devices for detecting and identifying biological pathogens, chemical and radiation hazards, and explosive materials.

SnifferSTAR, the result of a DOE/SC-Lockheed Martin Corporation partnership, is a half-ounce unit designed to ride on UAVs to detect nerve gases and blister agents. Operating on half a watt of power, it consists of a butter-pat-sized sensor platform on top of a microprocessor board. The airstream is sampled every 20 seconds by the sensors, which register the mass of airborne particles as electronic frequencies and send the signals to the processor; the digital data are transmitted to the UAV or to a ground link, where they are immediately compared against a library of data patterns for many dangerous gases. Other new sensor technologies include inexpensive microarrays of DNA sensors on a chip that can detect multiple pathogens, such as anthrax and smallpox; acoustic sensors that use sound waves to determine the chemical composition of materials in closed containers; and handheld radiation detectors, now commercially produced and deployed in homeland security activities.

Networks of tiny devices

NITRD advances in software and networking now also make it possible to federate microsensor arrays in ad hoc wireless networks, with potential not only for battlefield reconnaissance but for industrial, health, and environmental monitoring. "Smart dust," a DARPA project in sensor miniaturization, incorporates these new capabilities as a result of work funded by DARPA and NSF at the University of California at Berkeley and a partnership with the Intel Corporation. Researchers re-engineered a sensor prototype to turn it into a modular, component-based computing platform with a processor, sensor, radio, and power distribution system. Because the operating system – TinyOS – and database – TinyDB – are open source software, and Intel is sharing wireless networking technology, developers in many domains are now working on commercial applications.

DOE/SC, NOAA, and corporate partners are linking sensor and mass spectrometry technologies, wireless and wired networking, meteorological instruments, remote telemetry, and computer modeling in a prototype SensorNet, a nationwide system for real-time detection and assessment of chemical, biological, radiological, and nuclear threats. The goal of this effort is to provide immediate, scientifically accurate information to first responders about the nature, severity, and likely dispersion of such agents in the environment. This work complements fundamental investigations by NIH and NSF aimed at developing new methods both to prevent biological and chemical agents from causing harm and to mitigate the severity of contamination incidents.

Assuring technology quality

As the primary measurement and standards laboratory for the United States, NIST conducts research in ultra-precision sensors and works closely with other Federal agencies and industry to develop standards that ensure the accuracy of measurements made by new hazard-detection technologies. A NIST initiative with the Federal Aviation Administration, for example, is using mass spectrometry – a powerful laboratory method supported by IT that identifies a substance's unique chemical fingerprint – to assess the effectiveness of walk-through explosive detectors. Developed with EPA and NIH, NIST's digital library of mass spectral prints for 140,000 chemical compounds is included as the standard reference guide with most mass spectrometers sold today.

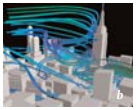
Help for first responders

With funding from the National Institute of Justice, NIST is working with the public safety community to standardize techniques and protocols in wireless telecommunications and IT applications for emergency response networks. NIST is also developing Web-based technologies for integrating sensors, real-time video, "smart tags," and embedded microprocessor devices in a next-generation distributed information-gathering and interactive communications system for field deployment by first responders.

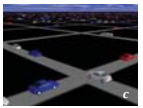
Powerful tools for emergency planning

Today, computational modeling, simulation, and visualization capabilities pioneered in NITRD research are helping emergency planners, first responders, public-health officials, and building engineers better understand and prepare for the complex impacts of catastrophic events. Some examples:

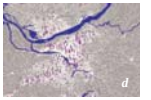
- DOE/SC researchers have developed high-resolution structural dynamics models to simulate the effects of bomb blasts on buildings and other structures. The simulations, which require very high-performance computing capabilities, can be used to evaluate structural vulnerabilities and assist in development of blast-resistant architectural designs and retrofits for existing structures.



- A NIST-developed computational model, the Fire Dynamic Simulator, and related software called SmokeView are enabling investigators of the World Trade Center disaster to study how building geometry, fuel distribution, and wind conditions interacted with the smoke and fires within and outside the towers. In conjunction with its ongoing evaluation of building materials in collaboration with industry, NIST is also preparing a technical assistance package including software tools to help building owners, contractors, designers, and emergency personnel consider how building attributes would factor in a crisis.



- TRANSIMS (Transportation Analysis and Simulation System) – developed for the Department of Transportation by scientists at the National Infrastructure Simulation and Analysis Center (transferred from DOE/SC to DHS) – is a high-end software tool that can integrate tens of millions of interacting variables to represent transportation and traffic flows across an entire urban area over time, from the level of a single pedestrian and traffic light to the aggregate. Designed to provide metropolitan planners with a highly accurate, comprehensive picture of traffic impacts, congestion, and air quality, the tool now is helping emergency planners analyze the effects of disruption on complex urban infrastructures to improve disaster preparedness. IBM Business Consulting Services has licensed TRANSIMS and is working with state and local officials to integrate the tool into their analyses.



- A derivative tool, EpiSIMS (Epidemiological Simulation System), couples models of disease transmission with population-mobility data so that planners can test the efficacy of various public-health response strategies.

NITRD guidance for improving cybersecurity

The NITRD agencies are key contributors to Federal efforts in partnership with the private sector to improve the security of existing networks and computing installations. Work by NIST, NSA, and other DoD agencies underlies the set of "security benchmarks" distributed nationwide in 2002 by the Center for Internet Security, a voluntary consortium of public and private organizations. These instructions and software tools for enhancing security in today's most widely used operating systems and networking technologies are termed "the gold standard" by the IT industry because they reflect public-private consensus on best practices based on thorough evaluation and testing. NIST and NSA jointly support the National Information Assurance Partnership, an international compact among countries that apply validated security standards to assess commercial IT products.

NSF and NIST were authorized by the Cybersecurity R&D Act of 2002 (P.L. 107-305) to take immediate action to address critical national needs in this area. NSF, chartered to take the lead in cybersecurity research and education, has more than doubled its research investment in fundamental security technologies and is supporting training of cybersecurity professionals. NSF plans are underway to expand educational and capacity-building activities in this critical area of workforce development. NIST's responsibilities under the new law include assessing national infrastructure vulnerabilities, fostering public-private partnerships to advance security technologies and standards, establishing postdoctoral cybersecurity fellowships, and coordinating on the IT security research agenda with NSF and other Federal agencies.

NITRD Program representatives participate in NSTC's Critical Information Infrastructure Protection Interagency Working Group, contributing research perspectives and results from long-term NITRD R&D for application in security-related technologies.

a) *"Sniffer Star," a butter-pat-size sensor, samples air for toxic agents and relays findings via wireless system to be checked against digital archive of known toxic gases.*

b) *EPA used computational fluid dynamics simulations after 9/11 to help evaluate the spread of materials from the World Trade Center.*
c) *TRANSIMS enables simulations incorporating millions of data points from disaggregated variables, such as pedestrians, vehicles, mass transport, traffic signals, and road characteristics.*

d) *DOE/SC researchers worked with Portland, Oregon officials to simulate the geographic spread (purple shows cases) of a smallpox epidemic in the city, using the EpiSIMS model. Effects of various interventions versus inaction were examined.*