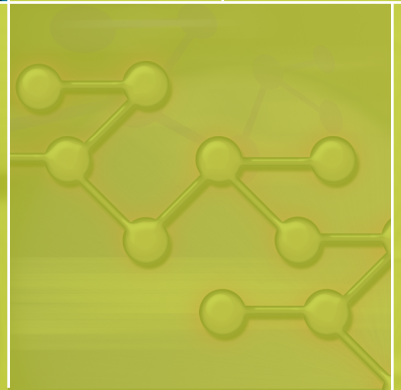
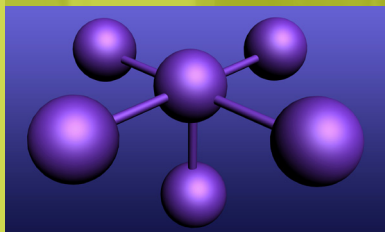
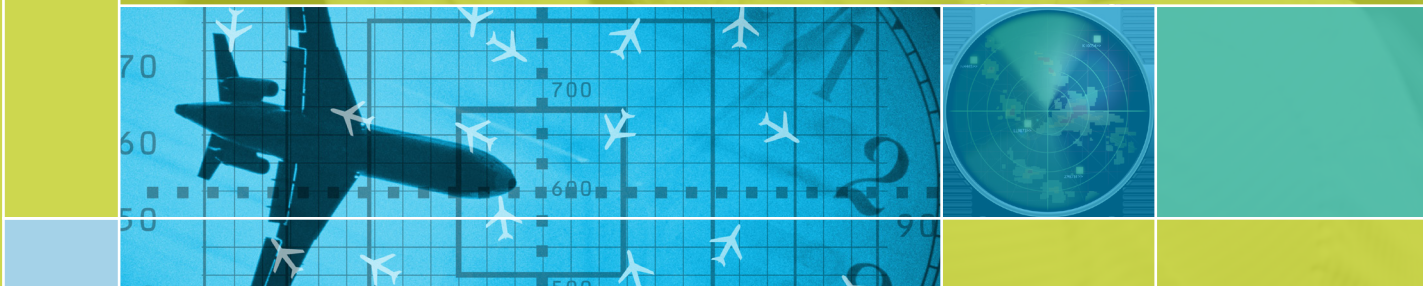




2010 Noblis Sponsored Research Projects

Advancing Technology—Inventing New Capabilities



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For the best of reasons

2010 Noblis Sponsored Research Projects
Advancing Technology—Inventing New Capabilities



Editorial and Production Staff

Denise Murphy
Shawn Blyther
Harry Cummins

2010 Noblis Sponsored Research Projects

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For more information about Noblis, please visit our Web site, noblis.org, or call Corporate Communications at 703-610-2002.

Introduction

Our Noblis Sponsored Research (NSR) program is a vital and essential part of our corporate life. Aligned with our corporate strategic goals, Noblis research allows us to create new intellectual capital and capabilities, to develop new thinking and models required to solve critical problems that our clients will face in the future, expand staff capabilities, and invest in our future. Noblis research also provides an interesting outlet for the creative and inventive spirit found throughout the Noblis organization. Many times, Noblis research is the forward thinking seed that generates not only larger corporate work programs and roles, but also sound, sustainable solutions with enduring impacts.

This year, Noblis is implementing nine projects relevant to a broad range of corporate science and technology and mission areas. This publication summarizes the NSR projects selected for funding and implementation during 2010. The principal investigators, objectives, background, approach, budget, and schedule are provided for each project.

The selected projects that comprise the 2010 NSR program represent the ideas and contributions of many individuals throughout the company. These individuals participated and collaborated in unique ways—some suggested ideas via formal proposals, and some through informal collaborative comments; some made constructive comments and helped in our review and analysis; still others will serve as principal investigators. Of the 83 proposals received in response to the June 2009 call for proposals, over 75 were briefed at the August NSR workshop. Ultimately, nine specific projects were funded and are currently underway. To recognize all who proposed research and to encourage broader participation during the next research call, all 83 proposals are listed in Appendix A.

H. Gilbert Miller, Ph.D.
Corporate Vice President and Chief Technology Officer
hgmiller@noblis.org

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Air Traffic Simulation and Modeling Facility

Michael J. Yablonski, Andrew M. Girard, Ph.D.

Objectives

The primary objective of this Noblis Sponsored Research (NSR) project is to develop an analytical capability that will enable the Federal Aviation Administration (FAA) to make informed decisions regarding the integration of a portfolio of complex operational capabilities for the Next Generation Air Transportation System (NextGen) air traffic modernization program. The following components will need to be developed:

- Air traffic simulation and modeling
- Portfolio integration of operational enhancements
- Performance metrics dashboard
- Decision modeling framework

Background

The National Airspace System (NAS) currently has technological and operational inefficiencies that result in delayed flights that cost airspace users time and money. A substantial investment is required to modernize the NAS to address these and other issues. The FAA NextGen program will provide for key infrastructure and operational changes to meet the needs of a growing aviation community well into the future.

The path to NextGen consists of relationships between technology and operational evolution processes. The optimal path is a balance between these processes; as technology is implemented, operations change to reflect more precise and efficient procedures. The current RTCA Task Force 5 NextGen implementation recommendations represent a mid-term solution that exploits the advantages of new technology with less emphasis on operational evolution. This research will investigate the different paths for NextGen technology and operational evolution through a detailed analysis of the NAS Enterprise Architecture Plan, NextGen Implementation Plan, NextGen Concept of Operations, and other supporting information. Using air traffic simulation and modeling techniques, a portfolio capability decision analysis framework will be developed to create a roadmap that serves as input for critical assessment of NextGen enhancements for FAA decision makers.

Approach

The current NextGen Implementation Plan consists of many complex technology and operational enhancements that are dependent on each other in regards to

implementation sequence and time. This research will proceed in four main stages consisting of technology and operational review, simulation and data development, decision framework development, and Noblis lab demonstrations. The overall goal of the decision framework is to provide recommendations of where and when specific operational enhancements should be implemented in the most timely and effective manner.

Technology and Operational Review

An initial review of the NextGen operational capabilities from current FAA and RTCA documentation will be performed to identify and develop modeling requirements for specific NextGen operational enhancements. These requirements will serve as the basis for the simulation and modeling development.

Simulation and Data Development

The research requires an investment in using the AwSim™ (Figure 1) capability which is a NAS-wide simulation and modeling tool that can be used to assess the value of NextGen operational evolutionary enhancements. A major component of this effort is in building infrastructure data such as routes, airspace, and traffic along with defining the critical metrics that are essential to NextGen enhancements review. To provide for a rich operational data set for analysis, Noblis has applied for access to the FAA Aircraft Situation Display to Industry (ASDI) data feed. This will require an integration effort with Noblis Innovation and Collaboration Center resources when the ASDI data is approved by the FAA for use by Noblis.

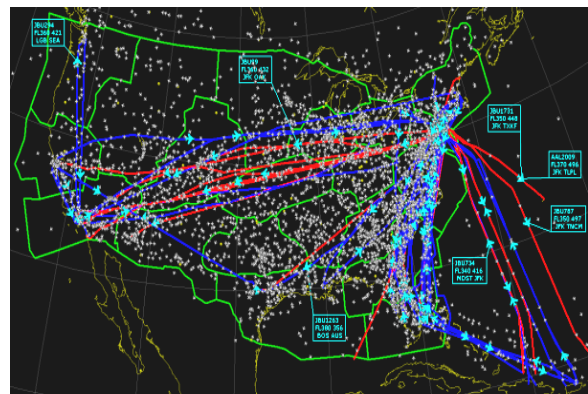


Figure 1. AwSim™ simulation software.

Having a robust set of operational data, modeling requirements, and simulation infrastructure will set the basis for creating simulation scenarios required for decision framework development.

Decision Framework Development

Metrics from simulation/modeling will be used to form solution portfolios in the context of a decision framework. The decision framework will be structured to assess the cost and benefits of each enhancement under consideration as they relate to each other in the system and how they are implemented relative to each other. For example, many of the enhancements could be implemented in serial or parallel or combinations of each. The end result is to understand where, when, and why the operational enhancements should be structured in the most meaningful manner, thus providing decision makers with a clear path and transparency in making implementation decisions.

Noblis Lab Demonstrations

There will be an initial demonstration of select operational scenarios and metrics using the AwSim™ simulation and modeling tool. At the conclusion of this project, a simple portfolio demonstration of the decision framework will be provided. This research will conclude with the creation of an initial NAS test bed for serving future FAA testing and validation of innovative NextGen solutions. Moreover, the analysis framework will be transparent and reusable by design for applications in other technical disciplines geared toward new customer business for Noblis.

Budget

The budget for FY10 is \$400K.

Schedule and Products

Table 1 provides the schedule and products for this NSR project. ■

Table 1. Milestones: Air Traffic Simulation and Modeling Facility.

Activities	Month	O	N	D	J	F	M	A	M	J	J	A	S
		1	2	3	4	5	6	7	8	9	10	11	12
Finish model infrastructure		■	■	■									
Initial technology and operational requirements			■	■	■								
AwSim™ initial lab demo				■	■	■							
Initial metrics developed					■	■	■						
Initial decision framework established						■	■	■	■	■			
ASDI data integration										■	■	■	
Framework review and lab demo											■	■	
Draft technical paper and documentation												■	■

Applied Computational Molecular Science and Biology

George O. Bizzigotti, Catherine E. Campbell, Ph.D., David C. Roberts, Ph.D.,
Ivan Boyer, Ph.D., J. Randall Good, Ph.D.

Objectives

The objective of this Noblis Sponsored Research (NSR) project is to establish a computational biology and chemistry facility capable of performing research-quality work to meet anticipated client needs.

Background

Molecular dynamics—the simulation of complex molecular systems by modeling atoms and the atomic and molecular forces governing their behavior—has made great strides over the past 20 years and is now a mature technology. These advances could be used to client advantage in many Noblis projects in such areas as chemical warfare agent environmental fate, detection and decontamination technologies, toxicology, and biomedical visualization. As demonstrated by the Transformational Medical Technology Initiative, the government recognizes the need for rapid response to emerging threats and Noblis' ability to model them—whether biological or chemical—will establish us as an important contributor in the field.

This capability could be routinely applied in predicting chemical and physical properties such as solubility and partitioning that govern the environmental fate of chemicals. It could also be used for simulation of molecular processes such as diffusion of small molecules on and off surfaces and estimation of rates of reactions under different conditions. Simulations are especially useful when experimental work with a given substance is impractical (for example, highly toxic chemicals/chemical warfare agents; behavior at high pressures or temperatures; behavior over long time spans).

On the biology side, molecular dynamics can model binding of small molecules to specific sites on proteins and other large biomolecules. Binding events often mediate important properties and processes such as toxicity, drug efficacy, immune response, and transport across membranes.

When cloned in a classified system, this framework could be used for projects involving classified information, a capability not found in academic environments.

Bioinformatics presents another aspect of applied computational biology. Bioinformatics tools use statis-

tical clustering analyses and pattern recognition algorithms on protein and nucleic acid sequences. The results of such analysis can be applied to a diverse set of problems such as prediction of pathogenicity and identification of biomarkers expressed after an infection.

Approach

During the first half of the fiscal year, we will design and implement this computational facility. As appropriate, we will obtain and implement a wide range of chemistry and biology tools. These tools will run in the Noblis Innovation and Collaboration Center (NICC) computing environment, with visualization in the NICC facility. Early implementation will be assisted by a George Mason University postdoctoral fellow and two graduate students from Johns Hopkins University. These collaborators will advise Noblis on hardware and software to complete the setup of the computational molecular science and biology facility, and will further assist Noblis personnel to assist their computational projects. The same students will develop models for use in computational biology.

To learn and quickly apply to our new facility, we will immediately conduct research. The initial projects will be a three phase bioinformatics study on "virtual virulence" and a molecular dynamics study of the environmental fate of chemical agents. These studies will commence as the required software is brought online in the NICC. These initial application studies will also be used to test and verify the relevant software packages; the initial computational portions of these studies are planned for completion in April (virtual virulence, phase 1: identification of organisms from a complex genetic background) and May of 2010 (virtual virulence, phase 3: integration of disparate data sources). The last phase of the virtual virulence study will be completed in September (phase 2, identification of novel virulence motifs). The environmental fate of chemical agents study will be completed in late August of 2010.

As additional computational molecular science and biology tools are brought online in the NICC, a third preliminary study in the area of computational toxicology will commence; this study will perform electron density calculations on a limited number of organophosphates that bind to Neuropathy Target Esterase

(NTE) to demonstrate the capability of the facility to use these tools. Conducting these calculations on the complete data set and correlating the results to observed toxicological effects will be the subject of follow-on work.

Multiple Noblis scientists will collaborate on each study in order to gain breadth of experience in use of the software tools and to maintain the focus of the individual studies. This project is anticipated to provide the NICC with a capability to perform high quality molecular science and biology studies that will continue operating beyond this initial project.

The NICC offers a conducive physical environment for conducting work and communicating issues and results to coworkers, managers, corporate officers, and clients. This project is committed to these key concepts and project staff members look forward to experiencing the synergies of working in the NICC in physical proximity to colleagues in such areas as

biometrics, modeling and simulation, and network computing.

Budget

The budget for FY10 is \$400K.

Schedule and Products

Table 1 provides the schedule and products for this NSR project.

This research is intended to support several of Noblis' strategic goals. Collectively, these projects will develop a toolset and analysis pipeline within Noblis that will give us the capability to perform computational biology and molecular science research for clients interested in areas such as microbial forensics and computational toxicology. Individual research projects will produce high quality scientific publications on topics of interest to potential customers, both growing the Noblis brand and strengthening our culture of learning. ■

Table 1. Milestones: Applied Computational Molecular Science and Biology.

Activities	Month	O	N	D	J	F	M	A	M	J	J	A	S
		1	2	3	4	5	6	7	8	9	10	11	12
NSR planning		█	█										
Develop MOAs with academic collaborators		█	█										
Software and hardware acquisition		█	█	█	█	█	█	█					
Obtain molecular dynamics staff support		█	█	█	█								
Obtain computational biology support			█	█									
Study—Environmental fate of chemical agents			█	█	█	█	█	█	█	█	█	█	
Study—Computational biology-virtual virulence			█	█	█	█	█	█	█	█	█	█	█
Study 1: Identification of organisms from a complex genetic background			█	█	█	█	█	█					
Study 2: Identification of novel virulence motifs								█	█	█	█	█	█
Study 3: Integration of disparate data sources			█	█	█	█	█	█					
Preliminary study—Small molecule binding to NTE			█	█	█	█	█	█	█	█	█	█	
Identification of organisms from a complex genetic background presentation								█					
Integration of disparate data sources presentation									█				
Environmental fate study presentation											█		
Identification of novel virulence motifs presentation													█
Computational molecular science capabilities demonstrated												█	

Adaptation Assessments from Regional Climate Change Downscaling

Maurice McHugh, Ph.D., Kenneth Carey

Objectives

The objectives of this Noblis Sponsored Research (NSR) project are to:

- Identify problems facing federal, state, and local stakeholders planning for local climate changes over the next several decades.
- Leverage the Noblis Innovation and Collaboration Center (NICC) (for example, computing, analysis, visualization) by hosting data produced from the global climate change modeling scenarios, and running nested regional climate models for targeted regions.
- Present recommendations on potential climate change adaptation, and as appropriate mitigation, response strategies to federal, regional, and local government officials.

Background

Climate-related environmental changes have already been observed globally, nationally, regionally, and locally. These changes include increases in air and water temperatures, reduced frost days, increased frequency and intensity of heavy downpours, a rise in sea level, and reduced snow cover, permafrost, and sea ice. Over the past 30 years, temperatures have risen faster in winter than any other season, with average winter temperatures in the Midwest and northern Great Plains increasing more than 7°F. These climate-related changes are expected to continue,

while new ones emerge. These changes will affect human health, fresh water supplies, agriculture, those living in coastal areas, and many other aspects of society and the natural environment.

Approach

Our approach is to:

- Understand dynamical regional climate downscaling techniques, their strengths and weaknesses, sensitivity to variations in forcing and model parameters, and the implications of these characteristics for providing actionable, regional-scale, climate change impact information.
- Install and run regional climate models and visualization software in the NICC.
- Apply results to other Noblis client initiatives.
- Present visualization and other output of dynamical downscaling simulations to decision makers.
- Publicize results to internal and external stakeholders; publish assessments in peer-reviewed documents.

Budget

The budget for FY10 is \$400K.

Schedule and Products

Table 1 provides the schedule and products for this NSR project. ■

Table 1. Milestones: Adaptation Assessments from Regional Climate Change Downscaling.

Activities	Month	O	N	D	J	F	M	A	M	J	J	A	S
		1	2	3	4	5	6	7	8	9	10	11	12
Identify specific questions facing potential clients		■	■	■									
Execute baseline and 21 st century simulation scenarios			■	■	■	■	■	■	■				
Produce intermodel comparisons and align simulation results with national strategic objectives and priorities, and client needs					■	■	■	■	■	■			
Present visualization and other actionable information of dynamical downscaling simulations to decision makers									■	■	■	■	
Publicize results to clients through meetings and publications												■	■

Pattern Recognition and Image Processing Rapid Application Development Environment

Mark J. Burge, Ph.D.

Objectives

The objective of this Noblis Sponsored Research (NSR) project is the design, development, and deployment of an environment for rapid development of pattern recognition and image processing applications.

Background

Through both internal and client funded research, Noblis has engineered systems that are in use throughout state, local, and federal government. Systems like the Universal Latent Workstation, which is used by law enforcement around the country for latent fingerprint examination, have established Noblis as a thought leader in the biometrics arena. The research and development of solutions to the increasingly complex problems arising in biometrics requires ready access to a broad spectrum of algorithms from computational imaging, machine learning, and numerical methods. This NSR project will address the need for the timely development of pattern recognition and image processing applications.

Approach

An agile development cycle will be used in which every six weeks, requirements will be solicited from both internal and external stakeholders, and a functional prototype will be developed for evaluation. The functional prototypes will be used to focus the direction of the rapid application development environment.

Ultimately, a software development environment supporting the following requirements will be developed: multiplatform—full support for Microsoft Windows, Apple's OS X, and Unix, optimized—processor specific optimizations through Intel Performance Primitives and custom multithreading, graphical user interface (GUI)—support for both Unix command line systems and multiplatform GUIs, and royalty free—built using open source software and libraries.

The first development cycle will:

- Complete a demonstrable version of the biometric extraction scanner initially developed in research year FY09
- Initiate a face recognition capability for the above scanner, including comparison of faces against a relatively small watch list
- Collaborate with users interested in the developed scanner capability
- Conceptual design of a light augmented reality interface for the scanner

Budget

The budget for FY10 is \$300K.

Schedule and Products

Table 1 provides the schedule and products for this NSR project. ■

Table 1. Milestones: Pattern Recognition and Image Processing Rapid Application Development Environment.

Activities	Month	O	N	D	J	F	M	A	M	J	J	A	S
		1	2	3	4	5	6	7	8	9	10	11	12
Image processing environment agile cycle		■	■	■									
Pattern recognition environment agile cycle				■	■	■							
Biometrics project using environment agile cycle					■	■	■	■					
Biometrics project using environment agile cycle							■	■	■	■			
Environment agile cycle									■	■	■	■	
Biometrics and machine learning project												■	■

Common Access Cards-Enabling Applications, Phase 1

Stephen Frost

Objectives

The objective of this Noblis Sponsored Research (NSR) project is to document and implement smart card (Common Access Cards (CAC)/HSPD12) authentication for Apache, IIS, and Domino platforms. The resulting documentation and understanding of smart card authentication will provide a basis for implementing smart card authentication on a number of existing systems and services which are provided to our clients. Specifically, we have had specific requests from the U.S. Department of Defense (DoD), General Services Administration, and other clients to support CAC and HSPD12 authentication.

Background

Every application has the basic requirement that users must be authenticated. Traditionally, this has been done by implementing either stovepipe authentication schemes (e.g., username/password) which is not shared across applications, or using more complicated systems such as Kerberos, Active Directory, or lightweight directory access protocol (LDAP). Unfortunately, stovepipe solutions require users to track multiple sets of credentials, and systems such as Kerberos and Active Directory are not generally used across organizations due to perceived risk of allowing cross-communication between authentication systems. Certificate-based authentication resolves a number of these issues and allows users to have a single set of credentials for all of the applications which they use.

CAC is a U.S. DoD smart card which stores a certificate for the user to use. HSPD12 cards are similar to CAC cards but have been implemented across the federal government and will also be used by the states. Users should be able to use their existing smart card credentials to authenticate to Noblis-provided systems and services. Clients are constantly asking for this capability.

Approach

Prior to implementation, it is important to understand and document CAC and HSPD12 authentication (policies, best practices, and existing work). As we will be implementing this authentication across multiple platforms, it is necessary to have a reference implementation in mind so that any differences due to platform specifics can be documented. Implementation will then be done on Apache, IIS, and Domino. Noblis Innovation and Collaboration Center systems will be used to implement these test systems. Results will be demonstrated upon completion.

Budget

The budget for FY10 is \$50K.

Schedule and Products

Table 1 provides the schedule and products for this NSR project. ■

Table 1. Milestones: Common Access Cards-Enabling Applications, Phase 1.

Activities	Month	O	N	D	J	F	M	A	M	J	J	A	S
		1	2	3	4	5	6	7	8	9	10	11	12
Understand and document CAC and HSPD12			■										
Implement in Apache				■									
Implement in IIS				■									
Implement in Domino				■									
Demonstrate new capabilities					■								

Analytic Performance Tool for Random Access Channel Networks

Martin J. Fischer, Ph.D.

Objectives

One of our clients, the Department of Homeland Security's National Communications System (NCS), has an extensive modeling and simulation program for Next Generation Networks (NGN) Government Emergency Telecommunications Service (GETS) wireless access during emergencies. The current plan is to develop standalone simulation models for each portion of the wireless network and then integrate the parts using OPNET. The objective of this Noblis Sponsored Research (NSR) project is to develop an initial analytic performance tool for a wireless random access network and to investigate the potential integration of parts using an analytics, versus discrete-event simulation, approach.

Background

The wireless access scheme being considered by the NCS, Code Division Multiple Access (CDMA), has existed for a long time. The system being considered is slot oriented. In a given slot, if more than one call attempts to access the network, the call is blocked and they have to try later. Current adaptations and ones being considered by the NCS consider scheduled and random back-off schemes (try in a later slot). PSIST sequencing, a (J,N) probe process where J probes are tried separated by back offs of random length N. Power and retries are just a few of the schemes being considered. This research will develop an initial analytic performance tool for a representative CDMA scheme of interferes to the NCS.

Approach

In order to develop analytics for this discipline, we must characterize the probability of blocking that a call sees in a cell. The original performance modeling of slotted aloha dates back to the 1960s. As different

back-off schemes were introduced, the analytic problem that needed to be solved was to determine the number of calls that arrived during a cell. Since only one call can be served and with each cell using a Poisson distribution, one could analytically calculate the call blocking in the cell. This is a classical approach for CDMA schemes used in most analyses. In this project, we will use an iterative method to estimate the call arrival process in a cell.

The development of the Random Access Channel (RACH) analytic performance model will follow a similar approach to that used in the past. We will define the exact discipline to be modeled and then develop a standalone event by event simulation of the discipline. The simulation will be used to experiment and calibrate the analytic RACH performance model. Our initial analytic methodology will be an iterative method. At iteration n the blocking probability from the previous iteration will be used to analytically estimate the blocking probability at the current iteration. The estimate will be based on assuming a Poisson call arrival process where the call arrival rate is a function on the call arrival rate of first offered call plus those that were blocked previously and are going through their retry sequences. The key in the development is the ability to estimate the total call arrival process in each cell. Using the simulation model as a calibration tool, we will develop and experiment with analytic methods to characterize the arrival process.

Budget

The budget for FY10 is \$75K.

Schedule and Products

Table 1 provides the schedule and products for this NSR project. ■

Table 1. Milestones: Analytic Performance Tool for Random Access Channel Networks.

Activities	Month	O	N	D	J	F	M	A	M	J	J	A	S
		1	2	3	4	5	6	7	8	9	10	11	12
Develop wireless analytic RACH performance model		[Solid black bar]											
• Literature search on CDMA performance model				[Solid black bar]									
• Define wireless discipline to be modeled			[Solid black bar]										
• Model development				[Solid black bar]	[Solid black bar]	[Solid black bar]	[Solid black bar]	[Solid black bar]					
• Initial model						[Solid black bar]							
• Calibrate and refine against simulation model						[Solid black bar]	[Solid black bar]	[Solid black bar]	[Solid black bar]				
Simulation model			[Solid black bar]										
Document model and comparisons with simulation										[Solid black bar]	[Solid black bar]		
Submit paper for conference publication												[Solid black bar]	
Investigate/document pros and cons of the current NCS OPNET paradigm												[Solid black bar]	[Solid black bar]

Cyber Resilience Modeling and Simulation Tools

Richard H. Murphy

Objectives

The objective of this Noblis Sponsored Research (NSR) project is to build a capability to simulate cyber attacks against real-world complex networks and to use that simulation to measure the effectiveness of mitigation strategies. The resulting metrics will provide a way to prioritize investment in security technology as well as demonstrating return on security investment.

This research will support the development of a Cyber Attack Resilience Toolkit (CART) to quantify the resilience of networks to cyber and physical attack scenarios. The work includes development of tools to evaluate performance of wide area Internet Protocol (IP) networks under cyber attack scenarios causing network congestion, degradation, and disruption as well as development of tools to assess resilience of those networks to physical disruptions over a range of threat scenarios.

Background

One of the “hard problems” defined by the U.S. Infosec Research Council is the problem of defining useful security metrics. System owners would like to justify security enhancements spending using repeatable, easily-understood measurements of the security posture. Such measurements can help decide budget changes to a system and justify investments in security upgrades by demonstrating how security improves as a function of changes. Additionally, metrics can support identification of weaknesses in an infrastructure that need additional investment to remove design flaws that render systems subject to well-known cyber attacks.

Noblis has experience in the application of analytic tools and techniques to solve complex, real-world problems. Noblis has built a set of analytic modeling tools that can be applied to a wide range of problems with the ability to build large-scale scenarios not possible using other techniques. This NSR project adapts those existing tools to support assessments of cyber security problems.

One such tool is the Network Performance and Analysis Tool (NPAT). This tool allows simulation of wide area networks and permits measurements of performance both in the normal operating state and while

under stress. NPAT permits assessment of the sensitivity of the network to changes and allows performance to be assessed.

Another Noblis analysis tool is the Telecommunications Infrastructure and Sensitivity Tool (TIST), which was created for the National Communications System. TIST is an interactive telecommunications critical infrastructure analysis tool, which addresses the government’s need to maintain the ability to communicate during a crisis. It incorporates data from government telecommunications contracts to allow users to view agencies’ telecommunications traffic inventories, identify homings of government locations to wire centers and interexchange carrier points of presence (POPs), and perform critical infrastructure/sensitivity analysis in the event of a disabled POP or wire center.

Both of these tools will be used in this research to form the CART, which will permit assessment of network performance and resilience while under several forms of attack.

Approach

A comprehensive toolkit having the ability to predict network performance and resilience for a range of cyber and physical attack scenarios, and which proposes options to mitigate the impact of outages, currently does not exist. CART will provide unique capabilities for network situational awareness planning. The use of an analytic performance model versus a simulation has the advantage of supporting much larger networks and cyber attack scenarios.

The Cyber Network Performance and Analysis Tool (C-NPAT) component of CART will be developed to evaluate the performance of wide area IP networks under cyber attack scenarios causing network congestion and degradation. The existing IP Network Performance and Analysis Tool (IP-NPAT) was developed using analytic queuing models and validated against high-fidelity simulation models to analyze the performance of federal IP networks. The models assess packet performance in terms of latency, jitter, and packet loss on individual network links and on an end-to-end basis. This research will enhance IP-NPAT to provide additional attack models.

C-NPAT will integrate a selected wide area tactical network into the existing IP-NPAT capability. The

C-NPAT model will evaluate network performance under both baseline and attack conditions. The attacks evaluated by IP-NPAT can include both cyber and physical attacks. The proposed work will augment the attack models already implemented in IP-NPAT. NPAT estimates performance using a network of individual queuing models, each corresponding to a network link. The C-NPAT model will enable one to estimate how corrective measures help mitigate the impact of attacks on network congestion. The C-NPAT will provide a valuable capability to estimate network congestion during selected cyber and physical attacks.

The Cyber Telecommunications Infrastructure and Sensitivity Tool (C-TIST) in CART will be developed to propose solutions to enhance the resilience of the telecommunications access infrastructure to physical failures and cyber incidents.

The majority of federal telecommunications services today are obtained through the General Services Administration's FTS2001 and Network contracts. Nearly all of these services depend on terrestrial transport through carrier wire centers and POPs. Agencies generally have limited knowledge of the wire centers and POPs that carry their traffic. This can leave the agencies unprepared when outages occur.

We will search for ways of filling this knowledge gap by using available databases of information related to critical telecommunications infrastructure. We will correlate the public data with commercial telecommunications databases and incorporate it into an application, the TIST. (A version of TIST processes network configuration data for the Department of Homeland Security.) We will develop C-TIST to analyze the collected data, allowing identification of crucial network links and suggestions for proposed changes to the network infrastructure. C-TIST will be of value to proactively pre-provision robustness at critical locations, or reactively to provide situational awareness and restoration strategies during events that impact telecommunications.

This NSR project will work closely with the Noblis Innovation and Collaboration Center-based Generalized Network Resilience Tools NSR project to ensure that the resulting model enhancements are usable for a wide range of environments.

Budget

The budget for FY10 is \$80K.

Schedule and Products

Table 1 provides the schedule and products for this NSR project. ■

Table 1. Milestones: Cyber Resilience Modeling and Simulation Tools.

Activities	Month	O	N	D	J	F	M	A	M	J	J	A	S
		1	2	3	4	5	6	7	8	9	10	11	12
Assess attack models in IP-NPAT		■	■	■				■		■		■	
Build and test new attack models				■	■	■	■	■	■				
Build network configuration dataset									■	■			
Validate sensitivity model performance											■	■	■
Collaboration with resilience tools research project		■	■	■	■	■	■	■	■	■	■	■	■

Noblis Innovation and Collaboration Center-Based Generalized Network Resilience Tools

David A. Garbin

Objectives

The objective of this Noblis Sponsored Research (NSR) project is to create a set of scalable generalized analytic tools capable of quantifying the resilience of network-based infrastructures. These tools will interface with standard Noblis Innovation and Collaboration Center (NICC) database and geographic information system (GIS) core services and be able to assess the resilience of different types of networks (e.g., telecommunications, electric grid, transportation).

Background

Different network types have many elements in common, such as nodes, links, and connectivity. There are many attributes of these elements that are common across network types. Examples include node location and link capacity. Two major elements differentiate the network types from an analytic point of view:

- The rules for routing commodities through the network
- The analytic relationship between demand, capacity, and performance metrics (e.g., throughput, delay)

A generic modeling capability with specific modules for the routing and performance areas would provide an efficient method for addressing a range of critical infrastructure initiatives. These include:

- Improving the resilience of government networks to all threats, including natural disasters, sabotage, and cyber attacks.
- National Diversity Assurance Initiative—joint project led by the National Communications System in concert with the financial community. A series of two reports concluded that physical diversity of circuits, a key component of high availability networks, cannot be assured in today's environment.
- SmartGrid—a wide ranging initiative to realize a national intelligent distribution system for current and renewable electricity sources. A key component is a highly available and survivable control system.

High-availability networks all share a set of common principles. Redundant physical paths through the network must be provided. Many logical connections share the same physical facility, both within and across networks. Adaptive routing strategies must discover alternative paths when primary paths become unavailable. Tools supporting high-availability networks must perform the following key functions:

- Analyze—the ability of a network to fulfill its mission in the face of disruptions must be quantified. Disruptions can be component failures, natural local disruptions, widespread natural disasters, and directed attacks.
- Design—network design tools must assist the analyst in determining topology augmentations and routing strategies necessary to achieve a certain standard of availability.
- Assure—the physical elements of the network must be implemented and maintained as designed. Specifically, the actual diversity of paths over time must be assured.

Approach

Our approach is to build on the current IP-SURVIV and TDM-SURVIV analysis tools. They are currently implemented in Microsoft VBA on Windows laptops. This severely limits their scalability and extensibility and requires considerable manual intervention for design. These limitations will be removed using the following approach:

- Use the PostgreSQL/PostGIS enterprise database hosted in the NICC as the master repository for network element data. This not only increases the size of data supported, but allows sharing of common data across projects.
- Migrate the applications to an object-oriented, cross-platform development environment. The new environment utilizes data structures and objects with properties and methods. This will allow efficient data models and facilitate the sharing of code among various network models.
- Host the applications on NICC Linux servers accessed through X-Windows clients. The models and data will be instantly available to all employees across the company.

- In the future, implement web-based input and output for remote users.

A key feature of these tools will be the data structures and algorithms associated with shared risk groups. These are logical network elements (e.g., circuits between switches, transmission lines between power stations) which share a common physical element, such as fiber optic cable or a right-of-way along a railroad track. A resilience analysis considers how a network responds to the loss of its physical assets, which may affect many disparate logical elements. Threat scenarios can take many forms, both natural (severe weather, earthquakes), unintentional (fiber cuts, electronic equipment failure), and intentional (malicious attacks on facilities, both physical and cy-

ber). This link between threat characterization and resilience analysis creates a synergy between this research and other ongoing research at Noblis in the areas of cyber security threat modeling and modeling extreme weather-related events in the arena of climate change.

Budget

The budget for FY10 is \$150K.

Schedule and Products

Table 1 provides the schedule and products for this NSR project. ■

Table 1. Milestones: Noblis Innovation and Collaboration Center-Based Generalized Network Resilience Tools.

Activities	Month	O	N	D	J	F	M	A	M	J	J	A	S
		1	2	3	4	5	6	7	8	9	10	11	12
Structured data model		■	■	■									
Object roadmap			■	■	■	■							
PG-SQL interface objects				■	■	■	■						
Resilience analysis algorithms				■	■	■	■						
Resilience tool deployment								■	■	■			
GIS integration											■	■	■
Electric grid control example										■	■	■	■

Rare Events Simulation Methods and Application

Martin J. Fischer, Ph.D.

Objectives

In 2009, the U.S. Department of Energy (DoE) awarded Noblis and George Mason University (GMU) a three-year grant titled *New Approaches for Rare-Event Simulation and Decision Making*. The DoE grant will continue research performed in partnership with GMU; this partnership created the Center for Network-Based Systems (CNBS). As part of the DoE grant, Noblis has agreed to provide in-kind funding. The objective of this Noblis Sponsored Research (NSR) project is to conduct research related to the topic of rare event analysis.

Background

We define a rare event as an event that has a small probability of occurrence (for example, 10^9). One could classify rare events as an infrequent event, completely unanticipated event, or a catastrophic impact event. Related to rare events are events that are generated by a heavy tailed probability distribution. A heavy-tailed distribution has the property that rare-events (say at the 10^9 threshold) can correspond to extremely large values. Roughly, “heavy-tailed” means “has a tail probability that decays more slowly than exponential.” So there is some overlap between rare events and heavy-tails. Examples of heavy-tailed distributions are the Pareto, Weibull, and Log-Normal distributions. It is possible to have a rare-event that comes from a non-heavy-tailed distribution (for example, the probability that a randomly chosen person is taller than 7 foot). The distribution of height is light-tailed (follows a Normal distribution), but the probability is still rare.

Noblis and GMU previously collaborated to develop methods to solve congestion systems where either the arrival or service distribution was heavy-tailed. That research was funded by two grants from the Na-

tional Science Foundation and in-kind funding from Noblis. The end product was a method called the Transform Approximation Method (TAM).

Rare events may not have a heavy-tailed distribution associated with them and so GMU has developed a simulation method to model rare events. It integrates the notions of optimal budget allocation and level splitting to optimally allocate the limited computing budget so that the overall efficiency of the simulation is maximized.

Approach

This research will result in the development of a simulation method that can be used to model critical real world problems. The approach we will use is a standard one, we will undertake a series of tasks to understand, test, refine, and apply the new simulation method developed by GMU. The real world problems that we will be applying it to will be in the area of cyber security, smart grids, and power networks. In this process we will have to develop an understanding of the GMU method and compare it with the TAM method on congestion problems. The DoE grant is a research oriented grant in the sense the main products beside the development of the simulation method, and is application of the research on real world problems and the dissemination of the results to the professional community in the form of peer reviewed conference and journal articles.

Budget

The budget for FY10 is \$75K.

Schedule and Products

Table 1 provides the schedule and products for this NSR project. ■

Table 1. Milestones: Rare Events Simulation Methods and Application.

Activities	Month	O	N	D	J	F	M	A	M	J	J	A	S
		1	2	3	4	5	6	7	8	9	10	11	12
Major products:													
• Develop understanding of GMU splitting algorithm			█	█									
• Review literature on rare events in electric power grids/cyber attacks			█	█	█								
• Develop issue of <i>Sigma</i> on rare events			█	█	█	█	█						
Related products to be developed under the DoE grant:													
• Research C++ versus Visual Basic for our use of the algorithm, and random number generators for Visual Basic			█										
• Implement rare events simulation algorithm and test against other methods				█	█	█							
• Develop simulation models to apply enhanced level splitting simulation to cyber security problem					█	█	█	█	█	█			
• Develop scenarios to test rare events simulator							█	█	█	█	█	█	
The accomplishments of both will be captured in:													
• Document studies and advances to be presented at national and international professional conferences												█	█

Appendix A: Noblis Sponsored Research Proposals Submitted

The following is a list of the 2010 Noblis Sponsored Research (NSR) proposals submitted. During the NSR forum and workshop process, these proposals were constructively and critically received, opportunities for combining or expanding proposals were examined, and final projects were selected.

Acquisition

Acquisition Source Selection Support Using Social Networking Tools	<i>Allan Kostreba, Alina Kostreba, Barbara Staples, John Hunsinger</i>
Strategic Modeling of Defense Acquisition	<i>Shawn Margolis, Eric Gottshall</i>
AcquTrak—IM Feature for Dispersed Web-based Source Selection Teams	<i>Eva Griffeth</i>
AcquTrak—Wiki Collaborative Document Development	<i>Eva Griffeth</i>
AcquTrak—Executive Dashboard	<i>Eva Griffeth</i>
Dynamical Analysis of Modeled Ozone Structures in the Upper Troposphere/ Lower Stratosphere Over North America	<i>Ivanka Stajner</i>
Web-Based RFP Developer	<i>Stephen Frost, James Soltys, Robert Menna</i>
Feasibility Study for Expanding “Acqu” Suite	<i>Matthew Haaga</i>

Analysis, Simulation, and Modeling

Heavy Tails and Rare Events Simulation Methods	<i>Martin Fischer</i>
Analytic Performance Tool for Random Access Channel Networks	<i>Martin Fischer</i>
Cyber Resilience Modeling and Simulation Tools	<i>Martin Fischer</i>
Outreach and Branding—Center for Network-Based Systems	<i>Martin Fischer</i>
Noblis Visualization Suite	<i>Michael McGurrin</i>
Enhancing Terrorist Threat Models for Communications Networks: A Game Theoretic Approach	<i>Steve Miksell</i>
Modeling Tool for Assessment of Climate Change Mitigation and Adaptation Strategies	<i>Christopher Condrey</i>
Smart Grid	<i>Keith Biesecker, Carl Kain</i>
Estimating Uncertainties in Tropospheric Composition and Transport from Assimilation of Carbon Monoxide Data	<i>Ivanka Stajner</i>
Computational Modeling of Virulence using Whole Genome Comparative Genomics	<i>Catherine Campbell</i>
Feasibility Assessment for Developing Models of Heavy-Tailed Probabilities in Biology for Microbial Forensics Applications	<i>Catherine Campbell</i>
Web Analytics Visualization	<i>Elizabeth Chang</i>
Computational Toxicology	<i>Ivan Boyer</i>
WMD Risk Analysis Tool	<i>Daisy Ligon, Robert Cutler</i>
Air Traffic Simulation and Modeling	<i>Michael Yablonski, Andrew Girard</i>
An Augmented Reality Platform	<i>Benjamin Pecheux, Christopher Tomaszewski</i>
A Centrifuge Multi-touch Display for the NICC	<i>Benjamin Pecheux, Christopher Tomaszewski</i>
A Rapid Image Categorization Tool	<i>Benjamin Pecheux, Jesse Wise</i>
Chesapeake Inundation Prediction System (CIPS) Visualization Prototype	<i>Barry Stamey</i>
Molecular Determinants of Influenza Virulence	<i>Ann Kennedy, Catherine Campbell</i>
Evidence Based Design (EBD) in National Capital Area	<i>Sharon Steele, Anthony Cicci, Julie Mann-Dooks</i>

Biometrics

Pattern Recognition and Image Processing Rapid Application Development	Mark Burge
Environment for Biometrics	
Improving Face Recognition Performance with Demographics	Nathaniel Hall, Ralph Broom, Matthew Monaco
Unattended Ground Sensor (UGS) Data Analysis for Improved	David Paciorkowski, Lawrence Nadel
Border Protection Operations	
Large-scale Biometric System Design through Effective Model Management	Nathaniel Hall

Computing and Software

Enterprise Architecture Governance	John Stevenson
Noblis Year of Code—Contributing Back to the Open Source Community	Stephen Frost, James Soltys
Infrastructure Support for Open Source Communities	Stephen Frost, James Soltys
PostgreSQL Performance/Benchmarking	Stephen Frost, James Soltys
Noblis iPhone Applications	Ronnie Shaw
Extensible Authorization Frameworks	James Fisher

Data and Knowledge Management

Leveraging Federal Government Datasets through Data.gov to Expand Noblis Capabilities	Ronnie Shaw
Information Support for Nuclear Event Management	Daniel Whitford
Application of Centrigue to Analysis of Land Imaging Use	Sue Russell

Environmental, Chemical, and Life Sciences

Adaptation Assessments from Regional Climate Change Downscaling	Kenneth Carey
Alternative Energy for the NICC and/or FVP	David Garbin, Jasper Saunders
Alternative Fuel/Energy Vehicle Pilot Program	David Garbin, Jasper Saunders
Season of Cancer Diagnosis and Probability of Death from that Cancer in the	Ivanka Stajner
United States	
Impact of Climate Change on Breast Cancer Incidence	Ivanka Stajner
Identification of Infectious Disease Biomarkers—A Bioinformatics Approach	Jane Tang
Environmental Fate Prediction via Molecular Dynamics	David Roberts, George Bizzigotti
Adapting to a Carbon-Constrained World: Developing a Blueprint for a	Judith Barry
Local Government	
Computational Biology and Chemistry Facility	George Bizzigotti, Ivan Boyer, Catherine Campbell, David Roberts

Information and Network Security

Offensive Cyber Security	Ralph Broom
CAC-Enabling Applications	Richard Murphy
Survey to Identify Forensic Tools for Cloud Computing	John Dobiac
IPv6 Security Tools and Technologies Survey	Ralph Broom, Richard Murphy
Encrypting Data at Rest in Computing Clouds	Ralph Broom
Usable Security—Bluetooth Proximity-detecting Screen Lock	Richard Murphy
Security Consequences of Social Networking Sites	Richard Murphy
Offensive Cyber Security	Ralph Broom

Program Management

Social Networking Tools, Geospatial Representation, and Program Management	Allan Kostreba, Barbara Staples, Alina Kostreba, John Hunsinger
Balanced Scorecard for Transportation Operations	Michael McGurrin, Karl Wunderlich
Earned Value Management Objective Study	Chris Stankus, Matthew Haaga
The Nature of Informative Talk in an Organization Utilizing Micro-Blogging Technology	Thomas Dembeck
Noblis Lean Six Sigma Guidance for Clients	Amanda Marvin

Systems Engineering

Early Life-Cycle Software Sizing to Support Decision Makers	<i>Allan Kostreba</i>
Mobile Nuclear Detection	<i>Keith Biesecker</i>
Enhanced Mobile Visualization	<i>Keith Biesecker</i>
Using Multifactor Authentication to Reduce Medical Errors and Improve..... Healthcare Security	<i>Matthew Monaco, Veronica Vela</i>
Strategic Facilities Planning Tool (SFP Tool)—Investment Planning Component.....	<i>Elisa Kepner</i>
Strategic Facilities Planning Tool (SFP Tool)—Expansion of Requirements..... Planning Component	<i>Elisa Kepner</i>
Strategic Facilities Planning Tool (SFP Tool)—Modification of SFP Tool Data Model	<i>Elisa Kepner</i>
Pharmacovigilance	<i>David Wong, Catherine Veum</i>
Measuring Climate Change Plan Actions: Emphasis on Transportation-Related..... Variables	<i>Emily Parkany</i>
Agile Development of Compliance Artifacts	<i>Ralph Broom</i>
Healthcare Acoustics—Improving the Hospital Soundscape.....	<i>Elisa Kepner</i>

Telecommunications and Networks

Mobile Multimedia for Enhanced Public Relations	<i>Keith Biesecker, Richard DiMassimo</i>
NICC-Based Generalized Network Resilience Tools	<i>David Garbin</i>
Wireless Focused Office Environment	<i>Gerald Warga</i>
Development of a Generic Telecom Price Comparison Tool.....	<i>Jeffrey Dauler</i>
Future of Telecommunications Industry and the Impact on the Government.....	<i>Larry Pueschel</i>
Business and Application Integration Using Unified Communications (UC).....	<i>Areg Gharakhanian</i>
Noblis Autonomous Maritime Sensor System (NAMSS)	<i>Barry Stamey</i>
Development of a Generic Telecom Price Comparison Tool.....	<i>Jeffrey Dauler</i>

Noblis, Inc.
3150 Fairview Park Drive South ▪ Falls Church, VA ▪ 22042-4519
703.610.2002 (voice) 703.610.1955 (fax)
corpcomm@noblis.org