advanced compiler support for chunk generation that delivers high performance at low power, and leverages all the programmability features of the architecture. They will also design an OS that supports and takes advantage of chunks. Finally, they will design a set of novel correctness and performance tools that exploit chunks, signatures, hashes, and all the other features of this architecture.  
  
The broader impacts of this work involve the creation of a multidisciplinary research and education center at University of Illinois and Purdue on Programmable Extreme Scale Computing. Faculty of diverse expertise will be devoted to solving the problem of programmable, very-high performance, very power/energy-efficient many-cores for mobile platforms of year 2020 and beyond. The PIs will broaden the course offerings at University of Illinois and Purdue in the four areas, with multidisciplinary courses at different depth levels. Graduate and undergraduate researchers in ECE and CS will be involved in the research. Overall, the PIs hope to prove that programmable, high-performance, and highly power/energy-efficient many-cores based on continuous atomic-block operation are attractive.

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# ****CSR: Small: Collaborative Research: Software Defined Energy Adaptation in Large Scale Data Centers****

**Award Abstract #1421913**  
http://www.nsf.gov/awardsearch/images/common/x.gif **CSR: Small: Collaborative Research: Software Defined Energy Adaptation in Large Scale Data Centers**  
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| **NSF Org:** | [**CNS**](http://www.nsf.gov/div/index.jsp?div=CNS) [**Division Of Computer and Network Systems**](http://www.nsf.gov/div/index.jsp?div=CNS) |
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| **Award Number:** | 1421913 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Weisong Shi CNS Division Of Computer and Network Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | October 1, 2014 |
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| **End Date:** | September 30, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $250,000.00 |
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| **Investigator(s):** | David Du du@cs.umn.edu (Principal Investigator) |
| divider line | |
| **Sponsor:** | University of Minnesota-Twin Cities 200 OAK ST SE Minneapolis, MN 55455-2070 (612)624-5599 |
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| **NSF Program(s):** | COMPUTER SYSTEMS |
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| **Program Reference Code(s):** | 7923 |
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| **Program Element Code(s):** | 7354 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Today many compute and data intensive applications are running on the computers in data centers. Therefore, data centers consume large amounts of energy. Within a data center, many compute, storage and networking components are coordinated together to support these applications. This project studies how to efficiently allocate resources in data centers to satisfy the requirements of these applications with guaranteed quality of service (QoS) and at the same time taking advantage of the available renewable (green) energy to reduce the total energy to be consumed. As the data centers increase in size and complexity, it is becoming clear that the traditional distributed control of their resources poses daunting problems in ensuring the desired agility and QoS support demanded by the enterprise applications. This problem is further compounded by the need for aggressive energy management in order to minimize energy cost, cope with power and thermal related constraints, and adapt to variability in the energy produced from local "green" sources. A distributed management of energy is particularly difficult since energy by its nature is a central resource that must be properly divided up among various infrastructure components in order to yield acceptable application performance.   
  
This project explores a flexible, policy driven, software defined mechanism to manage energy at all levels of the data center and for all major resources including networks, storage systems, and compute servers. A crucial aspect in this research is the coordination of energy management decisions at various levels which is essential to achieve optimal performance under given energy/thermal constraints. The project brings in the emerging concept of software defined resource management to seamlessly tackle the energy sustainability and corresponding QoS issues in data centers. The project also forms a pilot realization of the software defined data center, since energy adaptation requires an adept management of all major data center resources. A set of new algorithms in resource allocation, resource monitoring, QoS enforcement, energy allocation and distribution will be designed and developed. These algorithms will be implemented into a specific framework to demonstrate and validate the usage and benefits of the research. The broader impacts of the project include mechanisms to enhance energy sustainability of data centers and a comprehensive mechanism for software control of large computing systems. The project also augments the research being done in the NSF Industry/University Cooperative Research Center (IUCRC) on intelligent storage and will use it as a conduit for industry adoption of this research.

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# ****CAREER: Integrating Physical Models into Data-Driven Inference****

**Award Abstract #1350374**  
http://www.nsf.gov/awardsearch/images/common/x.gif **CAREER: Integrating Physical Models into Data-Driven Inference**

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| **NSF Org:** | [**ACI**](http://www.nsf.gov/div/index.jsp?div=ACI) [**Div Of Advanced Cyberinfrastructure**](http://www.nsf.gov/div/index.jsp?div=ACI) |
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| **Initial Amendment Date:** | February 3, 2014 |
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| **Latest Amendment Date:** | April 24, 2015 |
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| **Award Number:** | 1350374 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | sushil prasad ACI Div Of Advanced Cyberinfrastructure CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | June 1, 2014 |
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| **End Date:** | May 31, 2019 (Estimated) |
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| **Awarded Amount to Date:** | $482,143.00 |
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| **Investigator(s):** | Linwei Wang linwei.wang@rit.edu (Principal Investigator) |
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| **Sponsor:** | Rochester Institute of Tech 1 LOMB MEMORIAL DR ROCHESTER, NY 14623-5603 (585)475-7987 |
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| **NSF Program(s):** | CAREER: FACULTY EARLY CAR DEV |
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| **Program Reference Code(s):** | 1045, 9251 |
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| **Program Element Code(s):** | 1045 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Individualized assessment of high-dimensional spatiotemporal systems - such as in-vivo human physiological systems - has been increasingly enabled by paralleled advances in two fields: computer modeling that supports quantitative understanding of the dynamic behavior and mechanism of these systems, and modern sensor technologies that continuously improve the quantity and quality of measurement data available for analysis. There is, however, a gap between the two fields that is ubiquitous in many application domains: the current state of computer modeling is generally decoupled from specific measurements of an individual system, while individualized data-driven analysis often struggles for realistic domain contexts. This project aims to bridge this gap by investigating and developing new methodologies, algorithms, and software that will enable the integration of complex domain knowledge - yielded by computer simulation of domain physical models - into the process of data-driven inference. The overarching theme of this research is flexibility and robustness. Specifically, it addresses the following three challenges: 1) to enable a plug-and-play inclusion of domain physical models catering to different efficiency vs. accuracy needs; 2) to further overcome the lack of measurements and potential errors in domain physical models by exploiting the low-dimensional structure in high-dimensional systems; and 3) to enable a robust adaptation of the time-varying error that potentially exists in domain physical models. The driving application of this project is individualized modeling of in-vivo cardiovascular systems - using noninvasive biomedical and physiological data - for improved prevention, diagnosis, and treatment of heart diseases.   
  
The outcome of this project will contribute theoretically, algorithmically, and computationally to the foundations of statistical inference, and extend to a wide range of applications such as tumor modeling, climate modeling, systems biology, and finance. In addition, this project will deliver publicly-available multicore/GPU software that will encapsulate the most effective algorithms developed. These toolkits will contribute to the national effort toward noninvasive medicine and healthcare, while supporting numerous scientific applications involving data-driven modeling and inference. This project also includes an integrated educational and outreach program to foster interdisciplinary research training and to increase participation of underrepresented groups in STEM disciplines. It includes: 1) development and evaluation of "learning-by-doing" concept in graduate and undergraduate education; 2) research training for students from graduate to high-school levels, with a focus on engaging women and underrepresented students at an early stage; and 3) broader outreach activities to area K-12 students and Paramedic communities. The participation of women, underrepresented, K-12, and Paramedic groups are reinforced through continued partnerships between the PI and different programs offered in RIT, local school district, and community college.

Please report errors in award information by writing to: [awardsearch@nsf.gov](mailto:awardsearch@nsf.gov).

# ****Broadening Participation in the Workshop on Leveraging High Performance Computing Resources for Big Data Management****

**Award Abstract #1447000**  
http://www.nsf.gov/awardsearch/images/common/x.gif **Broadening Participation in the Workshop on Leveraging High Performance Computing Resources for Big Data Management**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**ACI**](http://www.nsf.gov/div/index.jsp?div=ACI) [**Div Of Advanced Cyberinfrastructure**](http://www.nsf.gov/div/index.jsp?div=ACI) |
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| **Initial Amendment Date:** | July 23, 2014 |
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| **Latest Amendment Date:** | July 23, 2014 |
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| **Award Number:** | 1447000 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | sushil prasad ACI Div Of Advanced Cyberinfrastructure CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | August 1, 2014 |
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| **End Date:** | July 31, 2015 (Estimated) |
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| **Awarded Amount to Date:** | $37,800.00 |
| divider line | |
| **Investigator(s):** | Ritu Ritu rauta@tacc.utexas.edu (Principal Investigator) Maria Esteva (Co-Principal Investigator) |
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| **Sponsor:** | University of Texas at Austin 101 E. 27th Street, Suite 5.300 Austin, TX 78712-1532 (512)471-6424 |
| divider line | |
| **NSF Program(s):** | INFORMATION TECHNOLOGY RESEARC, EDUCATION AND WORKFORCE |
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| **Program Reference Code(s):** | 7231, 7556 |
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| **Program Element Code(s):** | 1640, 7361 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
The goal of the proposed project is to broaden the participation of the individuals from underrepresented groups in the "First Hands-On Workshop on Leveraging High Performance Computing Resources for Managing Large Datasets". This one-day workshop has been accepted by the 2014 IEEE Big Data conference, and is tentatively scheduled to be held on October 27, 2014 in Washington DC. The objective of the workshop is to engage its participants in using the national Cyberinfrastructure (CI) for Big Data management activities, thereby enhancing the possibilities of making discoveries in the areas of data-driven and data-intensive computing. Through the proposed project, 20 students from underrepresented groups will be funded to participate in the aforementioned workshop, and will also be supported to participate in additional activities at the conference.

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# ****REU Site: Robots in the Real World****

**Award Abstract #1359480**  
http://www.nsf.gov/awardsearch/images/common/x.gif **REU Site: Robots in the Real World**  
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| **NSF Org:** | [**IIS**](http://www.nsf.gov/div/index.jsp?div=IIS) [**Div Of Information & Intelligent Systems**](http://www.nsf.gov/div/index.jsp?div=IIS) |
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| **Initial Amendment Date:** | April 23, 2014 |
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| **Latest Amendment Date:** | April 23, 2014 |
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| **Award Number:** | 1359480 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | William Bainbridge IIS Div Of Information & Intelligent Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | June 1, 2014 |
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| **End Date:** | May 31, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $339,981.00 |
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| **Investigator(s):** | William Smart bill.smart@oregonstate.edu (Principal Investigator) Cindy Grimm (Co-Principal Investigator) |
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| **Sponsor:** | Oregon State University OREGON STATE UNIVERSITY Corvallis, OR 97331-8507 (541)737-4933 |
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| **NSF Program(s):** | RSCH EXPER FOR UNDERGRAD SITES |
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| **Program Reference Code(s):** | 9250 |
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| **Program Element Code(s):** | 1139 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
The goal of this REU Site is to engage undergraduate students on a wide range of aspects in robotics research - including mechanical engineering, design, electrical engineering, and computer science - while learning how to build complete systems that are able to deal with all of the complexities and uncertainties of the real world. REU students gain insight into the process of doing research in a university environment, what it takes to be a successful graduate student, working on a multi-disciplinary robotics project in a large research group, and what graduate student life looks like. The skills that students are learning by participating in this REU Site will prepare them for graduate studies and to enter the rapidly-expanding robotics industry, and help the United States maintain its lead as a technological innovator. We are starting to see robots enter our daily lives, and we need students who understand how to put together complete working systems and make them work in the real world. The ability to work as a team, across disciplines, is a vital skill in today's research and work environments, and not only in robotics. This REU Site is teaching students the non-technical skills that will make them attractive hires in any field.   
  
REU students work alongside with faculty, graduate students, and other undergraduates on cutting-edge problems in robotics, with the goal of getting robots to work robustly in the real world, not just in the laboratory. Student projects are advancing the state of the art in walking robots, human-robot interaction, control of complex mechanical systems, and long-term autonomy. More information about this REU Site can be found at the web site (http://robotics.oregonstate.edu/reu).

Please report errors in award information by writing to: [awardsearch@nsf.gov](mailto:awardsearch@nsf.gov).

# ****SHF: Medium: Collaborative Research: Scalable Algorithms for Spatio-temporal Data Analysis****

**Award Abstract #1409601**  
http://www.nsf.gov/awardsearch/images/common/x.gif **SHF: Medium: Collaborative Research: Scalable Algorithms for Spatio-temporal Data Analysis**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CCF**](http://www.nsf.gov/div/index.jsp?div=CCF) [**Div Of Computer & Communication Foundati**](http://www.nsf.gov/div/index.jsp?div=CCF) |
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| **Initial Amendment Date:** | May 21, 2014 |
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| **Latest Amendment Date:** | May 21, 2014 |
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| **Award Number:** | 1409601 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Almadena Y. Chtchelkanova CCF Div Of Computer & Communication Foundati CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | June 1, 2014 |
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| **End Date:** | May 31, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $709,342.00 |
| divider line | |
| **Investigator(s):** | Alok Choudhary choudhar@ece.northwestern.edu (Principal Investigator) Wei-keng Liao (Co-Principal Investigator) Ankit Agrawal (Co-Principal Investigator) |
| divider line | |
| **Sponsor:** | Northwestern University 1801 Maple Ave. Evanston, IL 60201-3149 (847)491-3003 |
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| **NSF Program(s):** | SOFTWARE & HARDWARE FOUNDATION |
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| **Program Reference Code(s):** | 7924, 7942 |
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| **Program Element Code(s):** | 7798 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Acceleration of computing power of supercomputers along with development and deployment of large instruments such as telescopes, colliders, sensors and devices raises one fundamental question. "Can the time to insight and knowledge discovery be reduced at the same exponential rate?" The answer currently is clearly "NO", because a critical step that combines analytics, mining and discovering knowledge from the massive datasets has lagged far behind advances in software, simulation and generation of data. Analysis of data requires "data-driven" computing and analytics. This entails scalable software for data reduction, approximations, analysis, statistics, and bottom-up discovery. Scalable and parallel analytics software for processing large amount of data is required in order to make a significant leap forward in scientific discoveries.   
  
This project develops innovative, scalable, and sustainable data analytics algorithms to enable analysis and mining of massive data on high-performance parallel computers, which include (1) bottom-up and unsupervised data clustering algorithms that are suitable for spatio-temporal data, massive graph analytics, community computations, and detection of patterns in time-varying graphs, different types of data, and different data characteristics; (2) change detection and anomaly detection in spatio-temporal data; and (3) tracking moving data and cluster dynamics within certain time and space constraints. These parallel algorithms use the massive amount of data generated from scientific applications, such as astrophysics, cosmology simulations, climate modeling, and social networking analysis, for result verification and performance evaluation on modern high-performance parallel computers.  
  
This project directly addresses the critical needs for spatio-temporal data analysis, performance scalability, and programming productivity of large-scale scientific discovery via parallel analytics software for big data. This work will impact applications of enormous societal benefits and scientific importance such as climate understanding, environmental sustainability, astrophysics, biology and medicine by accelerating scientific discoveries. Furthermore, the developed software infrastructure can be used and adopted in commercial applications, such as commerce, social, security, drug discovery, and so on. The source codes are open to the public for all community to adapt, build-upon, customize and contribute to, thereby multiplying its value and usage.

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# ****CAREER: Cooperative Motion Planning for Human-Operated Robots****

**Award Abstract #1503177**  
http://www.nsf.gov/awardsearch/images/common/x.gif **CAREER: Cooperative Motion Planning for Human-Operated Robots**  
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| **NSF Org:** | [**IIS**](http://www.nsf.gov/div/index.jsp?div=IIS) [**Div Of Information & Intelligent Systems**](http://www.nsf.gov/div/index.jsp?div=IIS) |
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| **Initial Amendment Date:** | April 1, 2015 |
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| **Latest Amendment Date:** | April 1, 2015 |
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| **Award Number:** | 1503177 |
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| **Award Instrument:** | Continuing grant |
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| **Program Manager:** | Gregory Chirikjian IIS Div Of Information & Intelligent Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | August 15, 2014 |
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| **End Date:** | September 30, 2018 (Estimated) |
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| **Awarded Amount to Date:** | $180,370.00 |
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| **Investigator(s):** | Kris Hauser kris.hauser@duke.edu (Principal Investigator) |
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| **Sponsor:** | Duke University 2200 W. Main St, Suite 710 Durham, NC 27705-4010 (919)684-3030 |
| divider line | |
| **NSF Program(s):** | CAREER: FACULTY EARLY CAR DEV, ROBUST INTELLIGENCE |
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| **Program Reference Code(s):** | 1045, 7495 |
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| **Program Element Code(s):** | 1045, 7495 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
This proposal outlines a research and educational plan to advance decision-making techniques for robots that cooperate with human operators. Because humans far exceed the abilities of state-of-the-art robots in vision, creativity, and adaptability, interest is rapidly growing in a human-centered approach to robotics: combining the strengths of humans with the superior precision and repeatability of robots. And yet, our available motion planning tools, while powerful at computing motions for complex autonomous tasks, are poorly suited for human-centered applications that demand responsive and natural motions. This proposal hypothesizes that a new cooperative motion planning paradigm will support major advances in intuitiveness and task performance of human-operated robots such as intelligent vehicles, tele-surgery systems, search and-rescue robots, and household robots. This hypothesis is echoed in an educational plan that aims to train engineers with cross-disciplinary strengths that bridge both the technical and social dimensions of robotics. Initial human subjects studies on novice operators with the PI's cooperative motion planning algorithms suggest that the technique leads to dramatic reductions in task completion time and collision rate in cluttered environments. The proposed work will conduct further investigations along this line of research to 1) identify characteristics of cooperative planners - such as optimality, responsiveness, and completeness - that yield effective human-operator systems, both in terms of objective performance metrics and subjective preferences, 2) to design planners that optimize cooperativity metrics under computational resource and communication constraints, and 3) to enhance the capabilities of such planners to assist operators in complex manipulation tasks.  
  
The planners developed in this research and the rich datasets acquired via user studies will serve as resources to help human-robot interaction (HRI) researchers design safe and socially acceptable robot behaviors. Moreover, advances in cooperative motion planning may have long-term social and economic impact by enabling new applications of robotics in driver assist systems, space exploration, medicine, household robotics, manufacturing, and construction. Research is integrated with education in a range of activities that include CS curriculum development, development of a new graduate course on optimization and machine learning, and in new software libraries for robotics education. New modules on motion planning, behavior recognition, and HRI will be incorporated in AI and robotics courses. An REU is requested for each summer of the grant and will be recruited from a minority-serving institution in cooperation with the Alliance for the Advancement of African-American Researchers in Computing (A4RC). One or more IU undergraduates will be involved in research and mentored according to the Undergraduate Research Opportunities in Computing (UROC) program, with preference given to minority and women students.

Please report errors in award information by writing to: [awardsearch@nsf.gov](mailto:awardsearch@nsf.gov).

# ****SHF: Small: High Performance On-Chip Interconnects Design for Multicore Accelerators****

**Award Abstract #1423433**  
http://www.nsf.gov/awardsearch/images/common/x.gif **SHF: Small: High Performance On-Chip Interconnects Design for Multicore Accelerators**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CCF**](http://www.nsf.gov/div/index.jsp?div=CCF) [**Div Of Computer & Communication Foundati**](http://www.nsf.gov/div/index.jsp?div=CCF) |
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| **Initial Amendment Date:** | July 10, 2014 |
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| **Latest Amendment Date:** | July 10, 2014 |
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| **Award Number:** | 1423433 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Hong Jiang CCF Div Of Computer & Communication Foundati CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | July 15, 2014 |
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| **End Date:** | June 30, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $450,000.00 |
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| **Investigator(s):** | Eun Jung Kim ejkim@cs.tamu.edu (Principal Investigator) Ki Hwan Yum (Co-Principal Investigator) |
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| **Sponsor:** | Texas A&M Engineering Experiment Station TEES State Headquarters Bldg. College Station, TX 77845-4645 (979)458-7617 |
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| **NSF Program(s):** | SOFTWARE & HARDWARE FOUNDATION |
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| **Program Reference Code(s):** | 7923, 7941 |
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| **Program Element Code(s):** | 7798 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Advances in technology have made it possible to accommodate an increasing number of transistors on a die, enabling Multicore Accelerators like Graphics Processing Units(GPUs) by integrating diverse components on a single chip. GPUs have recently gained attention as a cost-effective approach for data parallel architectures, and the fast scaling of the GPUs increases the importance of designing an ideal on-chip interconnection network, which significantly impacts the overall system performance.  
In this project, we propose to develop a framework for high-performance and energy-efficient on-chip network mechanisms in synergy with Multicore Accelerator architectures. The desirable properties of a target on-chip network include re-usability across a wide range of Multicore Accelerator architectures, maximization of the use of routing resources, and support for reliable and energy-efficient data transfer.  
This project will make significant advances in understanding the interplay between Multicore Accelerator and Network-on-Chip (NoC) architectures, which leads us to scalable solutions for performance, area and energy.While the major communication of Chip Multiprocessor (CMP) systems is core-to-corefor shared caches, major traffic of Multicore Accelerators is core-to-memory, which makes the memory controllers hot spots. Since Multicore Accelerators execute many threads in order to hide memory latency, it is critical for the underlying NoC to provide high bandwidth.

The key contributions expected from the project are: (1) building a simulation testbed and analyzing the behavior of on-chip traffic workloads in Multicore Accelerators; (2) proposing mechanisms for a high-performance and energy-efficient NoC by utilizing emerging memory and NoC technologies in addition to novel topologies and routing mechanisms; (3) developing methodologies at the NoC level that will support data prefetching mechanisms in the Multicore Accelerators; and (4) providing multicast support and packet coalescing in the on-chip network to guarantee better system throughput. The results from this project are likely to foster new research directions in several areas of Computer Architecture and Parallel Computing. Also, high-performance and energy-aware computing and communication research is applicable to other areas, such as Embedded Systems and Cloud Computing. We will develop web-based tutorials to present and disseminate the results of this project, including tools and techniques, to a broad audience.

Please report errors in award information by writing to: [awardsearch@nsf.gov](mailto:awardsearch@nsf.gov).

# ****NRI-Large: Collaborative Research: Multilateral Manipulation by Human-Robot Collaborative Systems****

**Award Abstract #1522853**  
http://www.nsf.gov/awardsearch/images/common/x.gif **NRI-Large: Collaborative Research: Multilateral Manipulation by Human-Robot Collaborative Systems**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**IIS**](http://www.nsf.gov/div/index.jsp?div=IIS) [**Div Of Information & Intelligent Systems**](http://www.nsf.gov/div/index.jsp?div=IIS) |
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| **Initial Amendment Date:** | February 3, 2015 |
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| **Latest Amendment Date:** | February 3, 2015 |
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| **Award Number:** | 1522853 |
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| **Award Instrument:** | Continuing grant |
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| **Program Manager:** | Jeffrey Trinkle IIS Div Of Information & Intelligent Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | September 1, 2014 |
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| **End Date:** | September 30, 2016 (Estimated) |
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| **Awarded Amount to Date:** | $511,045.00 |
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| **Investigator(s):** | Jacob Rosen rosen@seas.ucla.edu (Principal Investigator) |
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| **Sponsor:** | University of California-Los Angeles 11000 Kinross Avenue, Suite 211 LOS ANGELES, CA 90095-2000 (310)794-0102 |
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| **NSF Program(s):** | National Robotics Initiative |
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| **Program Reference Code(s):** | 7925, 8086 |
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| **Program Element Code(s):** | 8013 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
This project addresses a large space of manipulation problems that are repetitive, injury-causing, or dangerous for humans to perform, yet are currently impossible to reliably achieve with purely autonomous robots. These problems generally require dexterity, complex perception, and complex physical interaction. Yet, many such problems can be reliably addressed with human/robot collaborative (HRC) systems, where one or more humans provide needed perception and adaptability, working with one or more robot systems that provide speed, precision, accuracy, and dexterity at an appropriate scale, combining these complementary capabilities.  
  
The project focuses on multilateral manipulation, which arises when a human controls one or more robot manipulators in partnership with one or more additional controllers (humans or autonomous agents). Complex operations in surgery and manufacturing can benefit from the extra degrees of freedom provided by more than two hands, and training often depends on hands-on interaction between expert and apprentice. Example applications include surgical operations, which typically involve several physicians and assistants, and other medical tasks such as turning a patient in bed and wrapping a cast to constrain a hand. Multilateral manipulation also applies in manufacturing, for example for threading wires or cables, aligning gaskets to obtain a tight seal, and in many household situations, such as folding tablecloths, wrapping packages, and zipping overfilled suitcases so they will fit inside diabolically-designed overhead airline compartments. Multilateral manipulation often arises with deformable materials or multi-jointed objects with more than six degrees of freedom (DOF). The extra DOFs in materials introduce challenges such as computational complexity, but they also can accommodate minor inconsistencies through redundancy and provide system damping. This project advances the fundamental science of multilateral manipulation guided by specific applications from surgery and manufacturing.  
  
Broader Impacts: Multilateral manipulation systems have the potential to improve healthcare, improve American competitiveness and product quality in manufacturing, and open the door to new service robot applications in the home. The project will be guided by an Advisory Board of experts from industry and medical practice. Project results will be disseminated through yearly conference workshops, open-source software tools integrated into common robotics software environments such as Robot Operating System (ROS), and the investigators' research and course webpages, to encourage integration of our approach into research projects and courses at many institutions. Outreach programs, public lab tours, and mentoring of minority students will broaden participation of underrepresented groups in engineering. These activities will encourage participation in STEM activities and provide student and postdoctoral researchers with mentoring experience.

Please report errors in award information by writing to: [awardsearch@nsf.gov](mailto:awardsearch@nsf.gov).

# ****TWC: Small: Understanding and Mitigating the Threat of a Malicious Network-on-Chip****

**Award Abstract #1421068**  
http://www.nsf.gov/awardsearch/images/common/x.gif **TWC: Small: Understanding and Mitigating the Threat of a Malicious Network-on-Chip**  
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| **NSF Org:** | [**CNS**](http://www.nsf.gov/div/index.jsp?div=CNS) [**Division Of Computer and Network Systems**](http://www.nsf.gov/div/index.jsp?div=CNS) |
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| **Initial Amendment Date:** | August 18, 2014 |
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| **Latest Amendment Date:** | February 2, 2015 |
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| **Award Number:** | 1421068 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Nina Amla CNS Division Of Computer and Network Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | September 1, 2014 |
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| **End Date:** | August 31, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $532,000.00 |
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| **Investigator(s):** | Koushik Chakraborty koushik.chakraborty@usu.edu (Principal Investigator) Sanghamitra Roy (Co-Principal Investigator) |
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| **Sponsor:** | Utah State University Sponsored Programs Office Logan, UT 84322-1415 (435)797-1226 |
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| **NSF Program(s):** | Secure &Trustworthy Cyberspace, SPECIAL PROJECTS - CISE |
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| **Program Reference Code(s):** | 7434, 7923, 9150, 9178, 9251 |
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| **Program Element Code(s):** | 8060, 1714 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
One of the key challenges in trustworthy computing is establishing trust in the hardware layer, which is the execution platform of all software applications. Modern multiprocessor system-on-chips employ many specialized components, and scalable network-on-chips (NoC) are often deployed to efficiently connect these components. In the light of these trends, this project investigates secure and reliable computation, when the underlying NoC is compromised.  
  
The project explores a range of threats posed by a compromised NoC in current and future multiprocessor systems. The layered security mechanisms in the multiprocessor firmware that can allow secure and reliable computation by tolerating a compromised NoC are investigated. The project enables trustworthy computing on next generation cost-effective hardware platforms driven by seamless integration of third party hardware components. Through educational activities, this project will disseminate vital skill sets to future work force to engage in trustworthy computer design.

Please report errors in award information by writing to: [awardsearch@nsf.gov](mailto:awardsearch@nsf.gov).

# ****SaTC: Hardware-Assisted Methods for Operating System Integrity****

**Award Abstract #1441724**  
http://www.nsf.gov/awardsearch/images/common/x.gif **SaTC: Hardware-Assisted Methods for Operating System Integrity**  
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| **NSF Org:** | [**CNS**](http://www.nsf.gov/div/index.jsp?div=CNS) [**Division Of Computer and Network Systems**](http://www.nsf.gov/div/index.jsp?div=CNS) |
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| **Initial Amendment Date:** | August 6, 2014 |
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| **Latest Amendment Date:** | August 6, 2014 |
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| **Award Number:** | 1441724 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Deborah Shands CNS Division Of Computer and Network Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | October 1, 2014 |
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| **End Date:** | September 30, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $499,988.00 |
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| **Investigator(s):** | Vinod Ganapathy vinodg@cs.rutgers.edu (Principal Investigator) Liviu Iftode (Co-Principal Investigator) Santosh Nagarakatte (Co-Principal Investigator) |
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| **Sponsor:** | Rutgers University New Brunswick 3 RUTGERS PLAZA NEW BRUNSWICK, NJ 08901-8559 (848)932-0150 |
| divider line | |
| **NSF Program(s):** | Secure &Trustworthy Cyberspace |
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| **Program Reference Code(s):** | 7434 |
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| **Program Element Code(s):** | 8060 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Operating systems (OS) form the core of the trusted computing base on most computer platforms. The security of a platform therefore crucially relies on the correct and secure operation of its OS. Unfortunately, malicious software such as rootkits infect the OS by compromising the integrity of its code and data, thereby jeopardizing the security of the entire platform.  
  
The goal of this project is to push the boundaries of hardware-assisted methods to ensure OS integrity. The methods explored include (1) formal verification of a hybrid hardware/software scheme that uses local memory to monitor OS integirty, (2) hardware support for kernel memory safety, and (3) a hardware-based scheme that leverages methods such as the ARM TrustZone to monitor the security of end-user devices. Throughout, the focus of this project is on developing hardware-based solutions to monitor OS integrity and to verify the security guarantees advertised by these solutions.  
  
The methods being developed can have broad impact by advancing the state of the art in personal, mobile and embedded device security. The proposed designs are close variants of currently-available hardware designs and are therefore likely to appeal to hardware manufacturers. The project also includes curriculum enhancements at the graduate and undergraduate level, and outreach programs aimed at high-school students as well as industry professionals.

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# ****CC\*IIE Engineer: A Software-Defined Campus Network for Big-Data Sciences****

**Award Abstract #1440750**  
http://www.nsf.gov/awardsearch/images/common/x.gif **CC\*IIE Engineer: A Software-Defined Campus Network for Big-Data Sciences**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**ACI**](http://www.nsf.gov/div/index.jsp?div=ACI) [**Div Of Advanced Cyberinfrastructure**](http://www.nsf.gov/div/index.jsp?div=ACI) |
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| **Initial Amendment Date:** | August 6, 2014 |
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| **Latest Amendment Date:** | August 6, 2014 |
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| **Award Number:** | 1440750 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Kevin L. Thompson ACI Div Of Advanced Cyberinfrastructure CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | September 1, 2014 |
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| **End Date:** | August 31, 2016 (Estimated) |
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| **Awarded Amount to Date:** | $399,776.00 |
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| **Investigator(s):** | Jennifer Rexford jrex@cs.princeton.edu (Principal Investigator) Christopher Tully (Co-Principal Investigator) Curtis Hillegas (Co-Principal Investigator) Nicholas Turk-Browne (Co-Principal Investigator) |
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| **Sponsor:** | Princeton University Off. of Research & Proj. Admin. Princeton, NJ 08540-0036 (609)258-3090 |
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| **NSF Program(s):** | Campus Cyberinfrastrc (CC-NIE) |
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| **Program Reference Code(s):** |  |
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| **Program Element Code(s):** | 8080 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Scientific researchers on university campuses create, analyze, visualize, and share large and diverse datasets from experimental devices like brain scanners, particle colliders, and genome sequencers. However, these "big data" applications place strain on traditional campus networks, due to rapidly increasing volumes of data, the need for either predictably low latency (to adapt experiments in real time) or high throughput (to transfer large data sets between locations), and sophisticated access-control policies (to protect the privacy of human subjects). To enable the next wave of scientific advances, university campuses must find effective ways to meet these challenging demands, at reasonable cost. The emerging technology of Software-Defined Networking (SDN) lowers the barrier to innovation in network management, and can substantially reduce cost through (i) inexpensive commodity network switches, (ii) greater automation of network configuration, and (iii) novel network-management applications that optimize bandwidth usage. Yet, existing innovation in SDN focuses primarily on the needs of commercial cloud providers, rather than the unique requirements of university campuses and scientific researchers. Princeton University is creating a software-defined campus network that can enable the next generation of data-driven scientific research. The initiative brings together big-data science researchers, computer scientists who are experts in SDN, and the campus Office of Information Technology. Princeton is deploying an open-source SDN platform for monitoring and configuring the network, conducting trials of new ways to support big-data applications, and bridging with the larger community, on and off campus, to support the sharing of scientific data, SDN software, and operational experiences.

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# ****BIGDATA: F: DKA: Scalable, Private Algorithms for Continual Data Analysis****

**Award Abstract #1447700**  
http://www.nsf.gov/awardsearch/images/common/x.gif **BIGDATA: F: DKA: Scalable, Private Algorithms for Continual Data Analysis**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**IIS**](http://www.nsf.gov/div/index.jsp?div=IIS) [**Div Of Information & Intelligent Systems**](http://www.nsf.gov/div/index.jsp?div=IIS) |
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| **Initial Amendment Date:** | August 26, 2014 |
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| **Latest Amendment Date:** | August 26, 2014 |
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| **Award Number:** | 1447700 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Balasubramanian Kalyanasundaram IIS Div Of Information & Intelligent Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | September 1, 2014 |
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| **End Date:** | August 31, 2018 (Estimated) |
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| **Awarded Amount to Date:** | $500,000.00 |
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| **Investigator(s):** | Adam Smith asmith@cse.psu.edu (Principal Investigator) Sofya Raskhodnikova (Co-Principal Investigator) |
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| **Sponsor:** | Pennsylvania State Univ University Park 110 Technology Center Building UNIVERSITY PARK, PA 16802-7000 (814)865-1372 |
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| **NSF Program(s):** | Secure &Trustworthy Cyberspace, Big Data Science &Engineering |
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| **Program Reference Code(s):** | 7433, 7434, 8083 |
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| **Program Element Code(s):** | 8060, 8083 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
For the very same reasons that big data is transforming modern life, it also presents a profound threat to privacy and the control of personal information. A major challenge associated with big data is to enable statistical analysis of complex data sets, without compromising the privacy of the individuals whose data they contain. Addressing this challenge is both necessary, since access to many data sources is restricted due to privacy concerns, and difficult, as numerous attacks on supposedly anonymized data demonstrate. This project will investigate the design and limitations of algorithms for the private, continual analysis of time-varying data sets. That is, it will study algorithms that release information about a data set as it is collected (say, in the form of a data stream from the web, or a long-term sociological study). The research will advance the state of the art in the private analysis of "big" -- massive, complex, time-varying -- data. If successful, the project will provide enabling technologies that facilitate research in areas where access to sensitive data is limited by confidentiality concerns.  
  
The project will focus on the design of algorithms that satisfy differential privacy -- a rigorous notion of privacy that is widely studied in computer science and related fields. The privacy implications of sequential releases are still poorly understood, and relatively few of the algorithms developed in the extensive recent literature on private data analysis allow for sequential releases with high accuracy. The two major thrusts of the project are (1) algorithms for the "continual release" model, and (2) algorithms for the "local" model, which offers even stronger privacy guarantees. The work will provide novel algorithmic design techniques and understanding of complexity-theoretic limitations of algorithms for these models. The research will entail advances in related areas such as learning theory, statistical inference and streaming algorithms. The project will also include educational, outreach and work-force training activities designed to broaden the impact of the research.  
  
For further information see the project web site at: http://www.cse.psu.edu/~asmith/projects/continual/

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# ****NRI: Co-Robots to Engage Next Generation of Students in STEM Learning****

**Award Abstract #1426989**  
http://www.nsf.gov/awardsearch/images/common/x.gif **NRI: Co-Robots to Engage Next Generation of Students in STEM Learning**  
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| **NSF Org:** | [**IIS**](http://www.nsf.gov/div/index.jsp?div=IIS) [**Div Of Information & Intelligent Systems**](http://www.nsf.gov/div/index.jsp?div=IIS) |
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| **Initial Amendment Date:** | August 21, 2014 |
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| **Latest Amendment Date:** | August 21, 2014 |
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| **Award Number:** | 1426989 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | John Krupczak IIS Div Of Information & Intelligent Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | September 1, 2014 |
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| **End Date:** | August 31, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $359,652.00 |
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| **Investigator(s):** | Nina Mahmoudian ninam@mtu.edu (Principal Investigator) Michele Miller (Co-Principal Investigator) Mohammad Rastgaar Aagaah (Co-Principal Investigator) |
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| **Sponsor:** | Michigan Technological University 1400 Townsend Drive Houghton, MI 49931-1295 (906)487-1885 |
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| **NSF Program(s):** | ITEST |
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| **Program Reference Code(s):** | 8086 |
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| **Program Element Code(s):** | 7227 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Robotic technologies are increasingly present in work spaces and homes. Maintaining investment in robotics research and education is vital to the 21st century US economy. Robotic technologies have the potential to transform not only the workplace and home, but also the classroom. This project by Michigan Technological University will introduce the use of two co-robots, robots that work cooperatively with people, as teaching tools. GUPPIE is an unmanned underwater glider that can monitor and inspect the environment and will be used to introduce students to the idea of robots as co-explorers in everyday life. Neu-pulator uses the electrical signals from a person's muscle to control its movement; without this human interaction it cannot operate. Neu-pulator will expose students to robotic assistive technologies that can enhance the capability of human beings, increase their mobility, and improve their general well-being. Both co-robots are low cost and their use is applicable in educational settings ranging from the 4th grade through graduate school. Use of both co-robots will be integrated into hands-on classroom and summer program activities for middle school students. These activities will also incorporate the concepts relevant to state standards for the middle school curriculum. The co-robot platforms are expected to utilize both right and left side thinking for students, encourage social interactions with team partners, and make explicit connections between engineering core concepts and the skills needed to solve today's most pressing problems. The project will investigate the hypothesis that application-based co-robotic activities will be of greater interest to some girls than the more prevalent mission-based robotics competition activities.  
  
The Next Generation Science Standards for Today's Students and Tomorrow's Workforce provides a curricular framework for using crosscutting concepts and disciplinary ideas in the classroom. The overall goal of this project is to develop and evaluate the use of two co-robotic platforms in learning contexts that are socially meaningful to students. Middle school students, particularly underrepresented students (female students from rural, low socioeconomic areas) will be the focus of this work. The specific objectives are to: 1) Optimize co-robotic platform designs for teaching STEM concepts, 2) Develop educational activities/curriculum utilizing co-robotic platforms, and 3) Investigate the co-robotic platforms effectiveness in engaging students in STEM learning. Taking advantage of 3D printing to make the parts for the robots will expand the range of possible designs that students can develop and reduce the amount of time necessary to do so. Hands-on activities using the co-robots in class, after school, or through summer programs will integrate science and engineering standards with core teaching concepts in the middle school curriculum. The dissemination of training modules and effective practices online will make the platforms accessible nationwide.  
  
Evaluation will investigate the hypothesis that the interest and creativity of some girls will show greater increases with application-based co-robotic activities than with mission-based robotics competitions. Researchers will assess the complexity and creativity of student designs. The project will also review student work products from each robotics activity to assess student achievement of relevant standards.

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# ****EAGER: Locality-Aware Data Access Control for Future 1000-core Processors****

**Award Abstract #1452327**  
http://www.nsf.gov/awardsearch/images/common/x.gif **EAGER: Locality-Aware Data Access Control for Future 1000-core Processors**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CCF**](http://www.nsf.gov/div/index.jsp?div=CCF) [**Div Of Computer & Communication Foundati**](http://www.nsf.gov/div/index.jsp?div=CCF) |
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| **Initial Amendment Date:** | August 6, 2014 |
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| **Latest Amendment Date:** | August 6, 2014 |
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| **Award Number:** | 1452327 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Hong Jiang CCF Div Of Computer & Communication Foundati CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | August 1, 2014 |
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| **End Date:** | July 31, 2016 (Estimated) |
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| **Awarded Amount to Date:** | $100,000.00 |
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| **Investigator(s):** | Omer Khan khan@uconn.edu (Principal Investigator) |
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| **Sponsor:** | University of Connecticut 438 Whitney Road Ext. Storrs, CT 06269-1133 (860)486-3622 |
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| **NSF Program(s):** | ALGORITHMIC FOUNDATIONS |
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| **Program Reference Code(s):** | 7916 |
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| **Program Element Code(s):** | 7796 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Computer architectures will soon approach an era of single-chip multicore processors with hundreds or even thousands of heterogeneous cores connected via complex interconnection networks and cache hierarchies. These many-core processors will concurrently execute next generation applications, such as big data analytics, to exploit parallelism and specialization for power-performance efficiency. Furthermore, new memory technologies will be integrated to minimize energy-inefficient off-chip accesses. However, the technology trends indicate that wire scaling will slow down dramatically as compared to computation. The cost of moving data efficiently through the future many-core processors will become a major challenge. The increasing core counts with heterogeneous computation and communication capabilities, as well as applications that process massive data with varying degrees of locality and reuse, will introduce data access variations at different layers of the processor.   
  
This project proposes to dynamically exploit and co-optimize this variability in locality and reuse of data as it flows through the processor resources. The strategy is to adopt a hardware-software co-design approach, and develop fine-through-coarse-grain cross-layer mechanisms for locality-optimal data access in future many-core processors. This will be achieved using a novel locality-aware data access control utility (LDAC) that intelligently and cooperatively orchestrates data movement in the shared heterogeneous processor resources to deliver the efficiency promise. If successful, this project will be a major step forward towards a new computational model where runtime management of processor efficiency can be utilized to make tradeoffs with security, privacy, resilience, or accuracy of computation. The PI will build a holistic prototype simulation environment to demonstrate the efficacy of the proposed locality-optimal data access utility. The development of simulator infrastructure and a many-core prototype will allow the products of this research to be disseminated widely. This project will introduce practical multicore computing to graduate and undergraduate students with a focus on writing parallel software for performance and energy efficiency. The research outcomes will enable the design of future many-core processors that use low energy to execute parallel applications efficiently.

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# ****CAREER: Towards a Big Data Application Server Stack****

**Award Abstract #1351047**  
http://www.nsf.gov/awardsearch/images/common/x.gif **CAREER: Towards a Big Data Application Server Stack**  
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| **NSF Org:** | [**CNS**](http://www.nsf.gov/div/index.jsp?div=CNS) [**Division Of Computer and Network Systems**](http://www.nsf.gov/div/index.jsp?div=CNS) |
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| **Initial Amendment Date:** | February 3, 2014 |
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| **Latest Amendment Date:** | August 27, 2014 |
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| **Award Number:** | 1351047 |
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| **Award Instrument:** | Continuing grant |
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| **Program Manager:** | M. Mimi McClure CNS Division Of Computer and Network Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | February 1, 2014 |
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| **End Date:** | January 31, 2019 (Estimated) |
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| **Awarded Amount to Date:** | $279,558.00 |
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| **Investigator(s):** | Tyson Condie tconde@cs.ucla.edu (Principal Investigator) |
| divider line | |
| **Sponsor:** | University of California-Los Angeles 11000 Kinross Avenue, Suite 211 LOS ANGELES, CA 90095-2000 (310)794-0102 |
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| **NSF Program(s):** | CAREER: FACULTY EARLY CAR DEV, COMPUTER SYSTEMS |
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| **Program Reference Code(s):** | 1045 |
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| **Program Element Code(s):** | 1045, 7354 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Google's MapReduce inspired much of the Big Data Analytics work and has served as a template for open source systems like Apache Hadoop. The MapReduce programming model has wide applicability, but widespread adoption has exposed some limitations, such as the lack of support for iteration (which is common in machine learning algorithms), stream processing, graph analytics, real-time and interactive queries. Beyond the programming framework, the underlying implementation offers a template for how to scale-out massively distributed computations: break them up into small tasks that can be carried out in parallel by partitioning the underlying data, and save intermediate state to mitigate the impact of partial failures (which must be planned for when running on large clusters). The challenge then, is to build implementations of other programming frameworks (e.g., SQL and machine learning) that share the same scale-out and fault-tolerance runtime characteristics of MapReduce without imposing its limitations.   
  
Resource managers such as Apache Hadoop YARN, Google Omega and Berkeley Mesos take a first step in this direction by separating resource allocation from the details of higher-level programming models and languages. Resource managers multiplex several jobs on the same underlying machine cluster, thereby increasing utilization and fostering clean-slate software stacks. When the task executing in a container a slice of a single machine's resources (CPU/GPU, memory, disk) is finished, the container is returned to the resource manager, where it is made available to other jobs. Unlike in higher-level stacks, a container is a blank-slate process, designed to host arbitrary computations. This project prescribes further reusable software layers that capture issues like how many resources should I dedicate to a job?; what are the redundant code-pathways and can I provide them in a reusable library?; what are the right language and runtime abstractions? Exploring these questions in the context of systems like MapReduce and related SQL implementations, ML toolkits, storage systems, and messaging systems, on next generation resource managers, is the primary focus of our work.  
  
The goal is to unify a suite of large-scale data processing tasks on a single runtime layer, built on modern resource managers (the cloud operating systems). Our results will factor out commonalities in specialized systems and provide them in a single underlying runtime system, shortening the time to ?market? for the next ready-to-use Big Data toolkit, which in turn would increase the availability of such tools to the broader community. Experience gained by implementing and deploying applications at scale, over next generation resource managers, could help inform critical design choices in the development of future cloud computing platforms, and hence impact a broad range of scientific, engineering, national security, healthcare and business applications. The project offers enhanced opportunities for research-based advanced training of graduate and undergraduate students, including members of groups that are currently under-represented in computer science, in databases, machine learning, and cloud computing.

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# ****CSR: Small: Plug into the SuperCloud****

**Award Abstract #1422544**  
http://www.nsf.gov/awardsearch/images/common/x.gif **CSR: Small: Plug into the SuperCloud**  
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| **NSF Org:** | [**CNS**](http://www.nsf.gov/div/index.jsp?div=CNS) [**Division Of Computer and Network Systems**](http://www.nsf.gov/div/index.jsp?div=CNS) |
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| **Initial Amendment Date:** | July 30, 2014 |
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| **Latest Amendment Date:** | July 30, 2014 |
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| **Award Number:** | 1422544 |
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| **Award Instrument:** | Continuing grant |
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| **Program Manager:** | M. Mimi McClure CNS Division Of Computer and Network Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | August 1, 2014 |
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| **End Date:** | July 31, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $152,448.00 |
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| **Investigator(s):** | Hakim Weatherspoon hweather@cs.cornell.edu (Principal Investigator) Robbert VanRenesse (Co-Principal Investigator) |
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| **Sponsor:** | Cornell University 373 Pine Tree Road Ithaca, NY 14850-2820 (607)255-5014 |
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| **NSF Program(s):** | COMPUTER SYSTEMS |
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| **Program Reference Code(s):** | 7923 |
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| **Program Element Code(s):** | 7354 |

**ABSTRACT**  
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The goal of this project is enable the creation of secure compute clouds (Superclouds) without requiring ownership of the underlying infrastructure. This will allow organizations and individuals to migrate to a cloud computing environment while retaining control over placement and scheduling. Superclouds make cloud computing and storage a commodity by freeing users from single providers.  
  
The research described in this proposal aims to create a Supercloud by utilizing nested virtualization, in which a virtual machine, as well as the network and storage it relies on, can be migrated between multiple underlying and heterogeneous cloud infrastructures without its user being aware of the provider's hardware, hypervisor, or networks and without any standardization of protocols between cloud providers. The project has three components: 1) Optimize and generalize support of a Supercloud via nested virtualization; 2) Develop a Supercloud manager; 3) Enhance the Supercloud with network and storage abstractions that allow applications to run across multiple clouds.  
  
Superclouds address many of the shortcomings of current cloud offerings. Users will no longer be tied to a particular provider; they can move their resources between providers and can even build applications that span multiple providers for increased performance and robustness. An open-source Supercloud will also allow students to experiment with their own cloud management algorithms, or instrument the Supercloud for study. Indeed, the proposal includes plans to incorporate this into a summer workshop that the proposers have been running in cooperation with a historically black university (Howard) and also into Cornell's cloud course offerings.

Please report errors in award information by writing to: [awardsearch@nsf.gov](mailto:awardsearch@nsf.gov).

# ****CAREER: DrCloud: Drill-Ready Cloud Computing****

**Award Abstract #1350499**  
http://www.nsf.gov/awardsearch/images/common/x.gif **CAREER: DrCloud: Drill-Ready Cloud Computing**  
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| **NSF Org:** | [**CNS**](http://www.nsf.gov/div/index.jsp?div=CNS) [**Division Of Computer and Network Systems**](http://www.nsf.gov/div/index.jsp?div=CNS) |
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| **Initial Amendment Date:** | December 11, 2013 |
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| **Latest Amendment Date:** | August 26, 2014 |
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| **Award Number:** | 1350499 |
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| **Award Instrument:** | Continuing grant |
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| **Program Manager:** | M. Mimi McClure CNS Division Of Computer and Network Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | May 1, 2014 |
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| **End Date:** | April 30, 2019 (Estimated) |
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| **Awarded Amount to Date:** | $196,385.00 |
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| **Investigator(s):** | Haryadi Gunawi haryadi@cs.uchicago.edu (Principal Investigator) |
| divider line | |
| **Sponsor:** | University of Chicago 5801 South Ellis Avenue Chicago, IL 60637-5418 (773)702-8669 |
| divider line | |
| **NSF Program(s):** | COMPUTER SYSTEMS |
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| **Program Reference Code(s):** | 1045 |
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| **Program Element Code(s):** | 7354 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Cloud computing is pervasive, but cloud service outages still take place. This proposal addresses how to ensure that failure recovery will work robustly in many deployment scenarios. To address this important question, this project proposes drill-ready cloud computing (DrCloud), a new dependability paradigm that advocates cloud systems to routinely perform "failure drills" in real deployments (i.e., deliberately schedule real failures rather than waiting for unexpected real failures to happen). This practice can unearth in-production recovery issues and prevent real outages.   
  
This project will create five building blocks of drill-ready cloud computing: methodology, safety, efficiency, usability, and generality. Specifically, these five sub-projects will substantiate a new research methodology via a formal study of hundreds of in-production recovery issues, devise mechanisms that guarantee safety (no data loss and performance disruptions) analogous to a proper fire drill preparation, develop techniques that maximize resource and monetary efficiency of drill execution, design a specification language and its runtime that simplifies drill usability, and finally boost drill generality beyond failure drills (e.g., supporting software upgrade and configuration change drills).   
  
The DrCloud project will enrich decades of research and literature in fault-tolerant computing. The project will also bring many direct benefits to the society; users from many areas increasingly use large-scale storage and computation services, depending on high availability and predictability that drill-ready cloud computing will facilitate. The project will also involve state-of-the-art scale-out cloud systems (Hadoop, Cassandra, HBase, etc.). Adding drill-readiness to these systems will provide prototypes of next-generation reliable systems.

Please report errors in award information by writing to: [awardsearch@nsf.gov](mailto:awardsearch@nsf.gov).

# ****RAPID: Robot-assisted Doffing of Personal Protective Equipment****

**Award Abstract #1514649**  
http://www.nsf.gov/awardsearch/images/common/x.gif **RAPID: Robot-assisted Doffing of Personal Protective Equipment**  
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| **NSF Org:** | [**IIS**](http://www.nsf.gov/div/index.jsp?div=IIS) [**Div Of Information & Intelligent Systems**](http://www.nsf.gov/div/index.jsp?div=IIS) |
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| **Initial Amendment Date:** | December 2, 2014 |
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| **Latest Amendment Date:** | December 2, 2014 |
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| **Award Number:** | 1514649 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Jeffrey Trinkle IIS Div Of Information & Intelligent Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | December 1, 2014 |
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| **End Date:** | November 30, 2015 (Estimated) |
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| **Awarded Amount to Date:** | $75,243.00 |
| divider line | |
| **Investigator(s):** | Dmitry Berenson dberenson@cs.wpi.edu (Principal Investigator) Taskin Padir (Co-Principal Investigator) |
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| **Sponsor:** | Worcester Polytechnic Institute 100 INSTITUTE RD WORCESTER, MA 01609-2247 (508)831-5000 |
| divider line | |
| **NSF Program(s):** | National Robotics Initiative, INFORMATION TECHNOLOGY RESEARC |
| divider line | |
| **Program Reference Code(s):** | 001Z, 7914, 8013, 1640 |
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| **Program Element Code(s):** | 8013, 1640 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
The goal of this Rapid Response Research is to create a human-robot system that will assist in the ``doffing'' (i.e., removal) of Personal Protective Equipment (PPE) worn by health-care workers treating Ebola. Because the PPE has multiple layers of clothing and involves numerous steps, and because doffing must be repeated often under stressful conditions, the process poses a significant risk of infection for health-care workers.   
  
This proposal seeks to use a robot to minimize the amount of contact between the worker's hands (covered with gloves) and the PPE, as this contact may enlarge the areas of the PPE that are contaminated and thus increase the risk of infecting the worker. To accomplish this goal, the PI and co-PI seek to develop manipulation strategies and primitives that will allow the robot to assist in the doffing process by using its hands as hooks, braces, and clamps so that the health-care worker uses their hands as little as possible during the doffing process. The work will be performed in close consultation with medical professionals to ensure that the developed procedures are both safe and provide an advantage over the manual doffing process.

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# ****EAGER: Quality of Configuration in Large Scale Data Centers****

**Award Abstract #1407876**  
http://www.nsf.gov/awardsearch/images/common/x.gif **EAGER: Quality of Configuration in Large Scale Data Centers**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CCF**](http://www.nsf.gov/div/index.jsp?div=CCF) [**Div Of Computer & Communication Foundati**](http://www.nsf.gov/div/index.jsp?div=CCF) |
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| **Initial Amendment Date:** | April 28, 2014 |
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| **Latest Amendment Date:** | April 28, 2014 |
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| **Award Number:** | 1407876 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Hong Jiang CCF Div Of Computer & Communication Foundati CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | May 1, 2014 |
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| **End Date:** | April 30, 2016 (Estimated) |
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| **Awarded Amount to Date:** | $299,353.00 |
| divider line | |
| **Investigator(s):** | Krishna Kant kkant@temple.edu (Principal Investigator) |
| divider line | |
| **Sponsor:** | Temple University 3340 N. Broad Street PHILADELPHIA, PA 19140-5104 (215)707-7379 |
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| **NSF Program(s):** | COMPUTER SYSTEMS |
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| **Program Reference Code(s):** | 7916 |
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| **Program Element Code(s):** | 7354 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
The management of the emerging data centers involves substantial complexity due to numerous resources that must be properly configured at all levels from individual devices to entire systems and services. The complexity of configuration management leads to numerous opportunities for misconfigurations and attacks. It has been estimated that misconfigurations are responsible for 62% of downtime and 65% of security exploits in current computer systems. These, already high percentages, are expected to continue increasing due to current trends of extensive virtualization, architectural heterogeneity, and increasing size.   
  
This project attempts to devise quality metrics to characterize the vulnerability of the given configuration to bad parameter values (set accidentally or by a malicious entity). The quality metrics are also expected to provide guidance for evaluating alternatives to proposed or required configuration changes. The main challenge in characterizing configuration quality is that in practice specifications of correct configuration are not available and the viability of the configuration must be determined by analyzing the application behavior. The key issue to consider in devising the quality metrics relates to the configuration management structure and the direct/indirect dependencies that it implies. The project will examine methods ranging from discovering the configuration structure to flow analysis of the source code along with methods to correlate the discovered information. In many cases, the dependencies are not definitive and hence the quality metrics need to consider fuzzy values and their composition. The project will evaluate the usefulness of the metrics in the context of current open-source software such as Apache web server.  
  
Reducing misconfigurations and detecting them quickly is expected to have a substantial impact on computing systems with respect to their availability, functional correctness, usability, and resistance against hacker attacks. The metrics explored in this project are expected to provide important insights into improving the configuration of systems at various stages including design, deployment, and dynamic reconfiguration.

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# ****NRI: Co-Robots for COMPUGIRLS - Culturally Responsive Robotics Education for Underrepresented Girls****

**Award Abstract #1427399**  
http://www.nsf.gov/awardsearch/images/common/x.gif **NRI: Co-Robots for COMPUGIRLS - Culturally Responsive Robotics Education for Underrepresented Girls**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**IIS**](http://www.nsf.gov/div/index.jsp?div=IIS) [**Div Of Information & Intelligent Systems**](http://www.nsf.gov/div/index.jsp?div=IIS) |
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| **Initial Amendment Date:** | August 20, 2014 |
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| **Latest Amendment Date:** | August 20, 2014 |
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| **Award Number:** | 1427399 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | John Krupczak IIS Div Of Information & Intelligent Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | September 1, 2014 |
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| **End Date:** | February 29, 2016 (Estimated) |
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| **Awarded Amount to Date:** | $500,000.00 |
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| **Investigator(s):** | Andrew Williams andrew.williams@marquette.edu (Principal Investigator) Kimberly Scott (Co-Principal Investigator) |
| divider line | |
| **Sponsor:** | Marquette University P.O. Box 1881 Milwaukee, WI 53201-1881 (414)288-7200 |
| divider line | |
| **NSF Program(s):** | National Robotics Initiative |
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| **Program Reference Code(s):** | 8086 |
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| **Program Element Code(s):** | 8013 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Robotics in the U.S. represents a multi-billion industry that is growing yearly. Currently a gap exists in the degree to which underrepresented populations participate in the fields of science, technology, engineering and mathematics. The gap is especially severe in the area of robotics. This project lead by Marquette University is developing a culturally-relevant curricula to teach girls to program co-robots or humanoid robots that work in collaboration with people. The focus of the co-robots for COMPUGIRLS program is to expose girls from under-resourced areas to co-robotics using effective, culturally-relevant curricula and instructional approaches. This robotics education program is designed to expand the already extant NSF-funded informal education program, COMPUGIRLS, through supplementing this program?s curriculum with humanoid co-robotic activities. Project activities will be facilitated with the support of engineering majors from Arizona State University serving as near peer mentors. Collaborations between high school students and undergraduates are expected to increase girls' interest in robotics-related careers, and will yield co-robot projects with features that allow the co-robots to interface with girls and members in their communities.  
  
The co-robots for COMPUGIRLS program offers an approach with a high potential to engage girls in the emerging field of co-robotics. The functioning of co-robots involves collaboration and interaction with people. Applications are expected to grow in significance in the future in such diverse areas as healthcare, agriculture, education, and advanced manufacturing. However, most current K-12 robotics activities are focused on task-based robot-to-robot competitions and electro-mechanical robots. These existing robotics programs face challenges in including girls, particularly those from underrepresented populations. The objectives of this project are to develop and study a culturally-responsive co-robotics curriculum in the context of COMPUGIRLS and involve girls in effective humanoid robotics programming. The approach taken is based on earlier COMPUGIRLS research results. The elements of cultural responsiveness consists of engaging girls at the interface of social and technical asset building in ways that require them to reflect on their intersectional identities both technical and social. Developing girls as technosocial change agents with skills in using technology to improve communities was found to be an important element in engaging girls in technological endeavors. This project will employ a mixed methods research design to determine the impact of engaging underrepresented girls in culturally responsive humanoid robotics using culturally relevant instruction and interactions. The research will advance the discipline of co-robotics by considering cultural aspects currently underexplored in robotics education.

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# ****SHF: Medium: Compute on Data Path: Combating Data Movement in High Performance Computing****

**Award Abstract #1409946**  
http://www.nsf.gov/awardsearch/images/common/x.gif **SHF: Medium: Compute on Data Path: Combating Data Movement in High Performance Computing**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CCF**](http://www.nsf.gov/div/index.jsp?div=CCF) [**Div Of Computer & Communication Foundati**](http://www.nsf.gov/div/index.jsp?div=CCF) |
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| **Initial Amendment Date:** | May 21, 2014 |
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| **Latest Amendment Date:** | May 21, 2014 |
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| **Award Number:** | 1409946 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Almadena Y. Chtchelkanova CCF Div Of Computer & Communication Foundati CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | June 1, 2014 |
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| **End Date:** | May 31, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $1,000,000.00 |
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| **Investigator(s):** | Yong Chen yong.chen@ttu.edu (Principal Investigator) Dries Kimpe (Co-Principal Investigator) Yonghong Yan (Co-Principal Investigator) Barbara Chapman (Co-Principal Investigator) |
| divider line | |
| **Sponsor:** | Texas Tech University 349 Administration Bldg Lubbock, TX 79409-1035 (806)742-3884 |
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| **NSF Program(s):** | SOFTWARE & HARDWARE FOUNDATION |
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| **Program Reference Code(s):** | 7924, 7942 |
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| **Program Element Code(s):** | 7798 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
High performance computing enabled simulation has been widely considered a third pillar of science along with theory and experimentation, and is a strategic tool in many aspects of scientific discovery and innovation. High performance computing simulations, however, have become highly data intensive in recent years due to data acquisition and generation becoming much cheaper, newer high-resolution multi-model scientific discovery producing and requiring more data, and the insight that useful data can be mined out of large amounts of data being substantially increased.   
  
This project combats the increasingly critical data movement challenge in high performance computing. This project studies the feasibility of a new Compute on Data Path methodology that expects to improve the performance and energy efficiency for high performance computing. This new methodology models both computations and data as objects with a data model that encapsulates and binds them. It fuses data motion and computation leveraging programming model and compiler. It develops an object-based store and runtime to enable computations along data path pipeline. In recent years, a proliferation of advanced high performance computing architectures including multi- and many-core systems, co-processors and accelerators, and heterogeneous computing platforms have been observed. The software solution that addresses the critical data movement challenge, however, has significantly lagged behind. This project has the potential of advancing the understandings and the software solution and further unleashing the power of high performance computing enabled simulation.

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# ****EAGER: Collaborative Research: Conflict Resolution and Exchange of Temporal Data****

**Award Abstract #1450560**  
http://www.nsf.gov/awardsearch/images/common/x.gif **EAGER: Collaborative Research: Conflict Resolution and Exchange of Temporal Data**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**IIS**](http://www.nsf.gov/div/index.jsp?div=IIS) [**Div Of Information & Intelligent Systems**](http://www.nsf.gov/div/index.jsp?div=IIS) |
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| **Initial Amendment Date:** | August 25, 2014 |
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| **Latest Amendment Date:** | August 25, 2014 |
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| **Award Number:** | 1450560 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Frank Olken IIS Div Of Information & Intelligent Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | September 1, 2014 |
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| **End Date:** | August 31, 2015 (Estimated) |
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| **Awarded Amount to Date:** | $100,000.00 |
| divider line | |
| **Investigator(s):** | Wang-Chiew Tan tan@cs.ucsc.edu (Principal Investigator) |
| divider line | |
| **Sponsor:** | University of California-Santa Cruz 1156 High Street Santa Cruz, CA 95064-1077 (831)459-5278 |
| divider line | |
| **NSF Program(s):** | INFO INTEGRATION & INFORMATICS |
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| **Program Reference Code(s):** | 7364, 7916 |
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| **Program Element Code(s):** | 7364 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
An increasing number of applications, such as fraud detection and personal electronic health records, all rely on the availability of an integrated, consistent, and query-able view of entities over time. Such a view, implemented as an integrated archive, consolidates temporal information from different data sources and creates significant added value by making explicit the times when facts about the entities are true. The task of creating an integrated archive remains non-trivial even with the state-of-the-art data integration techniques. This is a high-risk research project that targets challenging problems in the nexus of several research areas: data exchange, temporal databases, conflict resolution and data inconsistency. This project has the potential to make significant societal impact through the development of a foundational framework that facilitates the process of consolidating temporal data from different heterogeneous temporal data sources. It is anticipated that the availability of such a platform will lead to new classes of applications, particularly those involving profiling, tracking, monitoring, and understanding of the evolution of entities over time. This project will involve the research and training of graduate and undergraduate students in science and engineering, including members of groups underrepresented in computer science, in pertinent areas of data integration. Results obtained from this investigation will be incorporated into advanced graduate data management courses on large-scale data integration that will be developed and taught at both SUNY at Buffalo and UC Santa Cruz. Selected material from the outcomes of this project will also be incorporated into upper-division undergraduate database courses taught at both universities.   
  
This proposal will develop formal foundations and principled solutions to the problems of exchanging temporal data (i.e., transformations of temporal data from one format into another) and resolving conflicts of temporal data. The unique challenge in managing temporal data that underlies all aspects of this proposal is the management of the discrepancy between the abstract declarative view of temporal data and its corresponding concrete implementation view. The general approach adopted by this proposal will be two-tiered: data exchange and conflict resolution over temporal data are declaratively specified using the declarative point-based view, while computational tasks required to exchange data and resolve conflicts manipulate the underlying time intervals. Results from this investigation will also lay the groundwork for longer-term research such as answering queries over inconsistent temporal databases. For further information see the project web site at http://greenwich.cs.ucsc.edu or   
  
http://www.cse.buffalo.edu/~chomicki/.

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# ****High Performance Computing System Acquisition: Jetstream - A Self-Provisioned, Scalable Science and Engineering Cloud Environment****

**Award Abstract #1445604**  
http://www.nsf.gov/awardsearch/images/common/x.gif **High Performance Computing System Acquisition: Jetstream - A Self-Provisioned, Scalable Science and Engineering Cloud Environment**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**ACI**](http://www.nsf.gov/div/index.jsp?div=ACI) [**Div Of Advanced Cyberinfrastructure**](http://www.nsf.gov/div/index.jsp?div=ACI) |
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| **Initial Amendment Date:** | November 20, 2014 |
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| **Latest Amendment Date:** | November 20, 2014 |
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| **Award Number:** | 1445604 |
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| **Award Instrument:** | Cooperative Agreement |
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| **Program Manager:** | Robert Chadduck ACI Div Of Advanced Cyberinfrastructure CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | December 1, 2014 |
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| **End Date:** | November 30, 2019 (Estimated) |
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| **Awarded Amount to Date:** | $6,576,101.00 |
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| **Investigator(s):** | Craig Stewart stewart@iu.edu (Principal Investigator) Nirav Merchant (Co-Principal Investigator) Ian Foster (Co-Principal Investigator) James Taylor (Co-Principal Investigator) Matthew Vaughn (Co-Principal Investigator) |
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| **Sponsor:** | Indiana University 509 E 3RD ST Bloomington, IN 47401-3654 (812)855-0516 |
| divider line | |
| **NSF Program(s):** | EQUIPMENT ACQUISITIONS, DATANET |
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| **Program Reference Code(s):** | 7433 |
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| **Program Element Code(s):** | 7619, 7726 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
High Performance Computing System Acquisition: Jetstream - a self-provisioned, scalable science and engineering cloud environment  
Jetstream will be a new type of computational research resource open for the national (nonclassified) research community - a data analysis and computational resource that US scientists and engineers will use interactively to conduct their research anytime, anywhere. Jetstream will complement current NSF-funded computational resources and bring a cloud-based system to the NSF computational resources incorporating the best elements of commercial cloud computing resources with some of the best software in existence for solving important scientific problems. This system will enable many US researchers and engineers to make new discoveries that are important to understanding the world around us and will help researchers make new discoveries that improve the quality of life of American citizens.  
In terms of technical details, Jetstream will be a configurable large-scale computing resource that leverages both on-demand and persistent virtual machine technology to support a much wider array of software environments and services than current NSF resources can accommodate. As a fully configurable "cloud" resource, Jetstream bridges the obvious major gap in the current ecosystem, which has machines targeted at large-scale High-Performance Computing, high memory, large data, high-throughput, and visualization resources. As the open cloud for science, Jetstream will:  
\*Provide "self-serve" academic cloud services, enabling researchers or students to select a VM image from a published library, or alternatively to create or customize their own virtual environment for discipline- or task-specific personalized research computing.  
\*Host persistent VMs to provide services beyond the command line interface for science gateways and other science services. For example, Jetstream will become a primary host of the popular Galaxy scientific workbench and its main datasets, bringing many Galaxy users to the NSF ecosystem from day one.  
\*Enable new modes of sharing computations, data, and reproducibility.  
\*Expand access to the NSF XSEDE ecosystem by making virtual desktop services accessible from institutions with limited resources

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# ****EAGER: Spectrum Situational Awareness-Understanding the Data****

**Award Abstract #1454835**  
http://www.nsf.gov/awardsearch/images/common/x.gif **EAGER: Spectrum Situational Awareness-Understanding the Data**  
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| **NSF Org:** | [**CNS**](http://www.nsf.gov/div/index.jsp?div=CNS) [**Division Of Computer and Network Systems**](http://www.nsf.gov/div/index.jsp?div=CNS) |
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| **Initial Amendment Date:** | August 26, 2014 |
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| **Latest Amendment Date:** | August 26, 2014 |
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| **Award Number:** | 1454835 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Wenjing Lou CNS Division Of Computer and Network Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | October 1, 2014 |
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| **End Date:** | September 30, 2016 (Estimated) |
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| **Awarded Amount to Date:** | $180,832.00 |
| divider line | |
| **Investigator(s):** | Dmitri Perkins perkins@cacs.louisiana.edu (Principal Investigator) |
| divider line | |
| **Sponsor:** | University of Louisiana at Lafayette 104 University Circle Lafayette, LA 70503-2701 (337)482-6203 |
| divider line | |
| **NSF Program(s):** | RES IN NETWORKING TECH & SYS |
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| **Program Reference Code(s):** | 7916, 9150 |
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| **Program Element Code(s):** | 7363 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
The key resource shared by all wireless systems is the electromagnetic spectrum, which is challenged by temporal and spatial congestion, interference, and increasing security threats. This project investigates the hypothesis that building a resilient always-on wireless network, capable of meeting ever-increasing performance and security requirements, necessitates not only innovations in radio design but also innovations in the management and exploitation of vast amounts of radio spectrum knowledge. Such knowledge is referred to as spectrum situational awareness - the amount of actionable intelligence and understanding that a wireless network (or individual radio) has about its RF spectrum environment. This research work formally studies the nature of big spectrum data and investigates several critical issues, e.g., how should data from heterogeneous sources be prioritized or weighted, and what are the effects of inaccurate or sparse data measurements.  
  
The scientific goals of this project are to provide foundational principles and insights for developing innovative and scalable spectrum situational awareness architectures, and to enable more efficient and effective uses of the data as well as the improved protocol and system designs. Using formal statistical methods (e.g., regression analysis and response surface methodology) and new big data analytics tools, the research team fully characterizes big spectrum data, its potential impact on spectrum utilization and system performance, and its interaction with the plethora of influential radio, network, and environmental factors. The empirical work is based on experimental scenarios that reflect realistic networking environments, comprising multiple wireless access technologies, interconnected high-speed backhaul networks, and distributed cloud-based technologies. Two testbed instruments are used to design and execute large-scale simulation and emulation experiments: the Distributed Computing and Visual Analytics Sandbox for High Volume Data Streams combined with the Wireless Systems and Performance Engineering Research (WiSPER) laboratory. Additionally, the research team develops a multilayer spectrum situational awareness framework and is deriving performance indices that can be used to quickly quantify and compare the spectrum situational awareness capabilities of network systems. The project engages students from underrepresented groups via ongoing partnerships with Historically Black Colleges and Universities.

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# ****NeTS: Small: Collaborative Research: Dynamic Forwarding and Caching for Data-Centric Networks: Theory and Algorithms****

**Award Abstract #1423240**  
http://www.nsf.gov/awardsearch/images/common/x.gif **NeTS: Small: Collaborative Research: Dynamic Forwarding and Caching for Data-Centric Networks: Theory and Algorithms**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CNS**](http://www.nsf.gov/div/index.jsp?div=CNS) [**Division Of Computer and Network Systems**](http://www.nsf.gov/div/index.jsp?div=CNS) |
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| **Initial Amendment Date:** | August 27, 2014 |
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| **Latest Amendment Date:** | November 6, 2014 |
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| **Award Number:** | 1423240 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Darleen L. Fisher CNS Division Of Computer and Network Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | October 1, 2014 |
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| **End Date:** | September 30, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $250,000.00 |
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| **Investigator(s):** | John Doyle (Principal Investigator) Tracey Ho (Former Principal Investigator) |
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| **Sponsor:** | California Institute of Technology 1200 E California Blvd PASADENA, CA 91125-0600 (626)395-6219 |
| divider line | |
| **NSF Program(s):** | RES IN NETWORKING TECH & SYS |
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| **Program Reference Code(s):** | 7923 |
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| **Program Element Code(s):** | 7363 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Two fundamental trends in networking are clearly visible. First, the bulk of network traffic today, and of its projected enormous growth, consists mainly of content disseminated to multiple users. Second, network content is accessed increasingly in mobile wireless environments with dynamic and unreliable channel conditions. Traditional network protocols, designed originally for point-to-point communication over static wired networks, are fundamentally ill suited for such scenarios. Motivated by these trends, this project will develop dynamic and distributed algorithms which can fully exploit network resources (both bandwidth and storage) for efficient and robust content dissemination under changing network conditions.  
  
This project builds on recent active research efforts in data-centric networking, which places information content, rather than source-destination pairs, at the center of the network architecture. While there have been a number of significant results in data-centric networking research, the central problem of the joint design and optimization of dynamic caching and forwarding algorithms has yet to be thoroughly studied. This project will study the fundamental limits of caching and forwarding, as well as the design of practical and robust algorithms for optimizing the use of bandwidth and storage in data-centric content delivery. Unlike many existing works on centralized algorithms for static caching, this project will develop scalable, distributed, dynamic algorithms that can address large-scale caching and forwarding under changing content, user demands and network conditions.  
  
To achieve this goal, the project will take two complementary approaches. The first approach is based on a stochastic model for distributed caching and forwarding recently developed by the PIs. This approach significantly expands on classical backpressure-based routing techniques to incorporate caching within a unified framework, leading to new algorithms which maximize user demand rate satisfied by the network. The second approach is based on a flow-based distributed convex optimization framework, in which content-specific routing and caching are carried out on a distributed node-by-node basis to minimize a global cost objective such as delay.  
  
This project addresses both practical and theoretical issues, and consists of the following main thrusts: (1) the design of jointly optimal forwarding and caching algorithms for minimizing delay; (2) the design of scalable, robust, hierarchical dynamic caching and forwarding algorithms which operate with dynamically adjusted name resolutions; (3) the development of algorithms which combine dynamic caching and forwarding with congestion control for fairness and enhanced performance; (4) the exploration of coding techniques in storage and transmission for obtaining practical advantages in performance and reliability, as well as for enabling the study of fundamental performance limits in caching and forwarding; (5) the development of low-complexity, dynamic forwarding and caching algorithms delivering lower user delay and greater resilience to multi-user interference and channel fading in mobile wireless environments; and (6) development of algorithms for querying and caching which lead to optimal decision making in a sensing context.  
  
The broader significance of this work will include: (1) direct and long-term impact on network architectures for big data applications used in national security, commercial enterprise, scientific exploration and research, health services, and other important social projects; (2) impact on undergraduate and graduate education, with particular emphasis on involving female and minority students, through a planned course segment on 'theory and algorithms for data-centric networking' and active hands-on projects involving testbed investigation and validation; (3) enhancement of infrastructure for research and education through active partnering with other university departments, government research institutions and industry; and (4) broad dissemination to enhance scientific and technological understanding by participation in multi-disciplinary conferences and workshops, and exposure to broader media.

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# ****MRI: Acquisition of Instrument for Data-intensive Applications with Hybrid Cloud Computing Needs****

**Award Abstract #1429294**  
http://www.nsf.gov/awardsearch/images/common/x.gif **MRI: Acquisition of Instrument for Data-intensive Applications with Hybrid Cloud Computing Needs**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CNS**](http://www.nsf.gov/div/index.jsp?div=CNS) [**Division Of Computer and Network Systems**](http://www.nsf.gov/div/index.jsp?div=CNS) |
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| **Initial Amendment Date:** | August 20, 2014 |
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| **Latest Amendment Date:** | August 20, 2014 |
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| **Award Number:** | 1429294 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Rita V. Rodriguez CNS Division Of Computer and Network Systems CSE Direct For Computer & Info Scie & Enginr |
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| **Start Date:** | September 1, 2014 |
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| **End Date:** | August 31, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $600,408.00 |
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| **Investigator(s):** | Chi-Ren Shyu shyuc@missouri.edu (Principal Investigator) Prasad Calyam (Co-Principal Investigator) Dong Xu (Co-Principal Investigator) Gordon Springer (Co-Principal Investigator) Michela Becchi (Co-Principal Investigator) |
| divider line | |
| **Sponsor:** | University of Missouri-Columbia 310 JESSE HALL COLUMBIA, MO 65211-1230 (573)882-7560 |
| divider line | |
| **NSF Program(s):** | MAJOR RESEARCH INSTRUMENTATION |
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| **Program Reference Code(s):** | 1189 |
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| **Program Element Code(s):** | 1189 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
This project aims to acquire a supercomputer cluster that will in turn enable data-intensive research in many diverse fields such as bioscience, geoscience, imaging, and vision. Specifically, the acquisition responds to the need to transform campuses' supercomputer resource provisioning practices with federated, hybrid cloud services that can seamlessly orchestrate the provisioning of local and remote resources (e.g., cyber-enabled scientific instruments, public clouds) to meet data-intensive research and education needs of users. The project focuses on application workflows considering connectivity and communications necessary for interdisciplinary research and education collaborations.   
The supercomputer cluster augments existing facilities (e.g., Science DMZ 'network instrument' connected to the Internet2 Innovation platform, Transmission Electron Microscope, Federated-IAM 'entitlement service') and the core on-campus supercomputer resources. The project leverages advanced tools for central processing units and graphics processing units (CPU/GPU) as well as network visualization from existing funded projects for configuration of experiments with the instrument to develop 'custom templates' for diverse data intensive web-based applications. These custom templates will abstract the high-level policy and performance throughput requirements of data-intensive applications and 'personalize' them to lower-level control specifications implementable in an on-demand manner by virtualization technologies such as OpenStack and OpenFlow. Furthermore, the investigators will assess how the next-generation supercomputing user service models with custom templates can be composed to allow campus IT staff to sustainably and seamlessly support hybrid cloud use cases in research and education. Specifically, the instrument services  
- Hybrid Cloud Computing,  
- Bioinformatics and computational biology,   
- Multi-modal data analytics, and   
- Next generation HPC user services.  
The instrumentation supports 16 researchers and their external collaborators in diverse data-intensive science fields such as bioscience, geoscience, imaging, and vision. It also supports the delivery of high-performance computing and Big Data analytics courses to more than 500 students at this institution and those around it. Participation of underrepresented and underserved groups will be accomplished utilizing the current NSF REU site as well as the institution's EPSCoR activities. Best practices to streamline the engineering/operations of hybrid clouds for data intensive applications, technologies/tools, policies and service models will all be disseminated. The instrument supports undergraduate and graduate courses and various other education and training activities, including REU programs. The proposed projects advances computational science research, research training, and curriculum development.

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# ****EAGER: Toward Supervised Autonomy for Robotic Systems****

**Award Abstract #1449505**  
http://www.nsf.gov/awardsearch/images/common/x.gif **EAGER: Toward Supervised Autonomy for Robotic Systems**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**IIS**](http://www.nsf.gov/div/index.jsp?div=IIS) [**Division of Information & Intelligent Systems**](http://www.nsf.gov/div/index.jsp?div=IIS) |
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| **Initial Amendment Date:** | August 13, 2014 |
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| **Latest Amendment Date:** | August 13, 2014 |
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| **Award Number:** | 1449505 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Gregory Chirikjian IIS Division of Information & Intelligent Systems CSE Directorate for Computer & Information Science & Engineering |
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| **Start Date:** | August 15, 2014 |
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| **End Date:** | July 31, 2016 (Estimated) |
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| **Awarded Amount to Date:** | $149,995.00 |
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| **Investigator(s):** | Erion Plaku plaku@cua.edu (Principal Investigator) |
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| **Sponsor:** | Catholic University of America 620 Michigan Ave.N.E. Washington, DC 20064-0000 (202)635-5000 |
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| **NSF Program(s):** | ROBUST INTELLIGENCE |
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| **Program Reference Code(s):** | 7495, 7916 |
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| **Program Element Code(s):** | 7495 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
This project seeks to make the supervision of robotic systems operating in complex domains similar to that of humans so as to increase productivity and capabilities. The software framework resulting from this project frees supervisors from the burden of unnatural low-level commands and instead allows them to describe tasks in a structured language that has the ability to express global and local objectives across time spans. The framework then automatically computes the necessary motions to enable the robotic system accomplish the assigned tasks. This necessitates a comprehensive treatment of planning to account for sophisticated tasks, robot dynamics, collision avoidance, robust replanning, and interactions with human supervisors. To addresses such complexity, the framework employs a novel probabilistic search with discrete abstractions and enhanced sampling capability to focus the search on the space of feasible motions that enable the robotic system to make progress toward accomplishing the assigned task. The framework also provides critical feedback information about the progress made to help supervisors adapt the specifications in response to challenges encountered during planning and execution. This project is expected to establish a new paradigm for supervised autonomy and impact the development of research and commercial software for robotic systems. Doing so has the potential to enhance applications of robotic systems such as underwater vehicles in surveying marine wildlife, inspecting harbors and offshore platforms.

Please report errors in award information by writing to: [awardsearch@nsf.gov](mailto:awardsearch@nsf.gov).

# ****CSR: Small: Collaborative Research: Dependable Real-Time Computing on Heterogeneous Chip Multiprocessor Systems****

**Award Abstract #1421855**  
http://www.nsf.gov/awardsearch/images/common/x.gif **CSR: Small: Collaborative Research: Dependable Real-Time Computing on Heterogeneous Chip Multiprocessor Systems**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CNS**](http://www.nsf.gov/div/index.jsp?div=CNS) [**Division of Computer and Network Systems**](http://www.nsf.gov/div/index.jsp?div=CNS) |
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| **Initial Amendment Date:** | August 5, 2014 |
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| **Latest Amendment Date:** | August 5, 2014 |
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| **Award Number:** | 1421855 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | M. Mimi McClure CNS Division of Computer and Network Systems CSE Directorate for Computer & Information Science & Engineering |
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| **Start Date:** | August 15, 2014 |
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| **End Date:** | July 31, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $269,966.00 |
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| **Investigator(s):** | Hakan Aydin aydin@cs.gmu.edu (Principal Investigator) |
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| **Sponsor:** | George Mason University 4400 UNIVERSITY DR FAIRFAX, VA 22030-4422 (703)993-2295 |
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| **NSF Program(s):** | COMPUTER SYSTEMS |
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| **Program Reference Code(s):** | 7923 |
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| **Program Element Code(s):** | 7354 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Chip multiprocessor (CMP) systems, which provide multiple processors on a single chip, also known as multicore systems, have displaced single-processor architectures as the de facto standard model for computing platforms. This change is due to the fact that the CMPs offer superior performance and power efficiency, compared to the traditional designs. An emerging feature of the CMP era is the deployment of several different types of processing elements on the same platform, with varying computation speed and power consumption characteristics. An additional complicating factor is that a trend toward overprovisioned designs, where only a subset of the available cores can be active at any time, due to power and thermal constraints. Such heterogeneous CMPs are increasingly being deployed in systems where applications with different safety assurance (dependability) and timeliness requirements must co-exist on the same CMP. Hence, there is a growing need for an integrated framework to allocate heterogeneous hardware resources of a CMP among applications in a way that makes efficient use of the resources while assuring that the diverse safety and timeliness requirements of the applications are met.  
  
This project aims to develop models, algorithms, and run-time management schemes for collections of applications with a mix of different timing and dependability requirements running on a shared heterogeneous CMP platform. In particular, a central objective is to develop a sound methodology to selectively apply known hardware and software fault tolerance mechanisms (such as modular redundancy, task replication, re-execution) to such mixed-dependability applications, by considering resource, power, and timing constraints simultaneously. A second objective is to extend the framework to tackle the challenge of intermittent run-time faults that occur in bursts and can affect multiple applications at once during a bounded time window. Success in these efforts could improve the safety and reduce the development and production costs of the increasingly complex cyber-physical systems upon which we all have come to depend.   
  
Education and outreach activities include integration of aspects of the research into undergraduate and graduate courses at the two participating institutions, involvement of students as research assistants, and efforts to recruit student participants from under-represented demographic groups.

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# ****TWC: TTP Option: Small: A Linux ARM Hypervisor for System Security****

**Award Abstract #1422909**  
http://www.nsf.gov/awardsearch/images/common/x.gif **TWC: TTP Option: Small: A Linux ARM Hypervisor for System Security**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CNS**](http://www.nsf.gov/div/index.jsp?div=CNS) [**Division of Computer and Network Systems**](http://www.nsf.gov/div/index.jsp?div=CNS) |
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| **Initial Amendment Date:** | September 2, 2014 |
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| **Latest Amendment Date:** | September 2, 2014 |
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| **Award Number:** | 1422909 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Anita Nikolich CNS Division of Computer and Network Systems CSE Directorate for Computer & Information Science & Engineering |
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| **Start Date:** | October 1, 2014 |
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| **End Date:** | September 30, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $635,103.00 |
| divider line | |
| **Investigator(s):** | Jason Nieh nieh@cs.columbia.edu (Principal Investigator) |
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| **Sponsor:** | Columbia University 2960 Broadway NEW YORK, NY 10027-6902 (212)854-6851 |
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| **NSF Program(s):** | Secure &Trustworthy Cyberspace |
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| **Program Reference Code(s):** | 7434, 7923 |
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| **Program Element Code(s):** | 8060 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Mobile devices and embedded systems have become ubiquitous in our society. Such systems use ARM processors, which differ greatly from the traditional x86 processors found in larger computing devices. As devices become smaller, there is a growing demand for virtualization, which provides benefits such as energy efficiency and the ability to use the device in multiple operational modes. Virtualization is especially important in the context of system security as many security mechanisms leverage virtualization as a core technology for fault containment and isolation, intrusion detection, malware analysis, and the detection, diagnosis, and remediation of software vulnerabilities.   
  
To address the challenges of ARM virtualization, this project designs, implements, and deploys KVM/ARM, an open-source ARM hypervisor in the Linux operating system. Since the traditional x86 architecture is vastly different from ARM, past work on x86 hardware support for virtualization cannot be carried over to ARM. In addition, ARM processors vary greatly since each licensee of the ARM technology adapts and changes the systems software to meet their needs. Successfully creating an ARM hypervisor that is adaptable across a range of ARM implementations offers rich opportunities for incorporating security into the hardware itself. Adopting this research into mainline Linux code ensures that capability is broadly available on a supported foundation for system security research.

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# ****SHF: Small: Variation "Immune System" for Ultra Low Power Systems-on-Chip****

**Award Abstract #1422854**  
http://www.nsf.gov/awardsearch/images/common/x.gif **SHF: Small: Variation "Immune System" for Ultra Low Power Systems-on-Chip**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CCF**](http://www.nsf.gov/div/index.jsp?div=CCF) [**Division of Computer and Communication Foundations**](http://www.nsf.gov/div/index.jsp?div=CCF) |
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| **Initial Amendment Date:** | August 6, 2014 |
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| **Latest Amendment Date:** | August 6, 2014 |
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| **Award Number:** | 1422854 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Sankar Basu CCF Division of Computer and Communication Foundations CSE Directorate for Computer & Information Science & Engineering |
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| **Start Date:** | September 1, 2014 |
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| **End Date:** | August 31, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $425,000.00 |
| divider line | |
| **Investigator(s):** | Benton Calhoun bcalhoun@virginia.edu (Principal Investigator) |
| divider line | |
| **Sponsor:** | University of Virginia Main Campus P.O. BOX 400195 CHARLOTTESVILLE, VA 22904-4195 (434)924-4270 |
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| **NSF Program(s):** | SOFTWARE & HARDWARE FOUNDATION |
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| **Program Reference Code(s):** | 7923, 7945 |
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| **Program Element Code(s):** | 7798 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
A wide variety of emerging applications require electronics that operate at ultra-low power levels. To achieve extreme energy efficiency, such circuits operate at low voltages where they are "off" by conventional definitions and use tiny leakage currents, analogous to dripping faucets, to do useful work. This approach promises to revolutionize design on the power side, but a critical obstacle is the heightened sensitivity of low voltage circuits to variations in the transistor fabrication process, voltage and temperature, which limit product yield. An adaptive system that adjusts chip operation to account for such variations could potentially solve this problem and provide adequate yield to deploy ultra-low power circuits in high volumes. This project's objective is to create a new paradigm for ultra-low power chips in which a variation "immune system" internally adjusts circuit level knobs to meet system level requirements across variations. The technical results from this project could improve manufacturing yield, lower costs for commercial products, and enable a swath of applications that are currently not commercially viable. While the scope of applications is in wearable computing having a broad societal appeal, the project also plans to heavily involve of female and minority students in educational outreach activities.  
  
While current efforts to build ultra-low power ICs forcibly apply the conventional fixed voltage, fixed frequency approach, this project recognizes that chips should guarantee certain system level metrics and then release constraints on parameters that are conventionally fixed, which can instead act as knobs to compensate for variations in the process technology or environment. These knobs are used in the feedback controlled "immune system" to compensate for variations. Specific research in this effort creates low overhead hardware knobs for managing variations, and co-designs software for managing chip operation in a resource constrained space. At the chip level, this approach combines variants of dynamic voltage scaling and adaptive voltage scaling methods with mode based power management control and block specific tuning to maintain proper function and meet system metrics. Additionally, the proposed scheme uses co-design of integrated components and system design to ensure robust operation despite the exponential impact of process, voltage and temperature variations at low voltage.

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# ****XPS: EXPL: FP: Symbiotic Power Management for Integrated CPU - GPU Platforms****

**Award Abstract #1438958**  
http://www.nsf.gov/awardsearch/images/common/x.gif **XPS: EXPL: FP: Symbiotic Power Management for Integrated CPU - GPU Platforms**  
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| **NSF Org:** | [**CCF**](http://www.nsf.gov/div/index.jsp?div=CCF) [**Division of Computer and Communication Foundations**](http://www.nsf.gov/div/index.jsp?div=CCF) |
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| **Initial Amendment Date:** | August 7, 2014 |
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| **Latest Amendment Date:** | August 7, 2014 |
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| **Award Number:** | 1438958 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Tracy J. Kimbrel CCF Division of Computer and Communication Foundations CSE Directorate for Computer & Information Science & Engineering |
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| **Start Date:** | September 1, 2014 |
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| **End Date:** | August 31, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $300,000.00 |
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| **Investigator(s):** | Sherief Reda Sherief\_Reda@brown.edu (Principal Investigator) |
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| **Sponsor:** | Brown University BOX 1929 Providence, RI 02912-1929 (401)863-2777 |
| divider line | |
| **NSF Program(s):** | Exploiting Parallel&Scalabilty |
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| **Program Reference Code(s):** |  |
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| **Program Element Code(s):** | 8283 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Power consumption is a major constraint on the operation of mobile computing devices. By reducing power consumption, it will be possible to prolong the operational time of battery operated devices. Modern computing devices integrate Central Processing Units (CPUs) and Graphic Processing Units (GPUs) on the same die to cater to the performance needs of various software applications. These software applications are usually written to execute parallel threads that make use of the CPUs and the GPUs. Integrated CPU-GPU devices offer many advantages over discrete CPU-GPU systems, including higher performance, reduced power consumption, and finer-grained interactions between the CPU and GPU.  
  
The overarching goal of this proposal is to explore a new paradigm for symbiotic power management that exploits the structure and semantics of parallel programming languages for CPU-GPU devices to deliver improved power management capabilities. To achieve this goal, the PI will first identify the operational phases of software applications directly from their parallel programming constructs, and then use the identified phases to devise an adaptive power management method that determines the optimal resources (e.g., frequency-voltage settings and number of cores) to meet performance targets while offering large reductions in power consumption. In synergy with the overarching goal, the PI will pursue an educational outreach program that includes: expanding on-going projects targeted for local high-school students to increase their knowledge of energy challenges in computing systems; developing courses on high-performance computing systems; involving undergraduate students in research experiences; and outreach to industry.

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# ****CSR: CC: Small: Application-Level Consistency for Cloud-Based Computing****

**Award Abstract #1421033**  
http://www.nsf.gov/awardsearch/images/common/x.gif **CSR: CC: Small: Application-Level Consistency for Cloud-Based Computing**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CNS**](http://www.nsf.gov/div/index.jsp?div=CNS) [**Division of Computer and Network Systems**](http://www.nsf.gov/div/index.jsp?div=CNS) |
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| **Initial Amendment Date:** | August 5, 2014 |
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| **Latest Amendment Date:** | August 5, 2014 |
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| **Award Number:** | 1421033 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Weisong Shi CNS Division of Computer and Network Systems CSE Directorate for Computer & Information Science & Engineering |
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| **Start Date:** | October 1, 2014 |
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| **End Date:** | September 30, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $499,753.00 |
| divider line | |
| **Investigator(s):** | Remzi Arpaci-Dusseau remzi@cs.wisc.edu (Principal Investigator) |
| divider line | |
| **Sponsor:** | University of Wisconsin-Madison 21 North Park Street MADISON, WI 53715-1218 (608)262-3822 |
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| **NSF Program(s):** | COMPUTER SYSTEMS |
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| **Program Reference Code(s):** | 7923 |
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| **Program Element Code(s):** | 7354 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
The Wisconsin Crash-Consistency Project (WiCC) attacks the fundamental problem of crash recovery in cloud-based applications. Current web applications are not built in a principled and robust manner, relying on ad hoc implementation techniques and arcane system details to realize correct behavior. Unfortunately, the result of this approach can be chaotic, and, when an unfortunate event such as a system crash or power loss arises, can lead to data loss or corruption. As data lies at the heart of virtually every modern web service, such loss or corruption is a nuisance at best, and catastrophic at worst.  
  
The WiCC project addresses these issues in a two-pronged manner. First, WiCC provides tools to analyze current applications (and underlying file systems) and thus improves the current state of the art in crash recovery. These tools exercise the systems-under-test through novel state-space exploration techniques, constructing scenarios where a given system will not function correctly. Such feedback is critical for developers, as they can readily determine problems with the systems they are building. Second, WiCC puts forth a new storage system, StreamFS, that presents new abstractions to ease the construction of correct cloud-based data management applications. Current system interfaces are cumbersome and error-prone; StreamFS reduces the complexity of the file system interface and thus improves the state of the art in robust system construction.

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# ****TWC: Small: Self-Service Cloud Computing****

**Award Abstract #1420815**  
http://www.nsf.gov/awardsearch/images/common/x.gif **TWC: Small: Self-Service Cloud Computing**  
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| **NSF Org:** | [**CNS**](http://www.nsf.gov/div/index.jsp?div=CNS) [**Division of Computer and Network Systems**](http://www.nsf.gov/div/index.jsp?div=CNS) |
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| **Initial Amendment Date:** | August 5, 2014 |
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| **Latest Amendment Date:** | August 5, 2014 |
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| **Award Number:** | 1420815 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Jeremy Epstein CNS Division of Computer and Network Systems CSE Directorate for Computer & Information Science & Engineering |
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| **Start Date:** | October 1, 2014 |
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| **End Date:** | September 30, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $499,880.00 |
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| **Investigator(s):** | Vinod Ganapathy vinodg@cs.rutgers.edu (Principal Investigator) |
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| **Sponsor:** | Rutgers University New Brunswick 3 RUTGERS PLAZA NEW BRUNSWICK, NJ 08901-8559 (848)932-0150 |
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| **NSF Program(s):** | Secure &Trustworthy Cyberspace |
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| **Program Reference Code(s):** | 7434, 7923 |
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| **Program Element Code(s):** | 8060 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Cloud computing poses significant risks to the security of client data. Virtual Machine Monitors (VMMs) that underlie cloud systems typically have all-powerful administrative domains that can be exploited or misused to snoop on client virtual machines (VMs) and steal/modify their data. Moreover, although virtual machine technology enables several novel security services that clients may wish to use, such services are privileged and must be implemented within the administrative domain.   
  
This project develops the Self-service Cloud Computing (SSC) model to improve the security of client data. SSC employs privilege separation to reduce the privileges granted to the system-wide administrative domain, and expose new abstractions to clients that give them greater control over their VMs. Thus, SSC mitigates the impact of attacks directed on client VMs via the administrative domain, and allows clients to deploy security services on their own VMs.  
  
SSC can have broad impact by ameliorating the threats to client data on the cloud, thus encouraging clients to move to the cloud. The concept of cloud app markets developed in this project is also likely to be of independent interest. The project also includes an educational component that will develop new cloud-related material for inclusion in graduate and undergraduate curricula.

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# ****CSR: Small: System Support for Transiency in Data Center and Cloud Computing****

**Award Abstract #1422245**  
http://www.nsf.gov/awardsearch/images/common/x.gif **CSR: Small: System Support for Transiency in Data Center and Cloud Computing**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CNS**](http://www.nsf.gov/div/index.jsp?div=CNS) [**Division of Computer and Network Systems**](http://www.nsf.gov/div/index.jsp?div=CNS) |
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| **Initial Amendment Date:** | August 5, 2014 |
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| **Latest Amendment Date:** | August 5, 2014 |
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| **Award Number:** | 1422245 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Weisong Shi CNS Division of Computer and Network Systems CSE Directorate for Computer & Information Science & Engineering |
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| **Start Date:** | September 1, 2014 |
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| **End Date:** | August 31, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $500,000.00 |
| divider line | |
| **Investigator(s):** | Prashant Shenoy shenoy@cs.umass.edu (Principal Investigator) David Irwin (Co-Principal Investigator) |
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| **Sponsor:** | University of Massachusetts Amherst Research Administration Building AMHERST, MA 01003-9242 (413)545-0698 |
| divider line | |
| **NSF Program(s):** | COMPUTER SYSTEMS |
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| **Program Reference Code(s):** | 7923 |
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| **Program Element Code(s):** | 7354 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Today's distributed applications are built using the implicit assumption that the underlying data center servers will be stable and normally available, barring for occasional faults. In many emerging scenarios, however, data centers and clouds only provide transient, rather than continuous, availability of their servers. Transiency in modern distributed systems arises in many contexts such as green data centers powered using renewable intermittent sources, cloud platforms that provide lower-cost spot server instances which can be preempted from their users, or smart data centers that voluntarily curtail their energy usage when signaled by the smart electric grid. This project proposes new research in distributed systems design that treats transiency as a first-class design principle. Since traditional fault-tolerance methods are too expensive or not well suited to handling the intermittent availability of servers caused by transiency, this project proposes new low-cost transiency mechanisms for modern data center and cloud platforms. For transiency in green data centers, the project focuses on a new virtualization mechanism based on bounded migration, and applies it to design system-wide transiency management algorithms. For cloud platforms, the project focuses on transiency algorithms that intelligently manage different mixes of stable on-demand and transient spot servers. Finally, to handle transiency due to smart grid interactions, the project proposes new mechanisms to judiciously modulate energy use without impacting application performance. The project employs a systems-driven approach based on prototype implementation and experimental evaluation using realistic application to demonstrate the benefits of these transiency mechanisms. The design of distributed systems that incorporate transiency have the potential to significantly increase the use of renewable energy sources within data centers and better integrate modern data centers and cloud platforms with the smart grid. Broader impacts of the project will include graduate courses that incorporate research results, undergraduate summer research projects, outreach to local K-12 schools in green computing, and the release of source code for the transiency algorithms to the research community.

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# ****CDS&E: Compiler/Runtime Support for Developing Scalable Parallel Multi-Scale Multi-Physics****

**Award Abstract #1404995**  
http://www.nsf.gov/awardsearch/images/common/x.gif **CDS&E: Compiler/Runtime Support for Developing Scalable Parallel Multi-Scale Multi-Physics**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**ACI**](http://www.nsf.gov/div/index.jsp?div=ACI) [**Division of Advanced CyberInfrastructure**](http://www.nsf.gov/div/index.jsp?div=ACI) |
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| **Initial Amendment Date:** | June 26, 2014 |
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| **Latest Amendment Date:** | July 31, 2014 |
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| **Award Number:** | 1404995 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Daniel Katz ACI Division of Advanced CyberInfrastructure CSE Directorate for Computer & Information Science & Engineering |
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| **Start Date:** | July 1, 2014 |
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| **End Date:** | June 30, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $544,347.00 |
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| **Investigator(s):** | Ponnuswamy Sadayappan sadayappan.1@osu.edu (Principal Investigator) Atanas Rountev (Co-Principal Investigator) |
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| **Sponsor:** | Ohio State University Office of Sponsored Programs Columbus, OH 43210-1016 (614)292-3805 |
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| **NSF Program(s):** | CDS&E |
| divider line | |
| **Program Reference Code(s):** | 7433, 8084 |
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| **Program Element Code(s):** | 8084 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
The dramatic strides in computer speed and performance over the last few decades make it feasible to accurately model increasingly complex phenomena. However, achieving high performance on massively parallel supercomputers is an extremely challenging task. With deepening memory hierarchies, significantly higher degrees of per-chip multi-core parallelism, the task of programming compute-intensive engineering applications to attain high performance on a large scale cluster system has become increasingly difficult. It is often the case that the time and effort required to develop effective and efficient software has become the bottleneck in advancing many areas of science and engineering. This challenge can be overcome by advances in compile-time/runtime systems that can ease the burden on the programmer while delivering a high performance portable instantiation of the particular application on modern and emerging high performance platforms.  
  
To address this challenge, this project is developing a novel framework for transforming irregular scientific/engineering applications in a global address space framework. The research is grounded in a very different and complementary research direction to most current efforts in addressing the challenge of enhancing programmer productivity, maintaining portability, and achieving good performance on scalable distributed-memory parallel systems. The project will advance compiler/runtime techniques so that users can develop annotated sequential programs, to be automatically transformed by our system for efficient execution on distributed-memory parallel systems. This approach is motivated by the success of the popular OpenMP and OpenACC pragma based approaches to transforming annotated sequential programs for parallel execution on multicore and GPU/accelerator systems, respectively. An annotation based OpenAPP (APP - Asynchronous Partitioned Parallelism) framework is proposed for source-to-source transformation of an important class of scientific/engineering programs using the inspector/executor paradigm for execution on distributed-memory parallel systems. The proposed framework will be validated using several medium to large scale applications.  
  
The project seeks to significantly lower the entry barrier associated with effective use of scalable distributed-memory computers, which are essential if more than 100x performance improvement over sequential codes is sought. A successful outcome of this project will be transformative for computational and domain scientists and engineers who seek to use next generation parallel systems for their simulation and modeling. The developed tools will be made publicly available to the community under an open source license. The project will also organize workshops that bring together compiler/runtime experts and computational scientists developing massively parallel scientific/engineering applications.

Please report errors in award information by writing to: [awardsearch@nsf.gov](mailto:awardsearch@nsf.gov).

# ****XPS: FULL: CCA: Collaborative Research: Cache-Adaptive Algorithms: How to Share Core among Many Cores****

**Award Abstract #1439084**  
http://www.nsf.gov/awardsearch/images/common/x.gif **XPS: FULL: CCA: Collaborative Research: Cache-Adaptive Algorithms: How to Share Core among Many Cores**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CCF**](http://www.nsf.gov/div/index.jsp?div=CCF) [**Division of Computer and Communication Foundations**](http://www.nsf.gov/div/index.jsp?div=CCF) |
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| **Initial Amendment Date:** | August 1, 2014 |
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| **Latest Amendment Date:** | August 1, 2014 |
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| **Award Number:** | 1439084 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Tracy J. Kimbrel CCF Division of Computer and Communication Foundations CSE Directorate for Computer & Information Science & Engineering |
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| **Start Date:** | August 1, 2014 |
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| **End Date:** | July 31, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $799,999.00 |
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| **Investigator(s):** | Rob Johnson rob@cs.sunysb.edu (Principal Investigator) Michael Bender (Co-Principal Investigator) Rezaul Chowdhury (Co-Principal Investigator) |
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| **Sponsor:** | SUNY at Stony Brook WEST 5510 FRK MEL LIB STONY BROOK, NY 11794-3362 (631)632-9949 |
| divider line | |
| **NSF Program(s):** | Exploiting Parallel&Scalabilty |
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| **Program Reference Code(s):** |  |
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| **Program Element Code(s):** | 8283 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
This project will develop theoretical and algorithmic foundations for writing programs that efficiently share limited memory on multi-core computers. On a multi-core computer, each process is allocated some share of the memory, but its share can fluctuate over time as other processes start, stop, and change their demands for memory. Most of today's programs do not cope well with memory fluctuations -- they have difficulty taking full advantage of additional memory freed up by other processes and they can slow to a crawl when their memory allocation decreases.  
  
By enabling programmers to write software that can adapt to memory fluctuations, this research will provide new levels of flexibility, performance, and resource utilization for scientific and commercial applications running on shared-memory multi-core infrastructure. Cloud services will respond more rapidly to changes in workload. High-performance-computing applications will achieve higher memory utilization, enabling scientists to do more with less hardware. By creating a more efficient and flexible computing infrastructure, this project has the potential to accelerate the pace of discovery in other scientific fields. For example, biological applications such as protein docking are likely to benefit from this research because the performance of current software is limited by contention for memory.  
  
This project will build upon the PIs' recently proposed notion of cache-adaptive algorithms, i.e., algorithms that automatically adapt to memory fluctuations. This project will develop cache-adaptive theory and applications in four ways:  
  
1. The PIs will extend cache-adaptive analytical techniques to apply to more algorithms, such as cache-oblivious FFT and cache-oblivious serial and parallel dynamic programs.  
  
2. The PIs will develop the foundations of cache-adaptive data structures, such as cache-adaptive priority queues.  
  
3. The PIs will measure the impact of adaptivity on actual performance, focusing on cache-adaptive sorting, serial and parallel dynamic programs, and stencil computations.  
  
4. The PIs will implement cache-adaptive parallel software for computational biology applications, such as protein-protein docking, dynamic programs, and other HPC simulations.  
  
The PIs will offer courses on parallel algorithms, parallel programming, cache-efficient and external-memory algorithms as part of a new degree program in computational sciences that is being launched at Stony Brook through its recently established Institute for Advanced Computational Sciences (IACS). These courses are designed to disseminate high-performance computing research results to students and faculty in other fields, such as physics, chemistry, biology and math. The PIs will also design a course, targeted at computer science students, on theoretical and systems aspects of external memory computing in the context of big data, databases, and file systems. The PIs will use super-computing resources from the XSEDE program, giving students access to some of the world?s fastest supercomputing clusters for their programming assignments and course projects.  
  
The PIs will engage in outreach and dissemination by organizing parallel programming workshops as part of the IACS and in collaboration for Brookhaven National Labs. PIs will also give tutorials on parallel computing, memory-efficient computing, and big data and at conferences and at other universities.

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# ****SHF: Small: Some Error Correcting Codes for Computer Systems****

**Award Abstract #1423656**  
http://www.nsf.gov/awardsearch/images/common/x.gif **SHF: Small: Some Error Correcting Codes for Computer Systems**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CCF**](http://www.nsf.gov/div/index.jsp?div=CCF) [**Division of Computer and Communication Foundations**](http://www.nsf.gov/div/index.jsp?div=CCF) |
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| **Initial Amendment Date:** | July 21, 2014 |
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| **Latest Amendment Date:** | July 21, 2014 |
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| **Award Number:** | 1423656 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Sankar Basu CCF Division of Computer and Communication Foundations CSE Directorate for Computer & Information Science & Engineering |
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| **Start Date:** | September 1, 2014 |
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| **End Date:** | August 31, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $288,271.00 |
| divider line | |
| **Investigator(s):** | Bella Bose bose@eecs.orst.edu (Principal Investigator) |
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| **Sponsor:** | Oregon State University OREGON STATE UNIVERSITY Corvallis, OR 97331-8507 (541)737-4933 |
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| **NSF Program(s):** | SOFTWARE & HARDWARE FOUNDATION |
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| **Program Reference Code(s):** | 7923, 7945 |
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| **Program Element Code(s):** | 7798 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Error control codes play a major role in achieving high reliable operations of modern computer systems, DVDs, cameras, etc. In this project new classes of error correcting codes suitable for high density flash memories are to be developed. The market revenue of flash memories is estimated to be $100B per year. The PI has close collaboration with leading Flash memory industry (Micron). While this enables development of error correcting codes specifically in the practical context of applications, the results of this research will not only be easily transitioned to industry, it will also train students, postdocs and future industry researchers via lectures, seminars and course development at the PIs institution.   
  
In this project, multi-level flash, in which each cell can have 4 or 8 voltage levels, will be considered. Experiments indicate that the bit error rate of flash memory worsens as the Program/Erasure count increases. In addition, it is observed that most of the errors are of limited magnitude and of decreasing type. Study of error statistics of error characteristics justify that the L1 distance codes are more suitable to overcome errors in flash memories. New classes of L1 distance codes are to be developed using the concepts of elementary symmetric functions. The project will also consider the design of error correcting codes for insertion and deletion of repeated symbols in high speed data bus and communication systems. Furthermore, the theory and codes to be developed for flash memories can potentially be extended to design efficient high-ordered-spectral-null codes for optical discs and magnetic memories.

Please report errors in award information by writing to: [awardsearch@nsf.gov](mailto:awardsearch@nsf.gov).SHF: Small: Interactive Refactoring for Multicore Parallelism

**Award Abstract #1442157**  
http://www.nsf.gov/awardsearch/images/common/x.gif **SHF: Small: Interactive Refactoring for Multicore Parallelism**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CCF**](http://www.nsf.gov/div/index.jsp?div=CCF) [**Division of Computer and Communication Foundations**](http://www.nsf.gov/div/index.jsp?div=CCF) |
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| **Initial Amendment Date:** | April 14, 2014 |
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| **Latest Amendment Date:** | April 14, 2014 |
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| **Award Number:** | 1442157 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Sol J. Greenspan CCF Division of Computer and Communication Foundations CSE Directorate for Computer & Information Science & Engineering |
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| **Start Date:** | March 19, 2014 |
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| **End Date:** | August 31, 2015 (Estimated) |
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| **Awarded Amount to Date:** | $249,263.00 |
| divider line | |
| **Investigator(s):** | Daniel Dig digd@eecs.oregonstate.edu (Principal Investigator) |
| divider line | |
| **Sponsor:** | Oregon State University OREGON STATE UNIVERSITY Corvallis, OR 97331-8507 (541)737-4933 |
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| **NSF Program(s):** | SPECIAL PROJECTS - CCF |
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| **Program Reference Code(s):** | 7433, 7923 |
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| **Program Element Code(s):** | 2878 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
In the multicore era, a major programming task is to make existing sequential programs parallel. One approach to parallelizing an existing sequential program is to rewrite it from scratch. However, the most common way is to parallelize a program incrementally, by changing the existing code. Each small step can be seen as a behavior-preserving transformation, i.e., a refactoring. While refactoring is more economical than rewriting, it is still tedious because it requires changing many lines of code, and it is error-prone and non-trivial because programmers need to ensure non-interference of parallel operations.  
  
This project aims to significantly enrich educational resources and programmers' toolset for refactoring sequential programs for parallelism and improving the performance of already parallel programs. The PIs plan to pursue research activities in three areas:  
  
(1) mining refactorings by studying the evolution of widely used open-source programs; (2) automating refactorings for parallelism that programmers frequently use; and (3) suggesting refactorings that offer several candidate programs with different trade-offs in terms of performance or thread-safety. This project has the potential to revolutionize how programmers parallelize software, to educate them about successful parallelization techniques, and to significantly reduce the cost and increase the quality of their code.

Please report errors in award information by writing to: [awardsearch@nsf.gov](mailto:awardsearch@nsf.gov).

# ****SHF: Small: Collaborative Research: A Holistic Design Methodology for Fault-Tolerant and Robust Network-on-Chips (NoCs) Architectures****

**Award Abstract #1420681**  
http://www.nsf.gov/awardsearch/images/common/x.gif **SHF: Small: Collaborative Research: A Holistic Design Methodology for Fault-Tolerant and Robust Network-on-Chips (NoCs) Architectures**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CCF**](http://www.nsf.gov/div/index.jsp?div=CCF) [**Division of Computer and Communication Foundations**](http://www.nsf.gov/div/index.jsp?div=CCF) |
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| **Initial Amendment Date:** | July 10, 2014 |
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| **Latest Amendment Date:** | July 10, 2014 |
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| **Award Number:** | 1420681 |
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| **Award Instrument:** | Standard Grant |
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| **Program Manager:** | Hong Jiang CCF Division of Computer and Communication Foundations CSE Directorate for Computer & Information Science & Engineering |
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| **Start Date:** | July 15, 2014 |
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| **End Date:** | June 30, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $300,000.00 |
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| **Investigator(s):** | Ahmed Louri louri@ece.arizona.edu (Principal Investigator) |
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| **Sponsor:** | University of Arizona 888 N Euclid Ave TUCSON, AZ 85721-0001 (520)626-6000 |
| divider line | |
| **NSF Program(s):** | SOFTWARE & HARDWARE FOUNDATION |
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| **Program Reference Code(s):** | 7923, 7941 |
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| **Program Element Code(s):** | 7798 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Technology scaling down to the nanometer regime has aided the growth in transistors that have made multi-core architectures a power-efficient approach to harnessing parallelism and improving performance. Consequently, the design of low latency, high bandwidth, power-efficient and reliable Network-on-Chips (NoCs) is proving to be one of the most critical challenges to achieving the performance potential of future chips. While multicores are facilitating an enormous integration capacity, aggressive transistor scaling has also led to a steady degradation of the device and circuit reliability. Increased device wear-out (due to negative-bias temperature instability (NBTI), electro migration (EM) and hot carrier injection (HCI)) has exacerbated the waning reliability of transistors, thereby resulting in a significant increase in faults (both permanent and transient), and hardware failures. As faults manifest within the NoC substrate, multicore chips are faced with excessive delays and increased power consumption while recovering from the fault. While NoC reliability research has made significant strides at inter- and intra-router levels, there is still a lack of a holistic design approach covering the reliability of the entire NoC architecture, from device wear-out, to links and routers, to routing protocols, to applications in a cohesive manner.  
  
This project will develop a holistic design methodology that addresses the reliability of the entire NoC communication infrastructure (device, links, routers, routing algorithms, and topology) while minimizing energy footprint, reducing the area overhead and only marginally impacting performance. To achieve our goal of improving link fault-recovery, this project will develop techniques to maximize the utilization of the inter-router links with minimum power and area overhead. For the router, this project will propose intra-router reliability techniques with the goals of maximizing hardware utilization, reducing redundancy and area overhead, and minimizing router pipeline latency. Further, wear-leveling techniques developed by this project will improve the reliability of NoCs and the lifetime of the chip. Finally, the proposed techniques will be evaluated by developing fault models that are injected into the NoC and evaluate the fault coverage, performance degradation and energy efficiency through extensive modeling and simulation. The holistic design methodology spanning the entire NoC architecture and the reliability techniques developed from this project will positively impact the next generation multi-core and System-on-Chip (SoC) architectures with improvements in energy efficiency, performance and robustness to hard faults and soft errors. This project will play a major role in education by integrating discovery with teaching and training, and by attracting and training minority students in this field.

Please report errors in award information by writing to: [awardsearch@nsf.gov](mailto:awardsearch@nsf.gov).

# ****SHF: Small: Cooperative Memory Expansion (COMEX) for Networked Computing Systems via Remote Direct Memory Access****

**Award Abstract #1423302**  
http://www.nsf.gov/awardsearch/images/common/x.gif **SHF: Small: Cooperative Memory Expansion (COMEX) for Networked Computing Systems via Remote Direct Memory Access**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

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| **NSF Org:** | [**CCF**](http://www.nsf.gov/div/index.jsp?div=CCF) [**Division of Computer and Communication Foundations**](http://www.nsf.gov/div/index.jsp?div=CCF) |
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| **Initial Amendment Date:** | July 9, 2014 |
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| **Latest Amendment Date:** | July 9, 2014 |
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| **Award Number:** | 1423302 |
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| **Award Instrument:** | Standard Grant |
| divider line | |
| **Program Manager:** | Hong Jiang CCF Division of Computer and Communication Foundations CSE Directorate for Computer & Information Science & Engineering |
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| **Start Date:** | July 15, 2014 |
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| **End Date:** | June 30, 2017 (Estimated) |
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| **Awarded Amount to Date:** | $460,000.00 |
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| **Investigator(s):** | Nian-Feng Tzeng tzeng@cacs.louisiana.edu (Principal Investigator) |
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| **Sponsor:** | University of Louisiana at Lafayette 104 University Circle Lafayette, LA 70503-2701 (337)482-6203 |
| divider line | |
| **NSF Program(s):** | SOFTWARE & HARDWARE FOUNDATION |
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| **Program Reference Code(s):** | 7923, 7941, 9150 |
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| **Program Element Code(s):** | 7798 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Legacy and emerging applications with large working sets and, when executed on commodity servers,   
  
may exhibit poor performance due to frequent page faults which rely on the slow disk swap partition.   
  
This research aims to establish immense memory collectively across nodes of a networked computing system for holding pages   
  
evicted from the main memory of any participating nodes during application runs with large working sets,   
  
realizing cooperative memory expansion (COMEX). It has a great promise to advance technical understanding   
  
and scientific frontiers of networked computing systems.   
  
Given its wide adoption by operating systems and networking gear vendors nowadays,   
  
the remote direct memory access (RDMA) technology is adopted by COMEX for ultra-low latencies in page transfer   
  
between nodes whose OS kernel and CPU can be totally bypassed.   
  
This project deals with five technical challenges and the solution approaches to those challenges together   
  
will constitute the basis of the COMEX Handler, able to enhance execution performance and system throughput   
  
via better utilizing overall system DRAM memory on-demand.   
  
The project will also improve the research and educational activities on computer systems and distributed computing   
  
on the University of Louisiana at Lafayette campus, with its outcomes helping to integrate research and education for enriched teaching,   
  
training, and learning experience and to educate quality future workforce critical to the NSF mission, the state of Louisiana and the nation.

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# ****TWC: Frontier: Collaborative: Rethinking Security in the Era of Cloud Computing****

**Award Abstract #1440065**  
http://www.nsf.gov/awardsearch/images/common/x.gif **TWC: Frontier: Collaborative: Rethinking Security in the Era of Cloud Computing**  
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| **NSF Org:** | [**CNS**](http://www.nsf.gov/div/index.jsp?div=CNS) [**Division of Computer and Network Systems**](http://www.nsf.gov/div/index.jsp?div=CNS) |
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| **Initial Amendment Date:** | March 12, 2014 |
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| **Latest Amendment Date:** | June 27, 2014 |
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| **Award Number:** | 1440065 |
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| **Award Instrument:** | Continuing grant |
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| **Program Manager:** | Jeremy Epstein CNS Division of Computer and Network Systems CSE Directorate for Computer & Information Science & Engineering |
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| **Start Date:** | January 1, 2014 |
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| **End Date:** | August 31, 2018 (Estimated) |
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| **Awarded Amount to Date:** | $299,373.00 |
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| **Investigator(s):** | Vyas Sekar vsekar@andrew.cmu.edu (Principal Investigator) |
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| **Sponsor:** | Carnegie-Mellon University 5000 Forbes Avenue PITTSBURGH, PA 15213-3815 (412)268-9527 |
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| **NSF Program(s):** | Secure &Trustworthy Cyberspace |
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| **Program Reference Code(s):** | 7434, 8087 |
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| **Program Element Code(s):** | 8060 |

**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
There are at least two key features of the move to cloud computing that introduce the opportunity for significant leaps forward in computer security for tenant services. First, a compute cloud provides a common software, hardware and management basis for rolling out cross-cutting services en masse that have resisted incremental deployment in a one-service-at-a-time fashion. Second, compute clouds offer providers a broad view of activity across an unprecedented diversity of tenant services. This research project leverages these features to develop new approaches to a wide array of fundamental problems in computer security. By convening Cloud Security Horizons summits with industry stakeholders, this project further seeks to both contribute to industry directions in cloud computing and to be informed by them.  
  
Particular longstanding security challenges addressed in this project include secure transport, authorization, user and software authentication, security monitoring, and incident analysis. Moreover, since modern clouds are not sufficiently extensible to support the envisioned capabilities, this project is constructing cloud software platforms that enable the flexibility, extensibility and security needed for this research to come to fruition in practice.

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# ****CAREER: Algorithms for understanding data****

**Award Abstract #1351108**  
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| **NSF Org:** | [**CCF**](http://www.nsf.gov/div/index.jsp?div=CCF) [**Division of Computer and Communication Foundations**](http://www.nsf.gov/div/index.jsp?div=CCF) |
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| **Program Manager:** | Balasubramanian Kalyanasundaram CCF Division of Computer and Communication Foundations CSE Directorate for Computer & Information Science & Engineering |
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| **Investigator(s):** | Gregory Valiant gregory.valiant@gmail.com (Principal Investigator) |
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**ABSTRACT**  
http://www.nsf.gov/awardsearch/images/common/bluefade.jpg  
Given samples from some unknown distribution, what can one infer about the underlying distribution, and how efficiently can these inferences be made?  In many of the most fundamental settings, our understanding of the computational and information theoretic possibilities and barriers is still startlingly poor.  This project tackles two broad research objectives: developing efficient algorithms for probing data, and understanding how to efficiently estimate properties of distributions.  The first line of research seeks to understand which questions about a dataset can be answered extremely efficiently, requiring computational resources (time, or memory) that are sublinear in the size of the dataset or distribution.  The second research objective is to understand the minimal amount of information necessary to ascertain, with high probability, whether or not a distribution or dataset possesses a given property.  In the context of statistical property estimation, this problem asks how few samples are needed to estimate the property in question to a desired accuracy, with high probability.  This research pursues both new estimation algorithms, and new information theoretic tools and lower bounds.  
  
With vast and important datasets emerging across many disciplines, from genetic, biological, and medical databases, to databases documenting our economic and social behaviors, the challenge of how to make sense of them has particular immediate relevance and has rapidly become the bottleneck in scientific understanding.   The specific problems investigated in this project arise in the analysis of these datasets; algorithmic advances on these problems have the potential to very quickly be adopted and transform ongoing data analysis efforts.   Beyond the immediate implications for the data sciences, these questions are extremely basic and foundational. As such, new techniques, perspectives, and insights gleaned from their study are likely to have broad implications for other problems throughout computer science, statistics, information theory, and the data sciences.

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