# CAREER: Supporting Patterns for Embedded Network Systems

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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

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

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

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

# **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

|  |  |
| --- | --- |
| **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:** | August 19, 2014 |
| divider line | |
| **Latest Amendment Date:** | September 16, 2014 |
| divider line | |
| **Award Number:** | 1419199 |
| divider line | |
| **Award Instrument:** | Cooperative Agreement |
| divider line | |
| **Program Manager:** | Joseph Lyles CNS Division Of Computer and Network Systems CSE Direct For Computer & Info Scie & Enginr |
| divider line | |
| **Start Date:** | October 1, 2014 |
| divider line | |
| **End Date:** | September 30, 2017 (Estimated) |
| divider line | |
| **Awarded Amount to Date:** | $4,399,514.00 |
| divider line | |
| **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) |
| divider line | |
| **Sponsor:** | University of Utah 75 S 2000 E SALT LAKE CITY, UT 84112-8930 (801)581-6903 |
| divider line | |
| **NSF Program(s):** | INFORMATION TECHNOLOGY RESEARC |
| divider line | |
| **Program Reference Code(s):** | 8002, 9150 |
| divider line | |
| **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.

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

# **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**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

|  |  |
| --- | --- |
| **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) |
| divider line | |
| **Initial Amendment Date:** | December 16, 2014 |
| divider line | |
| **Latest Amendment Date:** | May 6, 2015 |
| divider line | |
| **Award Number:** | 1518652 |
| divider line | |
| **Award Instrument:** | Standard Grant |
| divider line | |
| **Program Manager:** | Gregory Chirikjian IIS Div Of Information & Intelligent Systems CSE Direct For Computer & Info Scie & Enginr |
| divider line | |
| **Start Date:** | December 15, 2014 |
| divider line | |
| **End Date:** | November 30, 2015 (Estimated) |
| divider line | |
| **Awarded Amount to Date:** | $79,002.00 |
| divider line | |
| **Investigator(s):** | William Smart bill.smart@oregonstate.edu (Principal Investigator) |
| divider line | |
| **Sponsor:** | Oregon State University OREGON STATE UNIVERSITY Corvallis, OR 97331-8507 (541)737-4933 |
| divider line | |
| **NSF Program(s):** | National Robotics Initiative, INFORMATION TECHNOLOGY RESEARC |
| divider line | |
| **Program Reference Code(s):** | 001Z, 1640, 7914, 8086, 9251 |
| divider line | |
| **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.

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

# **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**  
http://www.nsf.gov/awardsearch/images/common/greenline.jpg

|  |  |
| --- | --- |
| **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) |
| divider line | |
| **Initial Amendment Date:** | April 24, 2015 |
| divider line | |
| **Latest Amendment Date:** | April 24, 2015 |
| divider line | |
| **Award Number:** | 1536795 |
| divider line | |
| **Award Instrument:** | Continuing grant |
| divider line | |
| **Program Manager:** | Hong Jiang CCF Division of Computing and Communication Foundations CSE Direct For Computer & Info Scie & Enginr |
| divider line | |
| **Start Date:** | September 1, 2014 |
| divider line | |
| **End Date:** | December 31, 2015 (Estimated) |
| divider line | |
| **Awarded Amount to Date:** | $274,973.00 |
| divider line | |
| **Investigator(s):** | Samuel Midkiff smidkiff@purdue.edu (Principal Investigator) |
| divider line | |
| **Sponsor:** | University of Illinois at Urbana-Champaign SUITE A CHAMPAIGN, IL 61820-7473 (217)333-2187 |
| divider line | |
| **NSF Program(s):** | SOFTWARE & HARDWARE FOUNDATION |
| divider line | |
| **Program Reference Code(s):** | 6863, 7941 |
| divider line | |
| **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.

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

# **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**  
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:** | August 26, 2014 |
| divider line | |
| **Latest Amendment Date:** | August 26, 2014 |
| divider line | |
| **Award Number:** | 1421913 |
| divider line | |
| **Award Instrument:** | Standard Grant |
| divider line | |
| **Program Manager:** | Weisong Shi CNS Division Of Computer and Network Systems CSE Direct For Computer & Info Scie & Enginr |
| divider line | |
| **Start Date:** | October 1, 2014 |
| divider line | |
| **End Date:** | September 30, 2017 (Estimated) |
| divider line | |
| **Awarded Amount to Date:** | $250,000.00 |
| divider line | |
| **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 |
| divider line | |
| **NSF Program(s):** | COMPUTER SYSTEMS |
| divider line | |
| **Program Reference Code(s):** | 7923 |
| divider line | |
| **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.

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

# **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**

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