Managing Emergency Response with Science and Technology

March 2024

Science and Technology

The **Department of Homeland Security (DHS) Science and Technology Directorate (S&T)** works closely with first responders to improve their safety and effectiveness – lending expertise, conducting research and development, and funding innovation to ensure our nation's public safety services are well-equipped to provide aid in times of crisis. Those efforts are guided by direct engagement with responders from across the country as well as invaluable insight gained through the **First Responder Resource Group**. Experienced firefighters, paramedics, police officers, emergency managers, and other public safety disciplines across our nation volunteer to help S&T focus on top-priority needs and assess that technology solutions meet those needs. Thus, the emergency management community is naturally considered a key stakeholder and S&T is proud to serve the men and women sworn to protect all of us. The following is a select sampling of activities showcasing our work in support of emergency management.

EFFECTIVE COMMUNICATION

- The **Alerts and Warnings Using Social Media Project** issued actionable guidance for how best to disseminate information to communities in times of crisis via online platforms. The project included research of effective usage, a behavioral study, technology development, and a privacy workshop.
- The **Architecture to Secure Next-Generation 911 Multimedia Content** protects against malicious inbound and outbound calls. With Small Business Innovation Research (SBIR) program funding, SecureLogix is developing a solution that detects and mitigates inbound voice attacks, telephone denial of service (TDoS), robocalls, spoofing, and active shooter hoaxes, and helps organizations brand and spoof-protect outbound calls like 911 and other critical public safety calls. It will detect attacks in multimedia like text, audio, and video images.
- The **Complex Distributed TDoS Defense** protects emergency systems from cybersecurity attacks. With SBIR program funding, SecureLogix developed Call Secure, a managed service that provides security protection to mitigate TDoS attacks by authenticating calls and helping to defeat fraudulent call spoofing, shifting the advantage from TDoS attackers to network administrators.
- The **Computer Assisted Pre-Coordination Resource and Database (CAPRAD) System**, which allows public safety officials to stay connected over open airways during major events, was awarded a grant by S&T through partners at the National Regional Planning Council and the Association of Public Safety Communication Officials International. This ongoing effort enhances public safety spectrum efficiency and improves interoperability.
- **Emergency Digital Paging over Public Television (eDPPT)**, a digital paging system for emergency responders using public television broadcasting, is being developed by Device Solutions with SBIR funding. The solution leverages open standards, broadcast and public safety infrastructure, modern network devices, and new wireless electronics, to provide responders and incident commanders with improved pager coverage and capacity, quicker dispatching, and messaging details for improved situational awareness.
- **FirstNet's Push-to-Talk application** is a standards-based, mission-critical push-to-talk app that S&T field tested in collaboration with multiple federal partners over the course of a

The JamX 22 counter-jamming event was held at White Sands Missile Range in New Mexico. Photo: S&T

In Use/Commercially Available **In Development/Coming Soon**

month in 2021 to see how it performed in real-world emergency scenarios. The app allows voice, video, and data communications with high priority and low delays with the press of a button.

- The latest **First Responder Electronic Jamming Exercise (JamX)** took place in April 2022. The event assessed the impact of illegal jamming (blocking) on public safety communications systems and mission response. Participants identified gaps in training, and evaluated tactics and technologies to help better identify, locate, and mitigate the impact of jamming.

- An **In-building Coverage Analysis System (ICAS)** that leverages existing first responder radio and smartphone technology to enhance accessibility to wireless service is currently under development with SBIR funding. Epiq Solutions, Inc. is working to create an affordable, user-friendly ICAS capability for commonly used network types.

- The **Incident Management Information Sharing (IMIS) Capability Maturity Model (CMM)** enables responders to assess their capabilities and gaps. This tiered series of questions provides an objective picture of current needs and offers resources to achieve consistent and secure information sharing across public safety disciplines.

- **Incident Management Software** includes suites of tools that collect and manage critical incident data in a collaborative environment to aid decision-making for incident planning, multiagency coordination, resource allocation, and asset tracking. S&T's National Urban Security Technology Laboratory (NUSTL) conducted market research on commercially available incident management software for use by emergency managers and incident commanders.

- An **Integrated Justice Information Systems Institute** project received joint funding from S&T and the Cybersecurity and Infrastructure Security Agency (CISA) to develop interoperability standards for Computer Aided Dispatch (CAD) systems used by our nation's public safety agencies. The project seeks to rectify the current inability of first responders to reliably use their CAD systems to exchange information with other CAD systems during a joint response.

- The **Language Translator** will provide a portable, handheld device for rapid and effective translation with non-English speakers with and without the use of Internet access. S&T has partnered with the U.S. Coast Guard and two commercial startups to leverage artificial intelligence research in the areas of speech recognition, language translation and text-to-speech, to provide a cost-effective system that will detect and translate language to allow for two-way conversations in real-time.

- The **Mobility Acceleration Coalition** is a collaboration with Mobility 4 Public Safety to develop standardized, compatible mobile data systems. The Los Angeles and Houston regions are sharing lessons learned to help form the policies and procedures needed to ensure public safety officials can coordinate across jurisdictions in a strategic and effective manner.

- The **Project 25 Compliance Assessment Program (P25 CAP)** is a suite of standards that enables interoperability among digital two-way radio communications products developed for public safety professionals. P25 CAP provides confidence to end users that equipment will be compatible regardless of manufacturer.

- S&T and the Federal Emergency Management Agency (FEMA) have partnered with the Federal Communications Commission (FCC) and the wireless industry to create a National **Wireless Emergency Alert** and Warning Capability. This effort seeks to improve public response to alerts and warnings, ensure diverse populations are reached in a timely manner, and determine when geographic targeting is appropriate.

SITUATIONAL AWARENESS

- **CBRNResponder** is a secure platform that offers real-time situational awareness of all hazards for emergency professionals. S&T's Chemical Security Analysis Center (CSAC) engages in collaborative research with FEMA developers to augment the system by integrating an application programming interface and plume modeling.

- S&T's **CSAC** provides local and regional chemical hazard and vulnerability information to inform federal, state, territorial, tribal, and local responders in preparation of hurricane landfall—including a 24/7 technical assistance hotline (410.417.0910). The information provided helps protect the safety and security of chemical facilities or transport systems and the surrounding populations in a storm's path.

- The **Community Lifeline Status System (CLSS)** is a reporting structure for establishing incident stabilization. CLSS serves as a means for FEMA to better determine where to deploy critical resources during an emergency. There are seven lifelines within the framework: safety and security; health and medical; communications; hazardous materials; food, water, sheltering; energy (power & fuel); and transportation.

- The **Imaging System for Immersive Surveillance** captures a wide field of view in high resolution with a complex system of cameras. The system can identify anomalous activity and automatically send an immediate alert. This project is a partnership with Massachusetts Institute of Technology Lincoln Laboratory and the Pacific Northwest National Laboratory (PNNL).

- **Incident Management Software (IMS)** consists of a suite of tools that collect and manage critical incident data in a collaborative environment to aid decision-making for incident planning, multiagency coordination, resource allocation, and asset tracking. NUSTL conducted market research on commercially available incident management software for use by emergency managers and incident commanders.

- **Interferometric Reflectance Imaging Sensor for Rapid Multiplexed Biothreat Detection**, a compact and fieldable sensor for the rapid detection and presumptive identification of biological threats, is being developed by Physical Sciences with SBIR funding. The proposed platform is versatile and can simultaneously detect bacterial, viral and toxin threats in diverse environmental samples.

- **Internet of Things Low-Cost Flood Inundation Sensors** rapidly measure rising water levels and reports flood conditions, providing early warning for emergency managers and citizens alike. The inexpensive devices are deployed as part of a scalable wireless mesh network and could greatly reduce potential casualties and damage. Over 1,000 are currently in operational use.

Internet-of-Things flood sensor performing monitoring. Photo: S&T

- **Multiplexed Biothreat Detection with Fieldable Mass Spectrometry**, an automated, high resolution and high sensitivity biothreat detection solution, is being developed by Zeteo Tech, Inc. with SBIR funding. This technology will detect potential novel threats, eliminate supply chain issues, and enable detection in real time.

- With SBIR funding, N5 Sensors developed an **ultra-small, low-cost hazardous gas and particulate matter detector** using novel chip-scale chemical sensor technology that can be used by firefighters. The N5 Sensors detector leverages microscale gas sensor technology to detect up to 13 toxic gases and particulate matter.

- The **QuickRoute** mobile application recognizes the conditions and constraints emergency vehicle operators face and helps them to respond efficiently while navigating to an incident. The app, which is available for download, addresses more challenges than a typical GPS application, including narrow lanes, inclement weather, downed power lines, and other hazards. A recently enhanced version, QuickRoute Emergency Command Center, incorporates a dispatch function.

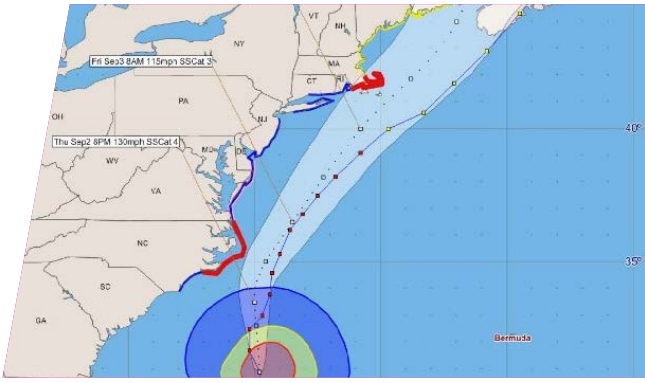
- The **Search and Rescue Common Operating Platform (SARCOP)** is an interagency dashboard designed to assist agency leadership with planning and conducting more effective and efficient operations. S&T developed SARCOP in partnership with the National Alliance for Public Safety GIS (Geographic Information System) Foundation.

- The **Smart City Interoperability Reference Architecture (SCIRA)** project aimed to seamlessly integrate Internet of Things sensors for public safety applications at the community level. A two-day pilot program in St. Louis, Missouri successfully proved the viability of SCIRA for delivering enhanced agility during an emergency response. Participants explored five different scenarios and observed instant communication capability across agencies that could ultimately save lives.

- An **Urban Search and Rescue Geospatial Response Intelligence Toolset (GRIT)** is needed to support emergency response during catastrophic events. The National Alliance for Public Safety Geographic Information Systems is working with S&T to define critical requirements and document any barriers to acceptance. GRIT will enhance consistent, strategic, data-driven decision making.

- The **Web-Based Hurricane Evacuation System (HURREVAC)** is an open-source platform to give state, local, and tribal emergency managers access to useful decision support tools during extreme weather events. The platform includes high quality maps, evacuation zones, clearance timetables, lie weather conditions, archived storms, and more. HURREVAC is available online here: https://hvx.hurrevac.com/hvx/.

- **MappedIn Response** delivers a cloud-based software prototype to emergency management and response agencies to digitize, maintain, and access pre-incident floor plans from anywhere. MappedIn Inc. will provide baseline floor plans and site safety information to provide operational context for tracking systems, HAZMAT response, augmented reality, and many other response applications.



HURREVAC screengrab showing storm along East Coast. Photo: S&T

ENHANCED PREPAREDNESS

- The **ADvanced CIRCulation (ADCIRC)** storm surge model combines rain, atmospheric pressure, and wind forecasts to predict when, where, and to what extent flooding will inundate a coastal community with greater precision than other available models.

- S&T and the **Central United States Earthquake Consortium (CUSEC)** have formed a partnership to develop nationally deployable decision support tools to promote community resilience. A memorandum of agreement signed by both parties outlines the intention to develop, test and evaluate technology solutions that will not only help emergency managers effectively mitigate earthquakes, but other disaster scenarios as well.

- The **Clean Power for Hours Prize Challenge** is crowdsourcing innovative back-up power solutions that will help critical facilities continue to operate during electrical outages. Citizen inventors are invited to compete for the $400K grand prize by creating an affordable, easy-to-use, and environmentally friendly way to ensure essential services remain uninterrupted.

- The **Community Hazard Assessment and Mitigation Planning System (CHAMPS)** provides decision support tools to help communities maximize use of mitigation resources and effectively assess alternatives. CHAMPS is offered as a free resource to enhance disaster management efforts based on the concept of understanding and then mitigating risk to reduce the loss of life and property.

- Compound flood events, which result from a combination rain-driven inland flooding and storm surge flooding, can be complex, unpredictable, and devastating. The **Community-Oriented Decision Support for Compound Flood Events** project seeks to develop, deliver, and demonstrate a community-oriented, flood hazard modeling and impact assessment tool designed to support planning processes.

- S&T's **Flood Data Collection & Analysis** capabilities are being adapted from the insurance industry by three startups in partnership with S&T to produce better predictive analytics tools that can help FEMA understand in detail the potential impacts before a flood and actual impacts after a flood and quantify those effects as they relate to National Flood Insurance Program policyholders.

- **H2Rescue** is a collaboration with the U.S. Army Corps of Engineers, Department of Energy, Department of Defense, and Accelera by Cummins, Inc. to deliver a hydrogen fuel cell-powered emergency relief truck. The vehicle can travel 180 miles and provide up 72 hours of continuous export power at 25 kilowatts while producing zero emissions.

H2Rescue hydrogen fuel cell/battery hybrid prototype vehicle. Photo: S&T

- The **Jack Rabbit** project involved large-scale outdoor chlorine release trials in 2015 and 2016. Follow-on studies have filled critical data gaps for toxic inhalation hazard chemical release modeling and emergency response procedures. This work, led by CSAC, continues its role in characterizing the evolving chemical supply chain landscapes to predict hazards and consequences should a multi-ton release of a common industrial chemical occur.

- The **Plan Integration for Resilience Scorecard**, developed by S&T's Coastal Resilience Center of Excellence partner, the Institute for Sustainable Communities at Texas A&M University, provides a way to evaluate community plans. The method identifies hazard risk and reduces vulnerabilities by resolving conflicts across different emergency plans within a community.

- The **Radiological/Nuclear Response and Recovery Research and Development** program managed by NUSTL develops tools, modeling, and guidance to help state, local, tribal, and territorial public safety agencies initiate a response in the first minutes, hours, and days following a radiological and nuclear incident and support their longer-term recovery needs.

- NUSTL manages the **Radiological/Nuclear Response and Recovery (RNRR) Research and Development (R&D)** program that develops tools, modeling and guidance to help state, local, tribal, and territorial public safety agencies initiate a response in the first minutes, hours, and days following a radiological and nuclear incident and support their longer-term recovery needs.

- S&T has awarded $1.67 million to partner PNNL, which will **research the future of emergency management** to advance next generation emergency operation centers; establish the framework for a national, coordinated approach; and develop new and novel information-sharing technologies, as well as planning, modeling and simulation tools.

- **Shaken Fury** was an emergency exercise that simulated the response and recovery to a 7.7 magnitude earthquake scenario near Memphis, Tennessee. Led by FEMA, S&T participated in the event to help test and evaluate first responder technologies and protocols in real-world scenarios while working across federal, state, and local governments, as well as non-governmental organizations and the private sector.

Urban search and rescue personnel participate in Shaken Fury emergency exercise. Photo: S&T

- **Standards protecting the nation against suspected biological attacks** are necessary to reduce exposure and speed recovery. S&T partnered with the National Institute of Standards and Technology, PNNL, the Environmental Protection Agency, the Federal Bureau of Investigation, and the Centers for Disease Control and Prevention to develop national operational guidance and sample collection protocols to effectively coordinate biothreat response activities.

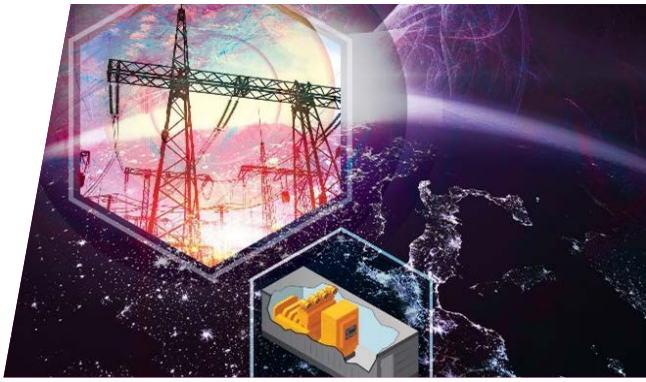
- **Urban Operational Experimentation (OpEx) 2022** evaluated new and emerging technology solutions in realistic, urban settings throughout the New York Metropolitan area. The lineup of technologies featured assessments of unmanned aircraft systems, deployable robotics, handheld sensors, artificial intelligence-enabled gun detection, incident management and situational awareness platforms, and deployable communications.

- The **Urban Security Initiative** is a portfolio of collaborative projects with the City of New York to help protect high-density urban areas and transit systems from chemical and biological threats. S&T and a coalition of partners, including the Metropolitan Transportation Authority, have developed enhanced mitigation strategies, and testing and evaluating various biosensor technologies to provide early warning for public transit.

REFERENCE MATERIALS

- The **Electromagnetic Pulse (EMP) Shielding Mitigations Best Practice** guidance summarizes recommendations to protect against the effects of an EMP event on our nation's critical infrastructure. The document was a joint effort with FEMA's Integrated Public Alert and Warning System (IPAWS) Program, and CISA.

- The **Flood Risk Assessment and Reduction Community Guidebook** is a data-driven framework and set of tools that dynamically assess, evaluate, and prioritize mitigation strategies at the individual building level. The document shares best practices for risk assessment and reduction based on an initiative led by Charlotte-Mecklenburg Storm Water Services in collaboration with the S&T Flood Apex Program.



Electromagnetic Pulse Shielding Mitigations Best Practice report cover. Photo: S&T

- The **Master Question List for Synthetic Opioids** document serves as an information resource for response personnel who might encounter these substances in the field. This document provides information on synthetic opioid topics such as: exposure limits, personal protective equipment, personnel decontamination, medical countermeasures, and more.

- The **New York Area Science and Technology (NYAST) Forum** is a consortium of federal, state, and local government organizations, first responders, academia, and private sector groups that regularly meet to promote and discuss advances in science and technology applications. NYAST is managed and hosted by NUSTL.

- The **Next Generation Incident Command System (NICS)** is an S&T-funded communications platform to advance worldwide first responder capabilities through technological exchanges, information sharing, and lessons learned. NICS was developed in collaboration with the Massachusetts Institute of Technology Lincoln Laboratory and the North Atlantic Treaty Organization.

- The **Probabilistic Analysis for National Threats, Hazards, and Risks** program provides decision support to first responder communities through its annual production of the Chemical, Biological, Radiological, and Nuclear (CBRN) Strategic Risk Assessment. State, local, tribal, and territorial partners leverage the results of the assessment to help inform concept of operations and to allow the community to best prepare for, respond to, and recover from CBRN attacks.

- Positioning, Navigation, and Timing (PNT) services underpin much of our nation's critical infrastructure. The **Resilient PNT Conformance Framework** provides guidance for what to expect from a resilient PNT system capable of withstanding disruption or interference. The document defines requirements to enable improved risk management, determination of appropriate mitigations, and decision making by end-users.

- The **System Assessment and Validation for Emergency Responders (SAVER)** program develops reference materials that help emergency response agencies make informed procurement decisions. SAVER has conducted more than 100 assessments on everything from tactical body armor and ballistic helmets to search and rescue robots and has published over 1000 knowledge products covering 700 different commercially available technologies.

- S&T's **Technology Clearinghouse** is a searchable repository of research and development findings and information about innovative technology solutions to inform procurement, policy, and research and development decisions.

Science and Technology

To learn more about S&T's support for emergency management, please visit our website:

https://www.dhs.gov/science-and-technology/first-responders-capability

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