National Institute of Standards and Technology (NIST) Submission for 2008 DHS Summer Internship Program

1. Experience:
NIST has been hosting undergraduate students for the DHS Summer Internship Program since 2005. A total of 10 students have been hosted, with five students participating at NIST this past summer (2007), at NIST-Gaithersburg and NIST-Boulder.
In addition, NIST has been hosting summer students through the NIST Summer Undergraduate Research Fellowship (SURF) Program since 1983, and so has a history of successful experience with summer students at NIST.

The National Institute of Standards and Technology (NIST) is the national metrology institute for the U.S., and is part of the Department of Commerce's Technology Administration. NIST has unique measurement and research facilities to develop and promote measurements, standards and technology, with the primary goals to enhance productivity, facilitate trade and improve the quality of life. NIST's staff of 2800 includes a technical staff of 1500 at two primary campuses in Gaithersburg, Maryland, and Boulder, Colorado, and at several joint institutes with universities. Unique facilities include the Advanced Measurement Laboratory, Advanced Chemical Sciences Laboratory and the NIST Center for Neutron Research. (Get a general description of NIST from pamphlet)

NIST's role in homeland security is to provide measurements, standards, and expert guidance needed to support the Nation's homeland security needs. These include effectively and efficiently deploying homeland security technologies, test and compare different types of these technologies; giving technical guidance on the implementation of such technologies, and to enable the development of new technologies. NIST measurement and standards support current activities and potential future advances in key homeland security areas including chemical, biological, radiological, nuclear, explosive (CBRNE) threat detection and remediation; safety of structures and occupants; safety and effectiveness of emergency responders; transportation system safety; information security and Critical Infrastructure Protection; and biometric identification.

2. Additional Benefits
It is possible for housing to be coordinated through the NIST Summer Undergraduate Research Fellowship (SURF) program, a large undergraduate program already well established at NIST. However, the students may prefer to arrange their own housing. For the latter option, there are lists of available housing in the area that the students can request from the Office of International and Academic Affairs at NIST.

The students have the flexibility to set their own start and end dates in coordination with their NIST mentor. However, if student wants to coordinate housing through the SURF program, they should follow the program guidelines of May 21 through August 10, 2007.

A benefit to using the housing from the SURF program is that transportation to and from NIST is provided each weekday.

There are many possibilities for lectures and seminars at NIST to which the students can elect to take advantage. The students are welcome to join the scheduled SURF activities, which include seminars, weekly socials, tours, and other networking opportunities. The DHS Summer students would also be welcome to attend the NIST-wide seminars that are held regularly during the summer.

3. Point of Contact
The primary point of contact at NIST for the DHS Summer Internship Program is

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NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY - 2008

DESCRIPTIONS OF AVAILABLE PROJECTS AND MENTOR CONTACT INFORMATION

Electronics and Electrical Engineering Laboratory (EEEL) www.eeel.nist.gov

RFID Electromagnetics Testing

NIST is studying the electromagnetic behavior of radio-frequency identification (RFID) cards and tags to understand the limits of their performance in homeland security applications. Projects include developing and carrying out electromagnetic tests to understand the absolute read range, the environmental stability, and the distances at which RFID card transactions can be detected surreptitiously.

Contact: Kate Remley <Kate.Remley@boulder.nist.gov> 303-497-3652

RFID Chip-Level Security

NIST is studying physical attacks aimed at compromising the security of radio-frequency identification (RFID) cards and tags. Help is needed in demonstrating attacks and developing countermeasures to these attacks. Projects include developing surrogate RFID cards, improving power management and packaging and evaluating security features of RFID cards.

Contact: Kate Remley <Kate.Remley@boulder.nist.gov> 303-497-3652

Wireless Personal Alarm Systems for Firefighters

NIST is developing ways to ensure the reliability of portable alarm systems (PASS devices) used by firefighters. These devices send an emergency signal when a firefighter is in distress. Wireless, RF-based PASS devices are relatively new, and help is needed in developing methods to verify their reliability and standardized evaluation of their performance. The project includes developing a completely new type of radio test method that captures the behavior of the PASS devices in firefighter environments and transferring those methods to the lab.

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Integrated Microfluidic System for DNA Identification

The goal of this program is to design and breadboard an automated DNA analysis system that is capable of extracting the DNA from raw cell samples; amplifying relevant single tandem repeat regions (STR) using polymerase chain reaction, and isolating the PCR STR amplicons from the contents of the PCR reaction. Our student interns will work with our staff in the development of new on-chip methods to extract (cell lysis) and amplify (PCR) DNA from forensic samples. These methods will be interfaced to a high-performance integrated microfluidic electrophoresis system that can then analyze the contents of this sample and ultimately yield relevant information on human identity.

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Chemical Science and Technology Laboratory (CSTL) www.cstl.nist.gov

Standards and Sensors for Detection of Chemical/Explosive Signatures

NIST is developing new measurement techniques, novel analytical instrumentation, high sensitivity microsensors for hazardous chemicals, novel reference materials, and a better understanding of the chemical reactions underlying chemical explosions. This research will underpin and enable the screening and identification of trace explosives and residues as well as detection of dangerous chemicals in the field.

Quantum chemistry and isopotential searching (IPS) are being used to obtain better understanding of the chemical reactions responsible for the decomposition, deflagration, and detonation of chemical explosives.

Unique instruments are being used to fabricate prototype standards for screening of trace explosives and narcotics residues. These include a state-of-the-art ink jet printing system for dispensing individual micrometer sized droplets of explosive compounds with fluorescent tags in patterned arrays on surfaces, a vibrating orifice particle generation system for producing individual polymer spheres doped with explosives or narcotics of interest, and a spin coating system used to prepare ultrathin doped polymer films on planar surfaces. Test materials are characterized by state-of-the-art secondary ion mass spectrometry, ion mobility spectrometry, optical microscopy, and scanning electron microscopy. Complementary research is underway to develop new analytical measurement methods and Standard Reference Materials (SRMs) that will support the detection of terrorist explosives threats and the forensic evaluation of post-blast residues. New strategies are being developed to identify explosive compounds, including fast GC analysis, addition of chemical ionization additives, and the use of atmospheric pressure photoionization for LC/MS. SRMs are being developed to simulate the morphology and chemical properties of explosive residues so that the performance of field detection equipment such as ion mobility spectrometers may be critically evaluated.

Research is also underway to develop a new generation of microfabricated chemical sensors. These MEMS-based devices integrate arrays of heaters, thermometers, and sensing materials in a tiny package. Their sensitivity, chemical selectivity, stability of operation, and speed of response are being improved to meet the challenging requirements of homeland security. Studies of sensing materials, including nanophase metal oxides and metal catalysts and polymers, are enhanced with combinatorial approaches that use arrays of microdevices as research tools. The sensing materials are characterized with mass spectrometry, x-ray photoelectron spectroscopy, atomic force microscopy, and scanning electron microscopy. Integration into microfluidic systems is being investigated and new methods to analyze signals from arrays using chemometric or neural network methods are being developed.

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Standards and Sensors for Detection of Biological Signatures

Robust and reliable detection methods for biological systems span issues from DNA diagnostics to Biological weapons. Research is being conducted on developing new DNA marker sets from mitochondrial DNA and the Y chromosome. Innovative DNA typing technologies involving techniques such as time-of-flight mass spectrometry to provide reliable forensic evidence are also being investigated. Parallel efforts address biological threats. Surrogates are being used to determine performance of detection devices and instruments. Techniques to characterize the relevant properties of the surrogates for their use as standards are being developed. The goal in developing biological standards is to have traceability to the SI unit of concentration (moles/liter), thereby assuring consistency and accuracy over time and space. Methods to increase the sensitivity of labeling individual molecules and organisms with fluorescent tags are being studied. Flow cytometers are being used to count individual events that are triggered by either light scattering or fluorescence Advances in imaging using sensitive cameras and microscopes will allow the detection of single molecules. The accurate and sensitive counting of DNA, proteins, bacteria, and viruses will be used to produce the next generation of biological standards based on SI units of concentration. These standards will then be used to test detection devices.

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Manufacturing Engineering Laboratory (MEL) http://www.mel.nist.gov

Standards and software assurance metrics for industrial control systems

Supervisory Control and Data Acquisition (SCADA) and industrial control systems perform remote monitoring and control of the electric power system and control industrial processes in the oil and gas, water, chemical, pharmaceutical, food and beverage, pulp and paper, and other industries. Software bugs or lack of security in the development of the software in these systems can lead to a compromise of the control system, which could cause loss of production, generation or distribution. Student support is sought to help identify, specify, and refine a systematic set of software assurance metrics that ensures that SCADA and industrial control system software processes and products conform to requirements, standards, and procedures. We can use either undergraduate or graduate students. Major in electrical engineering and/or computer science with some familiarity with either software assurance tools, IT security technologies and processes, or control system/real time hardware/software is preferred.

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Standards and test methods for sensor networks and alert systems

This project defines standards and test methods for performance and interoperability of networked CBRNE (chemical, biological, radioactive, nuclear, explosive) sensors and other appropriate sensors for homeland security. It also defines requirements for an integrated alert system for smart buildings, and for a national alert system for homeland security based on sensor information. Research and development activities include, 1) sensor networking via wired and wireless communications, and sensor integration into an alert system for the demonstration of functionality and validation of standards specifications; 2) developing test methods for the verification of conformance to standards. Undergraduate and graduate students majoring in electrical engineering and/or computer science with experience in programming languages such as C, C++, Java would be preferred. Experience or keen interest in working with Bluetooth, WiFi, and ZigBee wireless communication technology and protocols for sensor networking is a plus.

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Standards for Secure Shipping Containers

Deployment of advanced container security technologies is impeded by the lack of data exchange standards throughout the shipping environment. We are working to accelerate the development and deployment of standards for advanced devices and systems to be used to enhance the security of shipping containers and cargo handling processes. The project is particularly focused on modelling and standards needed to integrate security device and cargo handling process information outputs into supply chain information systems. The anticipated work on this project over the summer will be the development of a process and activity model for a system that will provide increased container security. There will be some amount of review of container security requirements and existing system architectures. The system will be modeled using formal modeling languages including IDEF and UML. This model will be used to help validate system requirements and identify needed standards development. Undergraduate or graduate students majoring in engineering and/or computer science/information technology with coursework or experience in object oriented programming or UML modeling would be preferred.

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Standards for urban search and rescue robots

DHS is funding NIST to work on defining standards for performance and interoperability for urban search and rescue robots. NIST will work closely with emergency responders, technology developers, vendors, and other government agencies to derive requirements, define specifications, and devise evaluation techniques. Support is needed in collecting information and data and in developing testing methods and tools. We can use either undergraduate or graduate students. Major in Engineering and/or Computer Science with some familiarity with either CAD/CAM systems, Matlab, Labview or programming languages (*e.g.* C) is preferred.
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Building and Fire Research Laboratory (BFRL) http://www.bfrl.nist.gov\

Thermal Imaging Cameras
Research is being conducted to develop metrics and standards to characterize the performance of thermal imagers.
1) To understand the extent to which the fire and non-fire environment affect the performance of thermal imaging cameras used in emergency response applications, (2) characterize the role of thermal imaging camera displays, compared with the performance of the camera package (i.e. the infrared detector, optics, and image processing circuitry), (3) provide a quantifiable physical and scientific basis upon which an industry standard for imaging performance can be based, and (4) to develop a document that provides guidance on best practices, selection, care, and maintenance of thermal imagers.
Contact: Francine Amon, <francine.amon@nist.gov> 301-975-4913

Virtual Fire Fighter Trainer
To develop a computer based fire fighting training tool to improve training opportunities while lowering the cost and risk of death and injury.
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PASS/RFID
Emergency Responder and Occupant Locator Technology
Monitoring the status and environment of firefighters and occupants inside buildings from outside the building is critical for managing the firefighting effort and preserving life. This effort examines the capabilities and limitations of different technologies including multi-nodal distributed systems(ad-hoc networks), RFID tags, and ultrawide band radio (UWB) locators. The results from this research will allow incident commanders, both fire service and law enforcement, to track search, rescue, or fire suppression teams within structures.
Contact: Nelson Bryner, <nelson.bryner@nist.gov> 301-975-6868

Reactive Cooling System
Develop performance metrics and standards testing protocols for reactive protective clothing for fire fighters and other first responders that use reactive cooling to respond to short duration high thermal load. A reactive system would use a chemical reaction or physical phase change to absorb heat energy in order to provide additional protection against burns. For fire fighters it may be the short duration, but intense, thermal exposure that leads to burns. For law enforcement officers it may be longer periods of exposure to less intense heat that leads to heat stroke.
Contact: Bob Vettori, <robert.vettori@nist.gov> 301-975-6577

Investigating the Impact of Positive Pressure Ventilation on Large Structures
To improve the safety of fire fighters and building occupants by enabling a better understanding of structural ventilation techniques, including positive pressure ventilation (PPV) and natural venting in large buildings.
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Thermal Exposure Measurement Method for First Responder Locators
This project is designed to evaluate the adequacy of current thermal equipment standards for electronic devices used by first responders for location purposes. In many cases, standards and test methods do not exist and will be developed by the project. Equipment that is used for first responder locators includes: Personal Alert Safety Systems (PASS), emergency radios, infrared cameras, and other electronic devices that provide information on the condition or location of first responders. The project will provide the scientific basis for standards development, recommendations for either new or revised standards, and will develop test methods to validate product compliance. Having these standards defined will improve product quality and safety for first responders.
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Real-time Monitoring of Respiratory Threats for First responders
Identify the key respiratory threats of the fire suppression environment and existing devices and technology that can detect these threats in real-time. Define performance criteria specific to the fire fighting event and evaluate the devices according to the performance criteria. Design experiments to simulate the conditions of the fire fighting event and evaluate the devices' performance under simulated conditions. Draft performance metrics and testing protocols and issue recommendations for improving the technology.
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Standard Methods to Predict Losses and Evaluate Disaster Resilience at the Community and Regional Scales
This project is to develop methods for improving economic models and tools needed to forecast losses incurred from natural and man-made disasters.
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Decision Support Tools for Economic Assessment of Multi-Hazard Solution
This project provides a decision support tool for the economic assessment of multi-hazard threats to constructed facilities, with a focus on risk and uncertainty in the decision-making process.
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Physics Laboratory (PL) http://www.pl.nist.gov

Dissolution of resistate materials
Dissolution of RDD/IND remediation materials assayed for radionuclide contamination are sometimes very difficult. Understanding which materials are difficult to dissolve and development of dissolution methods are the focus of this project.
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Radionuclide speciation
Effective remediation of contaminated urban areas following a RDD or IND incident depends on selection of the appropriate clean-up technology. The removability of the radioactive contamination from the urban environment is ultimately dependent on the speciation of the radionuclides embedded. The focus of the project is the optimization of a NIST sequential leaching protocol that characterizes the removability of radionuclides from surfaces.
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Information Technology Laboratory (ITL) http://www.itl.nist.gov

Multimodal biometric research and development

Scholars and fellows would support ongoing research in multimodal biometrics, with a particular systems focus. Potential topics include:

- Usability, ergonomics, and system flow design, analysis and evaluation
- Development of a suitable quality assurance and / or testing plans
- Hardware / software integration of biometric sensors with control software
- Database logical and physical modeling design and evaluation
- Understanding, documenting, and overcoming biometric-specific interoperability issues

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Guidance on media sanitization and disposal

- Overview of media sanitization
- Management of remanence risk
- Clearing of magnetic media
- Destruction of media

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Standards for urban search and rescue robots

This effort involves identifying standard performance test methodologies for potentially deployable Urban Search and Rescue robots (USaR) in particular, those concerneed with Human-Robot Interaction (HRI). Anticipated work should involve the conduct of empirical research to develop and evaluate testing methods reflecting best performance practices for search and rescue robotic systems. This may involve field experimentation, though most likely will include reviews of the current literature relating to the human-robot interface, and possibly entail data reduction subsequent to field testing. An additional intent of the project is to provide a scientific basis for compliant test standards development and recommendation, done so by applying appropriate validation techniques.

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Handheld device forensics

Cell phones and other types of handheld devices are increasing discovered at the scene of an incident and can yield important information to an investigator. Present days tools are often limited or non-existent for certain classes of devices. This project involves the analysis, development, and testing of forensic tools specialized for handheld devices.

Contact: David Ferraiolo dferraiolo@nist.gov 301-975-3046

BGP Security: Modeling and Analysis Tools for Understanding the Risk Profiles, Design Space and Solution Techniques.

Scholars and fellows would support on going research in test and measurement techniques to characterize the potential effectiveness and operational impact of schemes to improve the security and robustness of the global Border Gateway Protocol (BGP) routing infrastructure. Potential research activities include:

- Simulation modeling and analysis of BGP security mechanisms.
- Experimental / testbed evaluation of data-driven algorithms to improve global BGP robustness.
- Design and evaluation of measurement and monitoring techniques and infrastructures that could improve the effectiveness of data-driven techniques to improve robustness.

Projects would require understanding and experience with Internet/BGP technologies, network programming, modeling, and analysis techniques.
Contact: Doug Montgomery <dougm@nist.gov> 301-975-3630

DNS Security: Expediting the Commercial Realization and Deployment of Domain Name System Security Technologies.
Scholars and fellows would support on going research in test and measurement techniques to characterize the operational procedures and performance / behavioral impacts of global deployments of Domain Name System (DNS) Security (DNSSEC) technology. Potential research activities include:

- Design and development of performance measurement tools and data sets.
- Empirical measurement of DNSSEC deployment scenarios.
- Modeling and analysis of large scale impacts of DNSSEC deployment in the global Internet.
- Prototyping and evaluating technologies to assist in the operational management of DNSSEC infrastructures (e.g., key management technologies).

Projects would require understanding and experience with Internet/DNS technologies, network programming, modeling and analysis techniques.
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Standards for a Universal Access Control Mechanism (the Policy Machine)
The Policy Machine (PM) at its most abstract level, is a mechanism consisting of standardized sets of data, relations, and functions, which can specify and enforce arbitrary attribute-based access control policies. The PM functions enforce different policies by changing only the data and relations on which they operate. Some characteristics of the PM include the ability to specify and enforce combinations of policies under one mechanism, visualization of access control data and policies, strategies for defeating Trojan horse attacks and limiting the propagation of access rights. The PM consists of a decision-making authority (DMA) and a multitude of vendor product systems (VPS). The DMA includes a policy engine (PE) and a database of access control data and relations (ACDB). The student will be expected to assist in the development of the DMA standardized functional interfaces and/or the specification of the data elements and relations that compose the ACDB.
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Standards for the Human Computer Interaction and Usability of Biometric Systems
Human Factors and user behavior affect biometric performance including the time required to collect the images as well as quality of the collected image. These factors affect system performance including throughput, matching, and cost. This effort is at the intersection of biometrics and usability. As biometric applications become more widely deployed for homeland security applications such as identity management and authentication, the usability of these systems grows in importance. This effort will result in the identification of the significant characteristics and requirements from the context of use, users, goals and tasks, the development of an evaluation methodology for usability tests to understand the performance implications of these characteristics in terms of efficiency (timing), effectiveness (quality) and user satisfaction, and the development of standards and/or guidelines that can be instituted in operational environments that compensate for or mitigate the influence of these factors in biometric systems. This summer we will be defining and testing international symbols that provide instructions for use of fingerprint, iris and face systems. We will also be designing prototype interfaces for fingerprint devices focusing on affordance.
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Materials Science and Engineering Laboratory (EEEL) www.eeel.nist.gov

Pipeline Infrastructure Reliability

Oil and gas pipelines are a vital part of the nation's infrastructure. NIST is studying the mechanical behavior of oil and gas pipeline steels that are in use today, as well as new pipeline materials that are proposed for future use. A thorough understanding of pipeline material behavior, under both conventional and adverse conditions, is necessary in order to properly design pipelines for safety and reliability during day-to-day operations, and to protect oil and gas pipelines due to accidental or intentional damage. The proposed work on this project will involve mechanical properties testing of pipeline steels as well as analysis of the acquired data.

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