FutureTECH: Guidance to Understanding Future DHS S&T Critical Research/Innovation Focus Areas

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Due to the popularity of the SECURE Program introduced by the recently formed Commercialization Office, the U.S. Department of Homeland Security (DHS) Science and Technology (S&T) Directorate has now introduced a "sister program" called FutureTECH. The SECURE Program leverages the experience and resources of the private sector to develop fully deployable [i.e., technology readiness level nine, (TRL-9)] products and/or services based on DHS generated and vetted detailed operational requirements documents (ORDs) and a conservative estimate of the potential available market (represented by DHS operating components and ancillary markets comprised of first responders, critical infrastructure/key resources (CI/KR) owners/operators and other DHS stakeholders). The FutureTECH Program, on the other hand, is reserved for those critical research/innovation focus areas that could be inserted eventually into DHS acquisition or commercialization programs when development reaches TRL-6 based on metrics and milestones more specific than those of a broad technology need statement alone, yet not as specific as a detailed ORD.

FutureTECH identifies and focuses on the future needs of the Department as fully deployable technologies and capabilities, in many cases, are not readily available in the private sector or Federal government space. While the SECURE Program is valuable to all DHS operating components, organizational elements and DHS stakeholders, FutureTECH is intended for DHS S&T use only, particularly in the fields/portfolios related to Research and Innovation (see for example, http://www.dhs.gov/xabout/structure/editorial_0531.shtm for details on research and innovation activities and programs).

DHS S&T Basic Research Portfolio

The DHS S&T Basic Research Portfolio creates fundamental knowledge for enhancing homeland security, normally at a time frame exceeding 8 years. These efforts emphasize (but are not limited to) university fundamental research and governmental lab discovery and invention. Basic Research programs are executed in the Directorate's six divisions, facilitated by the Office of National Laboratories and the Office of University Programs and are closely coordinated with other government agencies.

Typically, the basic research efforts at S&T are motivated by one or more of the following:

1. The research addresses an important DHS issue (such as a High-Priority Technology Need) without a viable near-term solution.
2. The research pursues a creative solution that addresses a unique, long-term DHS need that is not addressed elsewhere.
3. The research exploits new scientific breakthroughs (e.g., from universities, laboratories, or industry) that could strengthen homeland security.

The Research Leads in S&T's six divisions developed Basic Research focus areas that represent the technological areas in which S&T seeks to create and/or exploit new scientific breakthroughs. These focus areas, generated with input from the research community and vetted through S&T's Research Council, will help guide the direction of the S&T Basic Research Portfolio, within resource constraints, to provide long-term science and technology advances for the benefit of homeland security.

DHS S&T Innovation Portfolio

The DHS S&T Innovation Portfolio focuses on homeland security research and development (R&D) that could lead to significant technology breakthroughs that could greatly enhance DHS operations.

The Office of the Director of Innovation oversees S&T's Homeland Security Advanced Research Projects Agency (HSARPA). Established by the Homeland Security Act of 2002 (P.L. 107-296), HSARPA funds R&D of homeland security technologies to "support basic and applied homeland security research to promote revolutionary changes in technologies that would promote homeland security; advance the development, testing and evaluation, and deployment of critical homeland security technologies; and accelerate the prototyping and deployment of technologies that would address homeland security vulnerabilities."

Innovation/HSARPA personnel work closely with the Under Secretary for Science and Technology, S&T divisions, DHS components, industry, academia, and other government organizations to determine topic areas for projects. Innovation's efforts are complementary to S&T's other programs and projects, pushing scientific limits to address gaps in areas where current technologies and R&D are inadequate or non-existent. Please see Table 1 for a current delineation of Innovation project areas.

Table 1: Description of Innovation Project Areas Categorized as High Impact Technology Solutions (HITS) and High Innovative Prototypical Solutions (HIPS) Projects.

High Impact Technology Solutions (HITS) Projects	
Cell-All Ubiquitous Chem/Bio Detect	Examines proofs-of-concept for integrating miniaturized chemical and biological agent detectors into personal devices, such as cellular telephones, in order to create a widely distributed network for detection, classification and notification in the event of a chemical release, and with possible extensions to detect chemical components of some biological agents. Individual device owners on the network would control the detection and transmission of the data, sensor timing and global positioning satellite (GPS) location information. The goals of this project include significant improvement to chemical and biological detectors' integration, size, costs, power, maintenance, durability and response

	characteristics.
Wide Areas Surveillance	Focuses on surveillance and tracking in densely populated infrastructure settings and urban landscapes (such as airports, train stations, city streets and squares) to protect the nation's highest priority infrastructure. In FY 2008, the project constructed an array of multiple high-resolution cameras that are digitally integrated into a single view with an overall resolution of 100 megapixels. The system provides high-resolution imagery and allows multiple operators to simultaneously view and manipulate (e.g., zoom and scan) regions of the scene in high-resolution detail while maintaining a full 360-degree field of view. The system includes automated change detection capabilities, and users can rapidly scan video images for forensic analysis. In FY 2009, the project plans to conduct a demonstration to evaluate the effectiveness of the system in a densely populated environment and also significantly advance the system hardware to more than double the current resolution and ultimately improve system cost effectiveness.
Resilient Tunnel Project	The project focuses on designing an inflatable tunnel plug to protect mass transit tunnels from fires, smoke and flooding. In FY 2008, the project initiated a partnership with the Washington Metropolitan Area Transit Authority (WMATA) and conducted a demonstration in a WMATA subway tunnel in August 2008. The results illustrated that a full-scale plug can be inflated quickly and efficiently in a real-world transit environment and that the plug effectively seals against the tunnel walls. In FY 2009, the project plans to conduct numerical modeling to optimize plug structure and performance; construct new small-scale plugs with stronger materials and optimized geometries; and subject these plugs to pressurized testing in the laboratory to simulate tunnel flooding.
Tunnel Detect Project	Develops detection technologies to locate clandestine underground tunnels that are used for cross-border illegal activities such as smuggling. In FY 2008, the project conducted a series of demonstrations of an electromagnetic gradiometer (radio frequency) mounted on an unmanned aircraft system, which is planned for further evaluation by Customs and Border Protection (CBP) and Immigration and Customs Enforcement (ICE) in FY 2009. Research and development activities include incorporating other sensors such as a hyper-spectral camera that detects differences in the environmental characteristics (e.g., moisture) at or near the tunnels that are indicators of the presence of a tunnel. The project initiated a parallel effort to prototype and test advanced ground-penetrating radar for tunnel detection. In FY 2009, S&T will test and demonstrate an advanced ground-penetrating radar and investigate additional technologies by leveraging Department of Defense (DOD) tunnel-detection efforts for border protection applications.
Homeland Innovative Prototypical Solutions (HIPS) Projects	
Future Attribute Screening Technologies Mobile Module (FASTM2) (formerly Future Attribute Screening Technologies) Project	Develops real-time, mobile screening technologies to automatically and remotely detect behavior indicative of intent to cause harm (identified as malintent) at screening checkpoints. In FY 2008, the project identified potential behavioral (illustrative gestures, gait, blinking, eye-gaze, etc.), physiological (change in heart beat, respiration, thermal, etc.), and paralinguistic cues that are likely indicative of malintent and identified remote sensors capable of detecting the associated physiological signals. The feedback from initial peer review and independent, nationally recognized subject matter experts was positive. In FY 2008, the project demonstrated the FAST laboratory module which is a functional test laboratory for the development, integration and implementation of real-time, mobile screening and future sensing technologies. In FY 2009, the project will continue validating and updating the malintent theory, sensors, and the module environment and incorporate the initial elements of data fusion and machine learning to improve screening accuracy. Independent peer review will be an ongoing element of the project to promote objectivity and ensure all aspects of the project are addressed. In FY 2009, the project will conduct an operational demonstration of a real-time intent detection capability.

Hurricane & Storm Surge Mitigation Project	Develops methods to better understand and accurately predict the behavior of a hurricane to help better predict its future track and to reduce the intensity and/or duration of a hurricane or storm. The focus will be on understanding the dynamics of storms as they grow from depressions to full hurricanes, and to try to determine if any of the dynamic variables can be used or manipulated against the storm itself in order to prevent further growth in strength. State and local officials will be able to more accurately and quickly determine which areas to evacuate. This project will focus on discovering variables to affect that could reduce the intensity and/or duration of a hurricane or storm before the storm reaches a point of runaway growth in strength. This project, in partnership with the National Oceanic and Atmospheric Administration (NOAA), will apply knowledge gained in the last 25 years (since the last attempt to modify hurricanes) to understand and model the life-cycle of a hurricane and identify/evaluate the effects of salt seeding, carbon black aerosol, upper ocean cooling, ion generators and monolayer films. The goal is not to stop hurricanes, which are an important part of the natural cycle, but to mitigate damage to life and property.
Levee Strengthening & Damage Mitigation Project	Develops techniques to rapidly repair breaches. Innovation has been able to work with S&T's Infrastructure and Geophysical Division to demonstrate technology for rapid repair. In September of FY 2008, the project successfully demonstrated technologies for rapid repair of levee breaches at the United States Department of Agriculture (USDA) facilities in Stillwater, Oklahoma. This proof-of-concept attracted the attention of potential end users and will lead to the development of full-scale systems. In FY 2009, the project will further develop the rapid repair prototypes for a full-scale demonstration and develop a concept of operations.
Resilient Electric Grid (REG) Project	Demonstrates Inherently Fault Current Limiting High-Temperature Superconducting (IFCL-HTS) technologies for reliable distribution and protection of electrical power. This technology would save millions-to-billions of dollars by providing continuous power in the event of a terrorist attack, brown outs, or black outs, and provide more efficient power distribution in the course of normal day-to-day operations. In FY 2008, the project conducted proof-of-concept demonstrations of a 3-meter, IFCL-HTS cable. The first demonstration in December 2007 showed that an HTS cable could transmit power with no electrical losses and simultaneously prevent cascading failures under normal conditions (i.e., no current overloads). Subsequently, the February 2008 demonstration was an important Go/No-go decision point because it confirmed that the HTS cable provides significant fault current limiting and also identified potential challenges due to higher than expected Alternating Current (AC) losses in the HTS cable. The project team conducted additional experiments and demonstrations in May 2008 to isolate the causes of the higher than expected AC losses and a third 3-meter cable was tested in August 2008. The results justified going forward with a 25-meter demonstration in FY 2009 at Oak Ridge National Laboratory. The project team successfully demonstrated the fault current limiting capability of the 25 meter test cable in March 2009. The project is planning an in-grid demonstration of the IFCL-HTS cable in the Manhattan grid for evaluation under operational conditions.
Safe Container (SAFECON) Project –	Investigates various technologies, including probe systems that detect and identify dangerous cargo and could be mounted on cranes used for on- and off-loading ship-carried containers. SAFECON also looks for sensors and specialized container materials designed to make screening more effective. The project aims to provide the capability to scan containers entering the country while minimizing the impacts to commerce; high reliability, high-throughput detection of weapons of mass destruction (WMD), explosives, contraband and human cargo; and immediate detection and isolation of

	suspected threat containers. In FY 2008, the project completed threat characterization and container characterization studies at the ports of Charleston, South Carolina and Boston, Massachusetts to inform decisions on sensor and prototype development. SAFECON also began the development of a remote vapor inspection system using advanced laser techniques to detect and identify threat chemicals and explosives. In FY 2009, the project will demonstrate integrated chemical and explosives sensor performance in a laboratory. In addition to the approach described above for rapid detection while the container is being moved by crane, DHS S&T is also looking at an alternative approach that takes advantage of the long transit time most shipping containers experience as they transit from their port of origin to the United States. This part of the SAFECON program is called Time Recorded Ubiquitous Sensor Technology (TRUST)**.** It would allow detection of Chemical, Biological, Radiological, Nuclear, Explosive and personnel (CBRNE/P) threats within any container while in its port of embarkation or in transit, thus enabling authorities to route a suspect container to a safe location for special handling and an entry determination prior to entering a U.S. port.
Scalable Common Operational Picture Experiment (SCOPE) Project	Leverages an existing effort by DOD. The DOD effort, called the Joint Concept Technology Demonstration for Global Observer, is developing a high-altitude, long-endurance unmanned aircraft system (GO UAS). This aircraft-mounted system will enable homeland security personnel at the federal, state and local levels to collectively see what is happening during an event and potentially provide a communication platform for regions where infrastructure has been destroyed. This will allow responders to quickly understand the extent of a natural disaster or terrorist attack, enable communications and provide sufficient time to make critical decisions and mount a coordinated response. Today, no such capability exists. In FY 2008, the project developed and integrated modular sensor and communication payloads and began the formal GO Critical Design Review (CDR). In early FY 2009, the project successfully completed CDR and will conduct a series of operational utility assessments that will serve as a proof-of-concept for DHS operational security needs.
Rapid Liquid Component Detector (MagViz) Project	Uses ultra-low-field Magnetic Resonance Imaging (MRI) technology to screen baggage for liquid explosives. To mitigate the liquid explosives threat, airline passengers currently must pack liquids or gels (such as certain toiletries and medicines) in containers that are 3 ounces or smaller. Those containers must be placed in a 1-quart-sized, clear plastic, zip-top bag; and only 1-bag-per-traveller is allowed. These are known as "3-1-1 bags," which undergo an X-ray inspection and possibly secondary screening using multiple methods, such as visual inspection. The goal of MagViz is to eliminate the 3-1-1 rule and allow passengers to place liquids in their carry-on baggage. MagViz will scan and identify individual materials that may be packaged together or separately as they go through the scanning process and evaluate them against a database that will differentiate between those items considered safe for carrying onto an aircraft (e.g., benign liquids and gels like mouthwash, toothpaste, etc.) and harmful ones. The intent is for the detection of liquids in baggage to be non-contact and to occur at the same rate as current X-ray machines, thus not hindering passenger throughput. In FY 2008, the project built and demonstrated a 3-1-1 bag-screening prototype in a lab. The August 2008 laboratory demonstration of this system showed that it can recognize and compare a wider range of liquids to a stored database and discriminate between harmful and benign liquids and gels with greater sensitivity and discrimination capability than previous demonstrations by overcoming operational challenges such as the orientation of containers and containers within containers.

	In December 2008, the project conducted a full demonstration of the 3-1-1 bag-screening prototype in an airport to assess its ability to detect liquid explosives within baggage in an operational setting. This public demonstration successfully showed that the prototype could distinguish between liquids in an operational environment overcoming challenges that could affect its sensitivity. Also in FY 2009, the project will build an exhaustive database of liquids through magnetic characterization and further address clutter in the operational environment; evaluate the capability of MagViz to detect dangerous solids; and demonstrate the capability of its research prototype to inspect at a depth of 20 cm. In FY 2010, the project plans to continue building the magnetic characterization database of liquids and demonstrate the capability of MagViz to seamlessly screen segregated liquids (without the 3-1-1 bag constraint) in an operational environment and subsequently evaluate termination or transition options.

DHS S&T Transition Portfolio

The DHS S&T Transition Portfolio focuses on the identification, evaluation and management of the near-term technology portfolio to develop and deliver advanced capabilities to DHS operating components, stakeholders and end-users for homeland security improvements. The Capstone Integrated Product Team (IPT) process is the framework that determines that developed capabilities meet operational needs, analyzes gaps in strategic needs and capabilities, determines operational requirements, and develops programs and projects to close capability gaps and expand mission competencies. This process is a DHS customer-led forum through which the identification of functional capability gaps and the prioritization of these gaps across the Department are formalized. The IPTs oversee the research and development efforts of DHS S&T and enable the proper allocation of resources to the highest priority needs established by the DHS operating components and first responders.

FutureTECH Program

Scope:

This program enables DHS S&T to efficiently and cost-effectively leverage the resources, skills, experience and productivity of the private sector and other non-DHS entities to develop technologies/capabilities in alignment with research/innovation focus areas obtained from DHS S&T (see above for examples). These technologies/capabilities, when successfully developed, may ultimately be used by DHS, the first responder community, critical infrastructure/key resources (CI/KR) owners/operators and other DHS stakeholders. In essence, FutureTECH provides a "window of visibility" or "preview" of research/innovation focus areas that DHS and its stakeholders believe are essential in future products and services where detailed operational requirements documents (ORDs) can not be fully developed at this time. The program also provides insight into areas where Independent Research and Development (IRAD) monies could be spent by firms possessing funding to address DHS research/innovation focus areas.

Analogous to the popular SECURE Program, FutureTECH is another innovative private-public partnership and outreach program that outlines focus areas for which current technology only exists at earlier stages on the technology readiness scale (TRL

1-6). Technologies developed in alignment to stated focus areas could lead to cost-effective and efficient product development (TRL 7-9) when detailed requirements contained in ORDs are available. Like the SECURE Program, DHS will provide information to the public in an open and free way. The private sector and other non-DHS entities may use their own resources (including IRAD) to develop technologies/capabilities that will be of potential benefit to the DHS mission. Like the SECURE Program, DHS may enter into a simple CRADA (Cooperative Research and Development Agreement) document with an organization that shows it has the ability to deliver technology aligned with the research/innovation focus area sought after by DHS.

To state it simply, the SECURE Program focuses on product/service development to create products and services to protect our nation in the shorter term, while FutureTECH focuses on science and technology development related to critical research/innovation focus areas. Like all of the Commercialization Office's programs, all parties "win" in the FutureTECH Program--the private sector and other non-DHS entities by receiving valuable insight into future research/innovation focus areas needed by DHS and its stakeholders. DHS “wins” because it will leverage the valuable skills, experience and resources of the private sector and others to expedite efficient and cost-effective technology development; the non-DHS entities “win” because they receive valuable information useful for their own strategic plans; and most importantly, all American taxpayers “win” because this innovative partnership yields valuable technologies/capabilities aligned with research/innovation focus areas developed in a more cost-effective and efficient way saving taxpayer money.

Overall Process:

Figure 1 is a graphical representation of the overall outreach process the Commercialization Office continues to implement to stimulate and engage the private sector and other non-DHS entities to use their resources to rapidly develop technology aligned with research/innovation focus areas that can yield significant benefits for DHS S&T with a speed-of-execution not typically observed in the public sector.

Outreach to the Private Sector

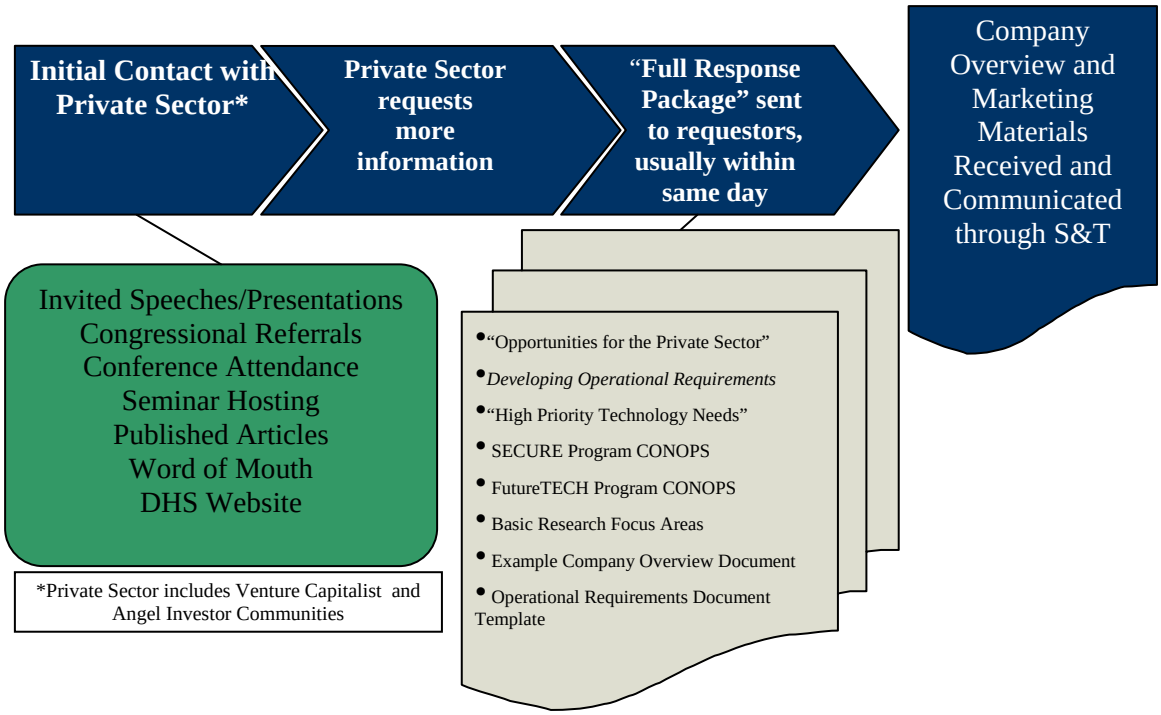


Figure 1: Overview of S&T Directorate Private Sector Outreach Process

Program Process:

DHS S&T will provide this FutureTECH vehicle by which the private sector and other non-DHS entities can identify or develop technology aligned with research/innovation focus areas ranging from TRL-1 through TRL-6 (not fully developed TRL-9 products and/or services) based on DHS S&T's insight and knowledge mainly through its Research and Innovation portfolios/areas.

This approach enables DHS S&T to collaborate on the development of technology aligned with several research/innovation focus areas in an open and free way. The private sector and other non-DHS entities receive information on what new technologies will be required over-the-horizon to protect our nation, removing much of the "guess work" normally associated with predicting future needs.

As with the popular SECURE Program, DHS will review third party, recognized test and evaluation data to ensure that all milestones/objectives of an executed CRADA agreement are met and DHS will place a given research/innovation focus area solution developed by an entity on the FutureTECH website demonstrating that the research/innovation focus area has met DHS's broadly defined requirements (in contrast to the SECURE Program where products or services must demonstrate compliance to detailed operational requirements contained in an ORD).

Expression of Interest:

In the adherence to fairness of opportunity, and in order to capitalize on the free-market system, DHS S&T intends to publish this program and all ancillary requirements documents/information on the DHS website. These materials will be accessible by ALL. Given this information, the private sector and other non-DHS entities may contact DHS S&T if they are interested in developing or enhancing their technology within a research/innovation focus area in cooperation with DHS S&T. Potential research/innovation focus areas for this program (along with a simple CRADA agreement used in the SECURE Program) are provided on our website. The private sector organization or non-DHS entity must provide DHS S&T with basic, non-proprietary business information, contact information and demonstrate their potential alignment to widely available DHS S&T research/innovation requirements that are more detailed than what are commonly referred to as technology need statements, yet not as detailed as a well-defined ORD.

Acceptance:

In order to be fully considered by DHS S&T for cooperative research/innovation focus area technology development:

- An entity must demonstrate they either possess technology at TRL-1 or higher (i.e. basic research) or possess the ability to develop a technology aligned with the research/innovation focus area to TRL-6 for later technology insertion into a potential acquisition or commercialization program.
- The private sector and other non-DHS entities must propose a research/innovation focus area technology development effort that has clear and substantial alignment with any published DHS S&T requirements delineated above.

A DHS committee will be established to review the private sector and/or non-DHS entities' potential alignment to DHS research/innovation focus areas, and monitor the mutually-agreed-upon roles and responsibilities of partnership participants. The committee will consider these and other DHS proprietary metrics for determining which opportunities to pursue.

CRADA:

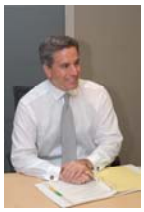
The private sector and/or non-DHS entity and DHS S&T could execute a simple, straightforward and binding CRADA whereby the non-DHS entity details milestones with dates and, in most cases, agrees to bear full and total financial responsibility to develop its technology aligned within the research/innovation focus area to a TRL-6 state. Under the Stevenson-Wydler Act (which is the statutory authority enabling DHS to enter into CRADAs), agencies may not contribute funds under a CRADA; however, they may contribute know-how, expertise, materials and equipment. It is important to mention that the execution of a CRADA agreement is at the sole discretion of the corresponding DHS S&T program manager. Additionally, a CRADA with DHS S&T will not necessarily lead to any follow-on contract actions or solicitations by DHS or other government agencies. Any solicitations for funding agreements related to technology areas collaborated upon in a CRADA would be subject to full and open competition. DHS S&T will publish on the DHS S&T website the factual finding(s) of any final assessment. DHS S&T has the right to cancel an agreement if the non-DHS entity does not fulfill/achieve its milestones or performance objectives by the mutually-agreed-upon dates.

Publication of Results:

It is apparent that the private sector and other non-DHS entities highly value DHS S&T's potential assessment of a given technology's recognized third-party test and evaluation (T&E) data. DHS S&T will openly publish summary findings and an acknowledgement of an entity's attainment of performance objectives on the DHS public web portal for review by the DHS operating components, first responder communities, CI/KR owners/operators and other potential users.

Acknowledgement

Many individuals contributed to the development of this article and the new FutureTECH Program, primarily the scientists, engineers, program managers and others within the S&T Directorate. Special thanks to the Research Leads within the divisions and the rest of the Research Council for development of the Basic Research focus areas. Ryan Policay is also thanked for his substantial contributions to this worthy effort.



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the Department. He possesses extensive experience as a senior executive and Board Member in high-technology firms in the private sector. He is also the first federal official on the Council of Competitiveness representing the U.S. Department of Homeland Security.

Doing Business with DHS S&T:

All U.S. Government business opportunities can be found at www.fedbizopps.gov.

- **HSARPA:** Register to join the HSARPA mailing list to receive various meeting and solicitation announcements. Link to the Long Range Broad Agency Announcement solicitation, where multiple awards are anticipated and will be based upon the proposal evaluation, funds availability, and other programmatic considerations. Also link to Representative High Priority Technology Areas, where DHS areas of interest can be found. **http://www.hsarpabaa.com**

- **Small Business Innovation Research(SBIR):** SBIR's goal is to increase the participation of innovative and creative small businesses in Federal Research/Research and Development (R/R&D) programs and challenge industry to bring innovative homeland security solutions to reality. **http://www.sbir.dhs.gov**

- **SAFETY Act:** The SAFETY Act enables the development and deployment of qualified anti-terrorism technologies and provides important legal liability protections for manufacturers and sellers of effective technologies. **https://www.safetyact.gov/**

- **TechSolutions:** The mission of TechSolutions is to rapidly address technology gaps identified by Federal, State, Local, and Tribal first responders by fielding prototypical solutions within 12 months at a cost less than $1M per project. **www.dhs.gov/techsolutions**

- **Commercialization:** The mission of S&T's commercialization efforts is to identify, evaluate, and commercialize technologies that meet the specific operational requirements of DHS operating components and first responder communities. The commercialization efforts actively reach out to the private sector to establish mutually beneficial working relationships to facilitate cost-effective and efficient product development efforts. Please contact Chief Commercialization Officer Tom Cellucci at **S&T-Commercialization@dhs.gov**.



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