NDIA Conference on Combating Terrorist Use of Explosives

Science & Technology to Counter Improvised Explosive Devices

April 28, 2010
Ft. Walton Beach, FL

Ruth M. Doherty, Ph.D.
PEO Counter-IED
DHS Science and Technology Directorate
Counter-IED Challenge:
Securing Special Events, Transportation Security and Beyond
U.S. Domestic Explosives Threats

• Bomb threats and suspicious packages in the U.S.
  • Over 2,300 since 2004*
  • Almost daily

• Terrorists continue planning explosives attacks in the U.S.

“Use of a conventional explosive continues to be the most probable al-Qa’ida (domestic) attack scenario” said Director of National Intelligence to Congress Intelligence Committee, January 2007

* ATF Bomb Data Center
International Domestic Explosives Events

• Bomb threats continue worldwide
  • 82,000 terrorist incidents between 1970 and 2007 *
  • Top three terrorist targets:
    • Private Citizen’s property 20%
    • Government 17%
    • Business 16%
  • 51% of time terrorists’ tactic was bombing
• Over 600 IED attacks per month worldwide
  • Aug 2008 to Aug 2009 averaged
  • Data excluded Iraq & Afghanistan

* “Global Terrorism Trends”, START presentation at the National Press Club on 14 September 2009.
"Just as today’s threats to our national security and strategic interests are evolving and interdependent, so too must our efforts to ensure the security of our homeland reflect these same characteristics. As we develop new capabilities and technologies, our adversaries will seek to evade them, as was shown by the attempted terrorist attack on Flight 253 on December 25, 2009. We must constantly work to stay ahead of our adversaries."

Secretary Janet Napolitano

Quadrennial Homeland Security Review
February 2010
Military and Domestic
- Some transferable technologies
- Different environments, threats, procedures

- Constant threat
- Population restricted in movement
- Access to certain areas limited

Protecting Warfighters in Theater

- Countermeasures constrained by civil liberties and operations within an open and free society
- Homemade explosives proliferating worldwide

Protecting Citizens in a Free and Open Society
Domestic IED Threat Domains

**Person-Borne IED**
Suicide bomber or leave behind bomb

**Vehicle-Borne IED**
Parked vehicle or suicide attack

- Rail
- Public arena events
- Government Facilities
- VIP events
- Seaport, ships and ferries
- Rail Terminals
- Tunnels, bridges and dams
- Border crossing or vehicle raveling to high-value target
- Buildings, malls and National Monuments
- Utilities
Domestic Terrorist IED Attack Cycle

- Decide to attack
- Plan the Attack
- Obtain Resources
- Prepare for Attack
- Conduct the Attack
- BOOM
- Observe Consequences
- Attribute Responsibility
DHS C-IED Investment Emphasis

- Identify indicators of radicalization in the U.S.
- Evaluate programs to counter violent extremism
- Track suspicious behaviors and prioritize likely targets, staging areas, and ISR assets
- Detect, isolate, and inert/defuse IEDs without detonation
- Protect population, infrastructure
- Detect, isolate, and inert/defuse IEDs without detonation

- Decide to attack
- Prevent & Predict
- Plan the Attack
- Obtain Resources
- Prepare for Attack
- Conduct the Attack
- Defeat
- Detect
- Mitigate
- Observe Consequences
- Attribute Responsibility

- Identify indicators of radicalization in the U.S.
- Evaluate programs to counter violent extremism
- Track suspicious behaviors and prioritize likely targets, staging areas, and ISR assets
- Detect, isolate, and inert/defuse IEDs without detonation
- Protect population, infrastructure
- Damaged structure stabilization
- Community resilience

- BOOM
S&T Countering Domestic Explosive Threats Program

Terrorist IED Attack Timeline

INTENT INITIAL PLANNING OBTAIN OPERATIONAL RESOURCES CONDUCT OPERATIONS ATTACK IMMEDIATE EFFECTS LONG-TERM EFFECTS

Prevent/Deter
Actionable Indicators & Countermeasures
- Community Characteristics
- Group Characteristics
- Pre-incident Behaviors & Rhetoric
- Integrated Framework
- Countermeasure Evaluation

Predict
Predictive Screening
- Behavior Analysis
- Video Tracking
- Video Identification & Alert
Risk Prediction
- Target Prediction
- Staging Area Prediction

Detect
Person Borne IED
- Suicide Bomber
- Leave-behind
Vehicle Borne IED
- Integration & Demonstration
- Canine

Defeat
Bomb Access & Diagnostics
- Type of Explosive
- Device Triggers
Render Safe
- Electronic Countermeasures
- Inerting
Robotics

Mitigate
Blast Mitigation
- Blast resistant materials
- Protective countermeasures
- Stabilize damaged structures
- Urban blast effects
- Predictive models
Effective Risk Communications

Cross Cutting:
- Standards, Technology Demonstration/ System Integration
- Outreach, Integration of Public Perception Data, Community Resilience
- Information Sharing: Intelligence Data Sharing (Intel Community); Interagency Technology, Resource & Test sharing (DoJ, DoD, DoE)
Counter-IED Investment Areas

• Social and behavioral science to identify potential IED threats
  – Real-time, automated video-based identification of suspicious behaviors
  – Framework integrating social and behavioral science indicators of radicalization

• Strategies to prevent potential IED attacks before they occur
  – Tested, effective strategies to counter violent extremism in domestic context

A portfolio focused on identifying and preventing potential IED threats
HFD Research on Violent Extremism

**Program Goals:** Improved ability to assess and counter potential extremist violence

**Needs/Gaps:**
- Identify indicators that actors are moving toward extremist violence
- Analyze the impact of countermeasures used to prevent extremist violence and IED attacks

**Strategy/Approach:**
Utilize multiple social and behavioral science methods to extract indicators
Develop and validate an integrated framework
Systematically assess the efficacy of countermeasures using qualitative and quantitative methods
HFD Research on Violent Extremism

The Performers
- Organize Workshops
- Collect and Analyze Data
- Develop Scientific Knowledge and Tools

The Sponsor
- Reviews State of Science and Agency Needs
- Develops Programs and Selects Performers
- Manages Projects and Evaluates Progress

The End-Users
- Communicate Needs
- Assess Utility of Research Products
- Utilize Knowledge and Tools

DHS Science & Technology Directorate
Human Factors/Behavioral Sciences Division (HFD)

DHS Components
- Law Enforcement
- Policy Makers

DOE National Labs
Private Sector
Academic Institutions

Homeland Security
HFD Research on Violent Extremism

Activity: Community Characteristics
Analysis of existing surveys and archival indicators, advanced data collection

Activity: Group Characteristics
Analysis of forensic and event data, development of integrated multi-level U.S. extremist database

Activity: Pre-Incident Rhetoric and Behaviors
Content analysis, case studies, internet experiments, comparisons with classified data

Activity: Countermeasures
International field work, focus groups, qualitative and quantitative analysis of countermeasures

Framework for Assessing Threats and Prevention Activities
HFD Research on Violent Extremism

Early Activities

• Delivered reports on
  – Characteristics of IED incidents based on analysis of Global Terrorism Database (GTD)
  – Existing polls of U.S. Muslims (preliminary)
  – Five international “de-radicalization” programs and the measures used to evaluate their efficacy

• Sponsored interagency workshops on
  – Coding methodologies for case studies
  – Community-level indicators of radicalization
  – The role of the internet in radicalization
  – Survey methodologies for assessing attitudes toward terrorism and counterterrorism initiatives
International Programs’ Research on Violent Extremism

- Radicalization in Europe and North America: Parallels and Divergence
- Social Determinants of Terrorist Organizations’ Resilience in Latin America
- The Impact of Israeli Counterterrorism Interventions on Rate and Intensity of Terrorist Activity
- Threat Assessment of Terrorist and Extremist Organizations in Indonesia, the Philippines, and Thailand
Counter-IED Investment Areas

• Improved detection capabilities for known and emerging IED threats  
  – Imaging technologies  
  – Spectroscopic and trace detection technologies

• Improved probability of detection by screening for IEDs more efficiently while minimizing effect on flow of people and commerce  
  – Non-contact interrogation  
  – Enhanced algorithms for automation

• Improved first responders’ ability to react to and defeat discovered IED threats  
  – IED identification and defeat tools  
  – Radio frequency jamming equipment

Diversified investment portfolio to maximize potential for success
**C-IED Detect**

**Program Goal:** Develop enabling technologies and operational solutions to improve customer IED threat detection capabilities

**Customers/Partners:**
- USSS, OIP, TSA, FPS, CBP, and USCG
- JIEDDO, USMC, ONR, DTRA, NIST, DNDO, NRL, NSWC-DD, and TSWG

**Needs/Gaps:**
- Detect explosive devices worn or carried by individuals (person borne threats)
- Detect explosive devices in unattended packages (leave behind threats)
- Detect explosive devices at a checkpoint concealed within stationary or slow moving vehicles (vehicle borne threats)
C-IED Detect

Strategy/Approach:

- Perform signature characterization studies of realistic explosive threat devices: provides data for detection requirements, test standards and performance benchmarks for detector development

- Develop cueing, tracking and target selection systems: incorporates advanced hardware and software solutions into layered security architectures

- Perform system analysis, engineering and architecture design: provides analysis of alternatives, baseline systems design, and integration of component technologies

- Develop high resolution detection technology: provides advanced imaging and trace detection hardware and software with improved detection performance characteristics to address broadening threat detection requirements

- Perform laboratory and operational test and evaluation of existing and emerging security solutions: baselines existing system performance, measures advanced system capabilities and defines technology shortfalls
C-IED Detect

Accomplishments:

- Demonstrated the use of a broadband, tunable laser system to enhance standoff threat detection capability
-Established a standoff detection test bed with interagency partners to demonstrate an integrated system approach towards explosives detection

Initiated programs

- to detect vehicle borne explosive devices through the use of high energy techniques
- to detect individuals carrying or wearing explosive devices, based upon acoustic and infrared detection techniques
- for standoff and non-contact detection of trace amounts of explosives
C-IED Response/Defeat

Program Goals: Initiate, prioritize, and execute research and development projects that meet bomb squad requirements to effectively render explosive devices safe, placing specific emphasis on technologies to access, diagnose, and defeat terrorist improvised explosive devices (IEDs)

Customers/Partners:
- OBP, OIP, FBI, ATF, USSS, USCG, CBP, State/Local Bomb Squads
- JIEDDO, TSWG, NIJ, FBI

Needs/Gaps:
- Analyze vehicles and leave behind packages utilizing Access and Diagnostic tools to determine content
- Defeat the improvised explosive devices (IEDs) containing both sensitive and insensitive explosives and enhanced payloads (includes VBIED, PBIED, WMD devices).
- Increase standoff distances, reduce collateral damage, and enhance the safety of bomb squad technicians.
C-IED Response/Defeat

Strategy/Approach:

- Develop and adapt a suite of interoperable response tools to improve and standardize bomb squad capabilities (e.g. platforms, interfaces, common architecture, standards, ECM, RF-based bomb squad technologies)

- Leverage existing robotics technology to provide advancements in stand-off and remote diagnosis and defeat

- Evolve advancements in robotic arm manipulation, while increasing power supply, decreasing overall weight, extending operational time, and improving navigation, communication, safety and operational control

- Enable detect sensors to integrate with bomb squad robotic platforms

- Conduct Test and Evaluate at the Bomb Squad test Bed (transition via the FBI’s Hazardous Device School)
C-IED Response/Defeat

Accomplishments:
- Established an interagency technical requirements working group to gather future Electronic Countermeasures (ECM) technical requirements
- Established the Bomb Squad Test Bed with the Michigan State Police to perform test and evaluation on prototype equipment
- Verified the following technology at the Michigan test bed:
  - Single-Sided Imaging System to image suspect VBIEDs
  - Pneumatic Water Canon to render a suspect VBIEED safe
- Drafted and delivered the Bomb Squad Strategic Plan, as well as explosive tool test data, to state and local bomb squads

Future Direction:
- Develop future Render Safe Tools through derivation and validation of vehicle bomb characteristics
- Continue to advance the capabilities of the current fleet of robots (e.g. employ surgical precision tools)
- Develop an intuitive diagnostics capability that can be quickly deployed when vehicle bombs are suspected
- Develop DHS-centric performance requirements for the next generation ECM systems
- Improve the Test and Evaluation and Transition processes by leveraging the Bomb Squad Test Bed and the FBI Hazardous Devices School
Counter-IED Investment Areas

• Enhanced blast resistance
  – Advanced blast-resistant materials
  – Models for assessing damage from blast

• Mitigation of effects
  – Rapidly deployable means to stabilize damaged structures

• Community resilience
  – Communication of clear, understandable, credible warnings in the event of an IED threat
  – Recovery in the aftermath of an attack

Preventive measures to reduce effects of an event, help for recovery afterwards
Advanced Materials Research

- Conduct basic research and testing of materials such as ultra-high performance concretes, ceramics, foams, layered composites, woven and nano-enabled materials.
- Report on the current state of the art for use of advanced materials to counter IED effects.
- Research UHPC/RPC to advance:
  - Ultra high strength
  - Ductility, flexibility
  - Toughness, Impact resistance
  - Durability
  - Impermeability
  - Freeze/thaw, corrosion resistance
  - Abrasion resistance

Novel materials may have more desirable environmental, durability, weight, aging, and cost properties.
Stabilization of Buildings

• **Criteria** for interpretation and dissemination of data, triage, and decision-making methods
  (Near-Collapse Buildings Workshop, TEEX April 28-29th, 2010)

• **First Responders Search and Rescue Issues**
  (Monitoring and Sensing Workshop, Oxford, MS April 6-7th, 2010)
  – Identify sensor technology to allow effective monitoring
  – Identify user-friendly technology that will not hinder the mission of first responders
  – Facility reconciliation of field data with analytical models
Bridge Vulnerability

PROJECT DESCRIPTION

• Study the vulnerability of steel plates, girders, and cables to terrorist threats, particularly explosives, and updating computational models based on the results.
• Specimens to evaluate vintage bridges will be taken from
  • Golden Gate Bridge (CA)
  • Crowne Point Bridge (NY) and
  • Williamsburg Bridge (NYC)
as they are being refurbished or demolished in order to evaluate IED effects on vintage bridges.

Impact

• Provides vulnerability information for bridge components subjected to aging, wear, and weathering
• Data can be used to validate and improve numerical models that predict failure for bridges subjected to explosives
• Understanding failure mechanisms for bridge components enables more effective design of protective countermeasures

Capitalizing on existing assets provides data on effects of real-world aging on material properties
Improved Numerical Modeling of Soils

The Problem
• Existing numerical & constitutive models for blast effects in soils do not match the test results
• Current estimates are
  • based limited data sets
  • have insufficient information about soil damage
  • unable to evaluate the integrity and condition of remaining material

Our Approach
• Conduct physical tests and numerical simulations to determine the shortfalls of current models and how they can be improved
• Improve on current physics based, 1st principle approaches to modeling soils subjected to blast and seismic loads

Impact
• Accurate models will reduce the need to conduct extensive and expensive physical tests to address new threat scenarios.
Community Perceptions of Technology Panels

• A formal process
  – to understand and incorporate community perceptions of critical technologies within the US.
  – to maintain the balance between security and personal privacy/civil rights and liberties

• Provides DHS agencies and Program Managers with insight prior to development and deployment of technology.
  • potential reactions
  • issues
  • obstacles to a technology

• Engages the public, making them active stakeholders in the research and development of critical technologies.
Community Perspectives into Technology Development: Challenges and Issues

- Civil Rights, Civil Liberties
- Privacy, Intrusiveness and Invasiveness
- Privacy of information
- Convenience and Comfort
- Perception of Threat
- Location
- Cost
- Complexity, usability
- Safety
- Tradeoff value
Incorporating Community Perspectives into Technology Development

- **CPT Panels 2008**
  - Microwave Vehicle Stopping
  - Raman Spectroscopy - IED Standoff Explosive Detection
  - Mobile Biometrics
  - Nonlinear Acoustic IED Standoff Threat Detection

- **CPT Panels 2009**
  - Northern Border Technology - RFID Registration and Low Resolution Imaging (Joint panel with Canada)
  - Standoff Threat Detection - Imaging Systems
Homeland Security S&T Enterprise

DHS RESEARCH AFFILIATES
- DHS Labs
- National Labs
- HSI Centers of Excellence

PRIVATE SECTOR PARTNERS
- Associations
- Industry
- International

FEDERAL PARTNERS
- DoD
- DoE
- DoJ
- DoT
- EPA
- HHS
- NASA
- NIH
- NIST
- NOAA
- NSF
- UARCs

INTERNATIONAL INDUSTRY ASSOCIATIONS
- Private Sector Partners

INTERNATIONAL PARTNERS
- International Industry Associations

DOMESTIC INDUSTRY PARTNERS
- DoJ
- DoT
- EPA
- HHS
- NASA
- NIH
- NIST
- NOAA
- NSF
- UARCs

DOMESTIC FEDERAL PARTNERS
- DoD
- DoE
- DoJ
- DoT
- EPA
- HHS
- NASA
- NIH
- NIST
- NOAA
- NSF
- UARCs

DOMESTIC PRIVATE SECTOR PARTNERS
- Industry
- Associations
- International
Summary

• The domestic threat is real; preparation is vital
• To protect our people in a free and open society, we must get ahead of the terrorists
  – Counter violent extremism/radicalization
  – Prepare people and infrastructure
• Cooperation makes us stronger
  – Domestic
  – International
Contact Information

• PEO, C-IED: SandT.cied@dhs.gov

• Broad Agency Announcements Solicitation Topics
  – Long Range BAA – addresses needs of 6 S&T divisions
  – For more about BAAs, visit www.FedBizOpps.gov and https://baa.st.dhs.gov

• NSTC Domestic IED Subcommittee report, Research Challenges in Combating Terrorist Use of Explosives in the United States:
What is “terrorism”?

• Title 18 USC Section 2331, (5)
  – (5) the term “domestic terrorism” means activities that—
  – (A) involve acts dangerous to human life that are a violation of the criminal laws of the United States or of any State;
  – (B) appear to be intended—
    – (i) to intimidate or coerce a civilian population;
    – (ii) to influence the policy of a government by intimidation or coercion; or
  – (iii) to affect the conduct of a government by mass destruction, assassination, or kidnapping; and
  – (C) occur primarily within the territorial jurisdiction of the United States.