Computer Science Research Report for 2013/2014

Key Computer Science research areas are Artificial Intelligence\(^1\), Computational Applications and Analytics\(^2\), Games and Interaction\(^3\), Networks\(^4\), Security\(^5\), Software Engineering\(^6\), Systems\(^7\), Technology-Enhanced Learning\(^8\), and Theory\(^9\). In 2013 our active research grants were $53 million, our annual external funding expenditures exceeded $10 million, and our total research expenditures exceed $14 million. CSC research funding continues to grow at 7-10% rate (Figure 1). Our funding has more than doubled since 2003/4. According to the CRA (2012-13) data our numbers put us into the top 20% of the CS in public institutions in terms of external funding overall, and in top 10% or so in terms of NSF funding. In fact, according to ASEE 2012-2013 data, we are 10\(^{th}\) in funding among 140+ CS departments in the US colleges of Engineering.

![Graph of research expenditures](http://www.csc.ncsu.edu/research/faculty_projs/fundedprojects.php)

**Figure 1.** CSC Received and projected research expenditures. Total expenditures include state funding and funding from other sources such as contracts and grants (C&G) from federal agencies, industry, gifts, etc. Full project and RADAR summaries are at [http://www.csc.ncsu.edu/research/faculty_projs/fundedprojects.php](http://www.csc.ncsu.edu/research/faculty_projs/fundedprojects.php).

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\(^1\) including Intelligent Agents, Machine Learning, Knowledge Representation, Planning, Natural Language Processing, Computational Economics and Management

\(^2\) including Scientific Computing, Bioinformatics, Data Mining, Information Visualization

\(^3\) including Games, Human-Computer Interaction, Graphics

\(^4\) including Networking and Performance Evaluation

\(^5\) including Software and Network Systems Security, Information Assurance, Privacy, Compliance

\(^6\) including Requirements, Formal Methods, Reliability Engineering, Process and Methods, Programming Languages

\(^7\) including Computer Architectures and Operating Systems, Databases, Embedded and Real-Time Systems, Parallel and Distributed Systems, High Performance Computing, Cloud Computing

\(^8\) including Intelligent Tutoring, Undergraduate Education in Computing

\(^9\) including Algorithms, Theory of Computation
Computer Science Faculty 2013/14

Randy Avent, Professor, PhD, University of North Carolina, 1986, Defense analytics, dealing with unstructured and semi-structured data mining and exploitation

Dennis R. Bahler, Associate Professor, PhD, University of Virginia, 1987 Artificial intelligence: constraint processing, machine learning, hybrid neural-symbolic computing

Tiffany Barnes, Associate Professor, PhD, North Carolina State University, 2003, Educational data mining, serious games for education, health and energy, broadening computing participation

Lina Battestilli, Teaching Assistant Professor, PhD, North Carolina State University, 2005, Computer science education, cloud computing and datacenter networks, networking architecture

Donald Bitzer, Distinguished University Research, Professor, PhD, University of Illinois, 1960, Convolutional codes, signal processing for biological systems, computer-based education

Kristy Boyer, Assistant Professor, PhD, North Carolina State University, 2010, Artificial intelligence, computational linguistics, intelligent tutoring systems, computer science education

Franc Bringle, Research Professor, PhD, University of Colorado, 1970, Distributed and collaborative workflows, databases, and groupware for the Internet

Min Chi, Assistant Professor, PhD, University of Pittsburgh, 2009, Machine learning, cognitive science and learning, math and science education.

Rada Y. Chirkova, Associate Professor, PhD, Stanford University, 2002, Database performance, query-processing efficiency by designing and materializing views

Jon Doyle, SAS Professor of Computer Science, PhD, Massachusetts Institute of Technology, 1980, Artificial Intelligence, mathematical and philosophical foundations, rational agents, decision making

Rudra Dutta, Professor, PhD, North Carolina State University, 2001, Network design: optical, wireless sensor and mesh networks; future Internet design

William Enck, Assistant Professor, PhD, Pennsylvania State University, 2011, Systems security, mobile operating systems security

Robert Fornarol, Professor, PhD, Pennsylvania State University, 1969, Networks and applications of real-time embedded computer systems, wireless sensor systems

Vincent Freeh, Associate Professor, PhD, University of Arizona, 1996, Operating systems, compilers, programming languages, distributed & parallel computing, embedded systems

Edward Gehringer, Associate Professor, PhD, Purdue University, 1979, Hardware support for memory management, object-oriented software systems—performance studies

Xiaohui (Helen) Hu, Associate Professor, PhD, University of Illinois, 2004, Distributed systems, operating systems, computer networks

Khaled Harfoush, Associate Professor, PhD, Boston University, 2002, Computer networking, Internet measurements, peer-to-peer systems, routing protocols

Christopher G. Healey, Professor, PhD, University of British Columbia, Canada, 1996, Visualization & computer graphics: methods for rapidly, accurately, effectively visualizing large complex datasets

Steffen Heber, Associate Professor, PhD, Universitä Heidelberg, Germany, 2001, Algorithms to compare and analyze gene order permutations, animation dev. for bioinformatics education

Sarah Heckman, Teaching Assistant Professor, PhD, North Carolina State University, 2009, Computer science and software engineering education, open educational resources

Xuxian Jiang, Associate Professor, PhD, Purdue University, 2006, Virtual machines and security
James C. Lester, Distinguished Computer Science, Professor, PhD, University of Texas, 1994, Artificial intelligence, intelligent user interfaces, intelligent tutoring systems, computational linguistics

Xiaosong Ma, Associate Professor (joint appointment with ORNL), PhD, University of Illinois, 2003, High performance computing, parallel I/O, storage systems, scientific data management

Brad Mott, Research Scientist, PhD, NC State University, 2006, Artificial intelligence, game-based learning environments, computational models of interactive narrative

Frank Mueller, Professor, PhD, Florida State University, 1994, Compilers and code optimization, concurrent and distributed, real-time and embedded systems

Emerson Murphy-Hill, Assistant Professor, PhD, Portland State University, 2009, Software engineering, esp. the intersection of human-computer interaction and software engineering.

Peng Ning, Professor, PhD, George Mason University, 2001, Computer and network security: new techniques for building trustworthy systems and wireless security

Kemafor Anyanwu Ogan, Assistant Professor, PhD, University of Georgia, 2007, Semantic computing: semantic Web, databases, data mining, information retrieval, services computing

Harry Perros, Alumni Distinguished Graduate Professor, PhD, Trinity College, Ireland, 1975, Performance analysis of optical networks, performance monitoring of grids, queueing networks

Michael Rappa, Distinguished University Professor, PhD, Univ. of Minnesota, 1987, Analytics, e-commerce, open courseware, open educational content, technology management

Douglas S. Reeves, Professor, PhD, The Pennsylvania State University, 1987, Internet protocols, multimedia computing and networking, information security, computer org.

Injong Rhee, Professor, PhD, UNC Chapel Hill, 1994, Computer/wireless/sensor networks, multimedia networking, distributed systems, operating systems

David Roberts, Assistant Professor, PhD, College of Computing, Georgia Tech, 2010, Machine learning and artificial intelligence and their application to interactive technological experiences

Robert D. Rodman, Professor, PhD, University of California, Los Angeles, 1973, Computational forensic linguistics, applying AI to error recovery in speech recognition

George N. Rouskas, Professor, PhD, Georgia Institute of Technology, 1994, Network architectures and protocols, optical networks, grid computing, scheduling

Nagiza Samatova, Professor (joint appt. w/ORNL), PhD, Russian Acad. of Sci. (CCAS), 1993, Graph theory & algorithms, bioinformatics, systems biology, data management, data integration

Carla D. Savage, Professor, PhD, University of Illinois, 1977, Combinatorics, combinatorial algorithms, network algorithms, graph theory, discrete mathematics

Munindar P. Singh, Professor, PhD, University of Texas, 1993, Multiagent systems, intelligent agents, service-oriented computing, agent languages and protocols

Robert St. Amant, Associate Professor, PhD, University of Massachusetts, Amherst, 1996, Human-computer interaction, artificial intelligence, intelligent user interfaces, statistical expert systems

Matthias Stallmann, Professor, PhD, University of Colorado, 1982, Algorithm design and analysis of both serial and parallel models of computation

William J. Stewart, Professor, PhD, Queen’s University, Northern Ireland, 1974, Performance evaluation of computer sys., numerical linear algebra, computer operating systems

David Sturgill, Teaching Assistant Professor, PhD, Cornell University, 1996, Parallel computation and its application to computationally hard problems, parallelism, machine learning

Blair Sullivan, Assistant Professor, PhD, Princeton University, 2008, Algorithm design, high-performance graph analysis, graph theory, parallel computing, combinatorial scientific computing
David Thuente, Professor, PhD, University of Kansas, 1974, Denial of service and security for wireless systems; media access control protocols

Mladen Vouk, Professor, PhD, King’s College, England, U.K., 1976, Software engineering, scientific computing, computer-based education, and cloud computing

Benjamin Watson, Associate Professor, PhD, Georgia Institute of Technology, 1997, Relationships between computer graphics and design

Laurie Williams, Professor, PhD, University of Utah, 2000, Agile software processes, software security, open software systems, healthcare information technology

R. Michael Young, Professor, PhD, University of Pittsburgh, 1997, AI: planning & plan recognition, natural language processing, dev. of human-computer interaction

Ting Yu, Associate Professor, PhD, University of Illinois, 2003, Security, trust management and privacy protection in open systems, semi-structured databases
Computer Science Research Projects 2013-14 (by start date)

Joint Faculty Agreement For Nagiza Samatova
Nagiza Samatova
$507,294 by Oak Ridge National Laboratories - UT Battelle, LLC
08/9/2007 - 08/8/2015
Dr. Nagiza Samatova's joint work with NC State University and Oak Ridge National Laboratory (ORNL) will provide the interface between the two organizations aiming to collaboratively address computational challenges in the Scientific Data Management, Data-Intensive Computing for Understanding Complex Biological Systems, Knowledge Integration for the Shewanella Federation, and the Large-Scale Analysis of Biological Networks with Applications to Bioenergy Production.

Secure Open Systems Initiative
Dennis Kekas; Peng Ning; Mladen Vouk; Rudra Dutta
$5,644,306 by Army Research Office
04/3/2008 - 11/30/2014
This program will establish a national Secure Open Systems Institute (SOSI), located on North Carolina State’s premier Centennial Campus that will be a global center for Open Source security research and development. The goals are twofold. First, SOSI will significantly contribute to strengthening mission critical information technology infrastructures vital to the Department of Defense, state and nation. Second, SOSI will accelerate the creation and growth of high tech industries in North Carolina and beyond by providing a centralized repository of research results, testing tools and qualification services.

CT-ISG: Understanding Botnet C&C Communication Protocols
Xuxian Jiang
$400,000 by the National Science Foundation
08/28/2008 - 08/31/2013
Botnets are recognized as one of the most serious threats to today's Internet. To combat them, one key step is to effectively understand how the botnet members communicate with each other. Unfortunately, the trend of adopting various obfuscation schemes (e.g., encryption) in recent bots greatly impedes our understanding. The main thrust of this research is the investigation of several interrelated key techniques to overcome the above challenges and significantly enrich the understanding of botnet command and control.

CAREER: Cooperative Developer Testing with Test Intentions
Tao Xie
$525,727 by the National Science Foundation
08/1/2009 - 06/30/2013
Developer testing has been widely recognized as an important, valuable means of improving software reliability. However, manual developer testing is often tedious and not sufficient. Automated testing tools can be used to reduce manual testing efforts. This project develops a systematic framework for cooperative developer testing to enable effective, synergetic cooperation between developers and testing tools. This framework centers around test intentions (i.e., what testing goals to satisfy) and consists of four components: intention specification, test generation, test abstraction, and intention inference. The project also includes integrated research and educational plans.

HCC: Small: Plan-Based Models of Narrative Structure For Virtual Environments
R. Michael Young
$513,860 by National Science Foundation
08/1/2009 - 07/31/2013
An increasing number of applications are set within narrative-oriented 3D virtual worlds. Current research on the generation of activities within these worlds holds the promise of tailored experiences customized to individual
users’ needs. The work described in this project seeks to expand the computational models of narrative being used to AI researchers, specifically to explore formal, plan-based models of actions to create stories that demonstrate complex conflict, rising action, dynamism and intentionality. The work will proceed both formally and empirically, with models being developed motivated by work from narrative theory and cognitive psychology and evaluated using experimental methods.

CSR: Small: Collaborative Research: Hybrid Opportunistic Computing For Green Clouds
Xiaohui Gu
$320,000 by NSF
09/1/2009 - 12/31/2013
We propose to explore the new computing model of offering computation- and/or data-intensive cloud services on active nodes serving on-demand utility computing users. More specifically, we plan to (1) assess the efficacy of resource sharing between foreground interactive utility computing workloads and background high-throughput cloud computing workloads on multi-core servers, in terms of energy saving and performance interference; (2) develop a scheduling and load management middleware that performs dynamic background workload distribution considering the energy-performance tradeoff; and (3) exploits the use of GPGPUs for cloud services on active nodes running foreground workloads mainly on the CPUs.

CSR: Small: Online System Anomaly Prediction and Diagnosis for Large-Scale Hosting Infrastructures
Xiaohui (Helen) Gu
$405,000 by National Science Foundation
09/1/2009 - 12/31/2013
Large-scale hosting infrastructures have become important platforms for many real-world systems such as cloud computing, virtual computing lab, enterprise data centers, and web hosting services. However, system administrators are often overwhelmed by the tasks of correcting various system anomalies such as performance bottlenecks, resource hotspots, and service level objective (SLO) violations. The goal of this project is to develop novel online anomaly prediction and diagnosis techniques to achieve robust continuous system operation. The major contributions will be an integrated framework consisting of three synergistic techniques: i) self-compressing information tracking to achieve low-cost continuous system monitoring; ii) online anomaly prediction that can raise advance alerts to impending anomalies; and iii) just-in-time anomaly diagnosis that can perform online anomaly diagnosis while the system approaches the anomaly state.

Collaborative Research: II-NEW: OpenVMI: A Software Infrastructure for Virtual Machine Introspection
Xuxian Jiang
$225,000 by National Science Foundation
09/1/2009 - 08/31/2014
Research in virtualization technologies has gained significant momentum in recent years. One of the basic yet powerful enabling function in many virtualization research efforts is virtual machine introspection or VMI: Observing a VM’s states and events from outside the VM. The goal of this project is to develop OpenVMI: a software-based research infrastructure for VMI, which is expected to enable new research and education opportunities, including, but not limited to, safe malware experiments, intelligent virtual infrastructure management etc.

CSR: Medium: Collaborative Research: Providing Predictable Timing for Task Migration in Embedded Multi-Core Environments (TiME-ME)
Frank Mueller
$390,000 by National Science Foundation
09/1/2009 - 08/31/2014
Assuring deadlines of embedded tasks for contemporary multicore architectures is becoming increasingly difficult. Real-time scheduling relies on task migration to exploit multicores, yet migration actually reduces timing predictability due to cache warm-up overheads and increased interconnect traffic. We propose a fundamentally new approach to increase the timing predictability of multicore architectures aimed at task migration in embedded environments making three major contributions. 1. We develop novel strategies to guide migration based on cost/benefit tradeoffs exploiting both static and dynamic analyses. 2. We devise mechanisms to increase timing predictability under task migration providing explicit support for proactive and reactive real-time data movement across cores and their caches. 3. We propose rate- and bandwidth-adaptive mechanisms as well as monitoring
capabilities to increase predictability under task migration. Our work aims at initiating a novel research direction investigating the benefits of interactions between hardware and software for embedded multicores with respect to timing predictability.

### III: Small: MOSAIC - Semantic Querying Paradigms for Supporting Discovery Oriented Tasks on the Semantic Web

**Kemafor Ogan**

$477,703 by National Science Foundation  
09/1/2009 - 01/31/2014

The Web is evolving from a resource for finding/verifying facts, to one used to support complex problem solving and exploratory tasks in a variety of domains. Thus, the traditional search paradigm targeted primarily at fact-finding, and is predicated on users knowing what they want and how to search for it, is unsuitable for such situations. This project focuses on developing support for advanced query models that capture the iterative process typical of problem solving and exploratory tasks where at each step users may only be able to formulate vague queries. It proposes to develop semantic techniques for integrating information created across the multiple steps of such tasks as and also predict and recommend other potentially relevant and informative data that the user may have missed.

### NetSE: Large: Collaborative Research: Platys: From Position to Place in Next Generation Networks

**Injong Rhee ; Munindar Singh**

$706,167 by National Science Foundation  
09/1/2009 - 08/31/2015

This project develops a high-level notion of context that exploits the capabilities of next generation networks to enable applications that deliver better user experiences. In particular, it exploits mobile devices always with a user to capture key elements of context: the user's location and, through localization, characteristics of the user's environment.

### Policy-Based Governance for the OOI Cyberinfrastructure

**Munindar Singh**

$124,688 by Univ of Calif-San Diego/NSF  
09/1/2009 - 02/25/2015

This project will develop policy-based service governance modules for the Oceanographic Observatories Initiative (OOI) Cyberinfrastructure. The main objectives of the proposed project include (1) formulating the key conceptual model underlying the patterns of governance; (2) formalizing "best practices" patterns familiar to the scientific community and seeding the cyberinfrastructure with them; (3) understanding user requirements for tools that support creating and editing patterns of governance.

### Policy-Based Governance for the OOI Cyberinfrastructure

**Munindar Singh**

$134,688 by the University of California-San Diego  
09/1/2009 - 08/31/2013

This project will develop policy-based service governance modules for the Oceanographic Observatories Initiative (OOI) Cyberinfrastructure. The main objectives of the proposed project include (1) formulating the key conceptual model underlying the patterns of governance; (2) formalizing "best practices" patterns familiar to the scientific community and seeding the cyberinfrastructure with them; (3) understanding user requirements for tools that support creating and editing patterns of governance.

### SHF: Small: Collaborative Research: Constraint-Based Generation of Database States for Testing Database Applications

**Tao Xie**

$265,880 by National Science Foundation  
09/1/2009 - 06/30/2013

Testing is essential for database applications to function correctly and with acceptable performance when deployed. In practice, it is often necessary for a database software vendor to test their software completely before selling or integrating their package to the database owner. In this proposal, we focus on two bottlenecks in database application testing: functional testing, which is to test whether the applications can perform a set of predefined
functions correctly, and performance testing, which is to test whether the applications can function with acceptable performance when deployed.

**TC: Large: Collaborative Research: Trustworthy Virtual Cloud Computing**
Peng Ning ; Xuxian Jiang ; Mladen Vouk
$1,523,685 by National Science Foundation
09/4/2009 - 09/30/2013
This project consists of three technical thrusts: (1) Thrust 1 -- new security architecture and services that better isolate different customers' workloads and enhance their trustworthiness; (2) Thrust 2 -- protection of management infrastructure against malicious workloads; and (3) Thrust 3 -- protection of hosted workloads from potentially malicious management infrastructure. The first thrust explores new opportunities to enhance the trustworthiness of virtual cloud computing against mutual threats between workloads as well as external security threats, while the last two address the service providers' security concerns for customers' workloads and customers' security concerns for the service providers, respectively.

**Collaborative Research: Automatic Extraction of Parallel I/O Benchmarks From HEC Applications**
Frank Mueller ; Xiaosong Ma
$499,999 by National Science Foundation
09/15/2009 - 08/31/2014
Parallel I/O benchmarks are crucial for application developers, I/O software/hardware designers, and center administrators. However, currently there lack portable and comprehensive I/O benchmarks for high-end storage systems. We address this gap by proposing automatic generation of parallel I/O benchmarks. More specifically, we target the automated creation of application I/O benchmarks.

**Computer-aided Human Centric Cyber Situation Awareness**
Doug Reeves ; Chris Healey
$979,463 by Pennsylvania State University
09/17/2009 - 09/16/2014
The NCSU participants will focus on the development of multi-level information fusion in the cyber world, VM-based automated vulnerability diagnosis of unknown cyber vulnerabilities, and application of video game technology to bridge the gap between the cyber and the human worlds.

**Quality of Information-Aware Networks for Tactical Applications (QUANTA)**
Munindar Singh
$669,028 by Penn State University (Army Research Laboratory)
09/28/2009 - 09/29/2014
This project will develop a computational approach to trust geared toward enhancing the quality of information in tactical networks. In particular, this project will develop a trust model that takes into account various objective and subjective qualities of service as well as the social relationships among the parties involved in a network who originate, propagate, or consume information. The proposed approach will build an ontology for quality of information and its constituent qualities, and will expand existing probabilistic techniques to multivalued settings. The project will develop a prototype software module that realize the techniques for producing trust assessments regarding the information exchanged.

**Collaborative Research: CPATH II: Incorporating Communication Outcomes into the Computer Science Curriculum**
Mladen Vouk ; Michael Carter (co-PI), Grad
$369,881 by National Science Foundation
10/1/2009 - 03/31/2015
In partnership with industry and faculty from across the country, this project will develop a transformative approach to developing the communication abilities (writing, speaking, teaming, and reading) of Computer Science and Software Engineering students. We will integrate communication instruction and activities throughout the curriculum in ways that enhance rather than replace their learning technical content and that supports development of computational thinking abilities of the students. We will implement the approach at two institutions. By creating concepts and resources that can be adapted by all CS and SE programs, this project also has the potential to increase higher education's ability nationwide to meet industry need for CS and SE graduates with much better
communication abilities than, on average, is the case today. In addition, by using the concepts and resources
developed in this project, CS and SE programs will be able to increase their graduates' mastery of technical content
and computational thinking.

**Scalable Statistical Computing for Physical Science Applications**
Nagiza Samatova ; Anatoli Melechko
$299,745 by Oak Ridge National Laboratory (US Dept of Energy)
10/5/2009 - 12/31/2013
Physical science applications such as nanoscience, fusion science, climate and biology generate large-scale data sets
from their simulations and high throughput technologies. This necessitates scalable technologies for processing and analyzing this data. We plan to research and develop advanced data mining algorithms for knowledge discovery from this complex, high-dimensional, and noisy data. We will apply these technologies to DOE-mission scientific applications related to fusion energy, bioenergy, understanding the impacts of climate extremes, and insider threat detection and mitigation.

**Ultrascale Computational Modeling of Phenotype-Specific Metabolic Processes in Microbial Communities**
Nagiza Samatova ; Anatoli Melechko
$454,311 by Oak National Laboratories - UT Battelle (DOE)
01/15/2010 - 12/31/2014
Ultrascale computational modeling methods will be developed for revealing phenotype-specific metabolic processes and their cross-talks and applied to the critical DOE problem of acid mine drainage (AMD). The apex of the project will be a systematic and iterative computational procedure for: (1) identification and expression-level characterization of phenotype-related genes; (2) reconstruction of phenotype-specific metabolic pathways enriched by these genes; (3) elucidation of the symbiotic and/or competing interplay between these pathways across species; and (4) characterization of evolutionary and environmental adaptation of the community.

**CAREER: Towards Exterminating Stealthy Rootkits -- A Systematic Immunization Approach**
Xuxian Jiang
$424,166 by the National Science Foundation
02/15/2010 - 01/31/2015
Stealthy rootkit attacks are one of the most foundational threats to cyberspace. With the capability of subverting the software root of trust of a computer system, i.e., the operating system (OS) or the hypervisor, a rootkit can instantly take over the control of the system and stealthily inhabit the victim. To effectively mitigate and defeat them, researchers have explored various solutions. Unfortunately, the state-of-the-art defense is mainly reactive and in a fundamentally disadvantageous position in the arms-race against these stealthy attacks. The proposed research aims to fundamentally change the arms-race by proposing a systematic immunization approach to proactively prevent and exterminate rootkit attacks. Inspired by our human immune system and fundamental biological design principles, the proposed approach transforms system software (i.e., the OS and the hypervisor) so that the new one will tip the balance of favor toward the rootkit defense. To accomplish that, we will investigate a suite of innovative techniques to preserve kernel/hypervisor control flow integrity and evaluate their effectiveness with real-world malware and infrastructures. The proposed education components include the creation and dissemination of unique hands-on course materials with live demos, lab sessions, and tutorials.

**II: NEW: ARC: A Root Cluster for Systems Research into Scalable Computing**
Frank Mueller ; Vincent Freeh ; Xiaohui (Helen) Gu ; Xuxian Jiang ; Xiaosong Ma
$549,999 by National Science Foundation
03/1/2010 - 02/28/2013
Scalability is one of the key challenges to computing with hundreds if not thousands of processor. Yet, testing software at scale with hundreds of processing cores is impossible if system software with privileged access rights needs to be modified. The inability to change system software at will in large-scale computing installations thus impedes progress in system software. This project creates a mid-size computational infrastructure, called ARC (A Root Cluster), that directly supports research into scalability for system-level software solutions. ARC empowers users temporarily with administrator (root) rights and allows them to replace arbitrary components of the software stack. Such replacements range from entire operating systems over drivers, kernel modules to runtime libraries, middleware and system tools. ARC ultimately enables a multitude of systems research directions to be assessed under scalability that could otherwise not be conducted. Through ARC, methodologies for scalability of
Experimental system software in various institutional projects and beyond can be explored and systematically improved. ARC is positioned to benefit the software systems community and indirectly science in general by this assessment of system software requirements at scale.

**An Integrated Architecture For Automatic Indication, Avoidance and Profiling of Kernel Rootkit Attacks**

Xuxian Jiang  
*$200,000 by Purdue University/US Air Force-Office of Scientific Research*  
04/1/2010 - 03/31/2014  
Kernel rootkit attacks are one of the most stealthy yet foundational threats to cyberspace. Unfortunately, current research and practice in kernel rootkit defense is mainly reactive and in a fundamentally disadvantageous position relative to the kernel attackers. In this work, we advocate the development of strategic kernel rootkit defense that is proactive with early kernel rootkit threat indication, automatic when performing rootkit attack avoidance and forensics, and integrated with all these capabilities enabled under the same architecture for production systems. Specifically, we envision a virtualization-based rootkit-prevention architecture that is capable of (1) indicating a kernel rootkit threat before it strikes, (2) avoiding the attack by "steering" the targeted production system away from the threat, and (3) profiling the (possibly zero-day) kernel rootkit for future kernel protection. The architecture is deployable in a wide range of virtualization-based cyber infrastructures, such as data centers, enterprises, and cloud computing environments (e.g., VCL).

**Collaborative Research: Dynamic Staging Architecture For Accelerating I/O Pipelines**

Mladen Vouk; Xiaosong Ma; Scott Klacky  
*$133,933 by National Science Foundation*  
04/1/2010 - 12/31/2013  
In the proposed work, we will investigate innovative techniques to enable efficient I/O staging at a variety of locations in the HEC storage stack. The proposed work will improve the application-visible I/O performance in Peta-scale applications and explore the scalable incorporation of solid state drives (SSDs) into the HEC I/O hierarchy.

**North Carolina Bio-Preparedness Collaboration (NCB-Prepared)**

Marc Hoit ; Laurie Williams  
*$1,760,486 by US Dept of Homeland Security via UNC-CH*  
06/1/2010 - 09/30/2014  
For this project, we will explore the potential benefits of symptomatic and syndromic surveillance using existing NCB-Prepared data sources, including EMS, ED and poison control data, to improve surveillance capacity and outbreak response relating to the area of food safety. During the initial phase, we will examine two years of NCB-Prepared national poison control data to evaluate its utility related to evaluating trends in foodborne illness. This initial phase will produce preliminary statistics by working with the SAS analytics team of NCB-Prepared to incorporate poison control data into the system. Some possible analytical techniques employed may include descriptive statistics, Fourier analysis and cluster analysis. Results from this phase will provide a baseline for identifying potential foodborne illness outbreaks in the future as part of the NCB-Prepared system. This first phase will demonstrate basic functionality of the poison control data by July 30, 2012. During the second phase, we will continue to explore relationships between the poison control, EMS and ED data in relationship to their ability to improve early detection of potential foodborne illness outbreaks. After the first phase, project will have a national poison center data set relating to food safety issues available covering at least 10 year. For example, we will select key national outbreaks and determine if the historical data provided to NCB-Prepared could have been used to provide earlier signals that an outbreak was ongoing. A preliminary result will be produced for this second phase by September 30. Additional efforts will be made to help the team explore relationships between the poison control, EMS and ED data as they pertain to foodborne illness outbreaks.

**Collaborative Research: II-EN: Infrastructure Support for Software Testing Research**

Tao Xie  
*$279,000 by the National Science Foundation*  
06/1/2010 - 06/30/2013  
The objective of this project is to enhance the Software-artifact Infrastructure Repository in order to enable the evaluation of various new research projects on software testing such as unit test generation.
**Predictive Anomaly Management For Resilient Virtualized Computing Infrastructures**

Xiaohui (Helen) Gu

$300,000 by Army Research Office

07/1/2010 - 08/15/2014

Large-scale virtualized computing infrastructures have become important platforms for many real-world systems such as cloud computing, virtual computing lab, and massive information processing. However, due to its inherent complexity and sharing nature, virtualized computing infrastructures are inevitably prone to various system anomaly problems such as software/hardware failures, performance anomalies, and malicious attacks. The goal of this project is to develop a new predictive anomaly management system to enhance the resilience of virtualized computing infrastructure. The major contributions will be an integrated framework consisting of four synergistic techniques: 1) scalable runtime virtual machine monitoring; 2) self-evolving online anomaly prediction; 3) speculative anomaly diagnosis; and 4) online anomaly correction.

**NeTS: Small: Investigation of Human Mobility: Measurement, Modeling, Analysis, Applications and Protocols**

Injong Rhee

$298,356 by National Science Foundation

08/1/2010 - 07/31/2015

Simulating realistic mobility patterns of mobile devices is important for the performance study of mobile networks because deploying a real testbed of mobile networks is extremely difficult, and furthermore, even with such a testbed, constructing repeatable performance experiments using mobile devices is not trivial. Humans are a big factor in simulating mobile networks as most mobile nodes or devices (cell phones, PDAs and cars) are attached to or driven by humans. Emulating the realistic mobility patterns of humans can enhance the realism of simulation-based performance evaluation of human-driven mobile networks. Our NSF-funded research that ends this year has studied the patterns of human mobility using GPS traces of over 100 volunteers from five different sites including university campuses, New York City, Disney World, and State Fair. This research has revealed many important fundamental statistical properties of human mobility, namely heavy-tail flight distributions, self-similar dispersion of visit points, and least-action principle for trip planning. Most of all, it finds that people tend to optimize their trips in a way to minimize their discomfort or cost of trips (e.g., distance). No existing mobility models explicitly represent all of these properties. Our results are very encouraging and the proposed research will extend the work well beyond what has been accomplished so far. We will perform a measurement study tracking the mobility of 100 or 200 students in a campus simultaneously, and analyze the mobility patterns associated with geo-physical and social contexts of participants including social networks, interactions, spatio-temporal correlations, and meetings. We will cast the problem of mobility modeling as an optimization problem borrowing techniques from AI and Robotics which will make it easy to incorporate the statistical properties of mobility patterns commonly arising from group mobility traces. The realism of our models in expressing human mobility will surpass any existing human mobility models. We will develop new routing protocols leveraging the researched statistical properties found in real traces to optimize delivery performance. The end products of the proposed research is (a) a new human mobility model that is capable of realistically expressing mobility patterns arising from reaction to social and geo-physical contexts, (b) their implementation in network simulators such as NS-2/3 and GloMoSim, (c) mobility traces that contain both trajectories of people in a university campus and contact times, (d) new efficient routing protocols for mobile networks.

**The Leonardo Project: An Intelligent Cyberlearning System for Interactive Scientific Modeling in Elementary Science Education**

James Lester ; Bradford Mott ; Michael Carter ; Eric Weibe

$3,499,409 by National Science Foundation

08/15/2010 - 07/31/2015

The goal of the Leonardo project is to develop an intelligent cyberlearning system for interactive scientific modeling. Students will use Leonardo's intelligent virtual science notebooks to create and experiment with interactive models of physical phenomena. As students design and test their models, Leonardo's intelligent virtual tutors will engage them in problem-solving exchanges in which they will interactively annotate their models as they devise explanations and make predictions. During the project, the Leonardo virtual science notebook system will be rolled out to 60 classrooms in North Carolina, Texas, and California.

**TC: Small: Defending against Insider Jammers in DSSS- and FH-Based Wireless Communication Systems**

Peng Ning ; Huaiyu Dai, ECE ; Mladen Vouk
Jamming resistance is crucial for applications where reliable wireless communication is required, such as rescue missions and military applications. Spread spectrum techniques such as Frequency Hopping (FH) and Direct Sequence Spread Spectrum (DSSS) have been used as countermeasures against jamming attacks. However, these anti-jamming techniques require that senders and receivers share a secret key to communicate with each other, and thus are vulnerable to insider attacks where the adversary has access to the secret key. The objective of this project is to develop a suite of techniques to defend against insider jammers in DSSS and FH based wireless communication systems. We will develop novel and efficient insider-jamming-resistant techniques for both DSSS- and FH-based wireless communication systems. Our proposed research consists of two thrusts. The first thrust is to develop novel spreading/despreading techniques, called DSD-DSSS (which stands for DSSS based on Delayed Seed Disclosure), to enhance DSSS-based wireless communication to defend against insider jamming threats, while the second thrust is to develop a new approach, called USD-FH (which stands for FH based on Uncoordinated Seed Disclosure), to enable sender and receivers using FH to communicate without pre-establishing any common secret hopping pattern. A key property of our new approaches is that they do not depend on any secret shared by the sender and receivers. Our solution has the potential to significantly enhance the anti-jamming capability of today?s wireless communication systems.

**Damsel: A Data Model Storage Library for Exascale Science**  
Nagiza Samatova  
$330,000 by US Department of Energy  
09/1/2010 - 03/31/2014  
Computational science applications have been described as having one of seven motifs (the ?seven dwarfs?), a particular pattern of computation and communication. While the exercise has not been performed, one can imagine that these applications can also be grouped into a number of data model motifs, describing the way data is organized and accessed during simulation and analysis. The goal of this project is to determine the data model motifs present in computational science applications, to identify where current I/O software falls short in usability and performance for each of these motifs, and to construct a software toolkit for developing optimized I/O support for computational science data models at exascale.

**Collaborative Research: Understanding Climate Change: A Data Driven Approach**  
Nagiza Samatova ; Frederick Semazzi  
$1,815,739 by National Science Foundation  
09/1/2010 - 08/31/2015  
The goal is to provide a computational capability for effective and efficient exploration of high-resolution climate networks derived from multivariate, uncertain, noisy and spatio-temporal climate data. We plan to increase the efficiency and climatologically relevancy of the network patterns identification through integrated research activities focused on: (a) supporting comparative analysis of multiple climate networks; (b) constraining the search space via exploiting the inherent structure (e.g., multi-partite) of climate networks; (c) establishing the foundation to efficiently update solutions for perturbed (changing) graphs; and (d) designing and implementing parallel algorithms scalable to thousands of processors on multi-node multi-core supercomputer architectures.

**Fault Localization Based on Combinatorial Testing**  
Tao Xie  
$124,999 by Univ of Texas Arlington via NIST  
09/1/2010 - 06/30/2013  
Testing and fault localization are two essential activities performed in virtually every engineering project. These activities can be very laborious and time-consuming. How to improve the effectiveness and efficiency of these two activities has been a major focus in many areas of engineering research. This project will develop effective and efficient fault localization techniques based on combinatorial testing, and adapt these techniques to produce domain-specific techniques applicable to different domains.

**Emerging Research-Empirical Research**--An Integrated Model of Cognitive and Affective Scaffolding for Intelligent Tutoring Systems  
James Lester ; Eric Wiebe
Intelligent tutoring systems leverage artificial intelligence technologies to create effective learning experiences for students. The project targets the design, implementation, and empirical validation of an integrated model of cognitive and affective scaffolding for intelligent tutoring systems. Computational models of tutorial strategies will be automatically acquired through machine learning techniques from human-human tutorial dialogue traces. The resulting models of cognitive and affective scaffolding, which are based on hierarchical hidden Markov models, will be incorporated into an intelligent tutoring system, JavaTutor. JavaTutor will be evaluated with first year university computer science students to assess its impact on student learning gains and motivation.

SHF: Small: RESYST: Resilience via Synergistic Redundancy and Fault Tolerance for High-End Computing
Frank Mueller
$376,219 by National Science Foundation
10/1/2010 - 09/30/2015
In High-End Computing (HEC), faults have become the norm rather than the exception for parallel computation on clusters with 10s/100s of thousands of cores. As the core count increases, so does the overhead for fault-tolerant techniques that rely on checkpoint/restart (C/R) mechanisms. At 50% overheads, redundancy is a viable alternative to fault recovery and actually scales, which makes the approach attractive for HEC. The objective of this work is to develop a synergistic approach by combining C/R-based fault tolerance with redundancy in computer to achieve high levels of resilience. This work alleviates scalability limitations of current fault tolerant practices. It contributes to fault modeling as well as fault detection and recovery in significantly advancing existing techniques by controlling levels of redundancy and checkpointing intervals in the presence of faults. It is transformative in providing a model where users select a target failure probability at the price of using additional resources.

Investigation of Application Service Architectures for Future Internet Testbeds
Injong Rhee
$150,000 by ETRI (Research Inst.-Electronics & Telecommunications)
10/15/2010 - 01/14/2014
In this collaborative research between NCSU and ETRI, both institutions investigate the application service architectures for future internet testbeds. The collaboration includes surveys, architecture designs and validation of the application service architectures for various types of future internet services.

Triangle Computer Science Distinguished Lecturer Series
Franc Brglez
$55,300 by Army Research Office
01/3/2011 - 01/2/2014
Since 1995, the Triangle Computer Science Distinguished Lecturer Series (TCSDLS) has been hosting influential university researchers and industry leaders from computer-related fields as speakers at the three universities within the Research Triangle Area. The lecturer series, sponsored by the Army Research Office (ARO), is organized and administered by the Computer Science departments at Duke University, NC State University, and the University of North Carolina at Chapel Hill. This proposal argues for continuation, for an additional 3 years, of this highly successful lecturer series.

Scalable and Power Efficient Data Analytics for Hybrid Exascale Systems
Nagiza Samatova
$364,944 by Oak Ridge National Laboratories/ US Dept. of Energy
01/31/2011 - 12/31/2014
The specific objectives of the proposal are as follows: 1. Design and develop data mining kernels and algorithms for acceleration on hybrid architectures which include many-core systems, GPUs, and other accelerators. 2. Design and develop approximate scalable algorithms for data mining and analysis kernels enabling faster exploration, more efficient resource usage, reduced memory footprint, and more power efficient computations. 3. Design and develop index-based data analysis and mining kernels and algorithms for performance and power optimizations including index-based perturbation analysis kernels for noisy and uncertain data. 4. Demonstrate the results of our project by enabling analytics at scale for selected applications on large-scale HPC systems.
Runtime System for I/O Staging in Support of In-Situ Processing of Extreme Scale Data
Nagiza Samatova
$286,140 by Oak Ridge National Laboratory/Dept. of Energy
01/31/2011 - 08/31/2014
Accelerating the rate of insight and scientific productivity demands new solutions to managing the avalanche of data expected in extreme-scale. Our approach is to use tools that can reduce, analyze, and index the data while it is still in memory (referred to as "in-situ" processing of data). In order to deal with the large amount of data generated by the simulations, our team has partnered with many application teams to deliver proven technology that can accelerate their knowledge discovery process. These technologies include ADIOS, FastBit, and Parallel R. In this proposal we wish to integrate these technologies together, and create a runtime system that will allow scientist to create an easy-to-use scientific workflow system, that will run in situ, in extra nodes on the system, which is used to not only accelerate their I/O speeds, but also to pre-analyze, index, visualize, and reduce the overall amount of information from these solutions.

CISCO-NCSU Internship Program
Peng Ning
$160,000 by Cisco Systems, Inc.
07/12/2011 - 07/14/2016
This is a pilot internship program between NCSU and Cisco for 4 undergraduate students to learn through working part-time on real life problems for Cisco with the hope that this pilot program can grow and develop into a long term working relationship. Specifically, NCSU students will participate in Cisco Software Application Support plus Upgrades (SASU) projects and/or conduct research for SASU. This will be done with an understanding that the interns are students, and as such are learning and being trained with the training coming from both the Cisco (for SASU-specific skills), and NCSU (through the undergraduate program they are enrolled in) in general relevant skills.

NeTS:Small: Computationally Scalable Optical Network Design
George Rouskas
$429,995 by NSF
08/1/2011 - 07/31/2015
Optical networking forms the foundation of the global network infrastructure, hence the planning and design of optical networks is crucial to the operation and economics of the Internet and its ability to support critical and reliable communication services. With this research project we aim to make contributions that will lead to a quantum leap in the ability to solve optimally a range of optical design problems. In particular, we will develop compact formulations and solution approaches that can be applied efficiently to instances encountered in Internet-scale environments. Our goal is to lower the barrier to entry in fully exploring the solution space and in implementing and deploying innovative designs. The solutions we will develop are “future-proof” with respect to advances in DWDM transmission technology, as the size of the corresponding problem formulations is independent of the number of wavelengths.

NeTS: Large: Collaborative Research: Network Innovation Through Choice
Rudra Dutta ; George Rouskas
$643,917 by National Science Foundation
09/15/2011 - 09/30/2015
This project builds on the SILO project that started in 2006 to design a new architecture for the Internet. In this new project, we will collaborate with teams of researchers from the University of Kentucky, the University of Massachusetts, and RENCI, to design critical parts of a new architecture for the Internet that will support the flexible use of widely applicable information transport and transformation modules to create good solutions for specific communication applications. The key idea is to allow a network to offer information transformation services at the edge or in the core transparently to the application, and creating a framework in which application can issue a request not only for communication but for specific reusable services. We also propose research tasks that will enable network virtualization and isolation seamlessly at many levels, currently a difficult but highly relevant problem in practical networking.

Investigating An Intelligent Cyberlearning System for Interactive Museum-based Sustainability Modeling
James Lester ; James Minogue ; Bradford Mott ; Patrick Fitzgerald
By leveraging intelligent cyberlearning technologies, rich media, and advanced digital storytelling, the Future Worlds demonstration project will enable children at a museum to take virtual journeys through time to explore the impact of social and economic decisions on the environment. Guided by a virtual environmentalist who will narrate their journeys and offer problem-solving advice, visitors will travel to the past, present, and future to explore the relationship between conservation decisions, energy use, and population growth on Earth's ecosystem.

NSA / North Carolina State University Science of Security Lablet: Analytics Supporting Security Science
Laurie Williams ; Michael Rappa
$2,475,248 by National Security Agency via US Army Research Office
10/ 1/2011 - 11/30/2014
North Carolina State University (NCSU), led by the Department of Computer Science and the Institute of Advanced Analytics in conjunction with the Institute for Next Generation IT Systems (ITng), will create and manage a Science of Security Lablet (SOSL) research organization on behalf of the National Security Agency (NSA). The SOSL research organization will conduct and coordinate basic science research projects focused on the Science of Security. SOSL will coordinate with related Lablet activities sponsored by NSA at Carnegie Mellon University and at University of Illinois at Urbana Champaign (UIUC). SOSL will also coordinate with the Security Science Virtual Organization at Vanderbilt University. The coordination will be in the form of workshops and technical exchanges.

Improving Energy Efficiency of Smartphones Through Elimination of Unnecessary WiFi Scans Using Cellular Signal Information
Mladen Vouk ; Kyunghan Lee
$75,000 by Samsung Electronics Co., Ltd. - Korea
12/ 1/2011 - 05/31/2014
In this project, a system providing intelligence to WiFi AP scan operations will be studied and developed for Android-operated smart devices, to reduce energy consumption in using WiFi chipsets. We ultimately aim at eliminating WiFi scans when users are mainly moving around their living boundaries by predicting which WiFi AP to connect without scanning. The prediction will be performed based on matching algorithms that find the similarity between a short term observation of cellular signal information measured in a smart device and a database of WiFi APs containing cellular base station IDs and their signal strength information per WiFi AP accumulated whenever the device is connected to a specific WiFi AP. Given our small scale measurement of energy consumption showing that WiFi scan operations drain about 10–15% of battery capacity of smartphones in their daily usages, our proposed algorithm is expected to be able to save substantial amount of energy in smart devices.

Improving Energy and Data Communication Efficiencies of Smartphones through a Receiver-based TCP Control Mechanism for Cellular Networks
Mladen Vouk ; Kyunghan Lee
$75,000 by Samsung Electronics Co., Ltd. - Korea
12/ 1/2011 - 05/31/2014
As smart devices like smartphones and tablet computers become prevalent, TCP performance over cellular networks is of growing importance. However, various measurement studies reveal that TCP suffers from excessively long delay as well as throughput degradation in cellular networks. In this project we will conduct extensive experiments over the 3G/4G networks of various cellular network carriers and investigate several under-developed issues: the current 3G/4G networks are over-buffered (termed as bufferbloat) and the excessive buffers void TCP congestion control who relies on packet loss to detect network congestion. Since all the overshot packets are absorbed by the buffers, no packet is lost and TCP will keep increasing its congestion window even if it is already much larger than the underlying bandwidth-delay product. To mitigate such problems, smartphones set the maximum receive buffer size to a relatively small value. Although this simple provisional scheme alleviates the aforementioned problem, it is losing performance in a number of scenarios due to its static nature. Through this project, we aim at proposing an adaptive receive window adjustment algorithm that requires changes only in receiver-side and implement it in Android phones and tablets.

Scalable Statistical Computing For Physical Science Applications
Nagiza Samatova ; Anatoli Melechko
$354,646 by US Department of Energy (DOE)
12/2/2011 - 06/30/2015
Physical science applications such as nanoscience, fusion science, climate and biology generate large-scale data sets from their simulations and high throughput technologies. This necessitates scalable technologies for processing and analyzing this data. We plan to research and develop advanced data mining algorithms for knowledge discovery from this complex, high-dimensional, and noisy data. We will apply these technologies to DOE-mission scientific applications related to fusion energy, bioenergy, understanding the impacts of climate extremes, and insider threat detection and mitigation.

CAREER: Enable Robust Virtualized Hosting Infrastructures via Coordinated Learning, Recovery, and Diagnosis
Xiaohui (Helen) Gu
$450,000 by National Science Foundation
01/1/2012 - 12/31/2016
Large-scale virtualized hosting infrastructures have become the fundamental platform for many real world systems such as cloud computing, enterprise data centers, and educational computing lab. However, due to their inherent complexity and sharing nature, hosting infrastructures are prone to various runtime problems such as performance anomalies and software/hardware failures. The overarching objective of this proposal is to systematically explore innovative runtime reliability management techniques for large-scale virtualized hosting infrastructures. Our research focuses on handling performance anomalies in distributed systems that are often very difficult to reproduce offline. Our approach combines the power of online learning, knowledge-driven first-response recovery, and in-situ diagnosis to handle unexpected system anomalies more efficiently and effectively. We aim at transforming the runtime system anomaly management from a trial-and-error guessing game into an efficient knowledge-driven self-healing process.

Type I: ENGAGE: Immersive Game-Based Learning for Middle Grade Computational Fluency
James Lester ; Kristy Boyer ; Bradford Mott ; Eric Wiebe
$1,047,996 by National Science Foundation
01/1/2012 - 12/31/2014
The goal of the ENGAGE project is to develop a game-based learning environment that will support middle grade computer fluency education. It will be conducted by an interdisciplinary research team drawn from computer science, computer science education, and education. In collaboration with North Carolina middle schools, the research team will design, develop, deploy, and evaluate a game-based learning environment that enables middle school students to acquire computer fluency knowledge and skills. The ENGAGE project will be evaluated in middle grade classrooms with respect to both learning effectiveness and engagement.

Investigation of a Novel Indoor Localization (Navigation) Technique For Smartphones
Mladen Vouk ; Kyunghan Lee
$75,000 by Samsung Telecommunications America, LLC - TX
01/2/2012 - 12/31/2014
In this project, we aim at developing a new indoor localization technique relying on low-frequency radio that can penetrate indoor obstacles (or detour obstacles by diffraction in the shortest path) by its long wave characteristics. The smartphone running this system would be able to identify its position by measuring straight-line distances from a few radio transmission towers deployed in a city scale (or in a district scale). Straight-line distances that have not been affected by indoor obstacles would be able to provide a three-dimensional position including floor information and position information in the floor (e.g., store information in a shopping complex).

Operating and Runtime System Resilience on the Path to Exascale
Frank Mueller
$55,448 by Sandia National Laboratory via US Dept of Energy
01/12/2012 - 01/12/2013
For large-scale high-performance computing (HPC) systems with 10s/100s of thousands of cores, faults have become the norm rather than the exception. To address this problem, we propose to develop and evaluate advanced mechanisms to protect the operating and runtime systems and thereby increase resilience to failures.
Comprehension-Driven Program Analysis (CPA) for Malware Detection in Android Phones
Xuxian Jiang
$556,488 by Iowa State University/US Air Force-Research Laboratory
02/3/2012 - 08/2/2016
Our goal is to develop new automated program analyses capable of proving that the application programs have security properties of interest to the DoD and demonstrate those analyses in the form of tools designed specifically to keep malicious code out of DoD Android-based mobile application marketplaces.

Scalable Data Management, Analysis, and Visualization (SDAV) Institute
Nagiza Samatova; Anatoli Melechko
$750,000 by US Department of Energy
02/15/2012 - 02/14/2017
The SDAV is a unique and comprehensive combination of scientific data management, analysis, and visualization expertise and technologies aimed at enabling scientific knowledge discovery for applications running on state-of-the-art computational platforms located at DOE's primary computing facilities. This integrated institute focuses on tackling key challenges facing applications in our three focus areas through a well-coordinated team and management organization that can respond to changing technical and programmatic objectives. The proposed work portfolio is a blend of applied research and development, aimed at having key software services operate effectively on large distributed memory multi-core, and many-core platforms and especially DOE's open high performance computing facilities. Our goal is to create an integrated, open source, sustainable framework and software tools for the science community.

Access Control Policy Tool (ACPT) Phase II Development
Tao Xie
$30,000 by National Institute of Standards & Technology
03/19/2012 - 02/18/2013
This project enhances the Access Control Policy Testing (ACPT) tool to support information sharing between affiliated organizations. The sharing of information should comply with security and privacy policies from federal, state, local or tribal security and privacy status. ACPT allows policy authors to compose and combine policies based on predefined templates of practical policy models. ACPT converts resulting models with user-provided attributes to machine-readable XACML representation, which can be directly enforced by information sharing entities.

Learning Environments Across Disciplines LEADS: Supporting Technology Rich Learning Across Disciplines: Affect Generation and Regulation During Co-Regulated Learning in Game-Based Learning Environments
James Lester
$77,864 by McGill University/Social Sciences and Humanities Research Council of Canada
04/1/2012 - 03/31/2015
Contemporary research on multi-agent learning environments has focused on self-regulated learning (SRL) while relatively little effort has been made to use co-regulated learning as a guiding theoretical framework (Hadwin et al., 2011). This oversight needs to be addressed given the complex nature that self-and other-regulatory processes play when human learners and artificial pedagogical agents (APAs) interact to support learners' internalization of cognitive, affective, and metacognitive (CAM) SRL processes. We will use the Crystal Island learning environment to investigate these issues.

Analytics-driven Efficient Indexing and Query Processing of Extreme Scale AMR Data
Nagiza Samatova
$149,999 by National Science Foundation
05/1/2012 - 12/31/2014
One of the most significant advances for large-scale scientific simulations has been the advent of Adaptive Mesh Refinement, or AMR. By using dynamic gridding, AMR can achieve substantial savings in memory, computation, and disk resources while maintaining or even increasing simulation accuracy, relative to static, uniform gridding. However, the resultant non-uniform structure of the simulation mesh produced by AMR methods cause inefficient post-simulation access patterns during AMR data analytics that is becoming a substantial bottleneck given the exponential increase in simulation output. Toward bridging this gap in efficient analytics support for AMR data, we propose an integrated, three-prong approach that aims: (a) To devise an AMR query model; (b) To explore effective
indexing methods for AMR data analytics; and (c) To investigate data storage layout strategies for AMR data retrieval optimized for analytics-induced heterogeneous data access patterns.

**SHF: Small: Scalable Trace-Based Tools for In-Situ Data Analysis of HPC Applications (ScalaJack)**
Frank Mueller  
$457,395 by National Science Foundation  
06/1/2012 - 05/31/2015  
This decade is projected to usher in the period of exascale computing with the advent of systems with more than 500 million concurrent tasks. Harnessing such hardware with coordinated computing in software poses significant challenges. Production codes tend to face scalability problems, but current performance analysis tools seldom operate effectively beyond 10,000 cores. We propose to combine trace analysis and in-situ data analysis techniques at runtime. Application developers thus create ultra low-overhead measurement and analysis facilities on-the-fly, customized for the performance problems of particular application. We propose an analysis generator called ScalaJack for this purpose. Results of this work will be contributed as open-source code to the research community and beyond as done in past projects. Pluggable, customization analysis not only allows other groups to build tools on top of our approach but to also contribute components to our framework that will be shared in a repository hosted by us.

**SHF: Small: Collaborative Research: Constraint-Based Generation of Database States for Testing Database Applications (Supplement)**
Tao Xie  
$8,000 by NSF  
06/1/2012 - 06/30/2013  
The objective of this project is to write parameterized mock objects for the database API to facilitate the application of Pex on database applications written in the Microsoft .NET platforms.

**Joint Faculty Agreement, Xiaosong Ma (Supplement)**
Xiaosong Ma  
$80,868 by ORNL - UT-Battelle LLC  
08/16/2012 - 08/15/2013  
This joint appointment will allow the PI to continue her long-term collaboration with ORNL researchers. Specifically for 2012-2013, the joint teams will focus on several HPC projects, including active storage on new memory media, automatic creation of parallel I/O benchmarks, and application I/O workload analysis based on server-side aggregate I/O load traces. The PI will supervise NCSU graduate students performing PhD research on these joint projects, who will also receive mentoring from ORNL collaborators.

**A Hybrid Computing Testbed For Mobile Threat Detection and Enhanced Research and Education in Information**
Xuxian Jiang; Peng Ning  
$150,000 by US ARMY - ARO  
08/21/2012 - 08/20/2014  
This proposal proposes to build a hybrid computing testbed for detecting emerging mobile threats and improving research and education in information security at North Carolina State University (NCSU). The proposed computing testbed will be developed on the basis of the current Virtual Computing Lab (VCL) environment to provide a prototyping environment, which will be used for rapid development and evaluation of a variety of ongoing research projects funded by DoD and other government agencies. Also, it supports research-related education components in system oriented information security courses at NCSU. Moreover, we propose to equip the hybrid testbed with various mobile devices for detecting and experimenting with emerging mobile threats (e.g., Android malware). One key use of this hybrid testbed is to detect emerging or new threats against current mobile gadgets (e.g., smart phones and tablets), which is not available or possible yet based on current computing resources. The results and experience gained from operating and managing a real computing testbed will also provide practical insights into emerging threats on mobile Internet for students and researchers. The experience in managing and operating such a hybrid computing testbed will also be valuable to identify new security and performance problems and develop their practical solutions.
Co-Design of Hardware / Software for Predicting MAV Aerodynamics
Frank Mueller
$799,999 by Virginia Polytechnic Institute and State University (US Air Force)
09/ 1/2012 - 10/31/2017
This proposal provides subcontractor support to Virginia Tech for a proposal submitted under the Air Force's Basic Research Initiative. The proposal will focus on development of reconfigurable mapping strategies for porting multi-block structured and unstructured-mesh CFD codes to computing clusters containing CPU/GPU processing units.

Workshop: HCC: VL/HCC 2012 Doctoral Consortium
Emerson Murphy-Hill
$27,061 by National Science Foundation
09/ 1/2012 - 02/28/2013
Recent advances in computing have led to continually deeper integration between computers and human society. Yet as socio-technical systems have grown in complexity, their underlying computation has become increasingly difficult for people to express, manipulate, and understand. This proposal aims to advance knowledge and understanding of solutions to these problems by supporting a Doctoral Consortium (DC) at the IEEE Conference on Visual Languages and Human-Centric Computing (VL/HCC).

III: Small: Optimization Techniques for Scalable Semantic Web Data Processing in the Cloud
Kemafor Ogan
$446,942 by National Science Foundation
09/ 1/2012 - 08/31/2015
Achieving scalable processing of the increasing amount of publicly-available Semantic Web data will hinge on parallelization. The Map-Reduce programming paradigm recently emerged as a de-facto parallel data processing standard and has demonstrated effectiveness with respect to structured and unstructured data. However, Semantic Web data presents challenges not adequately addressed by existing techniques due to its flexible, fine-grained data model and the need to reason beyond explicitly represented data. This project will investigate optimization techniques that address these unique challenges based on rethinking Semantic Web data processing on Map-Reduce platforms from the ground, up - from query algebra to query execution.

Lecture Hall Polytopes, Inversion Sequences, and Eulerian Polynomials
Carla Savage
$30,000 by Simons Foundation
09/ 1/2012 - 08/31/2017
Over the past ten years, lecture hall partitions have emerged as fundamental structures in combinatorics and number theory, leading to new generalizations and new interpretations of several classical theorems. This project takes a geometric view of lecture hall partitions and uses polyhedral geometry to investigate their remarkable properties.

TWC: Small: Collaborative: Characterizing the Security Limitations of Accessing the Mobile Web
William Enck
$167,000 by NSF
10/ 1/2012 - 09/30/2015
Mobile browsers are beginning to serve as critical enablers of modern computing. With a combination of rich features that rival their desktop counterparts and strong security mechanisms such as TLS/SSL, these applications are becoming the basis of many other mobile apps. Unfortunately, the security guarantees provided by mobile browsers and the risks associated with today's mobile web have not been evaluated in great detail. In the proposed work, we will investigate the security of mobile browsers and the mobile specific websites they access. Characterizing and responding to the threats in this space is critical, especially given that cellular devices are used by more than five billion people around the world.

SHF: Small: Expressive and Scalable Notifications from Program Analysis Tools
Emerson Murphy-Hill; Sarah Heckman
$250,000 by National Science Foundation
10/ 1/2012 - 09/30/2015
A wide variety of program analysis tools have been created to help software developers do their jobs, yet the output of these tools are often difficult to understand and vary significantly from tool to tool. As a result, software
developers may waste time trying to interpret the output of these tools, instead of making their software more capable and reliable. This proposal suggests a broad investigation of several types of program analysis tools, with the end goal being an improved understanding of how program analysis tools can inform developers in the most expressive and uniform way possible. Once this goal is reached, we can create program analysis tools that enable developers to make tremendous strides towards more correct, more reliable, and more on-time software systems.

Differential Analysis on Changes in Medical Device Software
Laurie Williams
$60,000 by NSF
10/1/2012 - 09/30/2014
As medical device technology evolves, so too does the software upon which the technology often relies. Changes in device software, after it has been approved or cleared, may compromise the safety of that device. Assessing the safety of such changes presents special challenges to regulators at the FDA. This project explores differential analysis techniques to assess the effects of software changes on device safety.

6fusion Collaborative Infrastructure Support (previous title: 6fusion Collaborative Infrastructure Support 11/1/2012-8/1/2013)
John Bass
$27,000 by 6fusion USA Inc
11/1/2012 - 08/1/2013
ITng Services will provide the following: - Two storage systems and set of Intel-based blades. These devices will be connected via gigabit ethernet networking. - As-needed support during normal business hours (8a-5p Eastern Time, Monday-Friday). Response for any support request occurring within the above business hours will receive a response within one business day upon receipt of the request. Otherwise, support is best effort. - All systems will be monitored by the lab Cacti installation.

Social Computing and Community Engagements for Collaborative Service Marketplace
Munindar Singh
$55,000 by Xerox Corporation
12/1/2012 - 11/30/2013
We propose to investigate the challenges of understanding social computing applied in the enterprise in the context of facilitating engagements among communities of service providers, requesters, and partners in enterprise service marketplace. Specifically, we will study the problems of (1) detecting and recommending relevant communities based on an analysis of interactions and transactions in the service marketplace to improve the engagement, and (2) building an intelligent model for recommending services and workflows to maximize value in the marketplace.

Division of Employment Security: Business Process Reengineering Project (NC Dept Commerce)
John Streck ; Mladen Vouk ; John Bass ; Dennis Kekas ; Munindar Singh
$30,000 by NC Division of Employment Security via NC Department of Commerce
12/3/2012 - 01/31/2013
The primary objective of the project is to help NCDES assess automatability of its workflows. This will lead into facilitation of NCDES?s successful participation in the Southeast Consortium for Unemployment Benefits Integration (SCUBI), and eventually into assisting NCDES in successfully implementing a new Primary Information System.

Detection and Transition Analysis of Engagement and Affect in a Simulation-Based Combat Medic Training Environment
James Lester ; Bradford Mott
$478,592 by Columbia University/US Army Research Laboratory
12/19/2012 - 06/17/2015
The project will develop automated detectors that can infer the engagement and affect of trainees learning through the vMedic training system. This project will combine interaction-based methods for detecting these constructs (e.g., models making inference solely from the trainee?s performance history) with scalable sensor-based methods for detecting these constructs, towards developing models that can leverage sensor information when it is available, but which can still assess trainee engagement and affect effectively even when sensors are not available. The automated detectors will be developed, integrated together, and validated for accuracy when applied to new trainees.
**BPC-AE: Scaling the STARS Alliance: A National Community for Broadening Participation Through Regional Partnerships**  
**Tiffany Barnes**  
**$150,000 by UNC-UNC Charlotte (NSF)**  
**01/1/2013 - 12/31/2014**

The Beauty and Joy of Computing project presents a unique opportunity to scale the STARS Alliance further while also enhancing national efforts to engage more high school teachers and students in teaching and learning computing and build stronger university/college/K12 partnerships. Through this supplement, we will extend the Alliance with at least three new STARS Computing Corps, providing leadership training to a group of 8-10 students in each Corps, all focused on supporting the BJC effort. New Corps will provide teaching assistance to high school teachers implementing the BJC course through classroom visits and monthly Computer Science Teacher Association chapter meetings. These new STARS Computing Corps will also teach BJC material either through in middle school Citizen Schools after-school programs, and K-12 summer camps. This will provide a vibrant community of support for high school teachers and students engaging the new BJC course.

**Continued PDSS and Pentairweb Support**  
**John Bass**  
**$15,000 by Pentair Water Pool and Spa, Inc**  
**01/1/2013 - 03/31/2013**

The following items will be completed in Q1 of 2013: 1) Continued support of Stark Media in implementation of a enterprise level web application that requests sensor data from PDSS; 2) Continued support of PDSS; 3) Continued support of Pentairweb; 4) Review of ?simplify? time series query where data is optimized for display not analytics.

**Application Skeleton Generation for Exascale HPC (previous title: Application Skeleton Generation for Exascale HPC Simulation)**  
**Frank Mueller**  
**$60,000 by Oak Ridge National Laboratories - UT-Battelle LLC (US Dept. of Energy (DOE))**  
**01/1/2013 - 08/30/2013**

The objective of this work is to complement ORNL’s xSim simulator with benchmark generation capabilities. ScalaBenchGen from NCSU will be extended to auto-generate source code suitable for evaluation under xSim. ScalaBenchGen will complement these capabilities with the ability to extract communication benchmark skeletons from actual HPC runs of applications. These skeletons include timings for computational parts and actual MPI communication calls. We propose to combine the ScalaBenchGen and xSim capabilities for sample HPC benchmarks/applications. Timings for the computational part will be enhanced to allow adaptation with respect to future (exascale) architectures. This co-design exploration supports the research path toward exascale.

**TX: Building Critical Mass in User Experience Research**  
**Ben Watson**  
**$16,600 by NCSU Research and Innovation Seed Funding Program**  
**01/1/2013 - 12/31/2013**

Digital technology now permeates our lives. We use it to work, play, and relate; from the moment our eyes open until they close. It is nothing less than a technical and societal revolution, one that has already reached the academy: in art, design, humanities, social sciences, psychology, geosciences, education and marketing, faculty are already studying technology’s impact. How do we shape our technology, and how does it shape us? How do we relate to technology, not only rationally but also emotionally? Recently, the discipline of "user experience" (UX) has emerged as the focus for work addressing questions such as these. Yet although this discipline is a central focus at leading companies such as Apple, Google and even IBM, we cannot find one major US university with a user experience degree program. We believe this represents a major opportunity, and that NC State is very well poised to seize it. In the next couple months, we will organize a small informal meeting for core members of the NCSU and corporate UX community, at which we will identify the funding, research and teaching opportunities we would like to pursue. Early next year, we will organize a larger workshop titled ITX: Interactive Technology Experience, designed to further shape our plans while also announcing our presence to the public.

**Diagraph Method in Detecting Rule Faults For Attribute Based Access Control Polices**  
**Laurie Williams**
Even though Access Control (AC) policies can be implemented based on different AC models, the most common and generic AC policies are composed by AC rules in propositions of privilege assignments described by attributes of subjects, actions, objects, and environment variables of the protected systems. Such modeless AC policies are called Attribute Based Access Control (ABAC) policies. Incorrect implementations of AC policies result in faults that not only leak but also disable access of information, and faults in ABAC policies are difficult to detect without support of formal embedded models such as Multi-Level Security (MLS) and Chinese Wall. This research proposes a diagram analysis method that detects faults including conflicts of privilege assignments, leaks of information, and conflicts of interest assignments.

Automated Inter-Application Testing of Mobile Applications
Tao Xie
$20,000 by Fujitsu Lab of America, Inc
01/1/2013 - 05/15/2013
Inter-application interaction on traditional desktop platforms is limited. In contrast, the mobile ecosystem encourages inter-application collaboration and reduces developer burden by facilitating component reuse. This research project develops an automatic technique to systematically explore and represent in a model the inter-application interactions of a given mobile AUT. Such model can be used as a basis for subsequent inter-application interaction testing of the AUT.

Graduate Industrial Traineeship for Sagar Jauhari
Douglas Reeves
$69,026 by SAS Institute, Inc.
01/7/2013 - 05/31/2014
"NC State University (NCSU), through the graduate industrial traineeship (GIT) student, will provide research and analysis to SAS. Such research and analysis shall include, but is not limited to, research, generation, testing and documentation of operation research software. GIT student will provide such services for SAS' offices in Cary, North Carolina, at such times as have been mutually agreed upon by the parties. GIT student agrees to abide by SAS' policies and procedures regarding security of SAS' facilities and computing resources."

Type I: Collaborative Research: FRABJOUS CS - Framing a Rigorous Approach to Beauty and Joy for Outreach to Underrepresented Students in Computing at Scale
Tiffany Barnes
$352,831 by National Science Foundation
02/1/2013 - 02/28/2016
In this FRABJOUS CS project, we will prepare 60 high school teachers to teach the Beauty and Joy of Computing (BJC) Computer Science Principles curriculum. The BJC course is a rigorous introductory computing course that highlights the meaning and applications of computing, while introducing low-threshold programming languages Snap-Scratch, GameMaker and AppInventor. BJC is informed and inspired by the Exploring Computer Science curriculum, that was explicitly designed to channel the interests of urban HS students with culturally relevant and meaningful curriculum [Goode 2011][Margolis 2008]. The BJC course uses collaborative classroom methods including pair learning, and student-selected projects are geared toward leveraging students' knowledge of social media, games, devices, and the internet. At UNC Charlotte in 2010 and 2011, PI Barnes engaged college students in supporting the BJC course, and in after-school outreach and summer camps that excite middle and high school students about this curriculum at different levels. The project engages three university faculty members and 6 college students to help the high school teachers build a Computer Science Teachers Association chapter and provide ongoing professional development and support for the BJC course. The project also engages high school teachers and an education researcher to help refine and enriches the BJC curriculum to be easier to adopt and teach in high schools.

Type I: Collaborative Research: FRABJOUS CS - Framing a Rigorous Approach to Beauty and Joy for Outreach to Underrepresented Students in Computing at Scale (Supplement)
Tiffany Barnes
$86,000 by NSF
02/1/2013 - 02/28/2016
In this FRABJOUS CS project, we will prepare 60 high school teachers to teach the Beauty and Joy of Computing (BJC) Computer Science Principles curriculum. The BJC course is a rigorous introductory computing course that highlights the meaning and applications of computing, while introducing low-threshold programming languages Snap-Scratch, GameMaker and AppInventor. BJC is informed and inspired by the Exploring Computer Science curriculum, that was explicitly designed to channel the interests of urban HS students with ?culturally relevant and meaningful curriculum? [Goode 2011][Margolis 2008]. The BJC course uses collaborative classroom methods including pair learning, and student-selected projects are geared toward leveraging students? knowledge of social media, games, devices, and the internet. At UNC Charlotte in 2010 and 2011, PI Barnes engaged college students in supporting the BJC course, and in after-school outreach and summer camps that excite middle and high school students about this curriculum at different levels. The project engages three university faculty members and 6 college students to help the high school teachers build a Computer Science Teachers Association chapter and provide ongoing professional development and support for the BJC course. The project also engages high school teachers and an education researcher to help refine and enriches the BJC curriculum to be easier to adopt and teach in high schools.

**CAREER: Secure OS Views for Modern Computing Platforms**  
William Enck  
$400,000 by National Science Foundation  
02/1/2013 - 01/31/2018  
Controlling the access and use of information is a fundamental challenge of computer security. Emerging computing platforms such as Android and Windows 8 further complicate access control by relying on sharing and collaboration between applications. When more than two applications participate in a workflow, existing permission systems break down due to their boolean nature. In this proposal, we seek to provide applications with residual control of their data and its copies. To do this, we propose secure OS views, which combines a new abstraction for accessing data with whole-system information tracking. We apply secure OS views to modern operating systems (e.g., Android and Windows 8), which use database-like abstractions for sharing and accessing information. Similar to a database view, secure OS views uses runtime context to dynamically define the protection domain, allowing the return of the value, a fake value, or nonexistence of the record.

**CPS: Breakthrough: Collaborative Research: Bringing the Multicore Revolution to Safety-Critical Cyber-Physical Systems**  
Frank Mueller  
$225,000 by National Science Foundation  
02/1/2013 - 01/31/2016  
Multicore platforms have the potential of revolutionizing the capabilities of embedded cyber-physical systems but lack predictability in execution time due to shared resources. Safety-critical systems require such predictability for certification. This research aims at resolving this multicore `predictability problem." It will develop methods that enable to share hardware resources to be allocated and provide predictability, including support for real-time operating systems, middleware, and associated analysis tools. The devised methods will be evaluated through experimental research involving synthetic micro-benchmarks and code for unmanned air vehicles `re-thinking" their adapting to changing environmental conditions within Cyber-Physical Systems.

**On the Influence of Norms and Sanctions on Socio-Technical Systems Governance-An Agent-Based Simulation Approach**  
Munidar Singh  
$10,000 by University Global Partnership Network (UGPN)  
03/1/2013 - 02/28/2014  
Sociotechnical systems are complex adaptive systems in which social systems and technologies co-evolve. A natural way to realize governance in these systems is through the use of norms and sanctions. However, the influence that different norms and sanctions have on sociotechnical systems is difficult to measure in a real environment. Therefore, we propose to further study the notions of norms and sanctioning in sociotechnical systems and analyze their influence through agent-based simulation. Further, we propose to model next-generation energy infrastructure to analyze how different norms and sanctions may influence the system components.

**Social Media Relationship Analytics**  
Munindar Singh
$16,036 by Whodini, Inc.  
03/11/2013 - 05/31/2013  
This project will develop techniques for mining and understanding social relationships as obtained from social media, including emails and chat. The techniques involve a combination of text processing heuristics, advanced natural language parsing, and machine learning.

REU Site: Interactive and Intelligent Media  
Tiffany Barnes  
$359,999 by National Science Foundation  
04/ 1/2013 - 03/31/2016  
The REU Site at NC State University will immerse a diverse group of undergraduates in a vibrant research community of faculty and graduate students working on cutting-edge games, intelligent tutors, and mobile applications. We will recruit students from underrepresented groups and colleges and universities with limited research opportunities through the STARS Alliance, an NSF-funded national consortium of institutions dedicated to broadening participation in computing. Using the Affinity Research Groups and STARS Training for REUs models, we will engage faculty and graduate student mentors with undergraduates to create a supportive culture of collaboration while promoting individual contributions to research through just-in-time training for both mentors and students throughout the summer.

PDSS Aquaculture Testing  
John Bass  
$15,000 by Pentair Water Pool and Spa, Inc.  
04/ 1/2013 - 09/30/2013  
The following items will be completed in Q2 of 2013. 1) Continued support of Stark Media in implementation of a enterprise level web application that requests sensor data from PDSS. 2) Develop a template to test PDSS with an aquaculture test bed.

Understanding I/O Patterns for Out-of-core Computing and Data-Intensive Applications  
Mladen Vouk ; Xiaosong Ma  
$45,369 by Oak Ridge National Laboratories/US Dept of Energy  
04/ 5/2013 - 12/31/2013  
In this project, we will collaborate with ORNL researchers on two research tasks: (1) Access pattern analysis for intelligent out-of-core parallel computing with deep memory hierarchy. The goal of the project is to place variables across multiple levels of memory devices (including DRAM and NVM layers) and achieve optimized overall out-of-core execution performance. (2) Access pattern analysis for automatic extraction of parallel application I/O signatures. The goal of the project is to detect ?heavy I/O applications? without application-level or file-system level instrumentation or profiling.

Graduate Industrial Traineeship for Da Young Lee  
Douglas Reeves  
$50,604 by SAS Institute, Inc  
05/13/2013 - 05/12/2014  
NC State University (NCSU), through the graduate industrial traineeship (GIT) student, will provide research and analysis to SAS. Such research and analysis shall include, but is not limited to, research, generation, testing and documentation of operation research software. GIT student will provide such services for SAS' offices in Cary, North Carolina, at such times as have been mutually agreed upon by the parties. GIT student agrees to abide by SAS' policies and procedures regarding security of SAS' facilities and computing resources.

Operating System Mechanisms for Many-Core Systems-Phase II (PICASO II) Pico-kernel Adaptive and Scalable Operating Systems Phase II  
Frank Mueller  
$225,000 by Securboration via US Air Force Research Laboratory  
06/ 1/2013 - 05/31/2015  
The objective of this work is to design and evaluate novel system and program abstractions for combined performance and scalability paving the path into a future of operating system supporting a massive number of cores on a single chip.
**Graduate Industrial Traineeship for Chris Barile**

**Douglas Reeves**

$44,535 by SAS Institute, Inc.

06/8/2013 - 06/7/2014

NCSU through the SAS GA will provide research and analysis to SAS as set forth in this Agreement. Such research and analysis shall include, but is not limited to, research, generation, testing, and documentation of operations research software. SAS GA will provide such services for SAS' offices in Cary, North Carolina, at such times as have been mutually agreed upon by the parties.

**Science of Security**

Laurie Williams; Michael Rappa (joint coll)

$2,117,740 by US Army - Army Research Office (National Security Agency)

06/25/2013 - 06/24/2015

Critical cyber systems must inspire trust and confidence, protect the privacy and integrity of data resources, and perform reliably. Therefore, a more scientific basis for the design and analysis of trusted systems is needed. In this proposal, we aim to progress the Science of Security. The Science of Security entails the development of a body of knowledge containing laws, axioms and provable theories relating to some aspect of system security. Security science should give us an understanding of the limits of what is possible in some security domain, by providing objective and quantifiable descriptions of security properties and behaviors. The notions embodied in security science should have broad applicability - transcending specific systems, attacks, and defensive mechanisms. A major goal is the creation of a unified body of knowledge that can serve as the basis of a trust engineering discipline, curriculum, and rigorous design methodologies. As such, we provide eight hard problems in the science of security. We also present representative projects which we feel will make progress in the discipline of the science of security.

**CAREER: Expanding Developers' Usage of Software Tools by Enabling Social Learning**

Emerson Murphy-Hill

$495,721 by National Science Foundation

08/1/2013 - 07/31/2018

Tools can help software developers alleviate the challenge of creating and maintaining software. Unfortunately, developers only use a small subset of the available tools. The proposed research investigates how social learning, an effective mechanism for discovering new tools, can help software developers to discover relevant tools. In doing so, developers will be able to increase software quality while decreasing development time.

**HCC: Small: Collaborative Research: Integrating Cognitive and Computational Models of Narrative for Cinematic Generation**

R. Michael Young

$352,696 by the National Science Foundation

08/1/2013 - 07/31/2016

Virtual cinematography, the use of a virtual camera within a three dimensional virtual world, is being used increasingly to communicate both in entertainment contexts as well as serious ones (e.g., training, education, news reporting). While many aspects of the use of virtual cameras are currently automated, the control of the camera is currently determined using either a pre-programmed script or a human operator controlling the camera at the time of filming. This project seeks to develop a model of virtual cinematography that is both computational -- providing a software system capable of generating camera control directives automatically -- and cognitive -- capable of modeling a viewer's understanding of an unfolding cinematic.

**Interaction and Visualization With Framegraphs for Intelligent Text Query and Analysis**

Christopher Healey

$38,000 by Soar Technology, Inc. (US Army)

08/12/2013 - 02/11/2014

This project has the overall objective of producing a novel intuitive decision making system to support a wide variety of military missions. The project has two components: assigning sentiment to social media, including representation of uncertainty, and connecting it to topic labels; and organizing information with respect to sensemaking in the areas of noticing and bracketing. The proposed project will investigate methods to build "smart queries" for data analysts. Specifically, we will design, develop, and implement a method for accepting flexible
queries from analysts, structuring the results into a hierarchical framegraph representation, and visualizing some or all of the framegraph in ways that support both real-time social network analysis, and disaster vulnerability analysis.

**Intuitive Information Fusion and Visualization (Interaction and Visualization With Framegraphs for Intelligent Text Query and Analysis)**

Christopher Healey ; Robert St. Amant  
$38,000 by Soar Technology, Inc. via US Army  
08/12/2013 - 02/11/2014

This project has the overall objective of producing a novel intuitive decision making system to support a wide variety of military missions. The project has two components: assigning sentiment to social media, including representation of uncertainty, and connecting it to topic labels; and organizing information with respect to sensemaking in the areas of noticing and bracketing.

**Is Wireless Channel Dependable for Security Provisioning?**  
Peng Ning (co-PI)  
$350,000 by the National Science Foundation  
08/12/2013 - 07/31/2016

Wireless security is receiving increasing attention as wireless systems become a key component in our daily life as well as critical cyber-physical systems. Recent progress in this area exploits physical layer characteristics to offer enhanced and sometimes the only available security mechanisms. The success of such security mechanisms depends crucially on the correct modeling of underlying wireless propagation. It is widely accepted that wireless channels decorrelate fast over space, and half a wavelength is the key distance metric used in existing wireless physical layer security mechanisms for security assurance. We believe that this channel correlation model is incorrect in general: it leads to wrong hypothesis about the inference capability of a passive adversary and results in false sense of security, which will expose the legitimate systems to severe threats with little awareness. In this project, we seek to understand the fundamental limits in passive inference of wireless channel characteristics, and further advance our knowledge and practice in wireless security.

**Graduate Industrial Traineeship for Savera Tanwir**  
Douglas Reeves  
$51,058 by SAS Institute, Inc  
08/21/2013 - 08/20/2014

NCSU through the SAS GA will provide research and analysis to SAS as set forth in this Agreement. Such research and analysis shall include, but is not limited to, research, generation, testing, and documentation of operations research software. SAS GA will provide such services for SAS' offices in Cary, North Carolina, at such times as have been mutually agreed upon by the parties.

**TWC SBE: Medium: Collaborative: User-Centric Risk Communication and Control on Mobile Devices**  
Douglas Reeves  
$267,096 by the National Science Foundation  
09/ 1/2013 - 08/31/2016

Human-system interactions is an integral part of any system. Because the vast majority of ordinary users have limited technical knowledge and can easily be confused and/or worn out by repeated security notifications/questions, the quality of users' decisions tends to be very low. On the other hand, any system targeting end-users must have the flexibility to accommodate a wide spectrum of different users, and therefore needs to get the full range of users involved in the decision making loop. This dilemma between fallible human nature and inevitable human decision making is one main challenge to the goal of improving security. In this project, we aim at developing principles and mechanisms for usable risk communication and control. The major technical innovations include (1) multi-granularity risk communications; (2) relative risk information in the context of comparison with alternatives; (3) Discover and integrate risk information from multiple sources; (4) Expand opportunities for risk communication and control.

Mladen Vouk ; Peng Ning  
$749,996 by National Science Foundation  
09/ 1/2013 - 08/31/2018
Increased use of cloud computing services is becoming a reality in today's IT management. The security risks of this move are active research topics, yielding cautionary examples of attacks enabled by the co-location of competing tenants. In this project, we propose to mitigate such risks through a new approach to cloud architecture defined by leveraging cloud providers as trusted (but auditable) security enablers. We will exploit cooperation between cloud providers and tenants in preventing attacks as a means to tackle long-standing open security problems, including protection of tenants against outsider attacks, improved intrusion detection and security diagnosis, and security-monitoring inlays.

**EDU: Motivating and Reaching Students and Professionals with Software Security Education**
Laurie Williams ; Emerson Murphy-Hill ; Kevin Oliver (Education)
$300,000 by National Science Foundation
09/ 1/2013 - 08/31/2015

According to a 2010 report that was based on the interviews from 2,800 Information Technology professionals worldwide, the gap between hacker threats and suitable security defenses is widening, and the types and numbers of threats are changing faster than ever before. In 2010, Jim Gosler, a fellow at the Sandia National Laboratory who works on countering attacks on U.S. networks, claimed that there are approximately 1,000 people in the country with the skills needed for cyber defense. Gosler went on to say that 20 to 30 times that many are needed. Additionally, the Chief Executive Officer (CEO) of the Mykonos Software security firm indicated that today's graduates in software engineering are unprepared to enter the workforce because they lack a solid understanding of how to make their applications secure. Particularly due to this shortage of security expertise, education of students and professionals already in the workforce is paramount. In this grant we provide a plan for motivating and providing software security education to students and professionals.

**DO 2 Task 3.3 - Bass**
John Bass
$43,978 by LAS
09/13/2013 - 09/30/2014
DO 2 Task 3.3 activities

**DO 2 Task 3.6 - Doyle**
Jon Doyle
$46,904 by Laboratory for Analytic Sciences
09/13/2013 - 12/31/2014
DO 2 task 3.6 activities

**LAS DO 2 task 3.3 - Lester-Taylor-Mott-Rowe**
James Lester
$54,488 by Lab for Analytic Sciences/NSA
09/13/2013 - 09/30/2014
DO 2 task 3.3 activities (no other abstract available)

**DO 2 Task 3.8 Lester-Mott-Rowe**
James Lester
$45,614 by Lab for Analytic Science/NSA
09/13/2013 - 09/30/2014
DO 2 Task 3.8 activities (no abstract available)

**DO 2 Task 3.5 Lester**
James Lester
$37,577 by Lab for Analytic Sciences/NSA
09/13/2013 - 09/30/2014
DO 2 Task 3.5 activities (no abstract available)

**DO 2 Task 3.7 - Murphy Hill**
Emerson Murphy-Hill
$49,486 by Laboratory for Analytic Sciences  
09/13/2013 - 12/31/2014  
DO 2 Task 3.7 activities

DO 2 Task 3.7  
Nagiza Samatova  
$49,585 by Laboratory for Analytic Sciences  
09/13/2013 - 12/31/2014  
DO 2 Task 3.7 activities

DO 2 Task 3.7 - Singh  
Munindar Singh  
$43,889 by Laboratory for Analytic Sciences  
09/13/2013 - 12/31/2014  
DO 2 Task 3.7 activities

DO 2 Task 3.8 - St. Amant  
Robert St. Amant  
$49,493 by Laboratory for Analytic Sciences  
09/13/2013 - 12/31/2014  
DO 2 Task 3.8 activities

DO 2 Task 3.2 - Streck  
John Streck  
$935,302 by NSA  
09/13/2013 - 09/30/2014  
DO 2 Task 3.2 activities

Joint Faculty Appointment For Vida Blair Sullivan  
Vida Sullivan  
$75,200 by Oak Ridge National Laboratories - UT-Battelle LLC  
09/13/2013 - 08/15/2014
The PI's unique combination of expertise in structural graph theory and scalable graph algorithms/big data is necessary to ensure the success of ORNL-based projects using applied discrete mathematics to enable advances in graph generation and HPC benchmarking, social network analysis, and multi-scale graph decompositions for the Department of Energy and Department of Defense. The PI will direct and conduct fundamental research, collaborate with ORNL staff, write up research results for peer-reviewed publication, give presentations, and mentor students and postdoctoral staff as appropriate.

DO 2 Task 3.5  
Laurie Williams  
$62,901 by LAS  
09/13/2013 - 12/31/2014  
DO 2 task 3.5 activities

DO 2 Task 3.4 - Young and Roberts  
R. Michael Young  
$1,017,700 by LAS/NSA  
09/13/2013 - 09/30/2014  
DO 2 Task 3.4 Activities

Resilience for Global Address Spaces  
Frank Mueller  
$153,934 by Lawrence Berkeley National Laboratory via US Dept of Energy  
09/24/2013 - 08/15/2015
The objective of this work is to provide functionality for the BLCR Linux module under a PGAS runtime system (within the DEGAS software stack) to support advanced fault-tolerant capabilities, which are of specific value in the context of large-scale computational science codes running on high-end clusters and, ultimately, exascale facilities. Our proposal is to develop and integrate into DEGAS a set of advanced techniques to reduce the checkpoint/restart (C/R) overhead.

**NetS: Small: Collaborative Research: Enabling Robust Communication in Cognitive Radio Networks with Multiple Lines of Defense**  
Rudra Dutta; Peng Ning  
$249,901 by National Science Foundation  
10/1/2013 - 09/30/2016

Cognitive radio is an emerging advanced radio technology in wireless access, with many promising benefits including dynamic spectrum sharing, robust cross-layer adaptation, and collaborative networking. Opportunistic spectrum access (OSA) is at the core of cognitive radio technologies, which has received great attention recently, focusing on improving spectrum utilization efficiency and reliability. However, the state-of-the-art still suffers from one severe security vulnerability, which has been largely overlooked by the research community so far. That is, a malicious jammer can always disrupt the legitimate network communication by leveraging the public-available channel statistic information to effectively jam the channels and thus lead to serious spectrum underutilization. In this proposal, we propose to address the challenge of effective anti-jamming communication in cognitive radio networks (CRNs). We propose a multiple lines of defense approach, which considers and integrates defense technologies from different dimensions, including frequency hopping, power control, cooperative communication, and signal processing. The proposed defense approach enables both reactive and proactive protection, from evading jammers to competing against jammers, and to expelling jamming signals, and thus guarantees effective anti-jamming communication under a variety of network environments.

**SCH: INT: Collaborative Research: A Self-Adaptive Personalized Behavior Change System for Adolescent Preventive Healthcare**  
James Lester  
$952,818 by National Science Foundation  
10/1/2013 - 09/30/2017

Although the majority of adolescent health problems are amenable to behavioral intervention, and most adolescents are comfortable using interactive computing technology, few health information technology interventions have been integrated into adolescent care. The objective of the proposed research is to design, implement, and investigate INSPIRE, a self-adaptive personalized behavior change system for adolescent preventive healthcare. With a focus on adolescents, INSPIRE will enable adolescents to be active participants in dynamically generated, personalized narrative experiences that operationalize theoretically grounded interventions for behavior change through interactive narratives? plot structures and virtual character interactions.

**TWC: Small: Collaborative: Discovering Software Vulnerabilities Through Interactive Static Analysis**  
Emerson Murphy-Hill  
$249,854 by National Science Foundation  
10/1/2013 - 09/30/2016

Software vulnerabilities originating from insecure code are one of the leading causes of security problems people face today. Current tool support for secure programming focuses on catching security errors after the program is written. We propose a new approach, interactive static analysis, to improve upon static analysis techniques by introducing a new mixed-initiative paradigm for interacting with developers to aid in the detection and prevention of security vulnerabilities.

**RI: Small: Collaborative Research: Speeding Up Learning through Modeling the Pragmatics of Training**  
David Roberts  
$156,203 by National Science Foundation  
10/1/2013 - 09/30/2015

We propose to develop techniques that will enable humans to train computers efficiently and intuitively. In this proposed work, we draw inspiration from the ways that human trainers teach dogs complex behaviors to develop novel machine learning paradigms that will enable intelligent agents to learn from human trainers quickly, and in a way that humans can intuitively take advantage of. This research aims to return to the basics of programming---it
seeks to develop novel methods that allow humans to tell computers what to do. More specifically, this research will develop learning techniques that explicitly model and leverage the implicit communication channel that humans use while training, a process akin to interpreting the pragmatic implicature of a natural language communication. We will develop algorithms that view the training process as an intentional communicative act, and can vastly outperform standard reward-seeking algorithms in terms of the speed and accuracy with which human trainers can generate desired behavior.

David Roberts ; Alper Bozkurt ECE ; Barbara Sherman CVM  
$999,103 by National Science Foundation  
10/ 1/2013 - 09/30/2016  
We propose to develop tools and techniques that will enable more effective two-way communication between dogs and handlers. We will work to create non-invasive physiological and inertial measuring devices that will transmit real-time information wirelessly to a computer. We will also develop technologies that will enable the computer to train desired behaviors using positive reinforcement without the direct input from humans. We will work to validate our approach using laboratory animals in the CVM as well as with a local assistance dog training organization working as a consultant.

**CSR: Small: Collaborative Research: Enabling Cost-effective Cloud HPC**  
Mladen Vouk ; Xiaosong Ma  
$311,998 by National Science Foundation  
10/ 1/2013 - 09/30/2016  
The proposed work examines novel services built on top of public cloud infrastructure to enable cost-effective high-performance computing. We will explore the on-demand, elastic, and configurable features of cloud computing to complement the traditional supercomputer/cluster platforms. If successful, this research will result in tools that adaptively aggregate, configure, and re-configure cloud resources for different HPC needs, with the purpose of offering low-cost R&D environments for scalable parallel applications.

**Hobbes: OS and Runtime Support for Application Composition**  
Frank Mueller  
$300,000 by Sandia National Laboratories via US Dept of Energy  
10/24/2013 - 10/23/2016  
This project intends to deliver an operating system and runtime system (OS/R) environment for extreme-scale scientific computing. We will develop the necessary OS/R interfaces and lowlevel system services to support isolation and sharing functionality for designing and implementing applications as well as performance and correctness tools. We propose a lightweight OS/R system with the flexibility to custom build runtimes for any particular purpose. Each component executes in its own "enclave" with a specialized runtime and isolation properties. A global runtime system provides the software required to compose applications out of a collection of enclaves, join them through secure and low-latency communication, and schedule them to avoid contention and maximize resource utilization. The primary deliverable of this project is a full OS/R stack based on the Kitten operating system and Palacios virtual machine monitor that can be delivered to vendors for further enhancement and optimization.

**CAREER: Educational Data Mining for Student Support in Interactive Learning Environment**  
Tiffany Barnes  
$237,770 by UNC Charlotte/NSF  
11/ 1/2013 - 06/30/2015  
Creating intelligent learning technologies from data has unique potential to transform the American educational system, by building a low cost way to adapt learning environments to individual students, while informing research on human learning. This project will create the technology for a new generation of data-driven intelligent tutors, enabling the rapid creation of individualized instruction to support learning in science, technology, engineering, and mathematics (STEM) fields. This has the potential to make individualized learning support accessible for a broad audience, from children to adults, including students that are traditionally underrepresented in STEM fields. This project will (1) develop computational methods to derive cognitive models from data that can be used to support individual learners through guidance, feedback, and help; (2) develop approaches to providing student support that
leverage data to provide hints and guidance based on information such as frequency of student responses, probability of future errors, and solution efficiency; (3) develop interactive visualization tools for teachers to learn from student data in real time, to allow teachers and instructional designers to tailor instruction to address actual, rather than perceived, student problem areas; and (4) conduct formal empirical evaluations of the pedagogical effectiveness of our student support. Our software will construct adaptive support for teaching and learning in logic, discrete mathematics, and other STEM domains using a data-driven approach. From the extensive but tractable student performance data in computer-aided learning environments, we will automatically construct student cognitive models. Our cognitive models will build on our prior work using Markov Decision Processes and dimensionality reduction methods that leverage past data to assess student performance, direct a student’s learning path, and provide contextualized hints. We will use machine learning techniques to expand our problem-specific models into more general cognitive models to bootstrap the construction of new tutors and learn about student learning. For teachers and learning researchers, we will build a web-based visualization and analysis tool to graphically and interactively model student solutions annotated with performance data that reflects frequency, tendency to commit future errors, and closeness to a final solution. Through our new tutors and tools we will conduct experiments to understand student learning in a variety of contexts and domains, including logic, algebra, and chemistry. We will engage a team of diverse students and colleagues to bring interdisciplinary expertise to our research and share our findings broadly. This award is funded under the American Recovery and Reinvestment Act of 2009 (Public Law 111-5).

ALICE: A Model for Sustaining Technology-Rich Adaptive Learning Spaces and Interactive Content Environments
R. Michael Young
$285,321 by Institute of Museum & Library Services
11/1/2013 - 10/31/2014
This proposal would fund the research and design phase of building the ALICE engine. The project will focus on creating a conceptual model for how to build an adaptive learning space; an architecture for the Artificial Intelligence (AI) engine and technology core; a series of "proof of concept" functional prototypes for collecting data and creating content; and a continuous assessment model for measuring the success of the AI as far as the quality of its engagement with the community and the success of the engine at enhancing a given technology-rich research and learning space.

Developing a K-5 Computer Science Curriculum
Kristy Boyer
$8,096 by WCPPS
01/1/2014 - 06/30/2014
Service contract amendment to increase total from 14038.00 to 22134.50.

Developing a K-5 Computer Science Curriculum
Kristy Boyer
$14,038 by Wake County Public School Systems (WCPSS)
01/1/2014 - 05/15/2014
While great resources have been committed to developing computer science curricula at the university and high school levels, much less time has been devoted to developing curricula for younger students. The time is ripe to extend effective computer science pedagogy into the elementary realm. This project will develop and pilot a six-week elementary computer science curriculum focusing on problem solving, creativity, and computer science principles.

IntraHealth International, Inc Spring 2014 Senior Design Project
Margaret Heil
$5,000 by IntraHealth International, Inc.
01/1/2014 - 05/15/2014
The shortage of health workers around the world is considered one of the fundamental constraints to achieving international health and development goals. Health workers are the backbone of any healthcare solution. Getting the right health worker in the right place at the right time is the key to preventing human health disasters. This was the motivation for IntraHealth International's leadership in developing the human resource information system called iHRIS. iHRIS is free and open source software for managing health workforce information and is currently employed in 16 countries around the world. With iHRIS, countries are saving lives by training and deploying health
workers where they are needed most. Without customization, however, iHRIS does not address all possible use cases in all countries. When iHRIS is deployed in a new country a great deal of form and page customization is necessary. To improve implementation speed and saturation in a country, students are tasked to build an administrative interface to allow customization of pages and forms through the application instead of using module configuration files. Building on that, students will create an interface to define, display, and edit pages based on the existing forms so more customization work can be done through the application instead of manually editing XML configuration files. The student group will be required to engage with stakeholders in Africa at both the ministry level and the open source community. iHRIS is built on a LAMP stack (Linux, Apache, MySQL and PHP) with source code hosted in Launchpad.

**Student Support for Participation in the Symposium and Bootcamp on the Science of Security (HotSoS)**

Munindar Singh

$5,000 by National Science Foundation (NSF)

01/1/2014 - 12/31/2014

This project will support travel by US student researchers to the Symposium and Bootcamp on the Science of Security (HotSoS), which will be held in April 2014 in Raleigh, North Carolina. Travel support will be critical in encouraging participation, which is especially important since HotSoS 2014 will be one of the first peer-reviewed events on the Science of Security.

**NCDS Data Science Faculty Fellow-Tracking Community Evolution in Dynamic Graph Data Using Tree-Like Structure**

Vida Sullivan

$30,000 by National Consortium for Data Science (UNC-UNC Chapel Hill)

01/1/2014 - 12/31/2014

"Big Data" sources for many real-world applications pose numerous challenges to understanding the complex and possibly hidden relationships between components of a complex network. Furthermore, these networks often consist of heterogeneous entities and types of relationships, and many existing algorithms for computing network features and similarity are not directly applicable. In order to draw actionable insights, analysis need to identify events of interest, place them in context, and understand their impact. Existing approaches which emphasize visualization (at the expense of analytics), struggle to coherently present networks with hundreds of entities, whereas practical applications require hundreds of thousands (or more). We propose to develop methods which integrate ideas from graph theory with multi-scale modeling (since events of interest may occur at different levels of granularity/contexts within the data) to improve comprehension of such relational data and form a foundation for novel methods of visualization and interaction.

**Graduate Industrial Traineeship for Ameeta Muralidharan**

George Rouskas

$65,051 by SAS Institute, Inc.

01/27/2014 - 05/31/2015

NCSU through the SAS GA will provide research and analysis to SAS as set forth in this Agreement. Such research and analysis shall include, but is not limited to, research, generation, testing, and documentation of operations research software. SAS GA will provide such services for SAS' offices in Cary, North Carolina, at such times as have been mutually agreed upon by the parties.

**Graduate Industrial Traineeship for Namita Shubhy**

George Rouskas

$65,050 by SAS Institute, Inc.

01/27/2014 - 05/31/2015

NCSU through the SAS GA will provide research and analysis to SAS as set forth in this Agreement. Such research and analysis shall include, but is not limited to, research, generation, testing, and documentation of operations research software. SAS GA will provide such services for SAS' offices in Cary, North Carolina, at such times as have been mutually agreed upon by the parties.

**Transcriptional Nodes Coordinate Patterning and Cellular Proliferation During Carpel Margin Meristem Development**

Steffen Heber
Runtime Enforcement of Security Policies
Douglas Reeves
$29,780 by US Army - Army Research Office
03/ 5/2014 - 12/ 4/2014

Android smartphones have grown in market share and have penetrated all corners of the market, including US Government and, in particular, DoD. The ecosystem of the Android App marketplace while encouraging creativity also has lax standards. Recent work by Aiken's group shows that it is possible to use static analysis techniques to identify vulnerabilities due to abuse of {perm permissions} afforded to the software app, by the user, but with potential for false positives and attendant necessity for manual analysis. In this preliminary investigation, we propose to investigate a run time monitor that could be used in combination with static analysis to enforce strict permission policies. The particular research questions we will consider are: x Design of a language for expressing positive (shall) and negative (should not) permission x Algorithms for instrumenting application code that would be used to maintain invariants implied by the permission policies set by the user x Algorithms for instrumenting application code to collect trace data that could be mined later for surreptitious violations of security policies, and algorithms for deleting applications automatically when policies are violated. The three parts of the research proposal, when taken together, correspond to traditional law enforcement strategies -- setting of the law, monitoring...
for compliance, and imposition of penalty when laws are broken. While the ultimate goal is to validate the proposed work in the context of the Android market place, the proposed preliminary investigation will be theoretical in nature.

**Mixed-Initiative Visualization and UI Modeling for Cyber-Physical Data**

Christopher Healey  
$36,834 by Scientific Systems Company, Inc (US Air Force)  
03/18/2014 - 09/18/2014

A significant challenge for Cyber-Physical systems is incorporating human judgment into a complex analysis process. In a fully automated analysis, results and their justification can be difficult for users to understand and trust; a more effective approach is to support interactive construction and incremental modification of findings. We are designing and implementing a visualization assistant, ViA, that supports mixed-initiative interaction to collaborate with an analyst during visualization construction. Mixed-initiative approaches allow the computer and the user to share their expertise: for example, large-scale computation, search, and query processing, performed by the visualization system, together with the application of domain knowledge and expertise, as well as suggestions or constraints based on the data and tasks, provided by an analyst. Extensions of ViA will concentrate on improved higher-level support an analyst current workflow and mental models. One common criticism of past visualization efforts has been that we provided tools and asked the analysts to fit their problems to our tools, rather than building tools for the analyst problems.

**Growing The Science Of Security Through Analytics**

Laurie Williams ; Munindar Singh  
$2,255,237 by NSA (US Dept of Defense)  
03/28/2014 - 03/27/2015

Since August 2011, North Carolina State University (NCSU) analytics-focused Science of Security Lablet (SOSL) has embraced and helped build a foundation for the NSA vision of the Science of Security (SoS) and a SoS community. Jointly with other SOSLs, we formulated five SoS hard problems, which lie at the core of the BAA. At NCSU, data-driven discovery and analytics have been used to formulate, validate, evolve, and solidify security models and theories as well as the practice of cyber-security. We propose to (1) investigate solutions to five cross-dependent hard problems, building on our extensive experience and research, including in the current SOSL; (2) advance our SoS community development activities; and (3) enhance our evaluation efforts regarding progress on the hard problems by bringing in experts on science evaluation.

**LAS DO3 Task Order 2.8 Analytic Workflow**

Kristy Boyer  
$33,853 by LAS  
03/31/2014 - 12/31/2014

Internal award supplement

**LAS DO3 Task Order 2.8 Analytic Workflow**

Kristy Boyer  
$16,529 by LAS  
03/31/2014 - 12/31/2014

DO3 Task Order 2.8 Analytic Workflow

**LAS DO3 Task Order 2.7 Data Readiness - Chirkova**

Rada Chirkova  
$74,660 by Laboratory for Analytic Sciences  
03/31/2014 - 12/31/2014

DO3 Task 2.7 Data Readiness

**LAS DO3 Task Order 2.9 KRM**

Jon Doyle  
$76,241 by LAS  
03/31/2014 - 12/31/2014

DO3 Task 2.9 KRM
LAS DO3 Task Order 2.11 Mission Enabling - Murphy-Hill
Emerson Murphy-Hill
$72,651 by Laboratory for Analytic Sciences
03/31/2014 - 12/31/2014
DO3 Task Order 2.11 Mission Enabling

LAS DO3 Task Order 2.8 Analytic Workflow
Emerson Murphy-Hill
$16,686 by LAS
03/31/2014 - 12/31/2014
DO3 Task Order 2.8 Analytic Workflow

LAS DO3 Task Order 2.9 KRM
Kemafor Ogan
$74,523 by LAS
03/31/2014 - 12/31/2014
DO3 Task Order 2.9 KRM

LAS DO3 Task Order 2.6 Future States
Nagiza Samatove
$50,320 by LAS
03/31/2014 - 12/31/2014
DO3 Task Order 2.6 Future States

LAS DO3 Task Order 2.11 Mission Enabling - Singh
Munindar Singh
$240,158 by Laboratory for Analytic Sciences
03/31/2014 - 12/31/2014
DO3 Task Order 2.11 Mission Enabling

LAS DO3 Task Order 2.8 Analytic Workflow
Munindar Singh
$61,570 by LAS
03/31/2014 - 12/31/2014
DO3 Task Order 2.8 Analytic Workflow

LAS DO3 Task Order 2.9 KRM
Munindar Singh
$80,116 by LAS
03/31/2014 - 12/31/2014
DO3 Task Order 2.9 KRM

LAS DO3 Task Order 2.5 Cognitive Processing
Robert St. Amant
$90,860 by LAS
03/31/2014 - 12/31/2014
DO3 Task Order 2.5 Cognitive Processing

LAS DO3 Task Order 2.4 Narrative Processing
R. Michael Young ; Christopher Healey
$170,941 by LAS
03/31/2014 - 12/31/2014
DO3 Task Order 2.4 Narrative Processing
NeTS: JUNO: Service Offering Model and Versatile Network Resource Grooming for Optical Packet and Circuit Integrated Networks
Rudra Dutta
$291,956 by National Science Foundation (NSF)
04/1/2014 - 03/31/2017
The explosive growth in bandwidth represented by advances in optical communication and networking technologies has underpinned the increasing reach and reliability of the Internet in the last two decades. However, the potential impact of increasingly sophisticated recent advances in optical technology, such as rapid switching and elastic wavelengths have not yet been realized. The main cause of this is that such technology, while possible to integrate into the data plane of planetary networking, is difficult to accommodate in the current planning, management, and control strategies. We propose in this project to work hand-in-hand with collaborating researchers from NICT, Japan, who are working to realize a novel technology of hybrid optical packet/circuit switching. Such a technology could be immensely useful to large transport network operators, but there are no existing algorithms that can easily determine how a provider can provision their resources between the circuit and packet possibilities on an ongoing dynamic basis. We envision a novel approach to this problem, where we utilize the concept of a "choice marketplace" that allows sophisticated rendezvous semantics between customer and provider, and allows them to cooperatively guide network resource provisioning to dynamically fulfill network objectives such as maximizing performance received by network traffic. Our approach also allows balancing of various objectives, such as network utilization, latency, and the increasingly important metric of energy expenditure in the network.

Graduate Industrial Traineeship for Vedika Seth
George Rouskas
$52,547 by SAS Institute, INC
05/11/2014 - 05/31/2015
NCSU through the SAS GA will provide research and analysis to SAS as set forth in this Agreement. Such research and analysis shall include, but is not limited to, research, generation, testing, and documentation of operations research software. SAS GA will provide such services for SAS' offices in Cary, North Carolina, at such times as have been mutually agreed upon by the parties.

Mobile Network Data Capture and Analytics Study
Kemafor Ogan
$16,067 by BOSH Global Services
06/1/2014 - 07/31/2014
BOSH performs test and evaluation of different wireless transmission links, particularly data links transporting Full Motion Video. Transmission may be air-to-ground, air-to-air, ground-to-ground, or ground-to-ground from different ranges and line-of-sight altitudes, such as from aircraft at different attitudes, and under different environmental conditions. Most of the post-test analysis is based on capture IP traffic and is manpower intensive. BOSH is seeking ways to improve data capture, identify capture parameters, and automate data analysis, and is considering a research partnership with some NCSU faculty to that end. In the proposed project, we would undertake a reasoned and in-depth analysis of their data analyses problems and assess the suitability of available open-source big data frameworks as a foundation for BOSH's IP data analytics platform. The result of this study will be recorded in a whitepaper.