IAB: First Responder Equipment Technology Assessment

IAB S&T Subcommittee Working Group Equipment Priority Lists 2014 - 2016

February 2018

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Science and Technology Subcommittee Working Group Priority Lists 2014 - 2016
Final Report

Prepared for:

Joint Program Executive Office for Chemical and Biological Defense

Prepared by:

Stephenson Disaster Management Institute
Louisiana State University
Louisiana Emerging Technology Center
340 E. Parker Street, Suite 366
Baton Rouge, LA 70803

Applied Research Associated
4300 San Mateo Blvd, NE, Suite A-220
Albuquerque, NM 8711

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Executive Summary

The InterAgency Board (IAB) annually conducts a poll of its members to determine and prioritize the latest research and development gaps primarily in first responder equipment, standards, planning, and training. While the priorities are established every year, the IAB has never done a complete investigation on the status of the gaps. Recognizing the value in determining the current technology readiness levels for first responder equipment gaps, the Joint Program Executive Office for Chemical and Biological Defense provided funding to conduct an investigation into emerging commercial technologies that may fill some of the gaps identified by the IAB. To conduct the study, the Stephenson Disaster Management Institute at Louisiana State University put together a research team to assess 15 of the priorities identified by the IAB. Using primarily open sources and direct engagement with vendors, the teams assessed the 15 highest equipment priorities. A summary of the overall assessment is provided in the table below.

Overall Rank	Consolidated Research Priority	Technology Readiness Level Assessed
1	3-D Tracking of Personnel	6.5
2	Handheld Field Deployed Biological Detection	7
3	Handheld Standoff Chemical and Explosive Identifier	7.5
4	Noise-filtering Digital Speaker/Microphone for SCBA Face Piece	7
5	3D X-Ray	7
6	Inexpensive, Portable, Ruggedized Point-of-Care Lab Testing Device	7
7	Improved Microclimate Cooling System for Down Range Use	6.5
8	Mission Critical Secure Communication over Non-LMR Networks	5
9	HME Neutralization	7
10	Enhance Communications in Environments that Interfere with Radio Transmissions	9
11	Hands-free Radio Intercom	4
12	Structure Fire/IDLH Escape Respirator	7.5
13	Less Harmful/Safer, More Effective Human Capture and Restraint Devices	6.5
14	Rapid, Universal Battery Charger for Portable In-Home Medical Devices	7.5
15	Multi-Meter for Bomb Technicians	9

Introduction

The horrific attacks that took place on September 11, 2001 would forever change how first responders prepare, organize, train and equip themselves for future threats in the United States. Following 9-11, first responders across the country would begin preparing themselves to respond to the potential of a terrorist attack. This effort would be enabled through the Department of Justice's Domestic Preparedness Grant Program administered by the Office of Domestic Preparedness (ODP) immediately after 9-11, and eventually transition to the Department of Homeland Security (DHS) through the enactment of the Homeland Security Act of 2002[1]. Since 2002, Congress has authorized over $33 billion for state and local first responders through the Homeland Security Grant Program (HSGP)[2]. Recognizing the criticality of first responders to be properly equipped, the overwhelming majority of the funding has been utilized to address critical equipment needs for first responders across all disciplines. In 2004, at the peak of the program, total grant dollars appropriated were approximately $3.5 billion dollars, while in the latest funding year, overall funding is slightly over $1 billion[3]. First responders across the country have been able to leverage these dollars to significantly enhance their response capabilities for man-made and natural threats. While these grant opportunities have allowed state and local first responders to acquire lifesaving and performance enabling equipment, there are still several unmet needs and technology gaps in the first responder community.

Purpose and Sponsor

The purpose of this research is to conduct an analysis and review of the current state of emerging technologies that can assist and support the first responder community by resolving existing technology gaps in first responder equipment. Through funding provided by the Joint Program Executive Office for Chemical and Biological Defense (JPEO-CBD) under the Office of Secretary of Defense, this study will investigate the current state of technology for needed first responder equipment as identified by the Department of Defense sponsored InterAgency Board (IAB). This study is focused on technology gaps for mission critical equipment that can be deployed to enable first responders to more efficiently perform their job requirements while minimizing risk to the first responder and the civilian population they are working to protect. Through funding provided by JPEO-CBD, this study will investigate the status of the top fifteen gaps in needed first responder equipment.

[1] Public Law. 107-296, Title IV, Sec. 403, 116 Stat. 2178
[2] Congressional Research Service: Department of Homeland Security Preparedness Grants: A Summary and Issues.
[3] Department of Homeland Security: Fiscal Year 2017 Homeland Security Grant Program Fact Sheet

InterAgency Board Overview

The InterAgency Board serves as a voluntary agency of emergency preparedness and first responders representing all levels of government and multiple first responder disciplines. The IAB was authorized in 1998 by the U.S. Attorney General, and was subsequently founded by the Department of Defense's Consequence Management Program Integration Office and the Department of Justice's Federal Bureau of Weapons of Mass Destruction Countermeasure Unit. The IAB executes its mission by performing as a collaborative body that "provides a structured forum for the exchange of ideas among operational, technical, and support organizations to improve national preparedness and promote interoperability and compatibility among local, state, tribal and federal response communities."[4] Relying on its vast experience of seasoned first responders, the IAB works collectively to identify standards, test protocols, technical and operational requirements, and performance criteria for all hazards response equipment with special emphasis on Chemical, Biological, Radiological, Nuclear, and Explosive (CBRNE) capabilities. To help accomplish its mission, the IAB has identified seven primary focus areas: 1) Equipment; 2) Health, Medical, and Responder Safety; 3) Information Management and Communications; 4) Science and Technology; 5) Standards Coordination; 6) Strategic Planning; and 7) Training and Exercise. In addition, the IAB has organized into one committee and seven SubGroups, with each focusing on a specific mission area as identified in the IAB's focus areas. JPEO-CBD serves as one of the federal agencies on the IAB's Federal Agency Coordinating Committee (FACC). As a member of the FACC, JPEO-CBD serves as a conduit between the IAB and the resources and personnel of the Department of Defense, while also supporting the IAB through funding in order for the IAB to conduct its mission.

IAB Mission: The mission of the IAB is to strengthen the nation's ability to prepare for and respond safely and effectively to emergencies, disasters, and CBRNE incidents.

Science and Technology SubGroup Overview

The Science and Technology SubGroup's (STSG) mission is "to identify interagency (local, state, federal, and tribal) research and development requirements and innovative technologies (fieldable in the next six months to five years) for first responders that address CBRNE focus areas." The STSG identifies its research and development requirements by focusing on the following areas: 1) Detection; 2) Individual Protection; 3) Collective Protection; 4) Medical Support; 5) Decontamination; 6) Communications Systems/Information Technology; 7) Deterrence and Prevention; and 8) Security/Situational Awareness. One of the areas in which the STSG performs its mission is the establishment of a first responder priority list for research and development.

Establishment of Research & Development Priority List

The STSG is responsible for conducting an annual survey of the IAB membership to prioritize research & development (R&D) requirements and priorities. Members of the STSG work collaboratively to identify the latest R&D requirements that will allow first responders to better perform their mission requirements,

[4] InterAgency Board Charter: Adopted October 21, 2015. https://www.interagencyboard.org/about

as well as enhance first responder and civilian safety. The R&D list covers a broad area of existing gaps within the first responder community and include gaps in equipment, training, standardization, and relevant areas in which additional data through research is required. The annual list is identified by the STSG through a deliberative process, and once finalized, is submitted through an electronic survey to the full membership of the IAB in which members are asked to rank the criticality of each gap. In FY 2016, the STSG further refined the priority lists by categorizing the R&D requirements by first responder disciplines. In addition to the complete comprehensive list, the priorities were further categorized by the following first responder disciplines: Communications; Emergency Management; Fire; HAZMAT; Explosive Ordinance Disposal; Law Enforcement; and Medical. In FY-2016 the IAB members were allowed to respond to and rank requirements in each of the six disciplines, not just the priorities in the discipline they are most closely affiliated, as had been done in the previous year.

They were asked to rank each of the priorities based on five questions. The following five questions served as the basis of the ranking, and represent the professional opinion of each responder:

1) This item fills a major gap in the nation's ability to prepare for and respond to emergencies, disasters, and/or CBRNE incidents;
2) This item will greatly improve the safety and welfare of first responders;
3) This idem will directly improve the safety and welfare of many civilians;
4) This item will greatly strengthen response systems;
5) Every community for which the item is appropriate would want to purchase or incorporate the item in their Emergency Management System.

Using a Likard scale, respondents were asked to score each question with a numerical range of 1 to 6, where a numerical value of 6 indicates strong agreement with the statement and a numerical value of 1 indicating strong disagreement with the statement. In addition to the Likard scale, each respondent was also asked to provide an ordinal ranking for each of the priorities in the six disciplines, with 1 being the most relevant priority for each discipline. Since two separate scoring systems were used, the final values for both methods were normalized so they could be compared and organized into a comprehensive ranking. Normalization was accomplished by zeroing the average of the combined scores within each of the six disciplines. The end result included high positive numbers to indicate that the required gap has a high ranking, while high negative numbers indicated the research gap has a low ranking. The values were determined by taking the number of standard deviations above or below the mean of the raw score. This effort provided a quantitative analysis of all 25 R&D priorities with a comprehensive ranking of all 25 priorities as well as a ranking of priorities in each of the six disciplines. For clarity, the rankings provided below are based on their ordinal ranking and not the actual scores derived from standardizing the two ranking methods.

The complete list of priorities for the last three years are provided below. The three tables include the overall rank, the long name of the R&D priority, and are categorized based on a classification developed for this project to identify similarly based priorities. A full explanation of the classification is provided later in this section. The STSG also compiled additional data for each of the priorities that provides clarification on the overall description of the requirement, the current gap that the requirement addresses, a scenario in which the requirement if filled will allow first responders to address, as well expected benefits that

priority will provide to the first responder community. The analysis of each R&D priority has changed slightly from year to year. A complete list of each of the 83 R&D priorities is provided in the appendices of this report.

2016 (25 Gaps)

Overall Rank	2016 Research Priority	Research Gap
1	3-D Tracking of Personnel	Deployable Equipment
2	Implementation of Unmanned Aerial Vehicles (UAVs)	Training / Standards
3	Handheld Standoff Chemical and Explosive Identifier	Deployable Equipment
4	3D X-Ray	Deployable Equipment
5	HME Neutralization	Deployable Equipment
6	Noise-filtering Digital Speaker/Microphone for SCBA Face Piece	Deployable Equipment
7	Female Ballistic Resistant Body Armor Research and Testing	Performance Standards
8	Handheld Field Deployed Biological Detection	Deployable Equipment
9	Improved Microclimate Cooling System for Down Range Use	Deployable Equipment
10	Mission Critical Secure Communication over Non-LMR Networks	Deployable Equipment
11	Meta-Analysis of Preventable Causes of Death of Law Enforcement	Research
12	Wearable Intrinsically Safe Miniaturized Multi-Detector Sensor Platform that Transmits Data through Integrated Wireless or Any Existing Communication System	Software and Hardware Integration
13	Robotic X-Ray Integration	Performance Standards
14	Inexpensive, Portable, Ruggedized Point-of-Care Lab Testing Device	Deployable Equipment
15	Redaction of Imagery from Body Worn, Vehicle, or Surveillance Cameras for Public Release	Software and Hardware Integration
16	Thermal Imaging Camera Training and Use Catalogue	Training / Standards
17	Multi-Meter for Bomb Technicians	Deployable Equipment
18	Post Incident Decontamination Use of Wipes for the Neck	Research
19	Structure Fire/IDLH Escape Respirator	Deployable Equipment
20	Responder/Receiver Mental Health and Wellness	Training / Standards
21	Non-Burning Treatment System for Illegal Fireworks	Performance Standards
22	Rapid, Universal, Battery Charger for Portable In-Home Medical Devices	Deployable Equipment
23	Collision Avoidance Systems for Response Vehicles	Software and Hardware Integration
24	Vessel Penetration Sampling Device	Deployable Equipment

2015 (32 Gaps)

Overall Rank	2015 Research Priority	Research Gap
1	Implementation of Unmanned Aerial Vehicles (UAVs)	Training / Standards
2	National Incident Collaboration System	Performance Standards
3	Virtual Reality Training Simulation	Training
4	Automated GPS Tracking and Universal Symbology for Large Area Search Events and Widespread Disasters	Performance Standards
5	Female Ballistic Resistant Body Armor Research and Testing	Performance Standards
6	Research into the Effects of Blast Overpressure from an Explosive Device	Performance Standards
7	Mission Critical Secure Communication over Non-LMR Networks	Deployable Equipment
8	Structural Firefighters PPE Interface Improvements to Reduce Contamination	Performance Standards
9	Isolating Specialized Systems to Improve Security	Performance Standards
10	Research into Improved Method for Assessing Helmets for Protection Against Ballistic Blunt Impact	Performance Standards
11	Decontamination of LE after a Crime Scene	Training / Standards
12	Improved Filtering Face Piece Respirator	Performance Standards
13	Standardized National Program for Emergency Management	Performance Standards
14	Less Harmful/Safer, More Effective Human Capture and Restraint Devices	Deployable Equipment
15	National Standardized Suite of Risk Assessment Tools	Performance Standards
16	Protective Shields Research and Testing	Performance Standards
17	Wearable Intrinsically Safe Miniaturized Multi-Detector Sensor Platform that Transmits Data through Integrated Wireless or Any Existing Communication System	Software and Hardware Integration
18	Automated CBRNE Event Isolation and Evacuation	Software and Hardware Integration
19	Handheld Field Deployed Biological detection	Deployable Equipment
20	Meta-Analysis of Preventable Causes of Death of Law Enforcement	Research
21	Interactive Simulator for Command Center Training (Virtual Playbook)	Performance Standards
22	Improved Microclimate Cooling System for Down Range Use	Deployable Equipment
23	Inexpensive, Portable, Ruggedized Point-of-Care Lab Testing Device	Deployable Equipment
24	Rapid, Universal Battery Charger for Portable In-Home Medical Devices	Deployable Equipment
25	Redaction of Imagery from Body Worn, Vehicle, or Surveillance Cameras for Public Release	Software and Hardware Integration

26	Efficacy of Fusion Centers at the Local/State/Federal Level	Performance Standards
27	Body-Worn Video Analytics	Software and Hardware Integration
28	Non-Burning Treatment System for Illegal Fireworks	Performance Standards
29	Develop a Fully Integrated SCBA/Seatbelt System for Fire Apparatus	Deployable Equipment
30	Data Interface Between NEMSIS Compliant, Patient Care Reports & Hospital Medical Records	Performance Standards
31	Standardized Model for Population Response to Disaster Events	Research
32	Small Portable Decon Kit for VIP	Performance Standards

2014 (26 Gaps)

Overall Rank	2014 Research Priority	Research Gap
1	3-D Tracking of Personnel	Deployable Equipment
2	Enhance Communications in Environments that Interfere with Radio Transmissions	Deployable Equipment
3	Hands-free Radio Intercom	Deployable Equipment
4	Noise-Filtering Digital Speaker/Microphone for SCBA Face Piece	Deployable Equipment
5	Modeling, Simulation & Simulation Software Evaluation Tool	Training / Standards
6	Proactive Training Resource (PTR) Initiative	Training / Standards
7	Sampling Kit for Clothing/Equipment Contamination Identification	Deployable Equipment
8	Implementation of Unmanned Aerial Vehicles (UAVs)	Training / Standards
9	Implementation of Protective Ballistic Gear for Fire and Medical Responders	Training / Standards
10	Field Detection/Analysis Devices for Fire Vapors, Gases and Particulates in Post-Fire Operations and Investigations	Deployable Equipment
11	Handheld Standoff Chemical and Explosive Identifier	Deployable Equipment
12	Vehicle Borne Improvised Explosive Device (VBIED) Render Safe Tool	Deployable Equipment
13	Smart Response Vehicles	Deployable Equipment
14	Develop Model Procedures and/or Lessons Learned from First Responders to Atypical Emergencies	Training / Standards
15	Virtual Reality Training Simulation	Training
16	Handheld Field Deployed Biological Detection	Deployable Equipment
17	Improved Filtering Face Piece Respirator	Performance Standards
18	Modems and Routers for Use between Personal Area Networks (PAN) Devices Land Mobile Radios	Performance Standards

19	Wearable Intrinsically Safe Miniaturized Multi-Detector Sensor Platform that Transmits Data through Integrated Wireless or Any Existing Communication System	Software and Hardware Integration
20	Improved Microclimate Cooling System for Down Range Use	Deployable Equipment
21	Protective Shields Research and Testing	Performance Standards
22	Female Ballistic Resistant Body Armor Research and Testing	Performance Standards
23	Device for Standoff Casualty Triage	Deployable Equipment
24	Equipment / Supply Guide for Relocating Special Needs Evacuees	Training / Standards
25	Emergency Responder Body Worn Integrated Electronics System	Software and Hardware Integration
26	Guide for Stress Management After Incidents	Training / Standards

Summary and Categorization of Priority List

Over the three-year period in which the R&D priority lists were established, the STSG and the full membership of the IAB identified a total of eighty-three R&D priorities that represented existing gaps throughout the first responder community. Of the eighty-three R&D priorities, the compiled lists of all three years actually includes sixty unique R&D priorities, as some of the priorities appeared in multiple years. In total, five R&D priorities appeared in all three years, while nine appeared in two of the years.

In order to focus this research effort on the primary goal of assessing R&D priorities for mission critical equipment that can be deployed to the field and enable first responders to more efficiently and safely perform mission requirements, the research team needed to categorize all sixty R&D priorities to identify deployable equipment from the lists. All sixty individual R&D priorities were reviewed and common gaps were identified that would allow categorizing of each gap by a similar capability. While the category for each gap selected does not always perfectly align with the actual priority, in order to limit the number of categories, priorities were groups based on a broad interpretation of each category. Employing this method, the research team was able to categorize all sixty R&D priorities into four categories and one sub-category. A complete assessment of the sixty R&D priorities resulted in the following five categories of R&D gaps:

1) Deployable Equipment – this R&D gap is the focus of this study and is designed to group current gaps in equipment used by first responders in the field for routine or specialized missions, such as bomb mitigation or detection of a biological or chemical agent. Deployable equipment gaps represent equipment that currently does not meet the full requirement of first responders due to a technological gap in currently deployed equipment.
2) Software and Hardware Integration – this is technically a subcategory of "Deployable Equipment"; however, it represents R&D priorities that desire to integrate software and hardware applications. While some of these gaps are by no means easy to resolve with simple software development and hardware enhancements, many of the priorities in this category represent first responder needs of several disparate capabilities that need to be integrated into a single deployable system. As an

example, law enforcement personnel identified the need to have vehicle and body worn cameras that automatically redact people in order to protect privacy in 2015 and 2016. Software with built in artificial intelligence is currently being developed and employed to recognize faces and automatically redact them to facilitate release of acquired video as part of a public request. This technology exists and doesn't represent a gap in technology, but more of integrating the sensor with the software. As of the time of the writing of this study in late 2017, there are currently several companies in the market that are providing this capability.

3) Performance Standards – many of the existing gaps that were identified as an R&D requirement are based on not having a national standard in which first responders can have a common benchmark to meet a specific operational requirement. A major R&D requirement is ballistic testing on Kevlar and plate armor for female first responders. This isn't a technology issue but a gap in standards on how to accurately test the performance of armor against female bodies in which a planar plate is not sufficient to provide full protection.
4) Training / Standards – a subcategory of the Standards focus area involves the R&D requirement to establish a national standard on training for specific areas within the first responder community. An example of this need is the existing gap on how to best implement unmanned aerial systems into first responder operations. To effectively implement this, a standard has to be established and a common training curriculum will need to be implemented to ensure all first responders are employing the UASs to an agreed upon standard.
5) Research – some of the R&D requirements represent an area in which additional investigation is required in order to acquire data that can be used to help researchers determine the root cause of a specific issue. Research is needed in order to understand a specific R&D gap and can be used to develop new policies and procedures to increase first responder safety, or research is needed to determine specific behaviors of different groups, which will then be used to create models that enable first responders to make better and more informed decisions.

At the completion of the categorization of the sixty R&D priorities using the definitions provided above, priorities were then categorized, which yielded the R&D priorities being group in the following manner:

Deployable Technology	-	22 R&D Priorities
Software and Hardware Integration	-	6 R&D Priorities
Performance Standards	-	18 R&D Priorities
Training / Standards	-	11 R&D Priorities
Research	-	3 R&D Priorities

Methods

Scoping Session

At the initiation of this effort, a scoping session was held among the principal investigator, the project manager, and select members of the STSG to identify the approach and method that would be implemented for the duration of the project. Through the scoping session, it was agreed upon that the focus would be on R&D gaps that address mission critical equipment needs that, if available, would allow first responders to more efficiently and safely perform the requirements of their jobs. A proposed plan for investigation was identified and agreed upon, allowing for the investigation of the equipment gaps to begin. The initial scoping session also explored how the top ten gaps would be identified, and it was left upon the research team to develop a methodology to assess the initial top ten gaps, with emphasis placed on gaps identified in 2016 and gaps that appeared in multiple years.

Identifying Top Equipment Priorities

With it agreed upon that mission critical deployable equipment gaps would serve as the focus of the investigation, the research team initially segregated the priorities over the previous three years into the five groups previously identified. A simplified ranking system was developed that ranked each of the priorities for each year by taking the percentage ranking of each item for each year. A percentage ranking was necessary to normalize the data as the number of equipment-based R&D gaps was different for each year (2014 – 12 equipment gaps; 2015 – 7 equipment gaps; 2016 – 13 equipment gaps). To give each gap a ranking for each of the three years, a formula of $1 - n/n_1$, was implemented, where n is the priority ranking for a given year and n_1 is the total number of equipment gaps were included for that year. Untouched, this would have left equipment gaps in 2014 equal to a gap in 2016. To compensate for this, each value in 2016 was multiplied by a factor of 2, while each value in 2015 was multiplied by a factor of 1.5. This ensured that 2016's highest priorities took precedence over 2015 and 2014, while 2015 took precedence over 2014. To finalize the ranking, the total for each gap was aggregated for all three years, which allowed for a cardinal ranking that met the intent of giving 2016 priority and gaps appearing in multiple years second priority. Based on this method, the total number of unique equipment gaps identified is 22. Initial funding for this project was based on a study that included the top ten priorities; however, the scope was later expanded to include the top 15 priorities. This method was also used to rank and prioritize all the R&D categories. A complete list showing all five categories is included as an appendix.

Final Priority Gaps Identified for Study

Overall Rank	Consolidated Research Priority	Years Identified
1	3-D Tracking of Personnel	2014, 2016
2	Handheld Field Deployed Biological Detection	2014, 2015, 2016
3	Handheld Standoff Chemical and Explosive Identifier	2014, 2016
4	Noise-filtering Digital Speaker/Microphone for SCBA Face Piece	2014, 2016
5	3D X-Ray	2016

6	Inexpensive, Portable, Ruggedized Point-of-Care Lab Testing Device	2015, 2016
7	Improved Microclimate Cooling System for Down Range Use	2014, 2015, 2016
8	Mission Critical Secure Communication over Non-LMR Networks	2015, 2016
9	HME Neutralization	2016
10	Enhance Communications in Environments that Interfere with Radio Transmissions	2014
11	Hands-Free Radio Intercom	2014
12	Structure Fire/IDLH Escape Respirator	2016
13	Less Harmful/Safer, More Effective Human Capture and Restraint Devices	2015
14	Rapid, Universal Battery Charger for Portable In-Home Medical Devices	2015, 2016
15	Multi-Meter for Bomb Technicians	2016
16	Sampling Kit for Clothing/Equipment Contamination Identification	2014
17	Vessel Penetration Sampling Device	2016
18	Field Detection/Analysis Devices for Fire Vapors, Gases and Particulates in Post-Fire Operations and Investigations	2014
19	Vehicle Borne Improvised Explosive Device (VBIED) Render Safe Tool	2014
20	Smart Response Vehicles	2014
21	Develop a Fully Integrated SCBA/Seatbelt System for Fire Apparatus	2015
22	Device for Standoff Casualty Triage	2014

Female Ballistic Resistant Body Armor Research and Testing

When the initial list was established, body armor was originally identified as a mission critical equipment gap and was added to original list of ten. During the investigation into the requirement, it became apparent that the gap was focused on establishing a standard for conducting testing and research on how body armor performs for female first responders. Over the three-year period, this R&D priority ranked number two on the consolidated lists of all R&D gaps. While this was no longer part of the full investigation, because of its criticality, a summary on the status of this gap is included as an appendix.

DOD Technology Readiness Levels

In order to conduct an investigation into the readiness of existing equipment gaps, it was necessary to identify a set of definitions against which technology readiness levels could be measured. Because this project is funded by JPEO-CBD, and DoD is a major sponsor of the IAB, it was agreed upon that the DoD definition of technology readiness levels would be used. The nine levels as defined by DoD are as follows:

Technology Readiness Levels in the Department of Defense (DoD)

(Source: DoD (2010), Defense Acquisition Guidebook)

1. Basic principles observed and reported Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties.

2. Technology concept and/or application formulated. Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.

3. Analytical and experimental critical function and/or characteristic proof of concept. Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.

4. Component and/or breadboard validation in laboratory environment. Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.

5. Component and/or breadboard validation in relevant environment. Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components.

6. System/subsystem model or prototype demonstration in a relevant environment. Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high fidelity laboratory environment or in simulated operational environment.

7. System prototype demonstration in an operational environment. Prototype near, or at, planned operational system. Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment such as an aircraft, vehicle, or space. Examples include testing the prototype in a test bed aircraft.

8. Actual system completed and qualified through test and demonstration. Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.

9. Actual system proven through successful mission operations. Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions.

Emerging Technology Investigation

The purpose of this limited study is to make a determination of technology readiness of mission critical equipment gaps that, if available, will enable first responders to more efficiently and safely perform their missions. This is not a comprehensive study that allowed for actual inspection and usage of the technologies that were investigated. Information gathered is based on open sources and involved direct engagements with vendors, practitioners, and researchers to help the research team better understand

the true gap in R&D, and new solutions that are already in the market space or being prepared to enter the market. The focus of this study is to identify technologies in the technology readiness levels 6 through 9. In addition to the open sources, the following entities contributed greatly in providing information and resources to help complete this study.

DHS S&T First Responder Group

The single most referenced government entity throughout this study is the DHS S&T First Responder Group. Over the years, they have been at the tip of the spear identifying first response and DHS component needs to help enable all entities to better conduct their missions. Many of the technologies that we reviewed were funded by DHS S&T. The National Urban Security Technology Laboratory (NUSTL) was extremely helpful in identifying emerging technologies. NUSTL sponsored an Urban Operational Experimentation in July 2015 that allowed municipal first responders to test and assess new technologies. Three of the items tested were reviewed as part of this assessment. DHS S&T First Responder Group has also sponsored the publication of the Project Responder 4 and Project Responder 5. Project Responder is focused on identifying capability needs and priorities to ensure Federal, state, and local first responders can respond to catastrophic events. Several of the needs identified in these studies have direct applicability to gaps identified by the IAB.

DIUx

The Defense Innovation Unit Experimental (DIUx) is designed to accelerate commercial innovation to aid in the defense of the nation. Many of the specialized skills that are required by the highly specialized first responder teams are also required for the Nation's military forces. The DIUx provided information on technologies they are following to enable Point-of-Care lab testing, three dimensional x-rays, communications, and chemical detection.

DHS S&T University Programs

While this effort was primarily focused on identifying new technologies in the applied phase and entering or about to enter the market space, the research team also wanted to identify any potential new technologies that are being developed by DHS S&T University Programs through their Centers of Excellence (COEs). Overall there are currently thirteen COEs that are conducting research on critical issues that need to be resolved for DHS and its different components. Projects for each of the thirteen centers were reviewed to determine if they were synergies that could be leveraged to help solve the gaps identified by the IAB. While none of the projects were directly involved with the gaps identified by the IAB (most are based on finding solution for different DHS components at the Federal level), several of the researchers were contacted to help provide clarity and explanation on different technologies as they clearly had expertise in the area.

NDPC Training Partners

The National Domestic Preparedness Consortium, sponsored by the Federal Emergency Management Administration, has several training partners that provide specialized training to first responders all over the country. Two of the training partners have expertise in biological and chemical detection and response and explosives. Experts at New Mexico Tech met with part of the research team to explain emerging trends in explosives, while also introducing researchers working on technologies in the basic phase at Sandia National Lab. Experts at Louisiana State University's National Center for Biomedical Response provided knowledge and expertise on trends and technologies in biological and chemical response.

First Responder Trade Shows/Vendor Engagement

In an effort to learn of the latest technologies that are being deployed, members of the research team attended multiple trade shows to scope out new potential technologies, as well as learn about existing technologies already at maturity. These venues provided a great resource to help understand existing and emerging technologies. Trade shows attended include the International Association of Chiefs of Police, EMS World Expo, International Association of Emergency Managers, and the National Homeland Security Conference. A planned trip to the Fire-Rescue International conference was also planned but had to be cancelled due to mechanical problems with the aircraft.

First Responder Engagement

Finally, a major contributor to helping understand the requirements for each gap, the current state of existing technology, and the potential limitations of emerging technologies was the direct engagement with multiple first responders. Throughout the process, periodic consultations took place with the National Guard's 62nd Civil Support Team stationed outside of Baton Rouge, LA, the Louisiana State Police Emergency Services Unit, and LSU's Fire and Emergency Training Institute. These professional and subject matter experts provided tremendous insight on many of the gaps identified by the IAB, and were instrumental in providing first responder insight into the existing R&D gaps.

Technology Assessment

For each of the 15 gaps identified, a technology assessment was developed to determine the current and future state of each particular gap. A consistent format was developed to ensure continuity for how each of the gaps were reviewed, information was gathered, and the assessment conducted.

Structure and Organization

Each assessment contains the following outline:

Technology Requirement Overview: Provide an overview of the current requirement for each R&D Gap.

Year the Requirement was Identified by the IAB: Captures each year the requirements appeared.

Requirements of the Technology: Defines the requirements identified from the first responder community to ensure the requirement can be fully met.

Rational for Radar Level: This is where we place the bottom line up front and define where we believe the technology is and how it ranks on the technology readiness level.

Assessment Methods: Explains how each requirement was assessed to determine its current technology readiness levels. Some requirements were assessed as a single entity, while others were broken down into different components, such as hardware and software. The different components were necessary in order to understand the overall technology.

Current State of Deployment: This explains the current state of how existing technology, when appropriate, is being used. It also explains some of the different types of technology that may lend itself to filling the R&D gap, as well as potential solutions that are currently in the process of being developed.

Evaluation of Products in the Market: This is an evaluation of equipment currently being deployed that either partially (overwhelming majority of products reviewed) or fully meets the technology gap. An evaluation of the product is provided, an assessment of where it is on the technology readiness level, how well it meets the requirements, and likely strengths and weaknesses of the project. Pricing for the project is also provided, and when companies willingly provided the information, the direction on where they are going with the technology.

Summary: Review of the current status of the technology gap.

Refinement from STSG

Throughout the development of the study, the STSG had an opportunity to review the first technology gap assessed to determine appropriateness of the format as well as the content. Feedback was provided and incorporated into the format based on that feedback. The STSG had a second opportunity to assess the format with the completion of the next two technologies and provided great feedback on the format and content while offering suggestions on how to improve the product. Their feedback was integrated into the final format and their input was highly valued.

Technology Gap Assessments

PRIORITY #1: Indoor/Outdoor 3-D Tracking of Personnel

Technology Requirement Overview

The entire first responder community has a significant need for technologies capable of tracking operating personnel in indoor and outdoor 3-D environments. From indoor environments like a high-rise building (XYZ coordinates within the structure) to outdoor environments such as wildland and hazmat out of line of sight), any associated technology much be capable of (a) integrating into current responder equipment, (b) coordinating transmission and receipt of responder-specific device signals, (c) displaying real-time location of personnel and/or assets, (d) serving police and fire disciplines, and (e) employing complementary systems and data sets, such as GIS systems and/or building blueprints.

Year the Requirement was Identified by the IAB

- 2016 – 3rd Priority
- 2014 – 1st Priority

Requirements of the Technology

The requirements for this technology will vary widely depending on use and situation, but principally, any deployed system must:

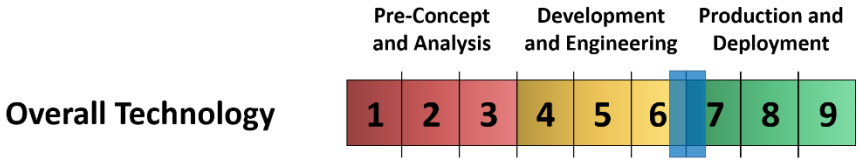
1. Locate, track, and monitor with considerable accuracy an individual (or team) within structures of any kind or across environments of differing nature, and do so through an easily-deployed system, and
2. Transmit electronically the location and associated data from inside the structure or across the environment to an incident commander.

In addition, the system should preferably integrate into already-employed equipment (such as radio, SCBA, or PPE).

Targeted End Users

- Fire
- Law Enforcement
- EMS
- Emergency Management
- Hazardous Materials Response

Radar: 3-D Tracking of Personnel



Rationale for Radar Level

Using the Department of Defense's TRL scale as a reference guide, we assess the overall state of 3-D Tracking of Personnel at **Level 6.5**. Because the entire emergency responder community benefits from advancements in 3-D tracking technology, our assessment relies on the current state to satisfy varying situational and stakeholder needs. As an integrated technology, the sophistication of its parts drive its extensibility. This need for innovation in both components and integration forms the basis for our rating.

Assessment Methodology

The focus is ultimately on implementation, deployment, and use by first responders. As 3-D tracking is a capability resulting from the integration of several discrete technologies, an accurate assessment of the technology (and its providers) must consider individual components within an integrated system. This approach acknowledges core infrastructure may be advanced and flexible, and various and discrete technologies to build the most trusted solution may be at various stages of maturation and cost.

At an individual vendor level, the vendor's approach, hardware/software, usability, extensibility, price, and strengths/weaknesses are all evaluated.

Current State of Deployment

As a long-time desired capability by numerous agencies with somewhat related missions, 3-D tracking has moved into a fully operational technology. Given all of the variables for a technology of its kind, there are differing approaches by multiple vendors. As a result, though 3-D tracking is available in several form factors, it remains a complex, integrated offering with only a few select vendors capable of delivering an end-to-end product.

In reviewing literature, assessing vendors, and evaluating integration, it's clear that core 3-D tracking capability generally includes the following technologies:

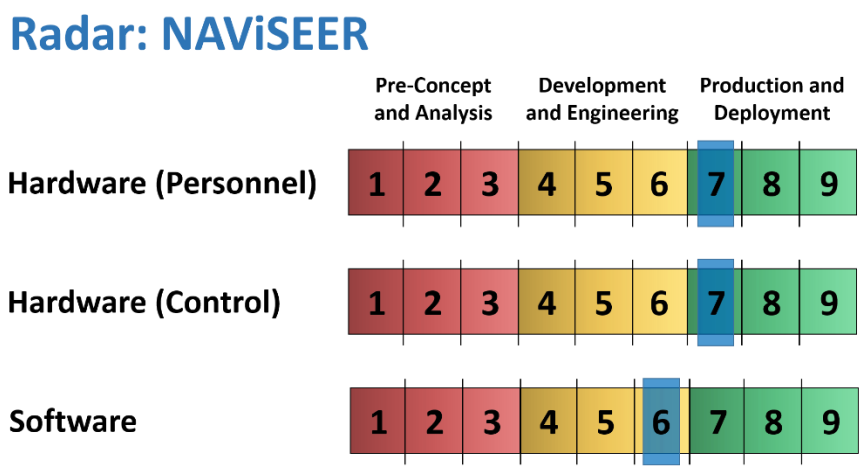
- **Hardware (personnel):** compact, hardened, low power, multiple sensors and outputs, and ability to connect to unit(s) easily
- **Hardware (control):** compact, hardened, flexible communication channels, encryption and security, ease of deployment and signal strength, ability to connect/translate with command and control machines
- **Software (control):** easy-to-use, stable, easily upgraded, software that allows for:
  - rapid coordination of units
  - adjustment (including manual) of unit parameters
  - consistent, valid environment creation (e.g., a new building) that resembles ground truth
  - easy updates to software
  - straightforward tools for coordination between units, PC(s), and control hardware

Evaluation of Personnel 3-D Tracking Currently on the Market

There are several noteworthy 3-D tracking technology vendors marketing to the first responder, defense, and law enforcement communities. Many of these vendors are led by research-oriented leadership teams, and promote their relationships with these communities. Two vendors in particular—SEER Technologies and TRX Systems—have mature, robust systems in the market.

SEER Technologies, Salt Lake City, UT

PRODUCT: *NAViSEER* | SITE: http://www.seertechnology.com/naviseer



Company Description

SEER provides advanced human asset tracking products, built for the first responder, military, industrial, environmental and homeland security sectors.

Product Description

NAViSEER is a GPS-denied tracking system for accurate geolocation of personnel where GPS is limited or unavailable.

Product Features

NAViSEER is deployed via a responder-worn mobile radio (compatible with existing digital radio frequency [RF] communications systems) or through the Global System for Mobile Communications/General Packet Radio Service (GSM/GPRS), which is the basis for existing public cellular networks. As a result, NAViSEER deploys easily, requires no supporting infrastructure, uses multiple methods to move data into a visualization environment, and may be used in buildings, urban canyons, tunnels, and areas of dense foliage – i.e., anywhere cellular or SMS communications apply.

The NAViSEER system is complemented by SEER's custom software program, SEER3D, which provides both 2- and 3-D views, and supports additional layers of incident information, such as blueprints or even hand-drawn floor plans. The system employs both GPS and Inertial Navigation System (INS) technology to generate X-Y-Z details for personnel, visible in a 3-D wireframe diagram of a structure, street, tunnel or open space within SEER3D.

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

- Personnel-borne unit is a compact and self-contained electronic navigation unit with durable power.
- The system is compatible with both existing digital RF communications systems (can connect directly to a portable tactical radio worn) and cellular radio technology/public cell networks.
- Personnel-borne units connect to a base unit responsible for transmission to PC, likely enabling multiple PCs to monitor and assist in coordination.
- Personnel-borne units consist of sophisticated hardware and firmware (multiple gyros, accelerometers, a magnetometer, and a baro altimeter), enabling very high accuracy in location.
- The software is powered by mathematical and motion classification algorithms, allowing for location to be determined through both dead-reckoning (DR) and in-motion methodologies.
- The command software lets users extract an estimated wireframe representation of any building or geography visible in Google Earth™.
- The command software allows for manual updates of deployed assets, control over all units or a single unit, parameter definition (stride length or step detection for individual users), remote update, and broadcast ability to other programs on the network.
- The SEER3D software is capable of ingesting digital blueprints, fire plans, aerial photos, or scanned hand drawings of facilities.

Likely Weaknesses

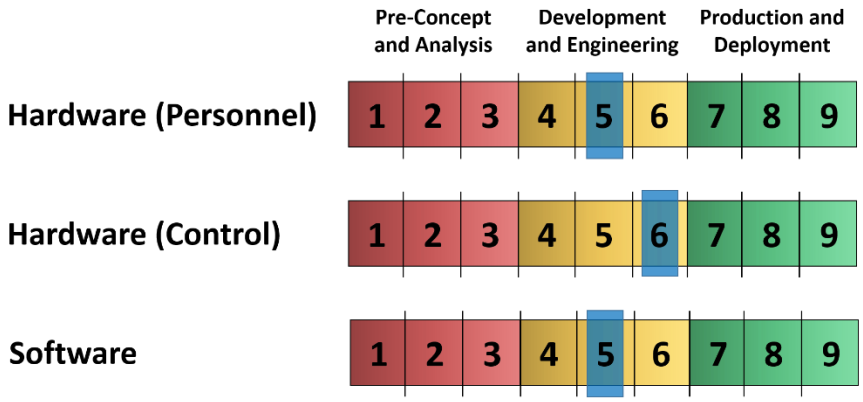
- The hardware and firmware may not be hardened for extreme environments.
- Secure communication gaps may exist between asset units, the base unit, and PC(s) as communication channels react to changing environments and signal availability.
- The sophistication of the software may be difficult for inexperienced users.
- The complexity of available features and coordination (like parameters for stride length for individual users) may hinder easy deployment.
- The differing configurations and settings (like radio unit vs standalone unit) may be needed for different events, and integration capability is unclear.
- There are very few visuals of the product units to assist in assessment.
- SEER's large list of international distributors may blunt strategic advantage in some situations.
- The technology could be cost-prohibitive at any significant scale, or for under-resourced units.

Additional Information

Pricing: Pricing for the NAViSEER at the time of the publication of this document is unavailable. The product is still in the development phase and is presently undergoing major hardware and software upgrades from its initial prototype. According to company representatives, it is expected to be ready for release to the commercial market in the 3rd quarter of calendar year 2018.

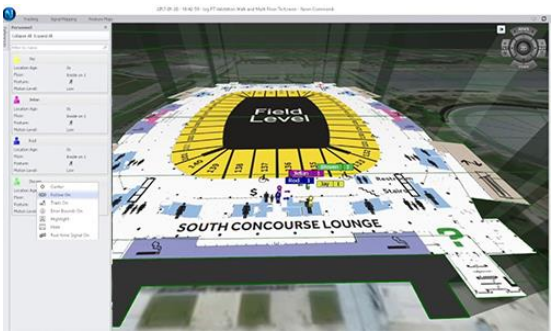
TRX Systems, Greenbelt, MD // PRODUCT: *NEON Personnel Tracker*
Site: http://www.trxsystems.com/personnel-tracker-store.html

Radar: NEON Personnel Tracker



Company Description

TRX has experience in sensor fusion, RF ranging, crowd-sourced map building, statistical modeling, control theory, and robotics; the company has a large portfolio of IP including 12 US-issued patents, 12 internationally, and 27 pending.



Product Description

NEON enables 3-D location and tracking of users in both indoors and outdoors. The application can locate and track personnel in areas without GPS, including building, urban canyons, and underground.

Product Features

NEON's ability to integrate several technologies—including sensor fusion, Wi-Fi, Bluetooth, and GPS—allows for flexible deployment. Its software component has robust integration and mapping/personnel coordination capability. For personnel coordination, the NEON application can be installed or deployed on Android mobile devices.

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

- The system uses a smart phone-enabled mapping technology, and TRX has a new ultra-wideband (UWB) product line that was approved by the FCC in 2016.
- The intuitive and functional mapping software provides users the ability to map entire structures in considerable detail, and allows for the ingest of floor plans and related data.
- Once mapped, structures reside in a cloud environment for quick and easy retrieval.

- The user interface (UI) allows for any building available in internet mapping software (like Google Earth™) to be selected for detailed mapping.
- TRX offers accessible and detailed customer support that provides step-by-step video and PDF deployment and implementation.
- TRX also offers a Signal Mapper, a real-time 3-D visualization and mapping software product that complements NEON Personnel Tracker.
- Because deployment is application-based, pricing is scalable.

Likely Weaknesses

- The mapping process appears to be very labor-intensive and an appropriate planning activity; it's unclear whether the software would be as responsive in emergency environments.
- The need for on-device applications means possible refresh cycle strategies across multiple devices, and maintaining systematic updates.
- The application appears to be currently only Android-based.
- The product is license-based, without available detail(s) on license coverage.
- End-to-end deployment appears to require considerable coordination between all elements (software, units, mapping components) and would require dedicated resources to at least manage mapping and planning efforts.
- The TRX Signal Mapper product is entirely separate from the Personnel Tracker, requiring additional development kits, possible integration and deployment strategies, and pricing/license.

Additional Information

Pricing:

- Personnel tracker UWB Development Kit: $4,999
    - NEON Personnel Tracker Development Kit with Ultra-wideband includes Android Location Services SDK, 4 multi-purpose Tracking/Anchor Units with UWB (TU8U) and a 6 month license for Command and Personnel Tracker software with cloud access for 4 users. Solution supports optional BLE and UWB ranging.
- Personnel Tracker 1 User Development Kit: $1,299
    - NEON Personnel Tracker Development Kit includes NEON Android Location Service SDK, 1 NEON Tracking Unit (TU8B) and a 6 month license for NEON Command and Personnel Tracker Software with cloud access for 1 user. Solution supports optional BLE ranging
- Personnel Tracker 4 User Development Kit: $3,499
    - NEON Personnel Tracker Development Kit includes NEON Android Location Service SDK, 4 NEON Tracking Units (TU8B) and 6 month license for NEON Command software and NEON Personnel Tracker software with cloud access for 4 users. Solution supports optional BLE ranging.

Potential Limitations and Considerations

With the current 3-D methodology, there are several potential limitations and opportunities. These are possible areas of focus by the research community to help drive greater capability of vendor-built technologies.

Potential Limitations

- Security/encryption between various channels
- Dearth of existing, consolidated, federated repository of building plans, blueprints, or environments
- Hardening of hardware and software
- Interoperability with existing emergency response software and hardware tools
- Inability to ingest and process data feeds from new sources
- Affordability may limit market penetration

Potential Considerations

- Development of better software for 2-D to 3-D mapping
- Integration of other sensing technologies (e.g., high-level: thermal, low-level: RFID) to build more comprehensive common operating picture of deployed assets
- Curation of strategic plans, blueprints, and environments, including crowdsourcing "mapping" of urban environments as a function of business plans
- Complementary technologies (feeds from UAV, or UAV-mapped environments) to help ensure greater visibility

Summary

Active 3-D tracking is now an established capability, and a prevailing methodology—personnel-borne units, a coordination unit, and coordination/mapping software working in concert—has emerged across several vendors. Given the spectrum of communication options (GPS, cellular, RF, GSM/GPRS), it's clear that even in GPS-denied environments, all current and future vendors' ability to communicate and track personnel will increase as new networks and protocols emerge. Similarly, all vendors have access to the same kinds of hardware, sensors, PCs, and infrastructure environments, like mapping and cloud systems. As a result, the vendors with the best 3-D tracking solutions will be those with the most intuitive and powerful software, the best-designed hardware, and the most thoughtful (and potentially creative) integration and tracking approach.

PRIORITY #2: Portable, Ruggedized, Biodetection and Identification Kit

Technology Requirement Overview

While not a routine occurrence, biological agents when encountered can have catastrophic consequences. In 1984, a cult poisoned the local food supply in effort to change the outcome of a local election. The result of the deliberate spiking of the food supply of local restaurants resulted in 751 people being diagnosed with salmonella. In 2001, 5 people were killed and 17 injured when anthrax-laced letters were mailed to federal officials in Washington DC and select media outlets in Florida. In order to minimize exposure to potential threatening environments, first responders need to have the capability to deploy hand held or portable bio sensing devices that can notify first responders that there is a biological threat in the area. In addition, first responders also need to have the ability to rapidly identify the potential threat in the field without having to wait on lengthy lab test to receive a confirmation of the threat.

Year the Requirement was Identified by the IAB

- 2016 – Technology Priority #5
- 2015 – Technology Priority #19
- 2014 – Technology Priority #16

Requirements of the Technology

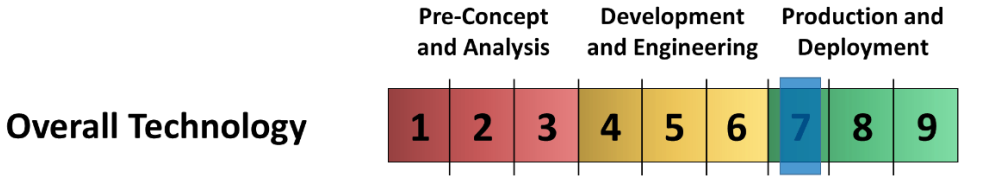
To provide additional protection and detection capabilities, bio detection and bio identification for first responders need to meet the following requirements:

1. Device must be compact and portable
2. Ruggedized to support harsh environments
3. Test results be reliable and accurate
4. Test results should take no more than ten minutes to provide
5. Detection capability should be able to discriminate between pathogenic and non-pathogenic organisms or toxins
6. Detection should be able to detect small amounts of biological agents
7. Device should weight no more than 14 lbs.
8. Device should be intrinsically safe
9. Device should be able to be sustained outside
10. Device should have its own internal battery source while also providing access to AC/DC power
11. Device should be able to communicate its results wirelessly or via Bluetooth
12. Devices should be user friendly and operable by non-laboratory specialists
13. Capable to operate in high heat and cold environments
14. Must be able to detect and identify the following biological agents: Anthrax, Plaque, Smallpox, Ricin, Campylobacter, Salmonella, Listeria, E. coli 0157-:H7, Shigella, B. Cerius, Norovirus, Botulism, Brucella, Tularemia, and Coxiella

Targeted End Users

- EMS – Primary
- HAZMAT Technicians

Radar: Bio Detection and Bio Identification



Rationale for Radar Level

Using the Department of Defense's TRL scale as a reference guide, we assess the overall state of Bio Detection and Bio Identification at **Level 7**. This capability is assessed at a TRL of 7 as all of the requirements identified by the first responder community are not met, including not having the ability to identify some of the required biological agents. Investigation of this capability did not yield a single platform that performed both as a bio detector and bio identification; however, there are currently platforms in the market that are being used by specialized first responders and military teams, particularly the National Guard's Civil Support Teams.

Assessment Methodology

In assessing the current state of bio detection and bio identification technology, an integrated approach is taken that focuses on the different components of an integrated system that are required to provide first responders with bio detection, followed by bio identification. The assessment focuses on existing vendors that are providing bio detection capabilities and bio identification capabilities. At an individual vendor level, hardware, usability, extensibility, price, and strengths/weaknesses are all evaluated.

We assessed technologies on the following component levels:

- **Hardware (Detection Platform):** The physical unit that collects and analyses air samples for biological aerosol threats.
- **Hardware (Identification Platform):** Device used to provide analysis of air samples to determine if they contain biological aerosol threats.
- **Software:** The user interface and display of sensors that are used to communicate to monitors whether alarms are being triggered or results of analysis of air samples.

Current State of Deployment

Biological agent detection and identification is a fully mature capability available throughout the United States. However, this capability is limited to specialized teams such as the National Guard's Civil Support Teams, which have a presence in all 50 states, the Federal Bureau of Investigations, and very large cities with in house detection and identification capabilities. These teams are routinely deployed to high profile events, such as professional and collegiate sports championship games, and have the technical capability to detect and identify biological agents. Prior to these events, the specialized teams will conduct active and passive surveillance to include point air sampling using air sampling systems, such as the BT-650, which is ruggedized, handheld and designed for reconnaissance of small areas. Civil Support Teams will also collect air samples and perform on site lab analysis using bio screening with fluorescence, DNA match and the Joint Biological Agent Identification and Diagnostic System (JBAIDS), which provides rapid identification and confirmation of biological agents and other pathogens by utilizing polymerase chain

reaction (PCR) technology. While this method is very effective, it requires enormous investments in mobile labs, highly skilled laboratory technicians, constant training, and major financial investments to maintain this capability.

Traditional bio detection and identification techniques are not sufficient to meet current threats faced by today's first responders. Air sampling collection and identification in public health laboratories can sometimes take as long as two days before positive or negative results are obtained. In addition, sampling is typically performed in intervals and does not provide continuous monitoring. These methods only apply to planned events and do not include areas that have faced potential exposure in which first responders have been dispatched. Rapid detection and preliminary identification is needed to allow first responders to provide treatment and triage for exposed victims. A detect to warn capability is needed to ensure the safety of first responders and the general population.

Today there are multiple capabilities to provide the biological agent warning without identification. Detectors have the ability to count aerosol particles and monitor when there is a change in density. These detectors are subject to false positives and are unable to distinguish between biological and non-biological agents. Another technology currently deployed is an optical sensor that uses ultraviolet stimulated fluorescence which has the capability to detect biological and non-biological agents; however, UV stimulated fluorescence cannot determine if a particle is a pathogen or benign. These detectors also do not possess any bio identification capability.

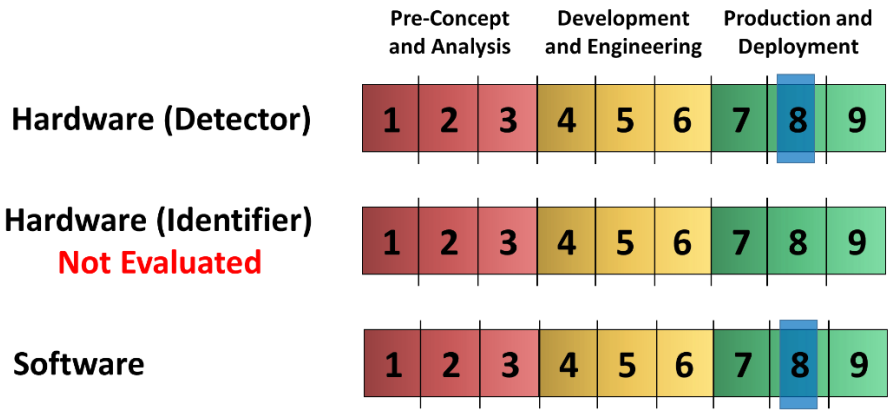
Biological agent identification confirmation usually takes place in an accredited public health laboratory. These laboratories identify biological agents through a variety of means that include culture methods, PCR amplification, and sequence detection of DNA, as well as mass spectrometry. Preliminary analysis is currently taking place in the field by qualified technicians with the appropriate mobile laboratory using PCR and mass spectrometry methods for identification. Collectively, the technology to facilitate the detection and identification capability exists for first responders; however, it is a complex and time consuming process that does not lend itself to rapid identification and analysis in order to determine quarantine and triage procedures.

Through reviewing literature, scientific approaches, engaging companies and technicians, there are available technological solutions that allow first responders to partially meet the requirement for onsite bio detection and bio identification. Through analysis of existing capabilities, there was no observed single solution that provides both bio detection and identification; however, through an integrated solution, first responders have the capability to combine a bio detection platform and bio identification system that partially meets this requirement.

Evaluation of Bio Detection and Bio Identification technology on the Market

FLIR, Wilsonville, OR
PRODUCT: *IBAC™ 2* | SITE: http:// www.flir.com/products/ibac-2

Radar: FLIR IBAC™ 2



Company Description

FLIR is a global company with over 3,000 employees around located in various countries around the globe. The company was established in 1978 to develop a high-performance, low-cost infrared (thermal) imaging system for airborne applications. This expertise was later converted to a variety of commercial applications that required the need to detect and measure temperature differences. Through multiple acquisitions, FLIR has expanded into adjacent markets, technologies, and products to expand its sensor solution set and its ability to service a broader set of customers. Today FLIR is providing technology solutions to the commercial and government sectors in thermal imaging systems, visible-light imaging systems, locator systems, measurement and diagnostic systems and advanced threat detection systems.

Product Description

The FLIR IBAC 2 is a fully automated biological agent detector that provides 24/7 air monitoring. Its alarms are designed to be triggered in less than 60 seconds when a bio-threat is present, triggering an onboard or remote sampler to collect a real-time sample for eventual analysis. The IBAC 2 is capable of detecting all four classes of biological aerosol threats (spore, viral, cellular, and protein toxins) at concentrations at or below industry goals. The IBAC 2 has undergone testing in an urban environment through the DHS S&T National Urban Security Technology Laboratory (NUSTL) in July 2015 in New York City where it received positive reviews from first

responders in the NE who participated in the testing. The IBAC 2 is currently deployed and used by multiple Civil Support Teams and civilian agencies to provide mobile as well as fixed surveillance to include subterranean environments.

Product Features

- Provides real-time warning capability for bio-aerosol threats
- Detects spores, bacteria, virus and toxins
- Autonomous 24/7 operations with no consumables
- Alarm automatically triggers sample collection
- Detection algorithms for indoor and outdoor use
- Compact, lightweight and rugged (7.5 lbs without battery and 13 lbs with battery)
- Integrates with facility monitoring and control systems
- U.S. Government validated

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

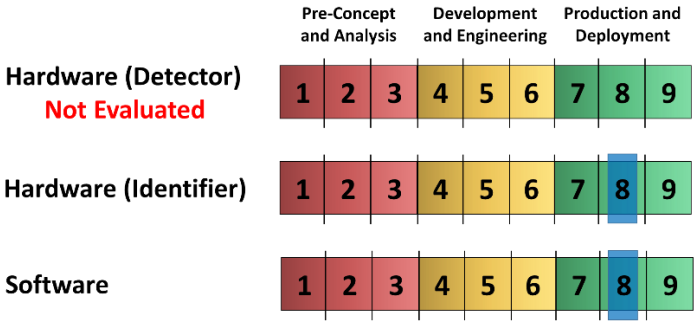
- The device is portable and can be easily transported
- The device comes in a mobile and fixed site version
- The system is slightly over 10 lbs. and can be carried
- The system allows for remote monitoring
- The system is rapidly deployable
- System can communicate via an Ethernet cable or through wireless using 900 MHz or 2.4GHz
- When triggered, the system automatically takes a sample for further analysis
- The sample taken can be either a wet sample or a dry sample, depending on the capabilities of the laboratory
- Unit contains a built in GPS to maintain geospatial awareness of unit location
- Comes in multiple configurations that allow it to be used at fixed locations or on site with portable version
- Can be connected to shore power or run on battery power
- Minimal false positives
- During a year long deployment in a subterranean environment the unit only set off 5 alarms in which 4 were explainable
- Large user community with over a 1,000 units deployed
- Does not use any consumables and requires little maintenance
- Can integrate with other command and control software platforms

Likely Weaknesses

- Device is not plug and play out of the box, as it requires training and continuous use to ensure proficiency is maintained and user is able to properly interpret the results
- During the field testing in New York it was noted that the alarm system inherent in the software monitoring package didn't provide a sufficient notification when a trigger was activated on the device
- At the time of the testing in New York, communication between the sensor and computer were not encrypted which could lead to the sensor potentially being compromised and activated to send off a false positive

BioFire Defense, Murray, UT.
PRODUCT: *RAZOR EX* | *SITE:* http://www.biofiredefense.com/razorex

Radar: RAZOR Ex



Company Description

BioFire was established in 1990 at an Idaho potato equipment facility and was originally called Idaho Technology, Inc. The company originally developed products with a firm commitment to eliminate disease through smart thinking and product innovation. Through rapid advancements, the company introduced a number of products for the molecular and bio surveillance industries. In 2012, the company changed its name to BioFire Diagnostics, and in 2014, merged with bioMerieux to better serve its markets and meet government regulations on security and business ownership. BioFire Diagnostics split into two companies: BioFire Diagnostics and BioFire Defense, with BioFire Defense focuseing on producing an integrated suite of biological agent identification products.

Product Description

The RAZOR EX system detects and identifies biological agents in the field. The RAZOR EX is compact, lightweight, and easy to use. It is a field PCR unit that can produce reliable DNA based results in 30 minutes from the time of the run being initiated. The RAZOR EX was originally created for first responders and front line military troops. The unit is designed to allow easy operation while working in protective equipment under the most extreme conditions. The new battery powered unit includes Bluetooth capabilities, bar code reader, and a bright, easy to read color screen.

The RAZOR EX uses BioFire's patented pouch system which integrates freeze-dried reagents and special packaging for ease of use. The pouches are designed to provide the user with a pre-formatted pouch configuration for the most common bioterror threats as well as the ability to custom formulate the pouches for individual need.

Product Features

- Unit is reliable, providing less than a 1% error rate
- Detection limit as low as 100 cfu/mil
- Less than 1% false positive error rate
- Results are calculated in less than 30 minutes
- The unit is portable and weighs less than 11 lbs.
- Battery powered with the ability to connect to shore power
- Utilizes the same PCR technology used in central labs
- Used world-wide by Military, Hazmat, and First responders
- Following tests are available:
    - Bio Threat – Anthrax, Ricin, Smallpox, Plague
    - Food Testing – Listeria, Salmonella, Campylobacter
    - Water Testing – Cryptosporidium, Salmonella, E. coli 0157
    - Environmental – Coxiella, Botulism, Brucella, Tularemia

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

- Device utilizes pre-selected pouches designed for specific threats: Bio Panel, Food Security Panel, and Water Security Panel
- The unit includes a positive and inhibition control to ensure you don't get a false negative
- Unit conducts 50 cycles to increase sensitivity levels and ensure identification is achieved
- The battery can support up to 8 runs on one charge and can be hot swapped during an actual run
- Freeze dried panels (consumables) can be maintained in a climate control room for up to six months
- BioFire allows for users to subscribe to a just in time delivery system to replace panels every six months
- Unit allows for users to use custom Reagents to test for biological agents not included in the panels
- Unit self-calibrates in less than two minutes after powered on
- Training is minimum, step by step directions are included in the digital display
- First version deployed since 2003 and includes a worldwide user base
- Unit is ruggedized and meets military specifications
- Large display and buttons will facilitate its deployment while wearing PPE

Likely Weaknesses

- Most Civil Support Teams are trained to conduct multiple tests to validate the press of a biological agent, this test is only one test and doesn't include a redundancy test to validate
- Panels are use or lose, and expire after six months

Additional Information and Pricing

The RAZOR EX was designed to meet specific requirements, and with years in the field, the bio identification aspect of the device has achieved that requirement. As such there are no current plans to add any significant upgrades to the system. One potential enhancement in the future would involve reducing the run time to conduct a full sample analysis. The RAZOR EX currently sells for approximately for $38,500. Each panel, which is consumed after a single run, cost approximately $180 to $200 per panel and can be stored in room temperature for up to six months.

Summary

While significant progress has been made on the development of bio detection and bio identification, there is no known single platform that provides both capabilities. Researchers from both companies highlighted in this technological capability assessment indicated that the science isn't available yet that will allow both technologies to be integrated into a single platform. While the single platform is the silver bullet for the first responder community, integrating existing capabilities of independent systems does offer a technological solution. Because these systems are independent but perform the functions of most of the desired requirements, the overall capability is considered to be a technological readiness level 7, while the individual systems are rated at TCL 8.

In addition to the two products highlighted in this summary there are additional alternatives. The German company Bruker produces the pBDi bio detector that has similar capabilities as the RAZOR EX, but is sold primarily overseas. In addition, Pathsystems produces the BioFlash-E System that also provides a bio identification for 21 agents, and includes a rapid response time of approximately 3 minutes. The BioFlash-E was part of the first responder urban operational experimentation hosted by NUSTL in July 2015, where it received positive feedback for its rapid identification. Some of the concerns addressed during the demonstration was the size (35 lbs.) and the cost of its consumables (approximately $100) that only maintained a shelf life of approximately 14 days.

PRIORITY #3: Handheld Standoff Chemical & Explosive Identifier

Technology Requirement Overview

Quick, effective standoff detection and identification (hereafter, SDI) of chemical threats—especially from a distance—is one of the most pressing needs for law enforcement and first responders across the globe. The proliferation of asymmetric warfare tactics through the reality and lethality of Improvised Explosive Devices (IEDs), including person- and vehicle-borne (PBIED and VBIED, respectively), has made detection and identification technology a priority for all governments. In addition to suspected explosive materials, first responders often face additional detection challenges in scenarios where they may encounter toxic industrial chemicals (TIC), narcotics, and chemical warfare agents (CWA). Detection and identification components notwithstanding, any standoff technology for first responders must also operate in real-time, be used from a distance that doesn't require PPE, be portable and easily operated, ruggedized, and affordable.

Year the Requirement was Identified by the IAB

- 2016 – Technology Priority #2
- 2014 – Technology Priority #7

Requirements of the Technology

Because first responders will encounter a vast range of analytes (any substance whose chemical nature is being identified and measured) across multiple scenarios, detection and identification are the most important requirements. To enable appropriate and timely action from first responders, standoff detection and identification must:

1. Detect and identify (or approximate) chemical substances, including Chemical Warfare Agents (CWAs), Toxic Industrial Chemicals (TICs), explosive substances, or unknown analytes from a distance/outside of exposure or contamination zone
2. Allow for identification in real-time
3. Be used from a distance that doesn't require PPE, or able to be used with gloves (cold or PPE)
4. Be portable, with appropriate power (battery, not generator)
5. Be ruggedized for field use, and able to withstand temperature and humidity changes
6. Provide for updates as new analytes are characterized, or features calibrated
7. Affordable – Less than $5,000

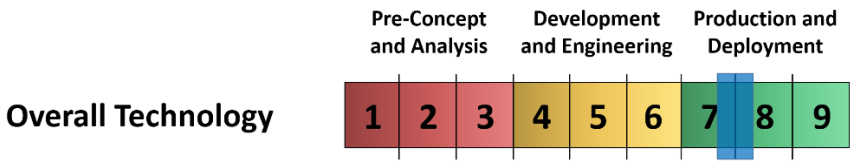
Targeted End Users

- Hazardous Materials Response – Primary
- Explosive Ordnance Disposal
- Fire
- Law Enforcement
- EMS
- Emergency Management

Summary of the Radar and Radar Purpose

The assessment takes an "at a glance" view of the overall technology and is intended to serve as a guide for evaluation of the vendor/landscape technology. The "subradar" is a more detailed assessment of individual technologies, a reflection of both the whole and constituent elements of the technology, and the vendor's maturation of each element.

Radar: Standoff Detection and Identification



Rationale for Radar Level

Using the Department of Defense's TRL scale as a reference guide, we assess the overall state of standoff detection and identification (SDI) at **Level 7.5**. The primary users of SDI for IAB will be hazardous materials and explosive ordnance responders; with this audience in mind, we considered the overall use of the system—from sensor and support system (hardware) to the software—and how well it satisfies the needs of the users and their mission. While targeted detection technology has made significant advances in detection and miniaturization, the integrated technology still requires the user to spend significant time in set up and calibration prior to being operational, and the current technology is not capable of non-stationary operation.

Assessment Methodology

Given that identification and detection (and the science behind them) are assumed components, the assessment methodology focuses on the integrated technology, from its current state to available vendors and products, particularly in chemical and explosive detection. In addition, the methodology will include emphasis on the emerging research in detection and sensing.

At an individual vendor level, hardware, usability, extensibility, price, and strengths/weaknesses are all evaluated.

Because SDI technologies are integrated by nature, the methodology also accounts for the state and status of the constituent elements, helping first responder audiences better align the technology to specific needs and situations. We assessed technologies on the following component levels:

- **Hardware (Sensor):** The physical scanning unit, including size and weight, power, capability, sophistication, operations and calibration, ease of use, and appropriateness for mission
- **Hardware (System):** The power generation, support structures for varying configurations (stationary v. mobile), peripherals, connectivity, and overall deployment
- **Software:** The user interface and any display, detection methodology and translation, integration of all components, and ability to upgrade / update as new compounds and materials are identified

Current State of Deployment

The growth of suicide bombers and use of IEDs of all kinds is driving transformational counter-terror technologies, with the need to detect and identify these threats emerging as one of government and law enforcement's greatest challenges. Governments and military must assume these asymmetric tactics can and will evolve to include attempts at chemical and biological agent dispersal, making the need for standoff technology critical and driving innovation across all containment and mitigation scenarios for first responders. The current state is marked by research & development across all disciplines and approaches, backed by intense investment, wide industry engagement, and rapid prototyping.

The current SDI ecosystem includes technology ranging from walkthrough units, large stationary configurations, quasi-mobile labs and analysis units, and sensors that can be hand-held or vehicle-mounted. Within this ecosystem, the emphasis is clearly on detection: it's far more important to notice and understand a potential threat as the decision factor to guide subsequent exploitation, countering activity, force protection, disablement, and/or processing.

Detection itself is both an art and a science, relying on physical methods to identifying chemical properties that are then translated through technological interfaces into understandable and actionable intelligence. The wide range of sophisticated physical methods relies on the exploitation of electromagnetic radiation from X-rays to microwaves. These approaches mean first responder communities have considerable options based on likely situations. It is helpful to understand various methodologies and terms:

- **Spectroscopy:** Simply, spectroscopy is the study of what happens to materials (like an explosive or narcotic compound) when exposed to electromagnetic radiation. It is at the heart of all detection methodologies
- **X-ray**: A very high frequency (and thus high energy) form of electromagnetic radiation, X-rays are well-known in imaging. X-rays for detection are excellent in walkthrough or stationary units, but are less effective in downrange standoff situations because they either (A) require a transmitter with a separate detector on the other side of the target object/individual or (B) employ scattering that still require additional detectors
- **Millimeter Wave (MMW):** Unlike X-rays, millimeter waves (MMW) are a subset of the microwave band and operate at a much lower frequency. The strength of the millimeter band is its unique set of imaging properties and high resolution, particularly in multi-static radar systems (multiple radar components to generate a shared coverage area). MMW resolution is related to its bandwidth, so higher bandwidth - and thus more data coming back to the system - equals better resolution. For example, finely tuned MMW systems can clearly distinguish items centimeters apart. In addition, MMW beams can be intensely focused at a target object or individual. MMW is being widely considered for concealed threat detection because typical clothing is highly transparent to MMW frequencies
- **Fourier transform infrared spectroscopy (FTIR):** The FTIR detection approach represents two separate and simultaneous techniques. First, infrared energy is used to generate (then measure) absorption or emission of a solid, liquid, or gas. Second, a Fourier transform (a mathematical process) converts the measured raw data into the actual spectrum. Because an FTIR spectrometer collects high resolution data over a wide range, it is excellent for chemical detection and analysis

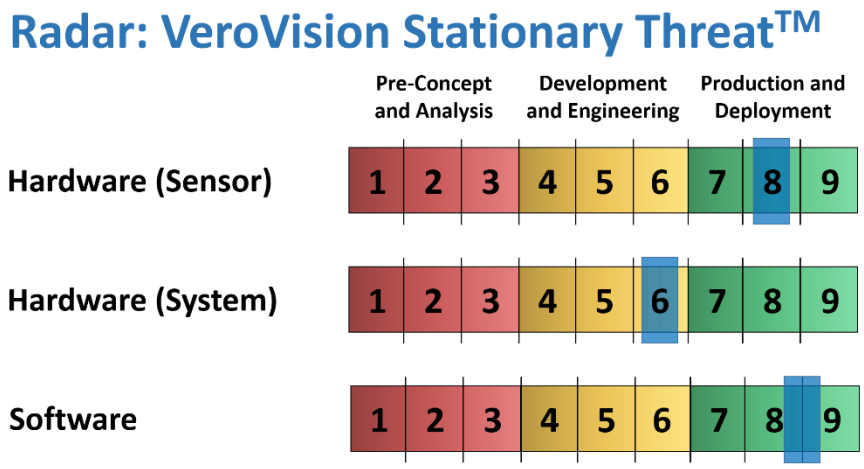
- **Hyperspectral Imaging (HSI):** HSI combines the power of digital imaging and spectroscopy to collect and process information from across the electromagnetic spectrum (hence, "hyperspectral"). By analyzing the spectrum in each pixel in an image, HSI can generate incredibly detailed images that can reveal hidden details, faults, structures, and chemical and material signatures on both people and surfaces

Through reviewing literature, scientific approaches, and engaging companies, it is apparent the complexity of the science and technologies means there is no universal approach to detection, though the power of FTIR and HSI is pushing the edge of the knowledge domain. Situational use dictates approach, and rapid advancements in military use on related technologies mean products will continue to develop.

Evaluation of Standoff Detection and Identification Currently on the Market

ChemImage Sensor Systems, Pittsburgh, PA

PRODUCT: *VeroVision Stationary Threat™* | SITE: http://www.cisensorsystems.com/ciss-products/verovision/



Company Description

ChemImage Sensor Systems, a subsidiary of ChemImage, focuses on protecting troops, first responders, and citizens by developing chemical imaging sensors to detect and identify drugs, chemical, biological, and explosive (CBE) threats. ChemImage's patented imaging capabilities have been used in sensors for point, proximity, and standoff detection and identification in both fixed and mobile configurations.

Founded in 1994 and headquartered in Pittsburgh, PA, parent company ChemImage provides advanced hyperspectral imaging technologies for chemical and biological applications, including threat detection, biomedical imaging, and forensics. ChemImage employs scientists, researchers, software designers, and hardware developers to build integrated solutions for real-world applications.

Product Description

Designed for end user safety, VeroVision Stationary Threat™ ("VeroVision") is a portable wide-area sensor for real-time, standoff detection capability of chemical and explosive materials. VeroVision is the civilian successor of LightGuard, a sensor in use by the U.S. military to screen traffic and locate explosives at military checkpoints.

VeroVision allows users to detect threat materials from up to 20 meters away and does not require reagents or lasers. The product utilizes a Short-Wave Infrared (SWIR) Hyperspectral Imaging wide-area sensor to detect threats at bulk and residue levels, and is designed for situations that demand quick, broad screening.

Product Features

VeroVision is both lightweight and completely portable, allowing first responders to rapidly establish scanning and screening for materials including narcotics, explosives (and precursors), and hazardous chemicals. It can detect these materials of interest—in both bulk and trace—from up to 20 meters away through hyperspectral imaging, and does so without the use of lasers or reagents. VeroVision can be powered by a small portable generator, conventional AC power sources, or an integrated battery pack that provides up to 5 hours of operational time.

VeroVision's sensing capability is powered by a highly agile, tunable liquid crystal that allows the user to modify wavelength filters, resulting in a single instrument that can detect a variety of materials without factory upgrades. In addition to detecting multiple material classes (such as drugs, explosives, and hazardous chemicals), it can detect these materials on surfaces including people, vehicles, and buildings. It also uses advanced algorithms to improve probability and minimize false alarms. Finally, the library of known chemical substances and explosives can be updated as new compound footprints are identified.

VeroVision can be equipped with a customized lens to provide a Dual Field of View (FOV). Optional auxiliary lenses can be used to further tailor the FOV. The sensor head can use auxiliary lighting for low light conditions, and with optional laser finder and GPS modules, VeroVision can be used to provide wide-area and close-up imaging scanning capabilities for any situation.

Product Offering

VeroVision Stationary Threat™ specifications:

Standoff Range: 1-20 meters
Optical System: Integrated dual FOV (dual magnification) lens system
Horizontal Viewing Region at 1 m
Low magnification: 0.45 m
High magnification: 0.22 m
Horizontal Viewing Region at 10 m
Low magnification: 4.1 m
High magnification: 2.0 m

Angular FOV

Low magnification: 24.0°

High magnification: 11.5°

Sensor Head Dimensions: 14.2" L x 7.9" W x 5.5" H

Weight

Sensor head: 8.3 lbs.

Tripod: 5.0 lbs.

Power supply: 5.0 lbs.

Operator display unit: 8 lbs.

Sensor Head Power Requirements: 90-240 VAC, 50/60 Hz, 60 Watts

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

- The device is portable and can be easily transported in standard law enforcement, fire, EMS, and HazMat vehicles
- The integrated system is lightweight (sensor and display unit are 16 total lbs.), allowing for easy deployment
- The display unit provides a full graphical display of the threat area, with positive identification of chemical and explosive threat materials locations precisely identified
- The system provides a standoff distance between the user and threat area of 20 meters
- Explosives and chemicals are visually discriminated as a specific color on a grayscale display image.
- HSI allows for identification of both bulk and trace materials
- Multiple power sources are available, including conventional AC, portable generator, and battery pack (which provides 5 hours of continuous operation)
- The system can be deployed and operated while wearing heavy/winter gloves
- The sensor and its support library are undergoing continuous refinement and enhancements

Likely Weaknesses

- The unit remains in prototype phase and will be very expensive, with an estimated cost of $100,000 to $150,000 per sensor; however, if the sensor is successful in the first responder market, scale will help with pricing challenges
- Set up and calibration of the unit is approximately 30 minutes before deployment
- The standoff distance is currently limited to 20 meters
- The sensor must be mounted to the tripod to maintain stability while scanning the area of interest
- The sensor is limited to stationary targets and cannot scan moving targets
- When not using the battery, the system requires an external power source

Additional Information and Pricing

As a developed military technology making its way into the market, the VeroVision Stationary Threat™ unit is in prototype phase (including current use by NYPD) and expected to enter the market in late 2017, with an estimated cost of **$100,000-150,000/sensor**. ChemImage continues to invest in new research for the VeroVision to ensure it can meet the needs of first responders. Future enhancements to the sensor are focused on reducing the time required for setup and calibration, integrating the capability to detect threat materials on moving targets, and minimizes its current reliance on a stabilization platform to allow the sensor to be handheld. Learn more: http://www.cisensorsystems.com/ciss-products/verovision/

Emerging Research and Direction of Innovation

With current threats in IEDs, the growing threat of chemical and biological weapons, and the chemical and explosive challenges already facing first responders, the military and first responder community need next-generation identification and detection capability. Significant military R&D resources are being put towards these efforts, from methods to lenses to integration. Emerging products will be hardened and portable, and capable of long-range and precise detection, including the ability to update as new compounds and substances are catalogued. The inclusion of machine-learning and Artificial Intelligence into these platforms will only increase their accuracy and power.

Summary

The need for effective chemical and explosive detection will only increase with the further proliferation and advancement of asymmetric warfare tactics. Continuing to exploit the electromagnetic spectrum and its powers of detection will benefit from advances in hardware (such as cameras and sensors), and the inclusion of Artificial Intelligence and computing resources will serve as a force multiplier for detection technologies. These innovations will be supported by both the military and industries of all kinds, positioning first responders to benefit in the form of discrete products and units they can use for mission-specific efforts.

As advanced as sensing technologies and methods become, deployment will continue to be a limiting factor. Identifying a molecular signature via imaging and then translating that into actionable intelligence is a task that cannot be yet achieved in a non-stationary environment. In addition, the complexity of these systems requires careful calibration and appropriate setup, even if the actual unit is relatively easy to use. Finally, there remains a fundamental difference between sensing and scanning, and minimizing the gap between the two will be an ongoing technical challenge for many industries.

Still, the ability for a minimally trained operator to point a simple unit at an unknown material and receive confirmation about its composition is nothing short of transformational. Products like VeroVision, even with their tactical and configuration limitations, provide first responders with capabilities that have never existed, and are only improving (as well as dropping in price). First responders can and should leverage these technologies as budgets permit and needs require, and take comfort knowing sensing and detection capability will not only advance, they'll outpace chemical evolution and the ability of the makers of IEDs to generate new kinds of asymmetric weapons.

PRIORITY #4: Noise Filtering Digital Speaker / Microchip for SCBA Face Piece

Technology Requirement Overview

The ability to effectively communicate is essential for all first responders. This need becomes even more critical when responders are exposed to hazardous environments. The equipment used to protect responders from hazardous environments presents its own unique challenges to effective communications. The positive pressure regulators used to provide a breathable atmosphere inside facemasks produce considerable noise when operating that interferes with voice communications, often making speech difficult to understand. For example, the iconic sound of the "Darth Vader" character in the Star Wars film franchise was created by recording a sound engineer breathing with this type of regulator. Responders who work in environments that are immediately dangerous to life or health (IDLH) require communications systems that are robust, affordable, and able to transmit voice clearly without interference from the self-contained breathing apparatus (SCBA).

Year the Requirement was identified by the IAB

- 2016 – Overall Priority #10
- 2014 – Overall Priority #4

Requirements of the Technology

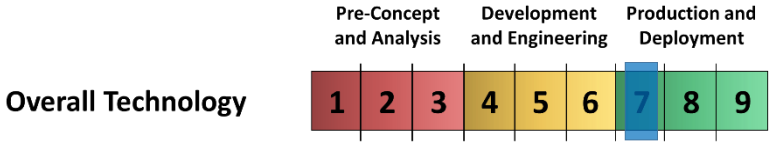
Because first responders require communications while working in high-noise environments and areas that require personal protective equipment and breathing apparatus, SCBA communications systems must:

1. Provide clear and consistent communications quality
2. Filter out breathing noise associated with the use of the SCBA regulator
3. Filter out high decibel background noise from sirens, firefighting apparatus and equipment, and the environment
4. Work without compromising the SCBA mask seal or functionality
5. Operate in high-heat environments
6. Be able to be controlled while wearing heavy personal protective equipment (PPE) and thick gloves
7. Be compatible with common commercially available public safety land mobile radio (LMR) equipment

Targeted End Users

- Fire – Primary
- Hazardous Materials Response Personnel

Radar: Noise Filtering/Microchip for SCBA



Rationale for Radar level

Using the Department of Defense's TRL scale as a reference guide, we assess the overall state of SCBA communications systems at **Level 7**. While not yet widely adopted, the technology exists and is in widespread commercial production to allow for relatively clear voice communications while wearing an SCBA. However, the application of this technology varies among different manufactures, and as a result, the technology is not rated as fully matured.

Assessment Methodology

SCBA communications equipment was assesses as the following constituent functional areas across all manufactures and model.

- **Speaker: A**bility to clearly replicate incoming radio communications as well as voice communications from the user to nearby personnel
- **Microphone:** Ability to transmit voice communications clearly without artifacts caused by breathing apparatus and noisy environments
- **Radio interface**: Reliable link between the communications equipment and the radio, via wired or wireless connection
- **Overall Usability:** Ease of use, fits securely, and the ability to be operated while wearing heavy protective equipment and gloves

Current State of Deployment

Despite the various brand and models of SCBA communications equipment available, SCBA communications systems can be broken down into three broad categories:

Passive Voice Emitters

Passive voice emitters are simple ports, typically on the sides of a facemask, that allow voice communications to more effectively pass through the side of the mask. This is accomplished by placing a small diaphragm to allow sound to pass through the mask without letting outside contaminants into the mask. Direct local communications are accomplished by "yelling through the mask". Likewise, radio communications are normally accomplished through the use of a shoulder microphone, where the wearer tilts his or her head to align the voice emitter to the microphone and yells. Interference from SCBA noise is high, and the voice is muffled by the mask itself. Although the quality of the voice transmissions is low, this system is rugged, and easy to use, and requires no additional cost as it is built in to the mask. This technology is widely used by fire departments across the country, particularly volunteer departments in rural areas.

Amplified Voice Emitters

Amplified voice emitters, as the name suggests, are powered units attached to the outside of the mask voice emitter port that utilize a microphone to pick up sound which is then amplified and played back

through a small speaker. This technology eliminates the need to "yell through the mask". Although this is a vast improvement over passive voice emitters, most amplifiers do not discriminate between voice communication and SCBA regulator sound, and therefore amplify those noises as well, making it difficult to understand the wearer's voice. Similar to the passive voice emitters, the wearer typically tilts the head to "aim" the speaker at a separate shoulder microphone and then speaks into the radio. While having the advantage of amplifying the sound, this system processes the user's voice twice, once through the voice emitter microphone, amplifier, and speaker, and then again through the radio, adding an extra layer of signal degradation. This technology is widely used and, combined with passive emitters, comprises the equipment used by the majority of firefighters in the US.

Integrated Communications Systems

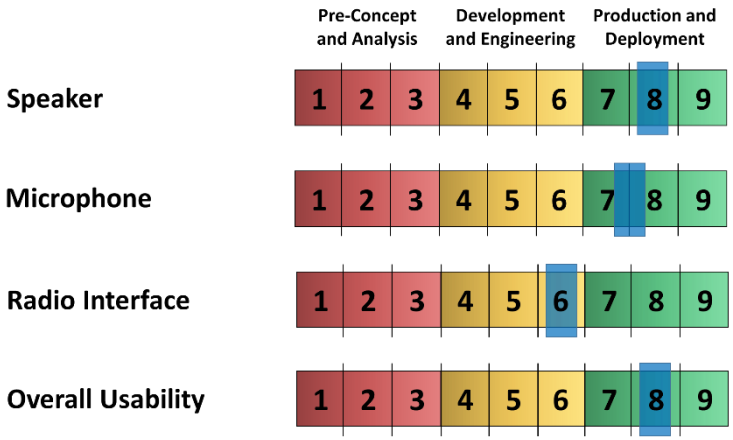
The third general type of communications system is comprised of a microphone and speaker system worn with, attached to, or integrated into the SCBA mask with a connection for a traditional public safety land mobile radio (LMR). These systems can connect to a radio via a wire or wirelessly using Bluetooth. Advanced noise canceling of background noise and the regulator noises from the SCBA can often be found on this type of system. Although products of this type already in the marketplace are capable of providing clear and consistent voice communications free of the majority of background and SCBA interference, the high initial cost of outfitting responders have kept market penetration low among all but the largest and most well-equipped agencies. Another significant barrier to adoption is the responder community's relative unfamiliarity with these new products.

Evaluation of SCBA Communications

Scott Safety, Monroe, NC

Product: Epic 3 Radio Interface (RI) Voice Communication System | SITE: https://www.scottsafety.com/en/us/Pages/ProductDetail.aspx?productdetail=EPIC+3+Radio+Interface+(RI)+Voice+Communication+System

Radar: EPIC 3 Radio Interface



Company Description

Scott Safety, a Tyco business, is a premier manufacturer of innovative respiratory and personal protective equipment and safety devices for firefighters, industrial workers, police squads, militaries, homeland security forces, and rescue teams around the world. With five global manufacturing locations, Scott products protect thousands of individuals each day from environmental hazards including smoke, toxic fumes, combustible gases, falling objects, and contaminants. The Scott product line includes self-contained breathing apparatus (SCBA), supplied air and air-purifying respirators, PPE, gas and flame detection instruments, thermal imaging cameras, and firefighter communications and accountability devices.

Headquartered in Monroe, North Carolina, Scott Safety generates approximately $500 million in revenues annually, employs more than 1,100 people worldwide, and has operations in Asia, Australia, Canada, China, Europe, Latin America, Middle East, New Zealand, and more.

Product Description

Communicate clearly and effectively on the fireground or en route with the EPIC 3 Radio Interface (RI) Voice Communication System. Enhance tactical and non-tactical communications with on-scene personnel, incident command, and remote dispatch. Working closely with first responders around the world, Scott Safety developed the EPIC 3 RI System — voice amplifiers, lapel speaker microphones, specialized accessories, and programming utilities — to meet the demanding conditions on the fireground. Clear, pervasive communication improves first responder safety and enhances situational awareness. Features include high-heat rated construction, Bluetooth® wireless technology, and class-leading two-way field radio interoperability, allowing you to utilize existing radio equipment when used with Scott Safety SCBA, PPE, and communication solutions. Upgrade capabilities and system compatibility with new and existing equipment make the EPIC 3 RI System virtually future-proof to maximize your investment. No other manufacturer provides this level of flexibility and value.

Product Features

- Enhances SCBA face piece voice communication intelligibility and loudness
- Advances safety through easy-to-use wireless communication interoperability with mobile field radios
- Provides easy transition from non-tactical to tactical communication modes
- Ensures operational compatibility with both legacy and new Scott SCBA and PPE
- Consolidates device functionality to reduce technology costs
- Improves user communications from the incident scene to remote locations

Analysis: Likely Strengths and Weaknesses

Likely Strengths

- Connects quickly when programmed correctly
- Clear consistent voice communications quality with little SCBA regulator interference
- Voice communications are fed directly into the radio, eliminating the extra microphone-to-speaker-to-microphone process associated with non-integrated systems

Likely Weaknesses

- Cost
- Perceived as bleeding edge technology

- Programming the wireless connection and pairing has been described as "complicated" and sometimes requires users to access buttons on the front of the radio, which is exceptionally difficult with fire protective gloves on
- Possibility of interference with Bluetooth link between Epic3 and radio in wideband RF environments
- "VIBRALERT" alarm inside Scott SCBA mask interferes with the Epic 3 voice transmissions during low-air alarm.

Additional Information and Pricing

Mask: $300; Epic 3: Approx. $500

Summary

Despite advances in the use of drones and automation, firefighters and hazardous materials response personnel will continue to be needed to enter dangerous environments, requiring the use of SCBAs for the foreseeable future. The ability to clearly communicate both tactically with responders in the immediate vicinity and strategically with personnel via radio remains one of the biggest communications challenges for the responders who operate under these conditions across the nation.

Although commercial "off the shelf" technologies exist today to mitigate these issues, adoption will continue to be hindered by several factors, including inconsistent application of the technology amongst manufacturers, the reluctance to adopt perceived "bleeding edge" technology, reliance on familiar equipment, and most of all, cost.

PRIORITY #5: 3D X-Ray

Technology Requirement Overview

Explosive Ordinance Disposal (EOD) technicians routinely encounter suspicious packages that are required to be evaluated to determine if they contain an Improvised Explosive Device (IED). The most common method of evaluating suspicious packages is the deployment of X-ray technology. Current X-ray technology that provides rapid two-dimensional (2D) imagery has reached maturation and is readily available to the first responder/EOD community. When X-ray technology is leveraged to expose an actual IED contained within a suspicious package, a single plane view that doesn't provide accurate depths of the different components within the package isn't sufficient for an EOD technician to develop a render safe plan for the IED.

Year the Requirement was Identified by the IAB

- 2016 – Technology Priority #1

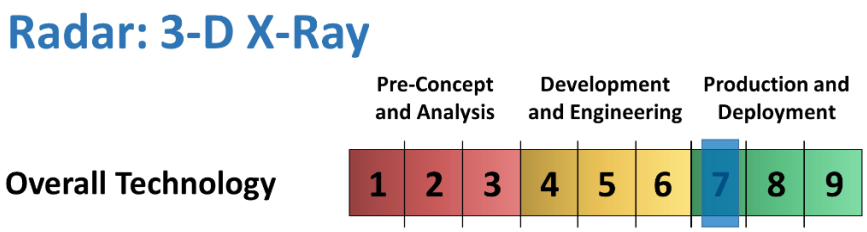
Requirements of the Technology

EOD technicians must be capable of developing render safe procedures for IEDs. In order to do that, gathering as much reconnaissance on a suspected IED is critical. To assist EOD technicians in developing the safest and most appropriate mitigation action on an IED, three-dimensional (3D) X-ray technology must meet the following requirements:

1. Provide high resolution 3D images that allow EOD technicians to determine accurate depths of IED critical components such as power sources, detonators, and electronic circuitry that can be exploited in order to render the IED safe.
2. Allow for identification in real-time and less than 10 minutes
3. Be used from a distance up to 300 meters
4. Must be portable with battery power
5. Must be rapidly deployable
6. Be ruggedized for field use, and able to withstand temperature and humidity changes
7. Must be able to be integrated with existing robotic platforms
8. Must weigh less than 60lbs
9. Compatible with X-Ray Toolkit, a common platform developed by Sandia Labs for EOD technicians

Targeted End Users

- Explosive Ordnance Disposal



Rationale for Radar Level

Using the Department of Defense's TRL scale as a reference guide, we assess the overall state of 3D x-ray generation at **Level 7**. The primary users of 3D X-ray technology will be explosive ordnance disposal responders; with this audience in mind, we considered the overall use of the system—X-ray generator, detector, and software — to determine how well current technology meets the needs of EOD technicians. While the current technology provides some capability to deliver in the field 3D rendered images through software interpretation, the ability to provide a comprehensive 3D image that can be freely manipulated and used to obtain exact measurements throughout the entire device does not currently exists.

Assessment Methodology

In assessing the current state of 3D X-ray technology, an integrated approach is taken that focuses on the different components of an integrated system that are required to generate X-ray images. The assessment focuses on existing vendors and labs that are providing comprehensive high-resolution 2D X-ray capabilities in the field, while introducing software that integrates multiple single plane captures to articulate a pseudo 3D image.

At an individual vendor level, hardware, usability, extensibility, price, and strengths/weaknesses are all evaluated.

We assessed technologies on the following component levels:

- **Hardware (X-Ray Generator):** The physical unit that generates x-rays must be portable, lightweight, self-powered, easy to use, and rapidly deployed.
- **Hardware (Detector):** The image plate or flat panel detectors that is used to measure different properties of x-ray in order to render a high-resolution digital image of the target.
- **Software:** The user interface and display of x-ray images which allows for manipulation, material discrimination, and 3D imagery.

Current State of Deployment

3D X-ray technology is currently fully evolved and is widely used in the industrial and medical fields. Most 3D X-ray technology currently deployed is based on computed tomography (CT). CT imaging devices take cross sectional images during a complete scan of the target and then use software to reformat the multiple images in multiple planes in order to render a 3D image of the desired object. In the medical field, these devices are used to assist doctors in diagnosing medical ailments, and have become very popular in dentistry. These systems rely on a rotating generator and detector around the target in order to conduct a complete and comprehensive scan. Industrial applications include CT technology for major pipelines inspections, and quality assurance and inspection of munitions and explosive ordnance during the manufacturing process, as well as quality control of purchased firearms, ammunitions, and explosives. These devices are expensive and very large, often requiring dedicated rooms, and do not lend themselves to being deployable to the field.

Traditional image capturing systems today deployed by EOD personnel rely on X-ray technology. EOD technicians manually deploy an X-ray generator in front of the target, along with a detector or image plate behind the suspected device. For suspected devices that indicate the potential for an IED, a robotic platform may be used to safely place the generator and detector in place. The generator and detector communicate to a laptop with proprietary software via a wireless connection or through a cable (Ethernet or fiber optic). While all vendors interviewed during the investigation of the technology had proprietary

software, a significant number of EOD technicians rely on X-Ray Toolkit, developed by Sandia National Laboratory, as their primary software interface with the hardware. All initially reviewed X-ray hardware systems indicated they were compatible with the X-Ray Toolkit.

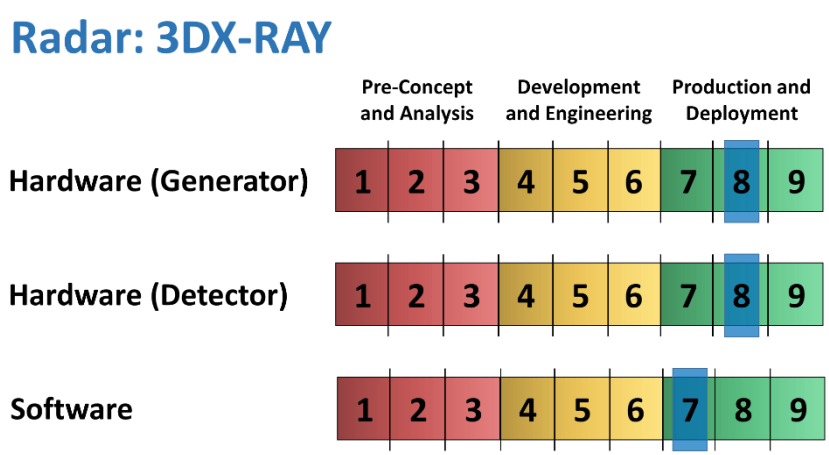
Through the desired software platform, images are initiated, captured, and communicated back to the laptop. Software allows the image to be viewed in a grayscale radiograph, or as a colored image that allows for material discrimination. Software applications also allow measurements to be taken which aid EOD technicians with identification, as well as help to plan for render safe procedures. When multiple single plane images are taken on different planes, primarily to A to C and B to D, software allows for a 3D rendering that can be used to help visualize and inspect the contents in the suspected device. Similar capabilities are used for orthoimagery when four oblique images are taken from four complementary directions. Software is able to analyze the image to interpolate heights and render highly accurate 3D models. In addition, some software applications allow for the interpretation of a 3D emboss image, which provides a more complete image of the target with 3D application.

Through reviewing literature, scientific approaches, engaging companies and technicians, there is consistency in approach that allows EOD technicians to take multiple plane views of a specified target while allowing the software to interpolate and combine the images to generate a 3D image that will help the EOD technician exploit and render safe an observed IED.

Evaluation of 3D X-Ray Technology on the Market

3DX-Ray, Loughborough, Leicestershire, UK

PRODUCT: *ThreatScan®-LS1* | SITE: http://www.3dx-ray.com/products/security/threatscan-ls1



Company Description

3DX-Ray Ltd is a global market and technology leader in line-scan X-ray imaging systems for security and industrial applications. Founded in 1996, 3DX-Ray is based out of England, and is a wholly owned subsidiary of Image Scan Holdings plc.

3DX-Ray security imaging systems offer a full complement of capabilities to include portable systems for first responders, mail screening systems, conveyor system, and full vehicle screenings systems.

Product Description

The ThreatScan®-LS1 is a powerful large format x-ray scanning system. The large imaging area of the ThreatScan®-LS1 enables typical bags and packages to be scanned in a single scan. The generator is capable of penetrating up to 34mm steel at 120kV, which allows for the production of a high quality, sub-millimeter resolution image.

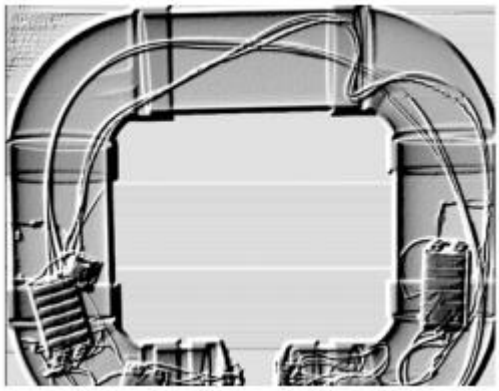
Product Features

- High penetration with sub-millimeter resolution
- Large area, thin detector panel
- Real-time images
- Designed for rapid deployment and ease of use
- Powerful image enhancement and analysis tools
- Intuitive, user-friendly ThreatSpect software
- A large, resilient detector panel
- A portable and robust X-ray generator
- A laptop imaging station
- Batteries and chargers
- Wireless communication
- Carry cases

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

- The device is portable and can be easily transported in standard law enforcement vehicles
- The integrated system is lightweight (sensor and display unit are 11 total lbs. each), allowing for easy deployment



- Multi-featured software with adjustable X-ray source parameters; standard, false color, or inverted imaging options; on-screen measurements; materials discrimination and 3D embossing; multi-file format capability; can be tablet or laptop based
- Wireless or wired network capability
- Quick image acquisition (6 seconds)
- Up to 2 hour charge for x-ray generator
- The Image Panel is less than 1 inch thick which will allow it to be placed behind suspected packages with minimal separation from a vertical barrier
- Software provides a 3D Emboss image that provides a pseudo 3D image of the targeted device

Likely Weaknesses

- The resulting imagery is not as comprehensive as computed tomography (CT) imagery
- Limited to stereoscopic 3D screen images and not a complete 3D image
- Multiple planer views are required to capture a 3D image

Smart Imaging Systems, Beltsville, MD

PRODUCT: *MXR – Modular X-Ray Robotic Scanner*

SITE: http://www.smartimagingsystems.com/aaa-products-mxr-modular-x-ray.html

Company Description

Smart Imaging Systems is a company consisting of scientists and engineers with decades of experience at NASA in developing ultra-miniature, ultra-sensitive, high performance radiation detectors and electronic systems. The company collaborated with DHS Science and Technology to develop a robotic scanner that focuses on Left Behind Incendiary Explosive Devices.

Product Description

The MXR was designed to fill a gap between large mounted X-ray scanning systems and small handheld portable systems. The MXR provides a complete 3D, multi-view picture of the entire object being scanned in real time. The MXR is available on its own robotic platform, or can be integrated with existing robotic platforms currently deployed in the EOD community. The MXR uses scanner that uses a fan-shaped operating x-ray beam that allows for greater penetration of the intended target. The MXR is also able to provide a user with precision 3D coordinates that mark the exact location of an explosive device within a suspicious package. Development of the MXR was partially funded by DHS S&T, and was featured at the Urban Operational Experimentation in July 2015, hosted by NUSTL.

Product Features

- Ultra compact detector arms and electronics
- Optimized detectors for high efficiency
- Miniaturization of all electrical components
- Modular system that can be mounted to virtually any mid-sized robot
- Provides a real time image display
- Scans a typical sized suitcase in 5 seconds
- Uses a remote Wi-Fi to communicate to the software

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

- The device is portable and can be easily transported in standard law enforcement vehicles
- Unit can be deployed on its own robotic platform
- Includes proprietary software but can also be used with X-Ray Toolkit
- Wireless or wired network capability
- Quick image acquisition (5 seconds)
- The fan shaped X-ray generating beam allows for greater penetration
- Platform can be integrated onto other robotic platforms
- Image generated includes full 3D coordinates that allows users to determine accurate measurements throughout the target.

Likely Weaknesses

- The resulting imagery is not as comprehensive as computed tomography (CT) imagery
- Battery is limited to 30 minutes operational time on the generator
- Multiple planer views are required to capture

Additional Information and Pricing

The MXR platform can be purchased in two different configurations. The x-ray equipment, along with its own robotic platform, is priced at approximately $250,000. A separate version called the RXTK with just the X-ray generator, detector, and software is available at approximately $120,000. This project is no longer being funded by DHS S&T and there are currently no versions of the MXR deployed in the United States. Future upgrades to the software will allow true material discrimination.

Summary

3D X-Ray capability is currently available in limited capacity with existing X-ray platforms, and is reliant on taking multiple single plane images to generate a stereoscopic 3D image. The XMR with its dual beamed X-ray generator is promising with its capability to collect actual coordinates of items contained within a package, but as of yet, it has not been able to generate a full 3D image.

PRIORITY #6: Inexpensive, Portable, Ruggedized Point-of-Care Lab Testing Device

Technology Requirement Overview

Point-of-care testing, or POCT, is testing completed outside of the traditional lab environment, at or near the patient's side. For all patients, POCT potentially reduces the time needed for lab results and leads to faster diagnoses and treatment decisions; for emergency patients or those in a disaster area, the benefits of POCT can reduce mortality and morbidity. The National Institute of Health's National Center for Biotechnology Information defines the disaster-emergency-critical care continuum as a process that begins with the identification of at-risk patients in a disaster environment, and those patients' subsequent stabilization and transfer to a hospital or alternative care facility (ACF). The absence of critical medical testing technology in those transition events contributes to excess mortality and morbidity, making clear the need for ruggedized, user-friendly, extensible, and reliable POCT technology for all first responders.

Year the Requirement was Identified by the IAB

- 2016 – Priority #7
- 2015 – Priority #22

Requirements of the Technology

To fully satisfy the intense needs of first responders, field-based point-of-care testing systems must be:

1. Easily operated, maintained, calibrated, and customized or adjusted for patient use;
2. Capable of performing a wide range of blood tests with high sensitivity;
3. Compliant with Clinical Laboratory Improvement Amendment (CLIA) of 1988 standards;
4. Portable or nearly hand-held, with battery life of at least 8 hours for field operations; and
5. Ruggedized for outdoor use to both withstand temperatures up to 100 degrees and resist damage from drops and transport

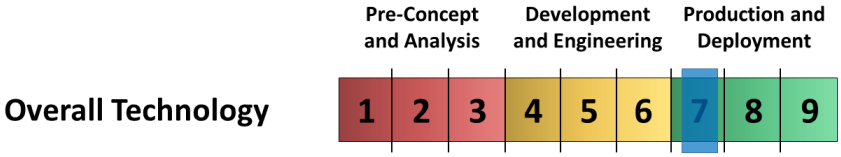
Targeted End Users

- EMS – Primary
- Fire
- Hazardous Materials Response
- Emergency Management

Summary of the Radar and Radar Purpose

The assessment takes a "at a glance" view of the overall technology and is intended to serve as a guide for evaluation of the vendor/landscape technology. The "subradar" is a more detailed assessment of individual technologies, a reflection of both the whole and constituent elements of the technology, and the vendor's maturation of each element.

Radar: Point-of-Care Testing (POCT)



Rationale for Radar Level

Using the Department of Defense's TRL scale as a reference guide, we assess the overall state of point-of-care testing or POCT systems at **Level 7**. Several prominent portable and handheld solutions are currently in the market, and these products continue to evolve in portability and sophistication, driven by industry trends away from primary care clinics. First responders looking for more ruggedized solutions will soon benefit from these trends; technology helps both doctors and patients obtain faster test results, resulting in proven increased patient satisfaction, better health outcomes, and decreased overall costs. Innovations in microfluidics, sensors, analytics, mobile technology, and micro-manufacturing will all enable improvements and price reductions. Because the medical community's POCT needs are generally for less-demanding environments (like bedside), no current technology meets the price, usability, and durability needs of the first responder community; this status is reflected in our rating.

Assessment Methodology

As an advanced technology, POCT systems were evaluated by considering first responder use in high-intensity, high-stress environments like disasters. While there is some market consensus in point-of-care methods – i.e., the evaluation of a patient's BGEM (blood gases, electrolytes, and metabolites) or pathogen detection for rapid early diagnosis – the means to conduct these tests vary by company. Differing technical approaches in products were also considered. At an individual company level, the vendor's approach, hardware/software, usability, extensibility, price, and strengths/weaknesses are all evaluated.

Current State of Deployment

Despite considerable uncertainty in the current state of healthcare, the evolution of medical devices and their underlying technology for POCT is accelerating, driven largely by pressure on physicians and medical professionals to improve outcomes through better efficiency, accessibility, accuracy, and flexibility in their care. Additionally, a 2013 World Health Organization study predicts a global shortfall of nearly 13 million healthcare workers by 2035. As the skilled workforce decreases, intuitive and non-invasive tests that can be operated by less skilled personnel (as well as patients) will be essential to maintain quality of care. Leading technology companies continue to invest heavily in mobile healthcare and sensing applications to leverage smartphones. Collectively, these trends suggest POCT is positioned to experience rapid innovation, particularly in those factors – ruggedness, portability, rapidity of testing, and ease of use – needed most by first responders.

The regulatory environment is relevant in this assessment. One of the IAB's key requirements for POCT is compliance with the Centers for Medicare & Medicaid Services' (CMS) Clinical Laboratory Improvement Amendments (CLIA). Because laboratory and blood testing places providers and patients at risk, even in clinical environments, CLIA ensures safety and accuracy standards for all patient body fluid testing by regulating both the manufacturers and users of laboratory testing devices. Additionally, any new lab

device must also be submitted to the Food and Drug Administration (FDA) for categorization. This classification of devices is relevant to the entire first responder community because devices not intended to assist in the diagnosis, prevention, or treatment of a disease do not require FDA approval (such lactate meters used by athletic trainers), and thus may be appropriate for first responder use.

It is worth noting that while the IAB identified CLIA compliance as a requirement, the first responder community might benefit most initially from devices and tests that are instead CLIA-waived, though a point-of-care coordinator would be highly recommended to ensure proper technique, training, and practice. For more information on devices and tests that may be available to first responders, IAB may want to visit http://www.cliawaived.com/

Just as in clinical labs, the standard methodology in POCT is testing the patient's blood for markers and indicators of a current or emerging condition. These tests are commonly referred to as Blood Gas, Electrolytes, and Metabolites, or BGEM. Examples include identification of high potassium as a precursor to cardiac arrest, recognizing elevated troponin levels as a condition of a myocardial infarction (heart attack), or diagnosing possible septic shock or infection by measuring lactate levels. Current POCT blood testing devices can measure a wide range of potential markers, and it is up to providers to not only read the results, but also appreciate and act on their context and significance. Current POCT focuses on comprehensive blood/blood gas analysis, aiming to identify and measure the following:

- Electrolytes (Sodium, Potassium, Chlorine, Calcium)
- Carbon dioxide
- Glucose
- Creatinine
- Urea Nitrogen
- Hematocrit and Hemoglobin
- Troponin
- Lactate

The use of lactate levels is widely regarded as a standard of POCT testing. Increased lactate indicates anaerobic metabolism, which can be triggered by an infection (sepsis), trauma, shock, or certain types of seizures. A high lactate level following major trauma is a reliable predictor of ICU admission and injury; however, it is also present in athletes after a lengthy run, which means lactate should be considered in context to the patient's condition to assess injury. Lactate is an important market for first responders because several lactate-measuring devices are CLIA-waived, meaning they may be readily available for IAB use.

The current form factor for BGEM POCT devices is analyte-containing cartridges or cards into which small blood samples are inserted; these cartridges or cards are then inserted into handheld or tabletop readers. Leading devices deliver results in anywhere from 30 to 120 seconds. Depending on the manufacturer, different cartridges can be used for different tests, while more sophisticated (and expensive) platforms can perform multiple tests from the same insert.

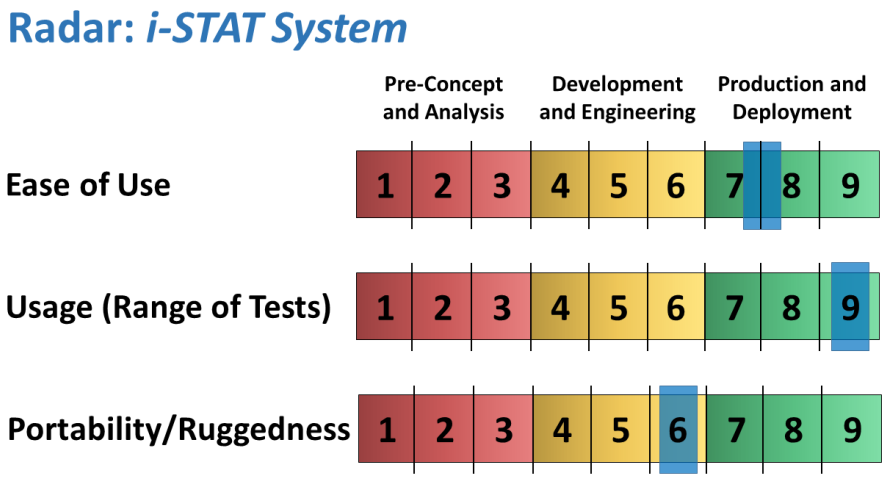
Evaluation of Point-of-Care Testing Technology on the Market

The broad and increasing need for compact POCT throughout healthcare means leading device manufacturers have well-established and mature market offerings. With the primary POCT audience being non-hospital clinical users, and CLIA considerations for tests of increasing complexity, no

manufacturer currently promotes their device as ready for emergency/disaster use. We have chosen to highlight companies that serve as clear leaders and innovators in POCT development.

Abbott Laboratories, Abbott Park, IL

PRODUCT: *i-STAT System* | SITE: https://www.pointofcare.abbott/us/en/offerings/istat



Company Description

Abbott develops on breakthrough products in diagnostics, medical devices, nutrition, and branded generic pharmaceuticals. Founded more than 125 years ago, Abbott has more than 94,000 employees globally, and serves more than 150 countries. Targeted focus and growth areas include nutrition, vascular care, and diabetes. Abbott is the global market leader in blood screening, immunoassay diagnostics, and adult and pediatric nutrition.

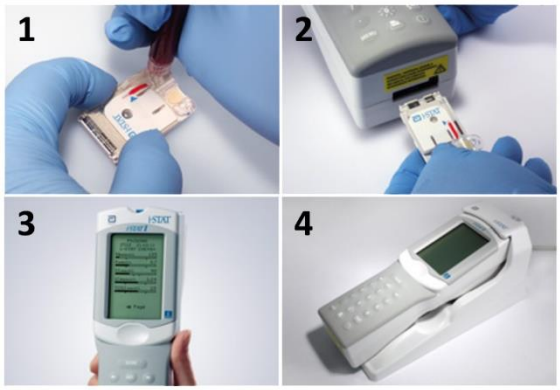
Product Description

Abbott's *i-STAT System* is an end-to-end integrated platform, consisting of a handheld analyzer, a wide array of test cartridges, and software to integrate the data into any point-of-care system. The system relies on nearly 20 separate specialized cartridges for different tests; each cartridge needs only 2-3 drops of blood to conduct the analysis. Once the cartridge is loaded into the handheld, results are available in under 2 minutes, and can be imported through a base or wirelessly into the point-of-care data management system.

Product Features

The i-STAT handheld operates in conjunction with i-STAT test cartridges to perform diagnostic tests, and then transmits test data either directly or through an optional downloader into a designated and configured point-of-care data environment. The process is straightforward: 2-3 drops of blood are loaded

into the cartridge, the cartridge is closed and inserted into the handheld for analysis, the results are viewed, and the results are then transmitted. The system can also include a portable printer.



i-STAT Cartridges

The handheld analyzer is approximately 7.5 inches wide, 24 inches long, and 7.2 inches deep. It can use either rechargeable or disposable batteries, and has a liquid crystal display. It also has a laser scanner feature that allows the operator to easily configure the handheld for the patient data (such as operator ID, patient ID, test type, patient temperature, and verification information); this data can also be entered manually. The handheld analyzer can be manually configured for different test situations.

Test cartridges contain subassemblies and features to simulate complex lab environments. Microfabricated thin film electrodes or sensors are built into the cartridges, which can also contain calibrant solutions (for blood gases and electrolytes), analysis solutions, reagents for coagulation tests, waste chambers, miniaturized sensors, conductive pads for the analyzer, and heating elements to thermally control the test sample. Cartridges are sealed for protection, and labeled for easy use and identification.

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

- The i-STAT is a clear leader in test range and breadth of platform, offering test cartridges for lactate, hematology, chemistries and electrolytes, cardiac markers, coagulation, and endocrinology.
- The handheld is lightweight, can be configured manually, and has clear and powerful features to ensure veracity and continuity of patient care, including bar scanner for test cartridges, patient IDs, and in-system memory for tracking.
- From handheld design to cartridge insertion to analysis and integration with printer or data system, the system is designed to facilitate easy user engagement.
- Test cartridges are widely available from distributors and available for bulk purchase.
- The i-STAT software is designed as an add-on component that complements existing records and clinical software.
- First responders could work quickly and accurately through the Dispensing Tip, and element that aligns with cartridge ports to allow rapid loading of the test cartridge.

Likely Weaknesses

- The i-STAT must be in an operational environment of 16-30°C (61-86°F) to ensure correct testing parameters; this may be well below some first responder operating conditions.
- All cartridges must be stored within normal temperature ranges, with some cartridges requiring possible refrigeration to ensure test stability, safety, and accuracy.
- While the analyzer is handheld, this is feature is more for close mobility rather than serving as an "external lab," making the system less than ideal for many rapid incident response situations.

- While certain test cartridges fall well within the IAB's desired $500 range/test, the high cost and less-than-rugged nature of the handheld analyzer limits the reach and use in incident response.
- User interfaces are largely text-based, monochromatic, and technical, potentially limiting ease-of-use in less skilled operators

Product Offering and Pricing

The system is available from major device distributors for either rental or purchase. The prices below reflect ranges encountered across various channels.

i-STAT Handheld Analyzer

Price: $6,500 - $8,000
Learn more: https://www.pointofcare.abbott/us/en/offerings/istat

i-STAT Test Cartridges

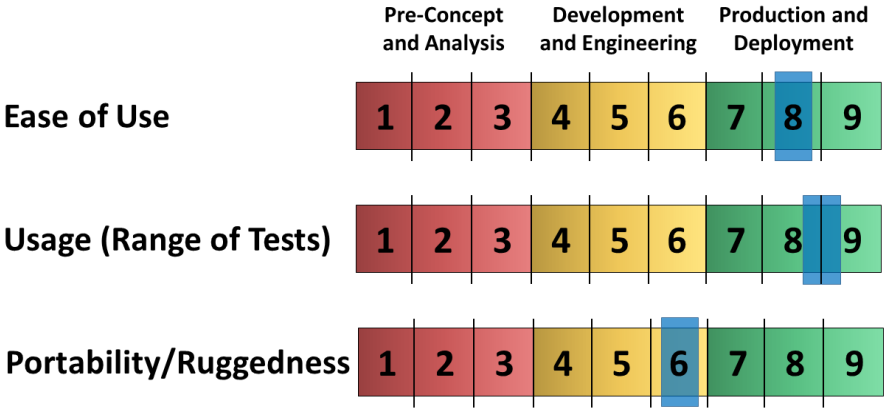
Price: $300 - $1,300 / 25 cartridges, depending on test
Learn more: https://www.pointofcare.abbott/us/en/offerings/istat/istat-test-cartridges

Alere, Waltham, MA

PRODUCT: ***epoc® Blood Analysis System***

Site: http://www.alere.com/en/home/product-details/epoc-blood-analysis-system-test-card.html

Radar: epoc® Blood Analysis System



Company Description

Founded in 2001, Alere is a NYSE-traded world leader in rapid point-of-care diagnostics, with focus on cardio metabolic disease, infectious disease, and toxicology. In 2015, Alere produced and delivered more than one billion tests to healthcare professionals and patients around the world; the company's product suites are built around delivering data to the right person at the time it is most needed. The company is a recognized innovator and leader in developing testing solutions, and has secured Federal contracts (HHS, others) for tests ranging from TB and HIV to molecular influenza to drug testing for transportation-regulated employees.

Product Description

The epoc® Blood Analysis System is an integrated point-of-care technology for measuring blood gas, electrolytes, and metabolites (BGEM). The technology includes a test card (the epoc® BGEM Test Card), a handheld computer (the Host[2] Mobile Computer), a Reader base, and an Enterprise Data Management Software suite for access to other care systems. The BGEM Test Card is a fully enclosed, single-use, and self-calibrating analyte environment for direct measurement of up to 11 parameters, and calculation of an additional 10 parameters. The Test Card can be stored at room temperature and requires only a small sample of whole blood, with initial measurements being made available within 30 seconds of inserting the Test Card into the Reader.

Product Features

- The epoc® ("enterprise point-of-care") system relies on a single-use, self-calibrated test card that is inserted into a reader/analyzer; test results are then passed into the Host2 software, which integrates with the provider's system.
- The Reader measures roughly 8.5 inches by 3.35 inches, and at a height of 2 inches, is less than 1.2 lbs. in weight. It has a 3.5" LCD touch screen interface, is fully portable, and can be powered by AC/rechargeable battery (for up to 5 hours of use or 40-90 tests). It also has an auto-scanning feature for simplified quality compliance and verification.
- The epoc® Blood Gas, Electrolyte, and Metabolite ("BGEM") Test Card is a single-use, self-calibrated card with a full menu of tests on a single platform. It can be stored at room temperature for up 6 months with no refrigeration, and is barcoded for tracking and validation. It requires only a 92-µL blood sample, can both measure directly and calculate parameters, and is designed for scale and cost demands.
- Once the test card is loaded into the reader, the epoc® Host^2 connects wirelessly and delivers results in 3 minutes. The software is customizable and can be configured to work with existing client data tools.

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

- Light and compact form factor allows for portability, and the combination of both keyed and touchscreen interface provide flexibility to ensure usability and accuracy.
- The Reader is both the analysis and base, which means the handheld unit (displaying results) can be moved and shared with other clinicians or responders without compromising or touching the test card within the base analysis unit, resulting in excellent communication in real environments.
- The test card is an entire self-contained platform for all available tests, requiring no refrigeration and operating at normal temperatures, and coded to ensure accurate tracking.
- Robust documentation library with ample screenshots, wide knowledge library, and easy-to-use interfaces make learning the system easy for users of all aptitudes and experience.
- User interfaces are bright and intuitive with clear icons and menus for operation, potentially providing better adoption.
- Unit can use cellular networks to send information.

Likely Weaknesses

- In the field, the need for the handheld unit and the base reader to be stable and connected may limit true mobility between patients and tests.
- The single-platform test card covers the basic/most popular tests, but may limit specialized tests in certain uses.
- The unit's reliance on wireless or cellular communications for data sharing may limit effectiveness in environments or situations where networks are compromised or not operational.

Product Offering and Pricing

The system is available from major device distributors for either rental or purchase. The prices below reflect ranges encountered across various channels.

epoc Point-Of-Care Blood Analysis System

Price: $12,500

epoc BGEM Test Cards

Price: $925 for 50 cards

Related Technologies

A notable and promising entrant to the POCT market is i-calQ, developers of one of the first smartphone-based point-of-care integrated mobile diagnosis and decision support systems. The system performs several diagnostic tests in minutes, and then employs rules-based decision trees to interpret the results and inform responders and clinicians. The technology uses a smartphone or tablet, the point-of-care test reading biosensor, a disposable diagnostic test cassette for blood or saliva, and an integrated mobile application to read and interpret tests. The i-calQ solution is a patented and mobile technology, with the biosensor weighing 52 grams, made of shatterproof and waterproof plastic, and using the phone or tablet's camera to eliminate any moving parts or power source. Results can be wirelessly printed, sent securely via SMS or email, or uploaded into an encrypted cloud environment. Currently, the i-calQ platform is very limited, offering only tests for thyroid-stimulating hormone (TSH), cortisol, and hemoglobin; these are available for under $10 per test. Nevertheless, the approach and platform illustrate a promising path for development as new tests and sensors emerge.

Emerging Research and Direction of Innovation

Point-of-care testing (POCT) has rapidly become a mature market; analysts place the global POCT market at $25+ billion, with major corporations like Abbott, Roche, Siemens, Johnson & Johnson, Alere, and Nova Biomedical all developing technologies and devices. However, like many emerging technologies, POCT is limited by the complex dynamics of technology, regulatory environments, user adoption, and healthcare market shifts. Despite being one of the most active segments within the diagnostic industry, the technological capabilities currently far exceed the rate of POCT adoption.

The ability to provide better and more convenient care, reduce costs, along with demands to leverage technology to reform healthcare, improve patient experience and outcomes, manage the increasing prevalence of infectious disease, support the rise of lifestyle diseases (such as cardiac and diabetes), address skilled lab shortages, and leverage home- or mobile-based devices are all POCT market drivers that show no sign of abating. Even with these positive market pressures, approach and segment fragmentation (with tests ranging from glucose monitoring to urinalysis to multi-assays) slow the pace of

innovation, as does the regulatory environment, though considerable precedent exists for CLIA-waived technologies and labs. Most notably, it is patients and their reluctance to change existing treatment practices – a measurement of trust involving their care provider versus a device – that serves as a key factor hampering the growth of the market.

As healthcare delivery paradigms continue to change and physician and clinician trust in POCT increases, better technologies and platforms will emerge and it's reasonable to assume the IAB and the first responder community will soon see the development of truly portable (and potentially hardened) technology, though it may still be cost-prohibitive to leverage at scale.

PRIORITY #7: Improved Microclimate Cooling System for Down Range Unit

Technology Requirement Overview

Heat-related injury is an ever-present risk across the first responder community. First responders' environments are defined by extremes: the combination of conditions, equipment, gear, and stress make heat a constant threat to first responder health. Cooling technologies exist in numerous forms, and all versions should: (a) first and foremost, maintain a safe body core temperature at acceptable levels, (b) perform without issue under heavy protective equipment—such as PPE or bomb suits—for short to medium durations without a break, (c) be lightweight, (d) operate in a manner to minimize perspiration so as not to compromise forensic operations, and (e) be easy to deploy, charge/recharge, and adjust.

Year the Requirement was Identified by the IAB

- 2016: Priority #12
- 2015: Priority #22
- 2014: Priority #20

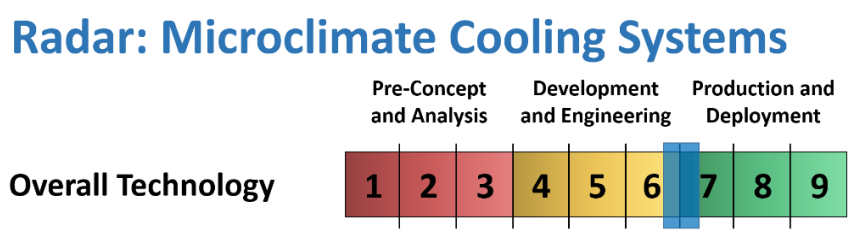
Requirements of the Technology

Cooling microclimate technology requirements will differ depending on the first responder and the nature of the work, but any technology must:

1. Operate without or with minimal power with little notice
2. Ensure torso area is acceptably cool for at least 30 minutes
3. Promote user safety and ease of use by being disposable or simply cleaned

Targeted End Users

- Fire
- Law Enforcement
- EMS
- Emergency Management
- Hazardous Materials Response



Rationale for Radar Level

Using the Department of Defense's TRL scale as a reference guide, we assess the overall state of microclimate cooling systems at **Level 6.5**. The users of these systems range from fire to HazMat responders, and our assessment is based on current technologies' ability to address shared needs (such as power, mobility, and cooling duration) across stakeholders. Innovations in areas like phase change materials make these technologies much more adaptable, but potentially pose risks. As a result, no technology will effectively satisfy the broad needs of the responder community, and our rating reflects that position.

Assessment Methodology

The focus is ultimately on situational use and deployment by first responders. As a complex physical process, cooling can be achieved through several means, and those methodologies and uses are reflected in the diverse products and technologies available, even within those technologies marketed directly towards the first responder community. Additionally, because these technologies all include a garment of some kind, they are a core part of the first responder's critical gear, and thus weight and ease of use must also be considered. Our assessment methodology acknowledges different cooling approaches may be appropriate for different response situations, and these approaches may change as technology evolves.

At an individual company level, the vendor's approach, hardware/software, usability, extensibility, price, and strengths/weaknesses are all evaluated.

Current State of Deployment

With the ever-present risk of heat-related injury, there is no shortage of cooling products, services, and approaches targeted directly to emergency responders and related personnel. These products are mature technologies and readily available, but innovation in certain approaches is ongoing. One area of consensus is the vest-like garment plus a cooling material: products are delivered through a vest- or open-garment system, allowing cooling of core torso and neck area, range of movement, and heat dissipation from normal areas like underarms.

It is helpful to highlight differing cooling systems. Cooling technology can be broken down into two types: active and passive. Active systems require power (electricity or battery) to operate and can provide continuous maximum cooling over an extended period. As a result, they are very portable and tend to be more expensive systems. Passive vests have no moving components, are easily transported, and are generally cheaper, but their cooling power is short-term compared to active systems.

In both active and passive cooling systems, cooling can take several forms:

Evaporative: Evaporative cooling occurs when water vapor or perspiration (via evaporation) absorbs heat and lowers the surrounding air temperature. It is the most common cooling approach because it is a normal physical transition that can be initiated or accelerated through passive, low-cost means. Concerns generally involve sanitation. Evaporative cooling products on the market include garments that must be soaked in water before use, garments filled with water or gel that must be chilled before use, or garments with pockets where ice or gel packs must be inserted before use.

Phase change: Phase change materials (PCMs) are engineered products that freeze at much higher temperatures than water (32°F), allowing them to remain frozen at normal and elevated temperatures. PCMs operate via an evaporative cooling process, and their high freezing temperature allows them to be re-frozen in a refrigerator or very cold water. It should be noted that once PCMs melt, they can work against the user by serving as an insulator

Circulation: Circulation is an active system, relying on moving cold water or material to absorb heat from the wearer and provide continuous cooling. Circulation requires power for an operational pump or driver system (which can be complemented by microchannel technology)

In reviewing literature, speaking with companies, and evaluating emerging technology, it is clear there is no consensus on the most effective approach; there are strengths and weaknesses across the product spectrum, and factors like situational use and price are as relevant as effectiveness.

Specialized environments (such as cooled or refrigerated trailers for firefighters) were not considered in this assessment because of the down-range requirement.

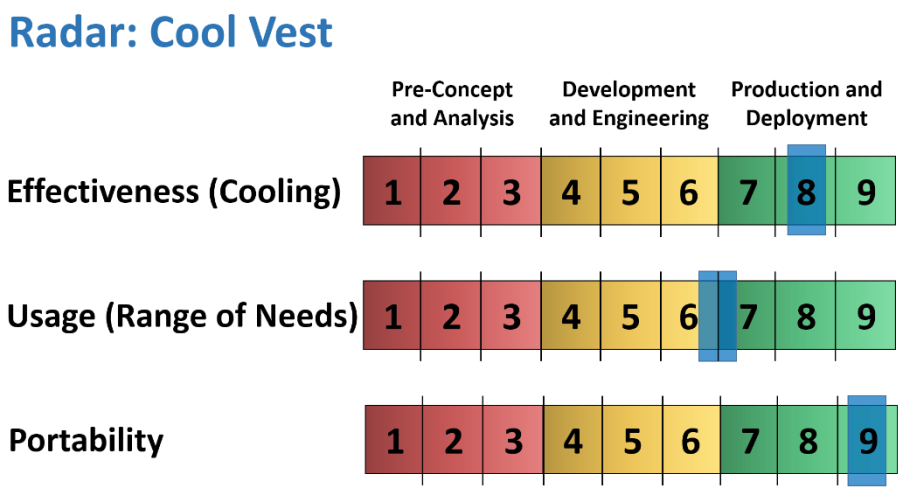
Evaluation of Microclimate Cooling Technology on the Market

Because the benefits of cooling systems extend beyond first responders to the health of the general public (particularly those with nervous system diseases), the marketplace is robust and mature. In particular, a number of companies offer products designated as military- or law enforcement-grade, and they compete primarily on approach.

While these companies market their varying approaches as superior (and actively highlight perceived weaknesses in competitors' strategies), discussions with the companies suggest situational use should be a primary factor for evaluation. Accordingly, we have chosen to highlight companies that are leaders in differing situational uses.

Glacier Tek, Plymouth, MN

PRODUCT: *Cool Vest* | SITE: http://www.coolvest.com



Company Description

Glacier Tek manufactures a wide range of cooling vests featuring bio-based phase change material designed to absorb human and canine wearer-generated heat. Glacier Tek offered one of the earliest completely self-contained body cooling vests in the market, now sold in over a dozen countries under numerous brand names.

Glacier Tek's parent company, Entropy Solutions (http://www.puretemp.com/), has been engineering 100% renewable phase change materials (PCMs) since 2007. Originally developed by the U.S. Department

of Agriculture, Entropy's PureTemp PCMs are U.S.-based and produced, and used in temperature-controlled applications ranging from cooling vests to warming blankets to packaging.

Product Description

Glacier Tek's Cool Vest offering consists of its proprietary PCM (contained in switchable packs) inserted into a wide variety of garment and vests, including concealable, disposable, and specifically built for use under body armor. In all configurations, the Glacier Tek solution weighs approximately 4 lbs. and maintains a comfortable 59°F/15°C for the user (including K-9 and children) for several hours.

Product Features

Glacier Tek's PCM (GlacierPack) is derived from animal fats and plant oils, making it the first of its kind to be 100% renewable. The PCM is biodegradable and non-toxic, making it harmless to wearers in the event of pack rupture. It is engineered to maintain more than 200 different transition temperatures, and freezes solid at any temperature less than 59°F/15°C, which means it can be frozen and re-frozen using refrigeration, ice water, or even very cold water.

Performance-wise, once frozen, the PCM helps wearers maintain 59°F/15°C temperature for 2.5 hours in any temperature up to 100°F/38°C. In an already-cooled environment, the PCM can maintain its temperature for an entire day. The PCM packs will completely freeze in ice water (within 20 minutes), in a normal freezer (within 60 minutes), or in a normal refrigerator (within a few hours to overnight). Glacier Tek maintains it has tested packs by recharging 10,000 times with no measurable change in performance. **In extreme conditions such as blazing fire, it should be noted that once any PCM melts, it can instead act as an insulator, potentially having an adverse effect on the user**.

All garments and PCM materials are manufactured here in the U.S.; garments are machine-washable and the PCM packs consist of a proprietary full barrier film for easy cleaning, disinfecting, and sterilization. A fully charged and loaded vest weighs approximately 4 lbs., and the company maintains switching to a charged (frozen) pack can be done quickly and easily with little practice.

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

- While phase change material (PCM) is specialized technology, cooling it to its freezing point (59°F/15°C) does not require any additional processes or equipment
- There is no power source or moving parts, eliminating maintenance and risk of product failure
- The packs can be frozen in iced or chilled water, which is readily available
- At 4lbs., the solution is imminently portable, and Glacier Tek reports PCM pack switching (to a new frozen pack) can be done in less than 90 seconds with minimal practice
- With the PCM in a contained pack, the wearer benefits from evaporative cooling without any of the sanitary risk associated with wet garments
- Garments may be washed in normal cycles and PCM packs can be easily cleaned and sterilized, allowing use and re-use by multiple users
- Glacier Tek's proprietary PCM is non-toxic, keeping wearers safe even in the event of rupture.

- The bio-based PCM is sustainable and environmentally friendly
- The variety of garment configurations allows for specific situational use: from fire recovery to law enforcement to hazardous materials to rescue (i.e., disposable) to K-9 units
- Glacier Tek has considerable experience with the Federal government, the military, and the emergency response community
- Pricing is very competitive with other technologies, and less expensive than active cooling solutions
- While the product is not for active firefighting, it appears to be an excellent technology for law enforcement, hazardous response, bomb squad activity, and downrange rescue operations
- Because the parent company (Entropy) is fundamentally an innovative chemical company focused on heating and cooling solutions, all future R&D is focused on improving PCM technology

Likely Weaknesses

- *The company advises against use of the PCM by firefighters actively combatting a fire for several critical reasons:*
- As temperature increases and the PCM melts, it can instead act as an insulator, having the opposite desired effect and making heat dissipation harder, thus putting a firefighter at risk
- While the PCM is bio-based, it does include versions of plant oils which may be flammable if exposed to fire
- The unit's effectiveness may gradually decrease as the PCM melts; this slow degradation may not be noticed by the wearer while active and focused
- Despite its portability, the wearer must be near charged units to restore the unit's full cooling potential
- Maintaining a repository of fully-charged PCM packs would require ample refrigeration space
- The technology could be cost-prohibitive at any significant scale, or for under-resourced units

Product Offering and Pricing

The PCM-pack approach allows Glacier Tek to provide function- and situation-specific vest configurations, including high-visibility and flame-retardant, though the company cautions against use of the technology by firefighters engaged in active fire events. Many vest configurations also come with extenders for customization and varying body type. Examples with relevance to the first responder community and pricing include:

Original: $199/unit (vest + pack)

Flame retardant and versatile for general cooling purposes
Learn more: http://store.coolvest.com/original-rpcm-cooling-vest-tan-khaki/

Cool Armor: $109/unit (vest + pack)

Designed to be worn under body armor, and weighs only 2 lbs. fully loaded
Learn more: http://store.coolvest.com/cool-armor/

Disposable: $199/unit (5 vests + packs)

Designed to be worn under chemical suits and PPE, the product includes 5 vests
Learn more: http://store.coolvest.com/disposable-rpcm-cool-vest-white/

Concealable: $199/unit (vest + pack)

Designed to be worn as slim profile under clothing
Learn more: http://store.coolvest.com/concealable-rpcm-cooling-vest-white/

Canine: $129-169/unit (vest + pack)

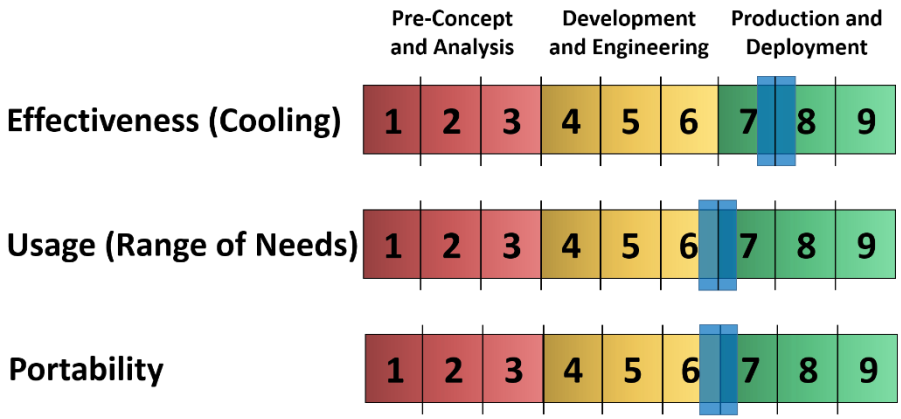
Designed for dogs, including high-visibility garments
Learn more: http://store.coolvest.com/chillydog-cooling-vest/

Glacier Tek's products have been purchased for military, law enforcement, and emergency response use, and the company offers a 25% discount for volume purchase for law enforcement. The company welcomes bulk purchase and indicated volume pricing may be available. Finally, Glacier Tek makes its product line available through distributors and has experience with government buyers (e.g. GSA, eBuy, FedBizOps, DoD eMall, US Military, Federal, State, and Local Municipalities).

Veskimo Personal Cooling Systems, San Juan Capistrano, CA

PRODUCT: *Complete Personal Cooling Systems* | Site: http://www.veskimo.com

Radar: Complete Personal Cooling Systems



Company Description

Founded in 2008, Veskimo Personal Cooling Systems (VPCS) relies on NASA-developed technology to provide continuous relief for the wearer, even under heavy protective clothing and equipment. The VPCS is a vest-like garment that employs a network of micro tubing; this helps chilled water circulate through and around the garment for consistent cooling activity, creating a personal microclimate.

Veskimo was established and is run by Kurt Jechel, a Caltech mechanical engineering graduate who worked in both aerospace and solar, with expertise in mechanical design, fluid dynamics, thermodynamics, and heat transfer. The VPCS emerged in response to the needs of auto racing enthusiasts, and the products are now in use across a number of industries where cooling is a critical need, including first responders, bomb disposal teams, wildland fire suppression, SWAT teams, HazMat personnel, and law enforcement professionals.

Product Description

The Veskimo Water Cooled Vest consists of a thin, lightweight mesh fabric with incorporated micro tubing through which chilled water is circulated. The Vest connects to a Chilled Water reservoir (either a Hydration Backpack or Portable Cooler) that contains ice and water. Both reservoirs also contain a water pump to circulate the chilled water through the Vest, and all components--from reservoirs to power sources--are modular, allowing customization options for differing situations. In addition, either reservoir can serve as a source of cool drinking water.

Product Features

The Personal Microclimate Body Cooling Vest (PMBCV) is a thin, lightweight, fast-wicking, quick-drying, and highly breathable mesh fabric garment. Each PMBCV contains over 50 feet of flexible micro tubing, terminating in an easily-accessed fitting designed for quick attachment and disconnecting to any of the

available chilled water reservoirs. The PMBCV is available in sizes from small to extra-large, and features a zippered front and size-adjusting elastic straps to allow for unrestricted range of motion. The PMBCV employs a single flexible insulated hose to connect to either of the available chilled water reservoirs: the 4.4 Quart Hydration Backpack or the 9 Quart Hand-Carry Cooler.

The backpack is a thermally-insulated container that works in concert with the PMBCV, and can hold up to 7 lbs. of ice plus 1-2 pints of water for anywhere from 90 minutes to four hours of body cooling, depending on user activity and ambient environment. Once filled, a high efficiency pump circulates chilled water through the vest's micro tubing. The pump can be powered for over 6 hours a single rechargeable lithium-ion battery or continuously powered using a 12V DC power cord.

The cooler is hand-held, and holds up to 14 lbs. and 2-4 pints of water for longer cooling periods where the user may be stationary. It's ideally suited for use on a motorcycle or ATV, and just like the backpack, may be powered by a single rechargeable lithium-ion battery or external 12V DC power cord.

Veskimo also offers a number of accessories, including adjustable cooling controllers, hose extenders, and fittings. These accessories extend the life and functionality of the system for differing situations.

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

- The 50 ft. of integrated micro tubing offers complete coverage of the torso, quickly, thoroughly, and consistently cooling the user
- The circulating chilled water ensures hours of cooling, and because only ice water is needed to begin cooling, there is no additional wait time for PCMs or ice/gel packs to freeze or recharge
- With the backpack reservoir in place, the system is fairly portable and self-contained, and offers hours of cooling
- For longer and more stationary activity, the cooler allows for extended cooling, much longer than available in other solutions on the market
- The vest and its integrated tubing are more than a garment for holding cooling material; rather, it is a unit designed to be lightweight, breathable, and extremely effective in cooling
- Both the backpack and cooler double as sources of cold drinking water, which could be critical for first responders in high stress/heat environments
- The vest is designed to be worn under clothing and uniforms, and functions better when external materials can assist in retaining a more consistent cool temperature
- Flexibility is built into the system: a single vest can use either reservoir and multiple connection and power options

Likely Weaknesses

- The vest cannot function without one of the reservoirs, adding complexity and bulk to the use of the system
- The vest is lightweight, but a fully-loaded backpack adds approximately 7 lbs. of ice and water to the user, which may be undesirable based on the circumstances
- While the vest is designed to hold a low profile, the backpack is conspicuous, potentially obstructing or impacting other gear on the first responder's back
- The integrated system relies on a number of parts (some moving): if the micro tubing tears or is twisted, or if the pump fails, or if the battery isn't charged or a power source isn't available, or if the reservoir becomes disconnected, the entire system is compromised
- Recharging in higher temperature environments is predicated on easy access to ice and water, and the ability to refill the reservoir. It is noteworthy that other approaches (PCM, gel packs) also can employ ice water, but only as a means to charge coolant packs
- The efficacy of the micro tubing relies on direct contact with the user's skin, requiring individual-specific or precise sizing, affecting the product's usefulness in certain situations
- In communications with Veskimo leadership, they indicated bulk pricing and availability would be a challenge
- While Veskimo offers any configuration of vest + reservoir + power source, the more portable version (i.e., the Backpack reservoir) complete system has retails for $1,116.00 USD, far higher than other, more simple solutions

Product Offering and Pricing

Veskimo's modular configurations provide flexibility for users, letting them adapt systems for likely use. Veskimo defines the Complete Personal Cooling System as the Cooling Vest + Reservoir (either hand-held Cooler or user-worn Backpack). Examples with relevance to the first responder community and pricing include:

Cooling Vest + Backpack: $1,116/unit (vest + reservoir)

Portable for myriad uses, with options on power systems (battery or cord)
Learn more: http://www.veskimo.com/cooling-hydration-backpack-system.html

Cooling Vest + Cooler: $493/unit (vest + reservoir)

Long cooling for stationary or vehicular use, with options on power systems (battery or cord)
Learn more: http://www.veskimo.com/personal-cooling-system-9quart.html

Related Technologies

The science behind how to cool the body via the torso is well-documented, and this knowledge governs the vast majority of the product designs (vest + coolant material). One such technology not fully assessed—as it is not intended for downrange use— but remains noteworthy because of its focus on the firefighter community, is Shafer Enterprises LLC's COOLSHIRT® technology. The COOLSHIRT system is used for firefighter rehab: the system is a pump-powered 15-gallon cooler with up to 6 hoses that connect to tube-filled vests. The system allows for quick rehab of multiple firefighters, or even civilians. As with other technologies, the system relies on iced water and a power source to circulate the cooled water.

The core cooler and pump apparatus retails for $1,195.00 USD, with vests and accessories available.

Emerging Research and Direction of Innovation

Given the ubiquity of the vest + coolant design, it is clear in discussions with companies in the market that R&D is moving towards materials: lighter, better vests; different designs with micro tubes that evaluate microfluidics; next-generation phase-change materials; and most interestingly, new physical properties emerging at nanoscale.

For example, recent National Science Foundation-sponsored research from Penn State University illustrated that a nanowire array—like a metallic mesh—of nanostructured materials actually cools (exhibit a reversible temperature change) when a normal electric field is applied. According to researchers, an iPad-sized battery pack could power the material for approximately 2 hours. Because the mesh is flexible, it could in theory be applied to any fabric, providing cooling with very little power and no actual coolant or chilling, instead using the physical properties of the engineered material. Reference: http://onlinelibrary.wiley.com/doi/10.1002/adma.201506118/epdf

In short, cooling systems of the future may be extremely thin, engineered t-shirt-like garments that cool when a small battery is applied.

The practical use of these technologies (and their cost-effective production) remains years away, but this early research illustrates the direction of the thinking and the promise of new directions.

Summary

Cooling technology geared towards the first responder community is fully mature, with numerous vendors, products, and methodologies in the market. Many of these technologies are intended to be fully portable (that is, downrange) and provide several hours of cooling before requiring recharge. First responders interested in cooling technology should expect to purchase specialized vests, with some kind of coolant or cooling apparatus. For law enforcement, bomb disposal, military, and related personnel, the downrange technology is well established, with reputable companies already offering products to the market.

The single largest gap is the firefighter community, and specifically for firefighters combatting an active fire in PPE. All current products for firefighters is rehab-focused, for good reason: the heat of an active fire would quickly turn the physics of evaporative cooling—irrespective of coolant composition—against the user, putting them not only at risk, but perhaps even increasing the potential of heat-driven illness as the unit would then work as an insulator.

The challenge of cooling an active firefighter has the potential to impact all other research; any advancements against that front would have profound implications for all other first responders. Nanostructured materials and phase change materials hold tremendous promise, and IAB should continue to monitor these developments or look for opportunities to support research of this nature.

In the absence of these next-generation technologies, advanced phase change materials (such as Glacier Tek's Cool Vest or comparable offerings) appear to be an excellent solution. They allow for downrange activity, are relatively light, can be easily updated or employed with multiple users, are inexpensive relative to other cooling systems, maintain a low profile, have no moving parts or need for power sources, cool better than water and gel packs, are sanitary and easily disinfected, leverage the best cooling approaches, could be used in custom-engineered garments, and are available by several reputable vendors already conducting business with emergency responder community.

PRIORITY #8: Mission Critical Voice Over LTE

Technology Requirement Overview

The Public Safety community relies on its ability to quickly and clearly communicate in order to protect the lives and property of the community, and well as to safely work in stressful and often dangerous environments. As new communications technologies emerge, First Responders must be able to leverage the advantages brought forth by these advancements without compromising the stringent requirements developed through years of experience in the field.

Much like the way the Association of Public Safety Communications Officials (APCO) Project 25 (P25) standards ushered in a new era of interoperable communications in Land Mobile Radio (LMR) networks, the National Public Safety Broadband Network (NPSBN), often referred to as "FirstNet", promises the opportunity to provide the First Responder community with a single, nation-wide network dedicated to high speed data. This data will be transmitted using Long Term Evolution (LTE) technology, new purpose-built public safety devices and applications, and voice services, based on the standards set forth by the 3rd Generation Partnership Project (3GPP), the standards development organization (SDO) responsible for the creation of LTE specifications.

Year the Requirement was identified by the IAB

- 2016 – Overall Priority #21
- 2015 – Overall Priority #7

Requirements of the Technology

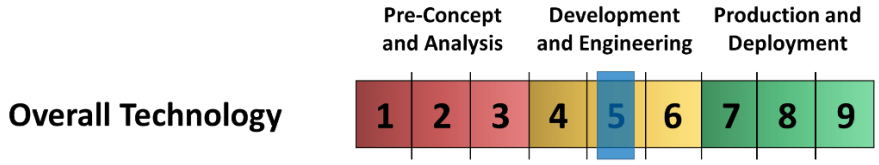
The NPSTC Broadband Working Group published a white paper in 2014 titled "Mission Critical Voice Communications Requirements for Public Safety" that outlines the following key functional elements for the definition of Mission Critical Voice:

- Direct or Talk Around: This mode of communications provides public safety with the ability to communicate unit-to-unit when out of range of a wireless network, OR when working in a confined area where direct unit-to-unit communications is required.
- Push-to-Talk (PTT): This is the standard form of public safety voice communications today – the speaker pushes a button on the radio and transmits the voice message to other units. When they are done speaking, they release the Push-to-Talk switch and return to the listen mode of operation.
- Full Duplex Voice Systems: This form of voice communications mimics that in use today on cellular or commercial wireless networks, where the networks are interconnected to the Public Switched Telephone Network (PSTN).
- Group Call: This method of voice communications provides communications from one-to-many members of a group, and is of vital importance to the Public Safety community.
- Talker Identification: This provides the ability for a user to identify the person speaking at any given time. It can be equated to caller ID, available on most commercial cellular systems today.
- Emergency Alerting: This indicates that a user has encountered a life-threatening condition and requires access to the system immediately. Therefore, this user is given the highest level of priority.
- Audio Quality: This is a vital ingredient for mission critical voice. The listener MUST be able to understand without repetition, identify the speaker, detect stress in a speaker's voice, and be able to hear background sounds as well without interfering with the prime voice communications.

Targeted End Users

- First Responders

Radar: Mission Critical Voice over LTE



Rationale for Mission Critical Voice over LTE level

Using the Department of Defense's TRL scale as a reference guide, we assess the overall state of Mission-Critical Voice over Long Term Evolution (MC VoLTE) at **Level 5**. While technology exists, and is currently in use, that can provide push to talk functions over LTE, the applications fail to meet the requirements of Mission-Critical Voice in a number of important aspects.

Many popular commercially available "push-to-talk-over-cellular" (PoC) applications utilize the data connection of the user's equipment to access the application's commercial servers "over-the-top" (OTT) of the network. As a result, they are subject to slow-downs and latency because they are not treated as priority data on the networks. PoC Apps that are network integrated are not yet 3GPP standards-based. 3GPP-set standards for Mission-Critical Push-to-Talk (MCPTT) were included in LTE Standards release #13, but have not yet been implemented by the vendors providing the hardware and software that run the LTE networks. Another important factor to consider is that while 3GPP release #13 set standards for MCPTT, no LTE standard yet exists for "Mission Critical Voice", which would also include full-duplex communications such as phone calls.

Further, although specialized devices are available, they are not widely available to responders in the field. PoC applications are commonly running on commercial smartphones that are not built for public safety use. They are not ruggedized, many lack the ability to switch batteries, and often rely on touchscreen Push-to-Talk (PTT) buttons that can't easily be activated by responders wearing gloves or in wet environments.

Finally, to leverage FirstNet and other LTE networks for Mission Critical Voice services, the network architecture itself must provide the same level of service and dependability that the responders have come to expect from traditional P25 voice communications systems. Chris Sambar, Senior Vice President of AT&T, presented at the National Public Safety Telecommunications Council (NPSTC) Governing Board meeting on Wednesday, September 6, 2017, in Washington, D.C., regarding AT&T's plans to build and maintain the NPSBN in accordance with public safety grade objectives as outlined in the FirstNet Request for Proposal (RFP) and FirstNet's contract with AT&T. These objectives were informed by FirstNet's Public Safety Advisory Committee (PSAC), which used the NPSTC's report on public safety grade. "I am familiar with NPSTC's commendable work, including the public safety grade report," Mr. Sambar said. "AT&T has a total commitment to public safety and its requirements." NPSTC acknowledges AT&T's participation in the development of its public safety grade definition, published in 2014. That said, while public safety grade network hardening technology is mature and would be considered Technology Readiness Level

(TRL) 9 by the Department of Defense Acquisition Guidebook, commercially available networks to date are not built to the same standards as expected in hardened public safety grade network infrastructure. During the historic August 2016 flooding event in south-central Louisiana, floodwaters inundated a Mobile Telephone Switching Office (MTSO), causing complete loss of commercial cellular service for a major carrier in and around Baton Rouge, LA. This contrasts with the Louisiana Wireless Information Network (LWIN), a statewide P25 LMR system that experienced no site failures in Baton Rouge, and only two site failures (out of 135) statewide.

Assessment Methodology

MC VoLTE was assessed against the following criteria:

- 3GPP adoption of standards addressing the key components of MCV
- Carrier implementation of 3GPP release standards
- MC VoLTE application and hardware availability

Current State of Development

As of now, no standards for "Mission Critical Voice" exist for LTE. However, Mission Critical Push to Talk (MCPTT) is widely understood to be a (if not the) major component of MC VoLTE for public safety users.

3GPP Adoption of MCV Standards

3GPP Release 12 (finalized in 2015) included basic specifications on two important features for public safety communications over LTE: Proximity Services (ProSe) and Group Communications System Enabler (GCSE).

3GPP Release 13 (finalized in 2016) provides a systematic set of technical specifications of mission-critical voice communication over LTE, including mission-critical push-to-talk, and Proximity Services (ProSe) enhancements. Such enhancements include direct-mode voice communications, a "discovery" feature that lets a user know of other users that are within direct-mode range, and a relay capability that allows an out-of-coverage user to connect to a fixed LTE network via a direct-mode connection with an in-network LTE device

3GPP Release 14 (released June 2017) carries the MCPTT standards efforts forward and will address mission-critical video and data.

Carrier Implementation of 3GPP Release Standards

The 3GPP sets the standards for the functions of LTE networks. LTE Network equipment and software manufacturers, in conjunction with their clients and network operators like AT&T and Verizon, are tasked with implementing these standards. To date, the MCPTT standards laid out in release 13 have not been fully implemented on any U.S. LTE networks.

MC VoLTE Application and Hardware Availability

PoC applications are readily available for Android, Windows, and iPhone platforms, but due to the lack of network standards integration, it would be difficult to classify these as "Mission Critical". These applications are gaining popularity for groups preforming quasi-public safety functions, such as the volunteer group that formed around the August 2016 south Louisiana flooding incident that became known as the "Cajun Navy". Despite large scale local network outages for one major carrier, OTT PoC

applications that worked across cellular network providers were used successfully by this group during the 2016 flooding event, and subsequently in Texas during volunteer search and rescue operations in the wake of Hurricane Harvey in 2017.

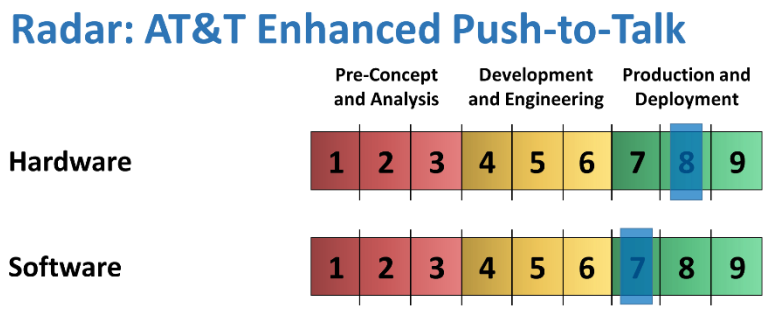
LTE hardware designed for public safety is available, such as the Sonim Technologies XP line of ruggedized smartphones, but choices are extremely limited.

Evaluation of Mission Critical Voice over LTE on the Market

AT&T, Dallas, TX

Product: AT&T Enhanced Push-to-Talk | SITE:

https://www.business.att.com/enterprise/Family/mobility-services/enhanced-push-to-talk/



Company Description

AT&T Inc. is an American multinational telecommunications conglomerate, headquartered at Whitacre Tower in downtown Dallas, Texas. AT&T is the world's largest telecommunications company, the second largest provider of mobile telephone services, and the largest provider of fixed telephone services in the United States. AT&T also provides broadband subscription television services through DirecTV; combined with AT&T's legacy U-verse service, this also makes AT&T the largest pay television operator.

Product Description

AT&T Enhanced PTT for Smartphones is a new solution for Push To Talk communications, providing fast call setup times and industry-leading features. Get instant one-to-one or group calling on a wide variety of smartphones and rugged devices, anywhere you go on AT&T's nationwide 4G LTE network.

Product Features

- Communicate instantly one-to-one or in groups of up to 250 members.
- Manage, monitor, and dispatch resources and workers in the field.

- Deploy integrated, mobile resource management applications, including AT&T Workforce Manager and AT&T Fleet Complete®.
- Interoperate and enable group communications with traditional two-way radio systems, including land mobile radio.
- Utilize on multiple smartphones, feature phones, and rugged devices
- Operate across multiple platforms, including Apple iOS and Android

Analysis: Likely Strengths and Weaknesses

Likely Strengths

- Carrier integrated solutions like AT&T Enhanced Push-to-Talk and corresponding offerings from other carriers like Verizon and Sprint are closely integrated with the network, which should provide faster call setup times and better performance during heavily congested periods. These network integrated solutions are provided guaranteed Quality of Service (QoS) by the network as this traffic has a QoS Class Identifier that assigns it a higher priority, lower latency, and lower error rates than general data traffic (to include OTT PoC applications data).

Likely Weaknesses

- There are several different technologies in use in the carrier-integrated solutions, some of which are not compatible. Even when utilizing the same technology, the companies have not to date shown a willingness to provide interoperability between carriers, hindering interoperability.

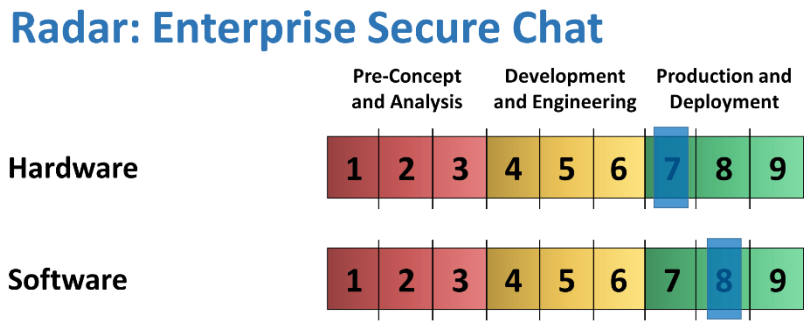
Additional Information and pricing

This application can be run on a wide variety of AT&T Devices. While consumer grade smartphones would not meet the technology requirements of mission-critical communications hardware, there are a limited (but growing) number of ruggedized, purpose-built hardware devices for public safety applications that include essential features such as a physical PTT button that can be activated while wearing gloves.

Enhanced PTT provides unlimited Push To Talk service for only $5/month when added to standard voice and data plans.

SLA, San Luis Obispo, CA

Product: Enterprise Secure Chat (ESChat) | http://www.eschat.com/



Company Description

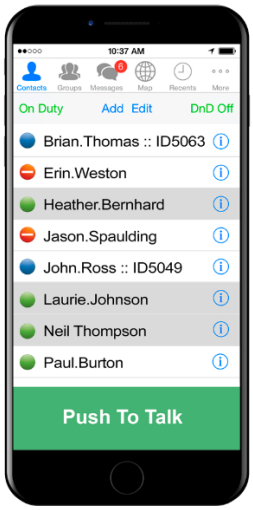
Based in San Luis Obispo, California, San Luis Aviation, Inc. dba SLA Corporation is a privately held product development and professional services corporation. Since 1991, SLA's team has been providing solutions for the United States Government for military and space satellite applications, as well as the wireless telecommunications industry. With a seasoned staff of engineering and business leaders, SLA's portfolio of Intellectual Property provides its basis for wireless networks and products deployed throughout the world. SLA possesses expertise in development of first generation through fourth generation (4G) wireless technologies, including CDMA, UMTS, LTE as well as many other communication technologies.

Product Description

ESChat allows users to communicate on a 1:1, adhoc, and Group basis. ESChat provides eight distinct Talk Group types, each customized to fill a particular mission. Talk Groups range from the basic Nextel type Group, to Groups for Surveillance, Command, Dispatch, Unicast, Emergency Broadcast, and more. Each multi-way Talk Group will support 255 members, while the Emergency Broadcast Groups can reach up to 60,000 Users with the press of a single button.

Product Features

- Voice Privacy including:
  - AES-256 bit Symmetric Key Encryption
  - ECDSA Asymmetric Encryption
- ECDH 384 bit Key Exchange
- SHA-384 Hashing
- User and Group Priority to control user access
- Priority Broadcast Calling
- Presence for Groups and Individual Contacts
- Priority Calling and in-call pre-emption
- Eight Talk Group Types
- Account management via the handset or web
- Guaranteed network isolation
- Dedicated Enterprise Servers



- Encrypted Account Management Transactions
- PC Based Dispatch Client for Windows and Linux
- Direct interface to Public Safety and LMR networks
- Late Join on Group Calls
- Front Screen Contact and Group navigation
- Initiate and Receive Calls with flip closed
- Historical [Bread Crumb] Mapping
- Historical [Bread Crumb] Data Download
- Easy to use Contact and Group Selection
- FLASH Based User Tutorials
- Live Customer Support 24/7/365
- Group and User Presence
- Floor Control Indication
- User and Group Management from:
    - Web based user interface, and
    - Handset User Interface
- Instant Ad Hoc Group Calling
- Enterprise Administration via Web Interface

Analysis: Likely Strengths and Weaknesses

Likely Strengths

- As an "over-the-top" (OTT) solution, ESChat is not integrated with any one wireless carrier, allowing it to be network agnostic, running on any of the carrier's networks. This provides interoperability between responders using different wireless carriers. This also allows responders to login to the application on emergency cache phones from a different provider.

Likely Weaknesses

- As it is unaffiliated with any of the carriers, the network providers do not provide priority for ESChat data. ESChat and similar OTT applications would likely fare worse during network congestion than a carrier-integrated solution with a higher network QCI.

Additional Information and pricing

ESChat is available for $4.99 per month on a month-to-month no-contract basis, and includes Secure PTT Voice, Group Messaging, and Location Tracking & Mapping. Annual subscribers can purchase ESChat for $4.49 per month and volume discounts are available.

Emerging Research and Direction of Innovation

FirstNet Request For Proposal (RFP) contains an App Ecosystem Roadmap document that listed milestones for Interim Operating Capabilities (IOCs) that must be met by the vendor chosen to implement the NPSBN.

- IOC 3 specifies "Mission-Critical Voice (VoLTE) with Priority" must be met by 3/30/2019
- IOC 4 specifies "Mission-Critical Push-to-Talk(PTT) (unicast only) must be met 3/30/2020
  [note: "unicast only" describes direct device-to-device, or "one-to 1" connection]
- IOC 5 specifies "Mission-Critical PTT with broadcast" must be met by 3/30/2021
  [Note: this would meet the "one-to-many" requirement of MCPTT]

Summary

The most promising avenue for Mission-Critical Voice Over LTE services is the FirstNet NPSBN that became available in Q4 of last year to states that "opted-in" to the service. The Interim Operating Capabilities in the FirstNet RFP set March 30th, 2021 as the date for the final MCPTT functionality to be provided. This will satisfy the many of the key requirements of MC VoLTE, with the possible exception of public safety grade network (RAN), and as such, provides the most reliable estimate for the availability of Mission-Critial Voice over LTE for the Public Safety community.

PRIORITY #9 HME Neutralization

Technology Requirement Overview

Law enforcement bomb squads and technicians employ a variety of methods in order to eliminate the threat of homemade explosives (HME). However, they could greatly benefit from technological advances that allow them to neutralize chemicals used to create HME, changing it from an explosive hazard to an inert material. This technology must be mobile and work in a reliable and time effective manner in order to increase the safety of bomb technicians and decrease their exposure to these volatile materials. According to the United States Bomb Data Center, there were a total of 400 bombing incidents reported within the United States in 2015. With the world of homemade explosives ever evolving, it is more important than ever that bomb technicians are equipped with the most effective chemical neutralization technologies.

Year the Requirement was Identified by the IAB

- 2016 – Priority #9

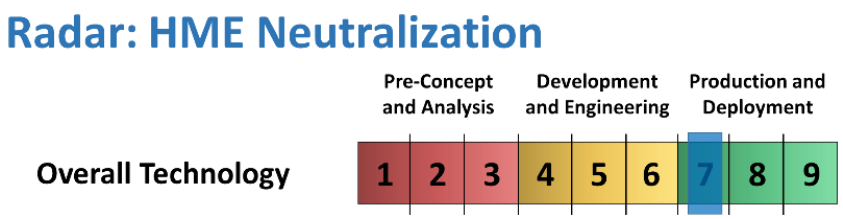
Requirements of the Technology

Because bomb squads and technicians often respond to clandestine HME labs and may encounter a variety of potentially hazardous and volatile substances, there is a need for the capability to neutralize these assorted compounds. Bomb technician safety is the most important requirement, as well as the safety of other law enforcement and members of the public in the area of operations. In conjunction with appropriate action and correct identification of substances from law enforcement and bomb squads, methods of HME neutralization must:

1. Provide bomb technicians with an effective method of HME neutralization, allowing them to transport and dispose of the materials.
2. Efficiently convert HME to an inert material in a relatively short amount of time.
3. Be portable and easily accessible to bomb squads and technicians.
4. Be affordable.

Targeted End Users

- EOD units



Rationale for Radar Level

Using the Department of Defense's TRL scale as a reference guide, we assess the overall state of HME neutralization methods at **Level 7**. The primary users of these products for IAB will be law enforcement bomb squads and technicians; with this audience in mind, we considered the overall use of the products and how well they satisfy the needs of the users and their mission. While physical HME elimination technology has advanced over the years, the current chemical neutralization methods of HME and HME materials are lacking in terms of the conversion of complex compounds to inert materials for transport and disposal.

Assessment Methodology

The assessment methodology focuses on the technology, from its current state to available vendors and products, particularly in HME and HME composition material neutralization. In addition, the methodology will include emphasis on the emerging research in HME neutralization.

At an individual vendor level, product type, usability, extensibility, price, and strengths/weaknesses are all evaluated.

We assessed technologies on the following component levels:

- **Situational effectiveness:** The product must be effective at the conversion of various HME and HME compounds to inert materials. In order for bomb technicians to transport and dispose of the materials, it must be completely stable and nonreactive.
- **Neutralization efficiency:** The product must be efficient at the conversion of various HME and HME compounds to inert materials. It is imperative that these materials be converted in as little time as possible as to reduce the exposure time to bomb technicians, other law enforcement, and the general public.
- **Portability and Accessibility:** The product must able to be carried by the bomb technician or on the bomb truck. Methods that require dilution with very large amounts of liquids may not be practical.
- **Cost/affordability:** Product must be affordable to purchase.

Current State of Deployment

The marketspace currently lacks a product tailored for the conversion of HME compounds to inert materials for transport and disposal. While the technology to neutralize acidic and basic materials commonly found in clandestine methamphetamine labs currently exists, and this technology could potentially be further developed for use in HME scenarios, there are no market-ready solutions that specifically address the neutralization of chemical compounds commonly used to create homemade explosives.

Through reviewing literature, speaking with law enforcement representatives, and researching companies, it is apparent that there is no real leading new product or technology being widely used regularly by bomb squads and technicians nationwide. Standard practices and policies of explosive ordnance disposal continue to be implemented throughout the country successfully.

This indicates the need and marketspace for such technology.

Evaluation of Homemade Explosives Neutralization Products Currently on the Market

Company Description

XploSafe, a provider of on-site detection kits used primarily for exposing improvised explosive compounds, was contacted about potential development of a product used to neutralize the same compounds detected by their kits. The company did not respond with positive news regarding future development of such a product.

Ideal Future Product Description and Features

The desired product will allow bomb technicians responding to clandestine HME labs the ability to convert the volatile HME materials to inert compounds so that they may be collected, transported, and disposed of properly. The product will need to work effectively and efficiently in order to minimize the risk to the bomb technician, additional law enforcement, and any general public that might be in the potential impact area. It will also need to be relatively portable, either able to be housed on the bomb truck or on the bomb technician him/herself.

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

- Effectiveness in the conversion of HME to an inert material so that it can be disposed of properly
- Efficiency in the conversion of HME to an inert material as to limit potential exposure
- Portable and easy to use

Likely Weaknesses

- Potentially high cost
- Technicians may have to be retrained on application methods and techniques

PRIORITY #10: Enhance Communications in Environments that Interfere with Radio Transmissions

Technology Requirement Overview

First responders rely heavily on portables radios as their primary means of communications. In large concrete and steel structures like hospitals, correctional facilities, governmental buildings, and tunnels, radio interference is a common problem. Often, the signals from portable radios are not able to penetrate beyond the exterior of the structure. This can have serious consequences as seconds and minutes can mean the difference between life and death in the first responder community.

In-building communication systems bring wireless signals into a structure from a "donor antenna" located outside where there is good coverage, amplifies those signals with a signal booster, referred to as a "Bi-Directional Amplifier" (BDA), and then distributes the amplified signals throughout a structure through a Distributed Antenna System (DAS). The DAS located in the building then picks up signals transmitted by the radios within the building that would not normally penetrate the building's exterior, amplifies them, and sends them back to the antenna outside to be transmitted to the local public safety radio system.

Building codes in some areas mandate these BDA – DAS systems, but not all areas. And even where such local ordinances exist, they don't always cover all scenarios that first responders may encounter, such as ships in a harbor or historical structures grandfathered from such ordinances.

Finally, due to the nature of public safety work, even buildings equipped with properly functioning BDA systems can experience outages and equipment failures during emergencies such as fires or earthquakes, the very time when the system would be most useful.

One solution for this problem is the use of a portable BDA system that responders can bring with them and deploy when and where needed. These systems function much like a standard in-building BDA-DAS system, where the DAS is replaced by an omnidirectional antenna that is connected via cable to the BDA. The omnidirectional antenna is then placed inside the structure in a location that provides temporary coverage for responders.

Year the Requirement was identified by the IAB

- 2014 – Overall Priority #2

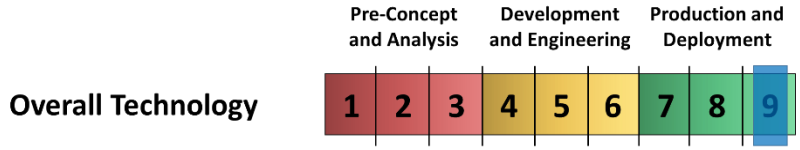
Requirements of the Technology

Enhanced Communications devices must be able to provide communications system coverage to structures that are not adequately covered by the local first responder's radio system. They must be portable enough to be easily deployed by one or two people, and able to be set up and operated by users without requiring intensive training. The system will also be expected to operate without external power for extended periods.

Targeted End Users

- First Responders

Radar: Enhanced Communications



Rationale for Enhanced Communications

Using the Department of Defense's TRL scale as a reference guide, we assess the overall state of Enhanced Communications at **Level 7**. Several commercial off the shelf systems are available that meet the requirements of this technology priority.

Assessment Methodology

Communications signal enhancement was assessed against the following criteria:

- Ease of use
- Setup time
- Portability
- Effectiveness

Current State of Deployment

Products currently on the market do a good job fulfilling this requirement. Systems are available today that can be set up relatively quickly and easily by users without extensive technical training. These systems can provide communications capabilities in areas where the local public safety communications system does not provide adequate coverage, while allowing the responders to continue to use the same radios and channels they normally use. The current technology does require responders to reposition the antennas providing coverage when moving throughout the structure, as no technology currently exists that would provide complete coverage to (for instance) all floors of a large, densely constructed multi-story hospital or government building.

Evaluation of Enhanced Communications technology in the Market

Excelwave Technologies, Ontario, Canada

Product: Ranger700/Ranger800: Self-Powered Tactical BDA Systems

SITE: http://excelwavetechnologies.com/index.php?route=product/category&path=232_268

Radar: Excelwave Technologies

Company Description

Excelwave Technologies provides RF products and engineering services for private and public wireless networks, from the design, manufacture and distribution of RF signal boosters, filters, duplexers, multinetwork and multichannel combiners, base station, DAS and transport antennas, to turnkey solutions for ITS, in-building and tunnel DAS systems.

Product Description

- Ranger700 and Ranger800: Self-Powered Tactical BDA Systems connect the first responders anywhere, anytime.
- Ranger700 and Ranger800 are self-powered BDAs which are transportable and re-deployable on various emergency sites to secure seamless radio connections in buildings, tunnels, subways, basements, underground parking lots and other dead zones for first responders.

- Assembled in a compact IP65 rated ruggedized case with rollers, Ranger700 and Ranger800 can be easily moved to the site where urgent communication needs to be established, or installed on a vehicle for mobile uses. Ranger700 and Ranger800 can start to work within one minute once they arrive on site.
- Ranger700 and Ranger800 come with on-board power management for continuous power from their integrated lithium-ion rechargeable battery pack for up to 20 hours, switchable to external 100-240VAC or 12VDC sources as backup. They are designed for rapid formation of voice trunking communications, especially in unknown zones.
- The lithium ion battery is designed and manufactured at military grade that will perform well against vibration and shock. The internal battery management system protects the battery against overcharging, over discharging, short circuit, penetration and thermal shock.
- The battery can be fully recharged in 3 to 5 hours by 120VAC source. With quick logic microprocessor, the built-in charger is featured with delta volt intuitive charging, fully automatic and multistage charging, zero spark technology, reverse polarity protection, temperature control and ignition protection. The LED lights indicate the state of charge to help you create peace of mind.

Analysis: Likely Strengths and Weaknesses

Likely Strengths

- Quick setup
- Ease of use
- Extended operation on battery power

Likely Weaknesses

- Omnidirectional antenna providing the interior coverage must be connected to the BDA via a cable, limiting the placement of the interior antenna.
- 700/800 MHz only, no VHF model

Additional Information and Pricing

The Ranger series comes in several different models and pricing as shown below:

Model Number	Maximum Operation	Recharge	Unit Price, USD	UL Freq	DL Freq
Ranger800-30	12 hours	3 hours	$7,640.00	806-824MHz	851-869MHz
Ranger800-40	16 Hours	4 hours	$7,883.00	806-824MHz	851-869MHz
Ranger800-50	20 hours	5 hours	$8,150.00	806-824MHz	851-869MHz
Ranger700-30	12 hours	3 hours	$8,022.00	788-806MHz	758-776MHz
Ranger700-40	16 Hours	4 hours	$8,277.00	788-806MHz	758-776MHz
Ranger700-50	20 hours	5 hours	$8,558.00	788-806MHz	758-776MHz

Emerging Research and Direction of Innovation

With the National Public Safety Broadband Network LTE data system scheduled to begin providing service in late 2017 or early 2018, responders are expected to begin using LTE data services at an expanding rate. This will necessitate the need for tactical BDAs that can cover public safety broadband 700MHz, as well as narrowband Land Mobile Radio 700/800MHz frequencies, without the LTE and P25 signals interfering with each other.

Summary

Commercial off the shelf products exist today that do a good job of fulfilling this request. These systems are portable, easy to use, and can be setup quickly without extensive training. Although these systems can vastly improve coverage inside structures where local public safety radio systems traditionally have difficulty adequately covering, they still have limitations based on the size and complexity of the structures. Even when properly deployed, single units will not be able to provide coverage to all areas of large and densely constructed structures.

PRIORITY #11: Hands Free Radio Intercom

Technology Requirement Overview

Continuous, secure radio communications for small teams in close proximity, with the ability for any member within the team to talk to command on an established talk group.

Year the Requirement was Identified by the IAB

- 2014 – Overall Priority #3 Equipment Priority #3

Requirements of the Technology

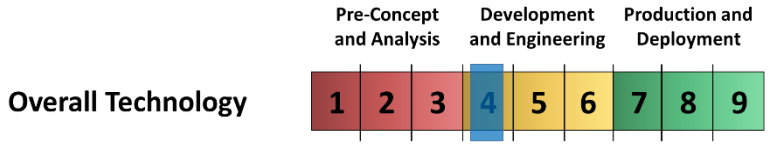
To meet the requirements of this technology priority, a product should function as a hands-free full-duplex intra-squad communications system. This system should have the ability to utilize a push-to-talk (PTT) button to access the LMR functionality required to communicate with the command element not typically within close proximity to the responders in the field.

In the intra-squad intercom role, the system should provide clear hands-free communications. For public safety applications, the system would have to "unmute" or "open the channel" when the responder speaks into the microphone, while not continually amplifying and broadcasting all the background noise such as loud machinery and sirens often associated with public safety work. In the LMR role, the user manually opens the channel through the use of a PTT button, and noise canceling features are utilized to cut down on the interference caused by background sounds so that the speaker's voice remains clear and understandable.

Targeted End Users

- While not directly specified in the technology priority list, hands-free communications systems are often utilized by responders wearing personal protective equipment that hamper the responder's ability to directly speak into a typical LMR or LMR remote speaker microphone.

Radar: Hands Free Radio Intercom



Rationale for Radar Level

Using the Department of Defense's TRL scale as a reference guide, we assess the overall state of Hands-free Radio Intercom at **Level 4**. Although technology exists for both hands-free "squad-level" or "intra-squad" (i.e., small group) intercom communications systems and LMR systems designed to communicate with command personnel outside of proximity for direct link without utilizing a repeater or trunked system, no product exists today that combines these capabilities into one integrated system.

Assessment Methodology

As no product is currently available to handle all aspects of the technology priority, the current state of the technology will be assessed for the individual parts needed to be combined to fulfil this priority.

- **LMR Communications:** Widely accepted standards for assessing LMR technology already exist. The Project 25 (P25) standards developed jointly by the Association of Public-Safety Communications Officials-International (APCO), National Association of State Telecommunications Directors (NASTD), National Telecommunications and Information Administration (NTIA), National Communications System (NCS), National Security Agency (NSA), and the Department of Defense (DoD) outline a suite of standards-based air interfaces in use by many manufacturers.
- **Hands-free Wireless Intercom Systems:**
    - Hands-free operation
    - Full-duplex
    - Clear, consistent audio
    - Sufficient range for squad-level operation
    - Battery capable of running for a typical 12 hr. shift

Current State of Deployment

LMR Communications

Land Mobile Radio (LMR) is a fully mature technology in use since the introduction of the first modern handheld self-contained transceiver unit, the SCR-536 "handie talkie" (more commonly referred to as the "walkie talkie") in 1940. Since then, the LMR has undergone constant improvements in form and technology, resulting in a wide range of products from numerous manufacturers that are ubiquitous in the public safety and defense sectors. While improvements continue, in its current form this technology meets or exceeds benchmarks for technology readiness level 9.

Hands-free Wireless Intercom Systems

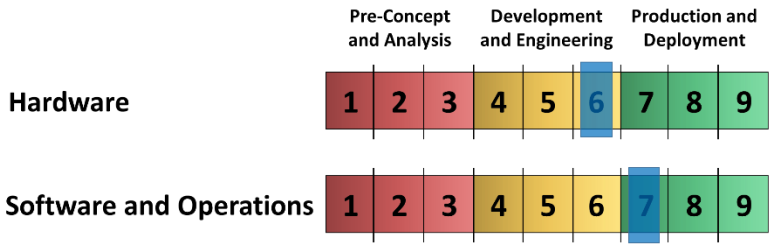
Although a much later development than LMR technology, hands free intercom devices have nonetheless been on the market for many years, borrowing technology from both LMR and early wireless home phone devices. Another factor in common with the LMR platform is the availability of hands-free wireless intercom devices from many manufacturers that perform to a high standard and demonstrate a mature technology.

Evaluation of Hands Free Radio Intercom

OTTO Engineering, Carpentersville, IL

Product: OTTO Connect intercom | SITE: https://www.otto-comm.com/products/ottoconnect

Radar: OTTO Connect Intercom



- Software and operation: 7
  - Hands-free duplex operation provides clear, consistent audio
  - Frequency hopping works well
- Hardware: 6
  - While receiving positive reviews for durability, the product is not built to the mission critical standards common in most widely-used LMR equipment.

Company Description

For more than 50 years, OTTO has been designing and manufacturing a full line of products for unique and demanding applications. Located in Carpentersville, Illinois, OTTO is recognized for superior performance and innovative two-way radio accessories for public safety, fire, police, security, surveillance, hospitality, industrial, and military markets. OTTO's full line of accessories includes surveillance kits, lightweight and heavy-duty headsets, remote speaker microphones, skull and throat microphones, tactical headsets, and intercoms. OTTO supports a wide range of radio platforms providing accessories to most major two-way radios.

Product Description

The OTTO Connect Wireless 210 1-Channel Intercom with 8 Talk Slots is a conversational system that enables hands-free communication among teams of people. It provides up to 18 hours of talk time with up to 8 speaking users and unlimited listeners in a group. The first 8 units powered on are speaking units. The digital signal processing technology provides ambient noise reduction in high-noise environments. The intercom operates in the 900 MHz frequency range, through walls, in rain, and over larger distances.

Product Features

- No base station—switching master unit
- Maximum range line-of-sight up to 4000'
- DSP (Digital Signal Processing)
- Hopping at 30ms intervals
- Up to 8 speaking users per synchronized group—multiple groups supported

- Talk-time up to 18 hours
- Protective rubber boot
- Heavy-duty rotating belt clip
- 24-hour cyclic humidity exposure
- ESD Level 3 & 4 exposures

Analysis: Likely Strengths and Weaknesses

Likely Strengths

- Maximum 400 foot line of sight range allowing for team members to focus on mission tasks without rear of roaming out of range
- Frequency hopping at 30ms intervals minimizes the risk of interference blocking critical transmissions
- 18 hour talk-time sufficient for the average 12 hour public safety operational periods.
- Light weight

Likely Weaknesses

- Does not possess intrinsically safe or common MIL-SPEC ratings.
- Operates in unlicensed 900MHz frequency band with no interference protections.

Additional Information and Pricing

OTTO Connect 210 Wireless 1-Channel Intercom with 8 Talk Slots: $849.00

Summary

While the technology to fully meet the technology requirement is not widely available today, the different components that comprise the technology solution already exist and are fully matured. This suggests the fully realized technology solution may not be far off.

PRIORITY #12: Structure Fire / IDLH Escape Respirator

Technology Requirement Overview

There are a number of widely accepted escape respirator technologies on the market, such as air-purifying respirators, self-contained emergency escape breathing apparatuses, and self-contained breathing apparatuses (SCBA). However, availability of an escape respirator as a proprietary SCBA attachment is limited. Previously, an escape filter canister called the EVAC Pro was available from Brookdale International Systems Incorporated. On July 11, 2001, a U.S. federal trademark registration was filed for EVAC PRO by Brookdale International Systems Inc., Vancouver, British Columbia V6P 6T3. At that time, the USPTO gave the EVAC PRO trademark a serial number of 76283500. However, the current federal status of this trademark filing is ABANDONED - NO STATEMENT OF USE FILED. According to the United States Consumer Product Safety Commission, a recall was made on several Brookdale EVAC products, citing filter issues that allowed carbon monoxide to pass through the system unfiltered and unimpeded. This fatal flaw ultimately caused the closure of Brookdale International Systems. With the void left in the market for a proper SCBA escape respirator, Essex recognized the need for the technology and acquired Brookdale's assets from DuPont, along with the original license to the patent.

Year the Requirement was Identified by the IAB

2016: Priority #16

Requirements of the Technology

Because emergency fire and hazardous materials responders typically encounter consistent hazardous environments and conditions at a moment's notice, and can be exposed to these conditions for an extended period of time, a need exists for an emergency escape respirator for use when the primary air source is depleted.

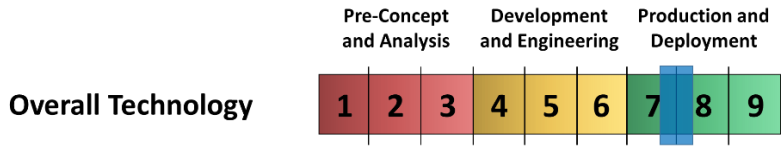
The escape respirator must:

- Filter and eliminate potentially lethal gases present in a structure fire
- Provide easy changeover with SCBA device
- Be portable

Targeted End Users

- Fire – Primary
- Hazardous Materials Response
- Explosive Ordnance Disposal

Radar: IDLH Escape Respirator



Rationale for Escape Respirator Level

Using the Department of Defense's TRL scale as a reference guide, we assess the overall state of structural fire/IDLH escape respirators at **Level 7.5**. The primary users of structural fire escape respirators will be fire and hazardous material responders; with this audience in mind, we considered the overall use of the system—from sensor and support system (hardware) to the software—and how well it satisfies the needs of the users and their mission. While currently available structural fire/IDLH escape respirators satisfy much of the requirements of this technology, a proprietary respirator filter that is optimized for a single respirator is limited in availability.

Assessment Methodology

Given that escape respirator filtration systems are the point of interest, the assessment methodology focuses on the integrated technology, from its current state to available vendors and products, particularly for use by fire and hazardous materials responders. In addition, the methodology will include emphasis on the emerging research in integration and compatibility with first responder technologies (SCBA) currently in use.

At an individual vendor level, hardware, usability, extensibility, price, and strengths/weaknesses are all evaluated.

We assessed technologies on the following component levels:

- **Hardware (Filter):** The individual filtration system component, including size and weight, filter capabilities, and ease of use.
- **Hardware (Respirator):** Portability, integration and compatibility amongst available filters.

Current State of Deployment

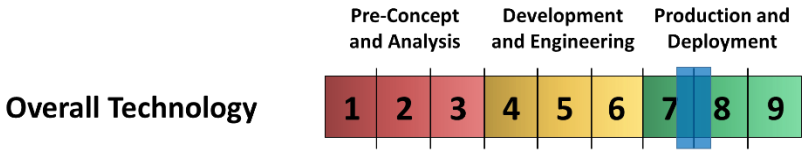
There are currently a number of widely accepted escape respirator technologies on the market, and these products do a fairly good job fulfilling this requirement. Escape respirators are available today that are relatively quickly and easily activated by users without extensive technical training. These units are lightweight, portable, and can provide adequate short-term protection against numerous toxic gasses found in environments that fire and hazardous materials responders might encounter. They are also compatible with a multitude of SBCA units, allowing for easy changeover. However, this technology can be improved upon in some areas. While the current technology allows for the possibility of verbal communication between first responders within close proximity of each other, the ability to be equipped with electronic communication devices would allow for clear communication between responders in a larger area, both inside and outside of the area of operation.

Evaluation of Escape Respirators Currently on the Market

Essex Industries, St. Louis, MO

PRODUCT: *Last Chance[R] Rescue Filter* | SITE: http://essexind.uberflip.com/i/114690-last-chance-rescue-filter-lcrf-training/4

Radar: Last Chance Rescue Filter



Company Description

Founded in 1947 by Harold and Sidney Guller, Essex Industries is a leading supplier in the Aerospace and Defense, First Response, and Safety and Medical markets. They first entered the market in cryogenics in 1963 manufacturing liquid oxygen convertors for military and commercial applications before establishing themselves in the healthcare market supplying oxygen regulators for patients. In 1991, Essex acquired Portable Breathing and Rescue Products Division from The DuPont Corporation, which enhanced the company's offering of Emergency Breathing Equipment.

Product Description

The Last Chance® Rescue Filter is equipped with patented technology and a triple filtration system that eliminates the potentially lethal gases present in a structure fire. It is available for a range of SCBA devices and easily changes over when needed. Its small, lightweight hard case, is easy to hook on to a belt or strap and carries a 5-year shelf life.

Product Features

The Last Chance® Rescue Filter is lightweight, portable emergency escape respirator. It features an Injected-molded canister made of impact- and heat-resistant polycarbonate that does not require maintenance. Its three-stage platform filter captures smoke particles 0.5 microns and larger, removes most harmful gasses through a carbon bed process of absorption and reaction. It then converts CO to non-toxic CO_2 through a granular bed of manganese dioxide/copper dioxide (hopcalite) and pushes the filtered air to the intake valve and into the SCBA face-piece. It provides up to 15 minutes of protection against exposure to smoke and toxic gasses. The Last Chance® Rescue Filter is currently compatible with the following:

- Scott SCBA Masks: AV-2000, AV-3000, Scott-O-Vista
- Draeger SCBA Masks: Panorama Nova-P, Futura P, F2P, FPS 7000
- MSA SCBA Mask: Firehawk
- Sperian SCBA Masks: Twenty Twenty Plus
- ISI SCBA Masks: RDV Facemasks

The Last Chance® Rescue Filter has a five year shelf life, provided the unit remains vacuum packed in the foil barrier pouch. Last Chance® Rescue Filter certifies the product to filter out harmful particles and smoke for 15 minutes, and reusable training filters are also available. Although the Last Chance® Rescue

Filter does not provide oxygen in an oxygen-deprived environment, it does reduce the possibility of smoke inhalation-related deaths. For instance, the filter is capable of converting CO to CO_2.

Last Chance® Rescue Filters specifications:

Canister: Injection-molded, impact- and heat-resistant polycarbonate, making it extremely durable, light and compact.
Adapter: Self-locating, identical to the Sperian second stage Air Klic™ fastening system, built into the device to allow easy one-handed attachment.
Three-stage filtration platform

- **Stage One:** An N95 pleated fiber filter captures smoke particulates and traps 95% of all particles 0.5 microns and larger.
- **Stage Two:** Once particulates are removed, the toxic gases enter an activated carbon bed. Through the process of absorption and reaction, most of the harmful gases, with the exception of CO, have been filtered.
- **Stage Three:** The air containing CO passes through a granular bed of manganese dioxide/copper dioxide (hopcalite) that converts CO to non-toxic CO2. The filtered air is now pulled up through the intake valve and into the SCBA face-piece.

Size: 3.25" Diameter; 5.5" Height
Weight: 7 oz.
Packaging: Consists of an inner moisture-resistant foil barrier pouch and an outer protective Nomex® carrying pouch.

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

- Enables verbal communication (as opposed to some stand-alone escape respirators)
- Can be utilized for more applications than "Escape Only" (including operations and search-and-rescue)
- By equipping the Last Chance® Rescue Filter, the firefighter can escape without the added weight of the air pack.
- Portability offers the ability to carry additional filters in RIT bags for multiple downed firefighters.
- Long shelf life (Last Chance® Rescue Filter rated at 5 year shelf life)

Likely Weaknesses

- Not guaranteed to remove all contaminants from any particular fire environment.
- Does not provide oxygen, and is not recommended for use in oxygen-deficient environments.
- Masks do not offer general skin protection, such as in the event of a chemical attack. In cases where employees are required to remain in the area of release, full-body chemical protection, such as chemical suits, would be needed.
- While it does provide verbal communication, it does not come equipped with electronic communication devices.

Additional Information and Pricing

The Last Chance® Rescue Filter is currently available in several models that are compatible with Scott, Sperian, Draeger, and MSA SCBA's. Trainer filters are also available with the aforementioned compatibility. Trainers provide an easy and cost-effective way to train personnel on their use as they are light-weight and reusable. The trainers also come with a mock barrier pouch that is re-sealable for future use. Pricing for filters start at $195 and trainers start at $125

Emerging Research and Direction of Innovation

While the use of portable, interchangeable escape respirator filters are ideal, the fire and hazardous materials responders could benefit from more optimized proprietary escape respirators at a lower cost. This would encourage their use in smaller communities that are equipped with less funding for these types of accessories. However, the technology currently satisfies the requirements needed.

Summary

The availability of proper structural fire/IDLH escape respirators is not widespread, but those that are available meet the current technology requirements. However, as mentioned, many communities are not equipped with the proper budget to facilitate the use of these accessories. At times, some communities are hesitant to purchase these escape respirator filters because of the reduced likeliness of these life-threatening scenarios, regardless of shelf life.

PRIORITY #13: Less Harmful / Safer More Effective Human Capture and Restraint Devices

Technology Requirement Overview

Police and corrections need more effective, safer, yet less harmful technologies to capture humans in flight as well as restrain them for prolonged periods. New technologies must reduce physical and psychological harm potential while increasing the safety and efficiency of Law Enforcement and correction operations. The mere presence of less lethal options has the potential to be enough to diffuse dangerous situations. According to the Bureau of Justice Statistics, the percentage of local police departments that authorized their officers to use conducted energy weapons such as Tasers increased from 60% in 2007 to 81% in 2013. Five years later, these numbers continue to rise as departments and agencies seek alternative methods of subject restraint and use of force.

Year the Requirement was Identified by the IAB

- 2015: Priority #15

Requirements of the Technology

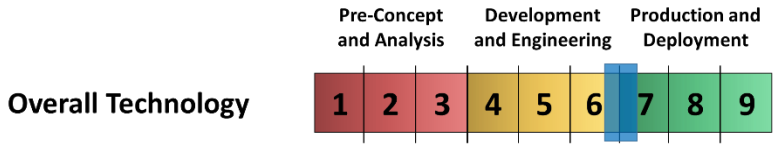
Because law enforcement and corrections personnel will experience events and incidents that require decisions potentially utilizing deadly force, there is a need for alternative choices of equipment for their use. Officer safety and subject safety are the most important requirements. In conjunction with appropriate action and timely decisions from law enforcement and corrections, safer capture and restraint devices must:

1. Provide law enforcement and corrections with a non-lethal, less harmful and safer option of capture and restraint of subjects.
2. Ease of use, ability to apply with one hand.
3. Be portable and easily accessible to officers.
4. Affordable without excessive training requirements.

Targeted End Users

- Law Enforcement

Radar: Human Capture and Restraint



Rationale for Radar Level

Using the Department of Defense's TRL scale as a reference guide, we assess the overall state of effective human capture and restraint devices at **Level 6.5**. The primary users of these products for IAB will be law enforcement and corrections; with this audience in mind, we considered the overall use of the equipment and how well it satisfies the needs of the users and their mission. While non-lethal use of force technology has made advances over the years since incidents like the Ferguson Officer Involved Shooting and the Freddy Gray event, the current traditional methods are still the standard for law enforcement and corrections units throughout the country. While many agencies and departments have capabilities that

can be classified as non-lethal, the traditional equipment (handcuffs, sidearm, baton) is the standard nationwide, coupled with consistent training on the decisions to use deadly force.

Assessment Methodology

The assessment methodology focuses on the technology, from its current state to available vendors and products, particularly in law enforcement equipment. In addition, the methodology will include emphasis on emerging research in non-lethal force, and what agencies and departments have implemented new products to their forces.

At an individual vendor level, product type, usability, extensibility, price, and strengths/weaknesses are all evaluated.

We assessed technologies on the following component levels:

- **Ease of use:** Equipment must be easy to use and accessible. Officers' decisions and actions to utilize any method of force must be swift and quick.
- **Additional training requirements:** Any new technologies will require training to all those whom the devices/equipment are issued if it deviates from standards or current equipment. Additional training time must be taken into consideration.
- **Officer and subject safety:** Must maintain safety standards for officers and subjects. Products that require more time for officers to deploy or use may in turn become an unsafe situation for responding officers.
- **Cost/affordability:** Product must be affordable to purchase, and maintain.

Current State of Deployment

The current design and composition of human capture and restraint devices has remained relatively similar for centuries. Recognizing the need to limit escalation of force, research and development of non-lethal weapons has been undertaken by many weapon manufactures in order to fill the gap. Less lethal weapons, tactics, techniques, and procedures may be employed in riot control, crowd control, prisoner control, refugee control, and self-defense. Beanbag loaded shot guns and non-lethal rounds are currently used in the market to incapacitate, but not kill. Rubber bullets, wax bullets, sponge grenades, and rubber bullets with electroshock effect are all less lethal than conventional bullets. With all of these technologies available, the marketspace continues to be dominated by the most popular products, but also offers some innovative alternatives.

It is helpful to understand various methodologies and terms:

- **Deadly or lethal force:** Force that a law enforcement officer uses with the purpose of causing, or that the officer knows to create a substantial risk of causing, death, or serious bodily harm.
- **Excessive use of force**: The application of lawful use of force in too many separate incidents.
- **Less-lethal weapons:** Less-lethal technologies give police an alternative to lethal force. These weapons are especially valuable when lethal force (1) is not necessary, (2) is justified and available for backup, but lesser force may resolve the situation, or (3) is justified, but its use could cause serious injury to bystanders or other unacceptable collateral effects. The weapons currently in use include chemical agents, batons, soft projectiles, and electrical devices such as stun guns and Tasers.

- **Non-deadly or less lethal force:** The level of force required to gain compliance that is not known to or intended to create serious bodily harm or death.
- **Use of excessive force:** The application of force beyond what is reasonably believed to be necessary to gain compliance from a subject in any given incident.
- **Use of force:** The amount of effort required by law enforcement to gain compliance from an unwilling subject.

Through reviewing literature, speaking with law enforcement representatives, and researching companies, it is apparent there is no real leading new product or technology being widely used regularly by law enforcement nationwide. Standard practices and policies of use of force and use of non-deadly or less lethal force continue to be implemented throughout the country successfully.

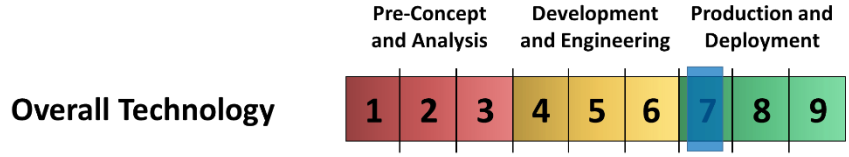
However, increasing situations resulting in excessive use of force, and increasing public protests over such incidents means that products will continue to be developed in search of alternative types of devices and equipment.

Evaluation of Human Capture and Restraint Devices Currently on the Market

Hobble

PRODUCT: *Hobble Restraint Device* | SITE: multiple vendors

Radar: Hobble Restraint Device



Company Description

Police hobbles are sold by different vendors and companies with no lead producer or seller.

Product Description

The Hobble Restraint Device may be used as an alternative to handcuffs on a non-violent subject. Hobbles are primarily made of a webbed belting material. Law enforcement may use the Hobble above the elbows with the subject's handcuffed hands behind the back to restrict further movement. The Hobble may also be used to restrict movement of the subject's legs by tightening the Hobble like a belt around legs or ankles. Some models include clips to connect the hobble to handcuffs.

The Hobble restraint device is primarily used in transport of subjects.

Product Features

Hobble devices are typically lightweight and completely portable, allowing first responders to rapidly detain subjects with a less lethal option. Most designs work with all models of handcuffs for the use of restraining combative subjects. It is ideal for all circumstances where restraints are needed, including but not limited to leg restraints, law body restraints, soft restraints, prison restraints, and hand restraints.

Product Examples

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

- Hobbles are portable and can be easily transported and stored in patrol cars
- Lightweight and not heavy or bulky
- Require no extensive training or policy changes for utilization
- Easy to use, quick to apply

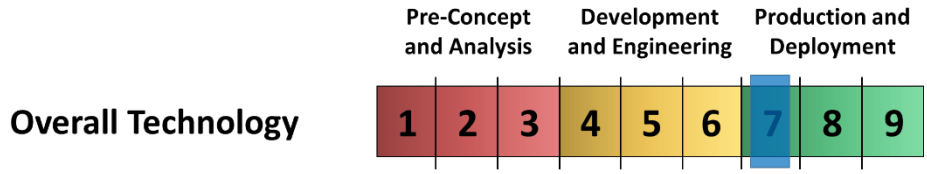
Likely Weaknesses

- For high risk or dangerous suspects only
- Primarily only used for transport
- Requires more than two hands to use properly

Learn more: https://blackdogtactical.net/collections/police-hobbles

Alternative Ballistics, Poway, CA
PRODUCT: *The Alternative* | SITE: http://www.alternativeballistics.com/en/

Radar: Alternative Ballistics



Company Description
Alternative Ballistics mission is to develop effective technology for law enforcement and military agencies across the globe. Research, testing and human effects studies helped the company create THE ALTERNATIVE®.

Product Description
THE ALTERNATIVE® is a bullet capture device designed to sit on top of the weapon to capture the bullet when fired. Once the bullet is fired, the device catches the bullet and they become one unit – ejecting THE ALTERNATIVE® from the barrel of the gun. By decreasing the velocity of the bullet, the result is the projectile impacting the threat, which results in serious pain, but with less internal injury than a traditional bullet. Developed in 2012, THE ALTERNATIVE® was designed for a simple one-handed removal of the device and attachment to the top of the weapon within seconds without officers needing to divert attention away from the threat.

Product Features
The device is one of the latest in a growing inventory of less lethal weapons for law enforcement. Other products like the Taser or beanbag shotgun require officers to carry additional gear. THE ALTERNATIVE® simply attaches to an already issued Glock, Sig Sauer, or other comparable 9mm pistol.

The attachment is mounted to the top of the weapon, and when fired, the bullet embeds into a metal-alloy capture device approximately the size of a ping-pong ball, traveling about 250 feet per second. Said to be effective out to 30 feet, the device incapacitates a subject through blunt force trauma with a diminished risk of serious injury or death.

In the wake of the death of Michael Brown, the device was recently tested and trained with by the Ferguson Police Department. According to THE ALTERNATIVE® website, distributors and sales representatives can be located worldwide, although there are no numbers on how many departments or agencies currently use their product.

Product Examples

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

- One handed, less lethal device
- Attaches to already issued duty weapon carried by offices
- Easy to carry and transport
- If weapon is not fired, attachment can be removed and put away

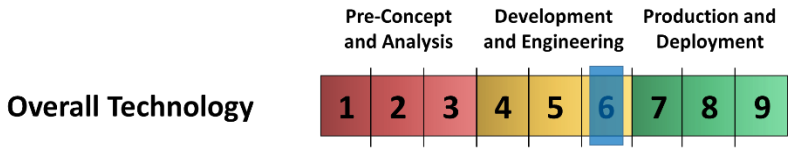
Likely Weaknesses

- One time use once fired
- First round will be non lethal with the attachment, however subsequent round will not have the attachment and fire as normal
- Extensive training of proper use for anyone issued the device
- While it is designed for one hand attachment, officers will still have to make a decision to use it, and may not have time to attach the product. Time wasted in any scenario could cost lives

Net Gun

PRODUCT: *Net Gun* | SITE: http://www.thenetgunstore.com/

Radar: Net Gun



Company Description

No single company stands out at a leader within manufacturing. Dozens of manufacturers and distributors of net gun technology both domestically and internationally.

Product Description

Averaging about the size of a flashlight, net guns can be easily stored in cars or carried by law enforcement. When fired, the CO2 powered device launches a net (averaging 12 feet) toward the target. Testing recommends firing from 15 feet away to ensure accuracy. On average, the nets land approximately 45 feet away.

Product Features

Originally created for safe rescuing of animals, the net gun is now used by law enforcement agencies for riot control and criminal capture situations. The device allows for a non-lethal means of subject capture by launching a net to stop them in their tracks.

Product specifications for standard models on http://www.net-gun.com/

- Coverage space: 16 square meters
- Product size: 118 mm (head) x 48 mm (handle) x 338 mm (length)
- Product weight: 1.03 kg
- Packaging size: 46 cm x 32 cm x 20 cm
- Packaging weight: 4.3 kg
- Traction head quantity: 4
- Power delivery: air bottle / compressed air via co2 cartridge
- Air bottle pressure value: 2.8 +/- 0.2 mpa

CO2 cartridges are purchased separately and can be found at any local bike shop.

Product Examples

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

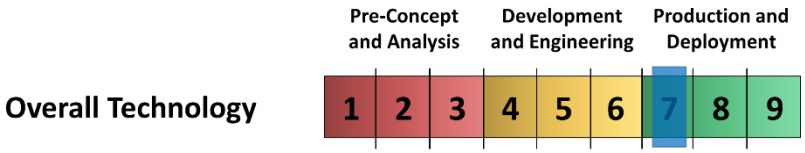
- One handed, less lethal device
- Easy to carry and transport
- Quick capture device that will leave suspects completely unharmed

Likely Weaknesses

- Product is expensive $500-800, plus CO2 refills
- Weather (wind) may play a key role in successful deployment of the net
- Accuracy is best at close range
- Law enforcement will still need to restrain the individual. The net will only keep them from moving any faster or further
- Used primarily for animal capture

Safe Restraints, Walnut Creek, CA
PRODUCT: *The WRAP* | SITE: http://saferestraints.com/

Radar: The Wrap



Company Description

Safe Restraints, Inc. provides products and training that increase security, increase safety for subjects and personnel, and increase protection of property. Founded by law enforcement officers, Safe Restraints, Inc. directly understands the immense and complicated dangers that both subjects and safety professionals face in restraint situations.

Product Description

Designed to stop these conflicts quickly, the WRAP restraint device provides rapid recovery for both officers and the subject. Subjects are restrained comfortably in an upright and seated position of max respiratory recovery. According to Safe Restraints, The WRAP has a 20-year history of saving lives, reducing injuries, and minimizing risks for all involved.

The WRAP is a four-piece restraint system available in two models. A "soft cuff" version exists primarily for custodial or medical care use. The device is comprised of a locking shoulder harness, leg restraint, and ankle strap. A tactical bag is included for storage and transport of the system.

Product Features

- **Locking Shoulder Harness**
  - Convenient back storage pocket for equipment such as spit masks and safety gloves
  - Locking carabineer for securing handcuffs
  - Stainless steel locking buckles
- **Leg Restraint**
  - With stainless steel locking buckles
  - Holds legs in an extended position
  - Eliminates the ability to kick
  - High grade mesh allows body heat to escape
  - 3-inch straps distribute pressure
- **Ankle Strap**
  - With carry handle
  - 3 inches wide
  - Locks the ankles (crossed)
  - Distributes pressure to reduce blood flow restriction
- **Tactical Bag**
  - With hands-free shoulder strap
  - Exterior bright yellow marking and interior yellow dividers for ease-of-use in low light

Product Examples

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

- Less lethal option for restraint
- Keeps suspects in a safe upright position for transport
- Good tool for combative subjects
- Can be used on all subjects, including juveniles

Likely Weaknesses

- Product is expensive
- System requires more than one officer for application
- Product cannot be easily carried, must be stored in large bag in vehicle
- Subjects will still require handcuffing in conjunction with the WRAP system

Emerging Research and Direction of Innovation and Summary

There does not seem to exist any new innovation or emerging research with this specific product.

PRIORITY #14: Rapid, Universal Battery Charger for Portable In-Home Medical Devices

Technology Requirement Overview

Power outages, especially those associated with both natural and man-made disasters, can pose many problems for the affected population. Arguably, no segment of the population is impacted by power outages as profoundly as the homebound special needs population, and particularly those who are reliant on electrical in-home medical devices such as infusion pumps, ventilators, and apnea monitors. Many of these devices have battery backups that can provide off the grid power for a relatively short amount of time, but these batteries might not be enough during events that extent over a period of days. In such events, these homebound patients must rely on first responders to transport them to a medical facility or specially outfitted shelter. Rather than further tax the first responder network, many patients in these conditions would greatly benefit from the development of a universal battery charger that first responders and EMS technicians could use to rapidly charge the backup batteries of various in home medical devices.

Summary of the Radar and Radar Purpose

The assessment takes an "at a glance" view of the overall technology and is intended to serve as a guide for evaluation of the vendor/landscape technology. The "subradar" is a more detailed assessment of individual technologies, a reflection of both the whole and constituent elements of the technology, and the vendor's maturation of each element.

Year the Requirement was Identified by the IAB

- 2016 – Priority #22
- 2015 – Priority #24

Requirements of the Technology

Because first responders and emergency medical technicians are often dispatched to residences of homebound patients for transport to medical facilities during power outages, a need exists for the capability to recharge batteries for in-home medical devices easily, quickly, and safely. Universal application of the charger for the various batteries employed is the most important requirement, as well as the ability to easily and safely recharge the battery in a relatively short amount of time.

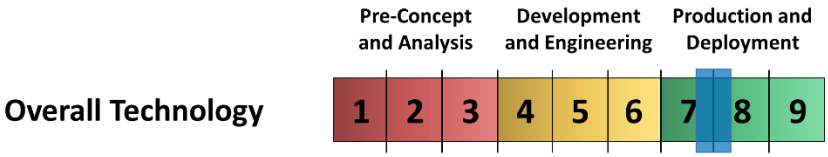
The battery charger must:

1. Provide first responders with a universal charger that is compatible with the various rechargeable batteries commonly used with in-home medical devices.
2. Efficiently recharge in-home medical device batteries within an hour.
3. Be portable and easily accessible for first responders and emergency medical technicians.
4. Be easily operated with minimal training involved.
5. Be intrinsically safe for extended operation and multiple charging sessions.

Targeted End Users

- EMS Technicians – Primary
- Emergency Managers
- First Responders

Radar: Universal Battery Charger



Rationale for Radar Level

Using the Department of Defense's TRL scale as a reference guide, we assess the overall state of in-home medical device rapid battery chargers at **Level 7.5**. The primary users of these products for IAB will be first responders and emergency medical technicians; with this audience in mind, we considered the overall use of the products and how well they satisfy the needs of the users and their mission. While rechargeable battery technology has advanced over the years and continues to do so, the development and wide spread use of these new battery systems for in-home medical applications is still multiple years away. The current state of rapid battery recharge technology is also fairly lacking in terms of compatibility with medical devices.

Assessment Methodology

The assessment methodology focuses on the technology, from its current state to available vendors and products, particularly in rechargeable batteries and battery charging options associated with in-home medical devices. In addition, the methodology will include emphasis on the emerging research in battery and battery recharging technology.

At an individual vendor level, product type, usability, extensibility, price, and strengths/weaknesses are all evaluated.

We assessed technologies on the following component levels:

- **Universal Application:** The product must be able to charge the various in-home medical devices that they might encounter. Because of the numerous types of batteries used in these devices, multiple connectors might be necessary.
- **Battery charging efficiency:** The product must be quick and efficient at recharging the batteries used in these devices. It is imperative that batteries be recharged in as little time as possible as to maximize the efforts and effectiveness of the first responders and emergency medical technicians responding to these types of calls.
- **Portability and Accessibility:** The product must able to be transported on the first responder's vehicle and carried by the first responder.
- **Ease of Operation:** Product must be easily operated , preferably by a single operator, with minimal training involved.
- **Safety:** The product must be safe to use for extended operation intervals and multiple charging sessions.

Current State of Deployment

The marketspace currently lacks a product tailored specifically for the rapid recharge of batteries used with in-home medical devices. One particular reason for this is not necessarily the fault of one particular charger, but rather the different types of batteries used in these devices. Recently, devices have been transitioning to the use of lithium ion and nickel-cadmium batteries, which can be recharged quickly. However, many devices still employ lead acid batteries, which can take anywhere from eight to sixteen hours to fully recharge. Therefore, while the charger itself may be sufficient to recharge a battery within an hour, the battery itself is not able to charge that quickly. While the technology to quickly recharge batteries exists, and this technology is being further refined and employed in other sectors of the market (i.e. cellphones, tablets, laptops etc.), there are no market-ready solutions that specifically address the universal application of a rapid battery charger that can be used in conjunction with various batteries found in in-home medical devices.

Through reviewing literature, speaking with medical field representatives, and researching companies, it is apparent that there is no real leading new product or technology that adequately addresses the requirements previously listed. The standard practice of transporting in-home patients to facilities with auxiliary power sources during times of outages continues to be implemented throughout the country. This indicates the need and marketspace for such technology.

Evaluation of Universal Rapid Battery Chargers Currently on the Market

Portable Solar Generators

PRODUCT: *Yeti 1250 Portable Power Station* | SITE: http://www.goalzero.com/

Radar: Universal Battery Charger

Company Description

The mission of Goal Zero has been to empower people by putting reliable power in the hands of every human being. They provide a wide array of portable battery and charging devices.

Product Description

The Yeti 1250 Portable Power Station is a portable, large capacity back up power supply that can power a wide variety of home appliances and electronics. Use indoor or outdoor to backup critical appliances including refrigerators, freezers & home health care equipment like a CPAP machine. It stores 1250 watts of power, making it your ideal backup emergency portable power station.

Product Features

The Yeti 1250 Portable Power Station features a large 1200 watt hour AGM battery capable of being charged from a regular wall outlet, as 12V car adapter, or compatible solar panels. It has three sets of power outputs: three USB ports, three 12V DC outlets, and three AC Inverter outlets.

Product specifications for this model can be found at http://www.goalzero.com/p/140/goal-zero-yeti-1250-portable-power-station

Product size: 11 x 16 x 14.5 in
Product weight: 103 lbs
Charge Time: Wall Charger – 18 hrs.; Car Charger – 44 hrs.; Solar Panels – Varies based on size
Power Output:

-AC inverter (output, pure sine wave): 110VAC 60Hz, 10A (1200W cont., 1500W surge max)
-USB Port: 5V, up to 2.1A (10.5 W max), regulated
-12V Power Pole Port (output): 12V, up to 33A (400W max)
-12V car port (output): 12V, up to 10A (120W max)

Product Examples

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

- Large power storage capacity allows for use/charging of multiple devices or multiple charging sessions
- Easy for single operator to use
- Requires no extensive training
- Medical devices can be plugged directly into the unit, eliminating need for adaptors
- Able to be recharged during power outages by way of solar panels

Likely Weaknesses

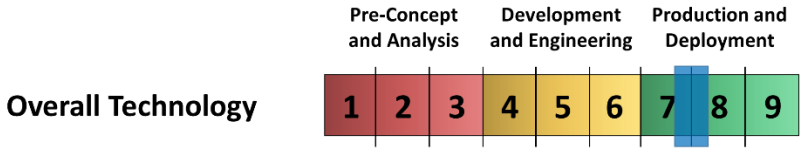
- No quick charge ability
- Weight makes it too heavy for one person to transport quickly and easily
- AGM (lead acid) batteries do not stay fully charged on their own and should be plugged into a power source at all times, especially during storage

Additional Information and Costs

Retails for $1,499

PRODUCT: *Generator Y1200 Portable Generator* | SITE: https://goenerplex.com/

Radar: Generator Y1200 Portable Generator



Company Description

EnerPlex is your ultimate portable power solution for any situation you may encounter. Whether on top of a mountain or in the boardroom, EnerPlex will always keep you powered up and in charge. They provide a wide array of portable battery and charging devices, ranging from business card sized phone chargers to portable solar generators.

Product Description

The EnerPlex Generatr™ 1200 is a lightweight and portable large format battery that is ideal for emergencies, camping, and any time you need power for long periods. At only 42 lbs., this unit is 60% lighter than similar products, yet holds the same amount of power that will keep your phones, tablets, laptops, and even mini fridges powered up for days.

Product Features

The EnerPlex Generatr™ 1200 features a large 1231-watt hour lithium-ion battery capable of being charged from a regular wall outlet, as 12V car adapter, or compatible solar panels. It has three sets of power outputs: three USB ports, three 12V DC outlets, one 19V DC outlet, and three AC Inverter outlets. It is also lightweight enough to be carried by one person, thanks to the built in ergonomic handles.

Product specifications for this model can be found at:
https://solarmade.com/store/product/download/file_id-4808

Product Dimensions: 16.14 x 11.96 x 11.41 in.
Battery Capacity: 1231-watt hours
Product Weight: 42 lbs.
Battery Type: Lithium-Ion
Power Output:

-AC inverter (output, pure sine wave): 110VAC 60Hz, 10A (1000W cont., 20000W surge max)
-USB Port: 5V, up to 2.4A (10.5 W max), regulated
-19V Port: 19V DC, 6.3A, regulated
-12V Port: 12V DC, 10A, regulated
-Charge Time: Wall Charger – 10-16 hrs.; Solar Panels – Varies based on panel size

Product Examples

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

- Large power storage capacity allows for use/charging of multiple devices or multiple charging sessions
- Easy for single operator to use
- Requires no extensive training
- Light enough for one person to transport quickly and easily
- Medical devices can be plugged directly into the unit, eliminating need for adaptors
- Able to be recharged during power outages by way of solar panels or 12V car adapter
- Lithium-Ion battery allows for more charging cycles, leading to a longer lifespan

Likely Weaknesses

- No quick charge ability

Additional Information and Costs

Retails for $1,399

PRIORITY #15: Multi-Meter for Bomb Technicians

Technology Requirement Overview

Law enforcement agencies are continuously seeking to improve response operations for both their own personnel and citizens of the communities they serve. Homemade explosive devices, suspicious packages, IEDs, and other forms of explosive devices continue to be a trend throughout the country. According to the 2016 Annual Explosives Incident Report (EIR), actual explosion incidents have decreased significantly since 2012. The EIR captures all bombing and explosive related incidents reported through multiple channels. While there has been a sharp decrease of the last 6 years, there was a slight increase in incidents recorded from 2015-2016. The need for responders to be equipped with the best technologies will continue to be a priority as long as the threats still exist.

To safely respond to explosion incidents, EOD units and bomb technicians require high levels of training, coupled with specialized equipment. Specifically, they may at times use multi-meters during a response operation. Typical multi-meters used by bomb technicians measure voltage, current, and resistance, but are not specifically designed for bomb squad use. A multi-meter designed specifically for bomb squads would reduce risk and make operations more efficient, effective, safe, and accurate with a dedicated tool that meets their needs.

Summary of the Radar and Radar Purpose

The assessment takes an "at a glance" view of the overall technology and is intended to serve as a guide for evaluation of the vendor/landscape technology. The "subradar" is a more detailed assessment of individual technologies, a reflection of both the whole and constituent elements of the technology, and the vendor's maturation of each element.

Year the Requirement was Identified by the IAB

- 2016 – Priority #18

Requirements of the Technology

HME devices, bombs, IEDs and suspicious packages will continue to require newer technology for response units to successfully disable or detonate threats. Because bomb squad and EOD personnel will be the primary response units, having a dedicated multi-meter specific to bomb tech needs would increase efficiency and safety.

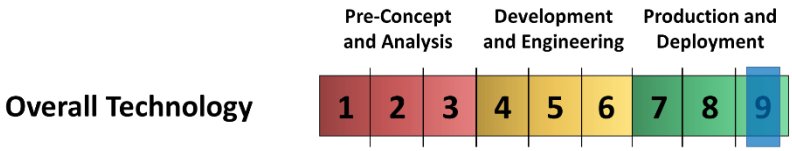
Bomb Technician specific devices must:

- Have integrated indirect current probe and voltage meter, ammeter and continuity tester.
- Color coded probes should be optimized for taking voltage and current measurements through the insulation of detonator leg wires.
- Tool should provide actions based on meter readings and have programmable thresholds.
- Operators should be able to easily take indirect current measurements using an integrated current probe whose readings are automatically converted to units of amperes.
- Have protections to prevent operator from inadvertently configuring the probes incorrectly to measure voltage or current.

Targeted End Users

- Bomb Technicians

Radar: Multi-Meter for Bomb Technicians



Rationale for Radar Level

Using the Department of Defense's TRL scale as a reference guide, we assess the overall state of specifically designed bomb technician multi-meter tools at **Level 9**. The primary users of these products will be bomb technicians; with this audience in mind, we considered the overall use of the equipment and how well it satisfies the needs of the users and their mission. While EOD and Bomb Squad capabilities and available technology has made advances over the years since incidents like the Oklahoma City, Centennial Park, or more recently, the NYC subway bomb, there remains a continued need to keep up with emerging technology and outfit responders with the appropriate tools. While there does not exist a customized multi-meter specifically designed for bomb technicians, the technology is readily available to meet this need.

Assessment Methodology

The assessment methodology focuses on the technology, from its current state to available vendors and products, particularly in law enforcement equipment. In addition, the methodology will include emphasis on the emerging research in bomb technician specific multi-meters and if departments have implemented new products to their forces.

At an individual vendor level, product type, usability, extensibility, price, and strengths/weaknesses are all evaluated.

We assessed technologies on the following component levels:

- **Ease of use:** Multi-meter must be easy to use and portable.
- **Additional training requirements:** Any new technologies will require training to all those whom the devices/equipment are issued if it deviates from standards or current equipment. Additional training time must be taken into consideration.
- **Technician safety:** Must maintain standards of safety for technicians.
- **Cost/affordability:** Product must be affordable option to purchase and maintain.

Current State of Deployment

The marketspace currently lacks a tailored multi-meter tool with manual entry scenarios requiring electronic detonator and switch diagnostic that measures (1) DC current (in-line and indirect current probe) and (2) DC voltage. With a device tailored specific to EOD operations, bomb technicians could improve efficiency and accuracy when responding to explosive involved incidents.

Through reviewing literature, speaking with law enforcement representatives, and researching companies, it is apparent there is no real leading new product or technology being produced. Multi-meter tools non-specific to bomb technicians are standard and do currently measure DC current, voltage, and continuity.

This shows the need and marketspace for such a device.

Evaluation of Multi-Meter for Bomb Technician Currently on the Market

Company Description

Companies such as Grainger and Fluke, leading brands for standard multi-meters, were contacted about potential development of a bomb technician specific multi-meter. Neither company responded with positive news of future product development.

Ideal Future Product Description and Features

The desired multi-meter will have integrated indirect current probe and voltage meter, ammeter, and continuity tester. Color coded probes should be optimized for taking voltage and current measurements through the insulation of detonator leg wires. The tool should provide actions based on meter readings, and have programmable thresholds. Operators should be able to easily take indirect current measurements using an integrated current probe, whose readings are automatically converted to units of amperes. The device should have protections to prevent the operator from inadvertently configuring the probes incorrectly to measure voltage or current.

Analysis: Likely Strengths and Likely Weaknesses

Likely Strengths

- Easy to use, portable
- Provides all in one tool for technicians
- Increased efficiency
- Increased accuracy

Likely Weaknesses

- Potentially high cost
- Technicians may have to be retrained on the new equipment

Conclusion

Equipment for first responders is in a continuous improvement cycle, and new technologies continue to enter the market. This research has attempted to identify many of the emerging technologies that are now available to first responders and align them with research and development gaps identified by members of the IAB as critical requirements. Numerous products were reviewed, and those most closely aligned with each of the 15 research gaps were assessed. Based on the capabilities of the equipment and how well the technology met the gaps, a technology readiness level was assigned to each to help illustrate how close each research gap is to being realized.

Many of the gaps reviewed failed to meet the requirements but for different reasons. In some cases, the desired technology exists; however, the hardware to make the technology meet the first responders' needs doesn't exist. As an example, the equipment may not be portable, could require shore power, or a host of other reasons (see 3D x-ray). In some instances, the technology is fully matured; however, the equipment hasn't been configured to meet specific needs of the first responder (see multi-meters for bomb technicians). Another issue that was observed is that components of a single technology exists and are at full maturity; however, they lack a complete integrated system of the separate components. A good example of this is the need to have a portable bio detection and identification system that will allow first responders to conduct active reconnaissance and, when necessary, immediate identification of a biological threat. Independently, the products reviewed perform their required mission; however, there is no single system that can be purchased as an integrated system that will allow one platform to both detect and identify a biological agent. In fact the two companies that were engaged for bio detection and identification stated neither plan on conducting research into the function they are not currently performing primarily because there are other commercial companies that not only perform the complementary function, but perform it well. Hands free radio intercom technological requirements are another example where the technology for squad-level intercom systems and LMR systems, there is no product today that combines these capabilities into an integrated system. Another observed limiting factor to full maturation of a specific technology are individual requirements that are not currently available on products currently in the market. An example of this is the technological requirement for Point-of-Care lab testing device. The i-STAT POCT meets the testing requirements of the gap; however, it isn't currently hardened and doesn't meet compliance requirements from the Center's for Medicare & Medicaid Services.

The research conducted for this project is meant to provide a general overview on the current state of identified critical mission technological requirements of first responders. To accomplish this, researcher's analyzed existing technology that is currently on the market to determine whether the specific needs identified by the IAB are currently being met and if not, how close are specific gaps to reaching maturation. This research is meant to provide a general overview for each of the technological gaps and not meant to be a detailed analysis and complete investigation into each of the products. For most of the technological gaps, this worked well and reviewers of the information are able to gain an understanding of the current status and limitations of a specific gap. However, this method didn't always result in a comprehensive understanding of where a technological gap currently resides on the technological readiness level. As an example, the requirement to have a universal rapid battery charger for medical devices relies on analysis

of deployable generators to provide a power source to medical device. While this meets the requirement of keeping the device powered, it isn't providing a capability to rapidly charge the battery so it can be used without the benefit of being connected to the power source. As such, the investigation into the capability isn't a complete analysis of the full requirement of the gap. The same can be said for the current gap in less harmful, safer, more effective human capture and restraint devices. While a full analysis of products currently on the market is provided, none of the products and capabilities investigated fully meet the needs of the gap as identified by the IAB.

While not part of the original scope for this project, any future investigations on the current status of first responder technological requirements should also include the National Laboratories and Federally Funded Research and Development Centers (FFRDCs). These centers are conducting research in multiple areas of interest to first responders and engagement with these centers could provide valuable insight on emerging technologies. During the course of the investigation for this project, a research team associated with Sandia National Laboratories was interviewed regarding their research into biological detection. Dynamic testing in a field environment for biological agents requires live proteins. While these are currently being used to provide real-time advanced warning in climate controlled environments, because these proteins rapidly deteriorate in adverse environments they are not viable for non-climate controlled environments. The Sandia National Lab research team is currently conducting research into the development of an "iron-man" suit for the individual cells to enhance their survivability in non-climate controlled environments. While this research is in the early stages and years from being deployed to the field, it provides valuable insight to what may be available to first responders in the future. The National Labs and FFRDCs are an extremely valuable resource and future investigation of first responder technological gaps should include engagement with these facilities.

Appendixes

Appendix A: Body Armor for Women

Ballistic Testing Standards For Female Body Armor

Summary of Gap

The use of body armor has been around for centuries, originally designed to provide protection from weapons used in hand-to-hand combat. With the advent of firearms, these traditional armors became less and less effective. Eventually, plate armor was constructed to be so thick and heavy that it completely prohibited the soldier's mobility. It also was incredibly hot to wear in warmer environments, which greatly increased fatigue within the ranks.

With the invention of Kevlar in the mid 1960's, body armor was able to transition from heavy plate metal to a lighter, thinner, fiber-based design. Soon after, other companies developed their own version of these materials, allowing for body armor to become easily and cheaply available. Additional improvements were soon made that allowed ceramic plates to be inserted into pockets in the vest, providing additional protection in critical areas of the body. The design of these different materials and body armors have been modified and improved dramatically since their introduction in the 1970's, but they were always developed based on a male physique. Recently, there has been a push for the creation of body armor that was more suitable for protection of the female form. However, the modifications of this new design has created gaps within the traditional testing standards that should be addressed.

Why is there a Gap?

Historically, the majority of body armor users have been male. This allowed for a relatively generic design to be used when manufacturing and testing the body armor. However, according to the National Law Enforcement Officers Memorial Fund, there are currently more than 900,000 sworn law enforcement officers now serving in the United States, which is the highest figure ever. About 12 percent of those are female[5]. The emergence and continual growth of women in these roles have created the need for body armor that is specifically tailored to the curves of the female form. The features of body armor optimized specifically for women, primarily focus on modifications to the chest and hip areas, enable women to be as protected and comfortable as men while wearing body armor[6].

With the new female-specific design of body armor comes the issue of testing this new equipment. While it is important for the body armor to fit properly, the non-planar aspect of the female-specific armor may have a negative effect on the armor's efficacy. Male or gender neutral models of body armor might be sufficient for female officers with smaller busts or more slender builds. However, they may not be suitable for those with larger busts, as the busts push the front armor panel forward, enlarging the underarm gap and therefore lessening the area of coverage between the front and rear panels[7]. And with the number of women in active military duty and law enforcement growing each year, the creation of specific ballistic testing standards for these non-planar vests is vital to the safety of these women in the line of duty.

[5] National Law Enforcement Officers Memorial Fund (Link)
[6] DHS Tech Note: Ballistic-Resistant Body Armor for Women (Link)
[7] Body Armor for Female Officers: What's Next?
By Michele Coppola (Link) - 2014

Current Standards and Testing Gaps

Adopted in 2008, the NIJ Test Standard 0101.06 provides the guidelines used in the ballistic testing of both male and female body armor. Viewed as a major revision to the previous standards in terms of testing male/gender neutral body armor, the NIJ 0101.06 standard is the most comprehensive, stringent and rigorous body armor compliance standard that exists today. However, as strict and thorough as this standard is, it does not adequately address issues presented by the unique design of female-specific body armor. According to Dr. David Otterson, "the test methods used in the current NIJ test standard, NIJ 0101.06, were historically used for the testing of planar armor panels. Female armor panels have features introduced into their designs that are meant to accommodate the female upper torso. The testing community felt the way the current standard addresses the testing of these unique constructions was too vague and led to inconsistencies in testing between laboratories."[8]

One example of an issue with current methodology when testing female body armor is how the armor fits against the body. Typically, male and gender-neutral armor is designed to rest flush against the body. However, due to the natural curvature of a woman's upper torso, air gaps will inevitably exist between the woman's bust and the armor, particularly gaps created by the intermammary cleft present in female law enforcement officers. It is currently unclear how this gap affects the ballistic performance of the body armor. From a testing environment perspective, ballistic panels are tested by pressing them flat against a clay testing block so that it assumes a planar shape. There is currently no consistent standard in place to simulate the female form and the air gaps created. Dan Longhurst, standards coordinator with the Justice Technology Information Center (JTIC), notes that "because manufacturing techniques have improved to accommodate female officers with more comfortable armor that provides better coverage, the standard needs to ensure that these armors are adequately tested to the same rigor as flat armor has been tested in the past."[9]

Another discrepancy in testing methods of male and female body armor centers around manufacturing techniques. Most commonly used within the law enforcement community, flexible armor is comprised of separate panels for the front and the back of the armor. When designed for male or gender-neutral applications, both front and back of the armor uses planar panels. However, two separate panels are used for female-specific armor, planar for the back and nonplanar for the front. The composition materials for both the planar and nonplanar panels are the same, but the nonplanar panels are enhanced with additional stitching and folds to better accommodate the female form.

The current testing standard addresses this in a somewhat vague manner, stating "For armors that have folds, seams, or other discontinuities (such as the bust cups of some female armors or the closures of front closing vests), additional shots shall be fired so that at least one shot impacts each fold, seam, or discontinuity. If a single fold, seam, or discontinuity extends more than one half the width or height of the armor (such as closure of a front closing vest), at least two shots shall impact that discontinuity."[10] While this provides a little guidance in terms of procedures, it lacks the precision found in the rest of the testing standards. In particular, the guidelines regarding the specific locations and distance between the supplemental shots fired at the discontinuities should be better defined.

[8] Email from Dr. David Otterson via Debra Stoe with NIJ

[9] Interactive TechBeat (Link)

[10] NIJ Standard-0101.06 – Ballistic Resistance of Body Armor (Link)

Additionally, the current testing standards do not address the specific location of shots fired at and around the formed bust area. Manufacturers employ a variety of methods to create bust cups, including cutting and stitching the material, or darting the material to form bust cups, or inserting molded bust cups into the armor. These manufacturing differences can possibly require different standards for testing. The different sized bust cups also need to be assessed, and testing standards for each size/shape should be identified. Because of the nonplanar nature of the panels used in female specific armor, test locations should focus on areas employ shapes that differ from male and gender-neutral armor, such as the sides, apex, and center of the bust area. With angles being introduced to the test environment that are not found in traditional armor, guidelines for number of shots, shot patterns, and shot locations need to be specified in such a way as to ensure consistent and reliable testing.

Another aspect of testing that could be further explored and defined is the potential effect of the non-planar aspect of female body armor on the acceptable amount of backface deformation. The term backface deformation in ballistic-resistant armor testing is the measurement on the indent in a clay backing material when a bullet that does not penetrate a vest makes an impression on the clay. Currently, the extent of allowable deformation set by the National Institute of Justice is 44mm. However, it is unknown whether the differences in shape and design of female armor require the amount of allowed deformation to be changed for the breast area.

In February 2013, the NIJ began meeting to discuss revisions to Standard 0101.06. Through these revisions, they expected to address several aspects of the current ballistic testing standards, including the creation of a testing protocol for shaped armor that ensures that a level of rigor is applied that results in confidence in the compliant product. The NIJ stated that they anticipated that a draft of the new standard, NIJ Standard-0101.07, be published and made available for public comment in the summer of 2017. However, according to Dr. Otterson, the NIJ 0101.07 draft is currently being reviewed internally within the National Institute of Justice and has not yet been released to the public. He also noted that the NIJ anticipates the release of the draft standard for public comment in the coming weeks.

Appendix B: Composite Priority List

Overall Rank	Research Priority	Research Gap	2014	2015	2016	Aggregated
1	Implementation of Unmanned Aerial Vehicles (UAVs)	Training / Standards	0.69	1.45	1.52	3.67
2	Female Balistic Resistant Body Armor research and testing	Performance Standards	0.15	1.27	1.36	2.78
3	3-D Tracking of Personnel	Deployable Technology	0.96		1.76	2.72
4	Handheld field deployed Biological detection	Deployable Technology	0.38	0.61	1.60	2.59
5	Handheld Standoff Chemical and Explosive Identifer	Deployable Technology	0.58		1.84	2.42
6	Noise-filtering Digital Speaker/Microphone for SCBA facepiece	Deployable Technology	0.85		1.20	2.05
7	3D X-Ray	Deployable Technology			1.92	1.92
8	Inexpensive, Portable, Ruggedized Point-of-Care Lab Testing Device	Deployable Technology		0.42	1.44	1.86
9	Virtual Reality Training Simulation	Training / Standards	0.42	1.36		1.78
10	Wearable Intrinsically safe miniaturized multi-detector sensor platform that's transmits data through integrated wireless or any existing communication system	Software and Hardware Integration	0.27	0.70	0.80	1.77
11	Improved Microclimate Cooling System for Down Range Use	Deployable Technology	0.23	0.47	1.04	1.74
12	Thermal Imaging Camera Training and Use Catalogue	Training / Standards			1.68	1.68
13	Mission Critical Secure Communication over Non-LMR networks	Deployable Technology		1.17	0.40	1.57
14	National Incident Collaboration System	Performance Standards		1.41		1.41
15	Automated GPS Tracking and Universal Symbology for Large Area Search Events and Widespread Disasters	Performance Standards		1.31		1.31

16	Improved Filtering Facepiece Respirator	Performance Standards	0.35	0.94		1.28
17	HME Neutralization	Deployable Technology			1.28	1.28
18	Research into the effects of Blast Overpressure from an Explosive Device	Performance Standards		1.22		1.22
19	Structural Firefighters PPE Interface Improvements to Reduce Contamination	Performance Standards		1.13		1.13
20	Meta-Analysis of Preventable Causes of Death of Law Enforcement	Research		0.56	0.56	1.12
21	Post Incident Decontamination Use of Wipes for the Neck	Research			1.12	1.12
22	Isolating Specialized Systems to Improve Security	Performance Standards		1.08		1.08
23	Research into improved method for assessing helmets for protection against ballistic blunt impact	Performance Standards		1.03		1.03
24	Decontamination of LE after a crime scene	Training / Standards		0.98		0.98
25	Robotic X-Ray Integration	Performance Standards			0.96	0.96
26	Protective Shields Research and Testing	Performance Standards	0.19	0.75		0.94
27	Enhance communications in environments that interfere with radio transmissions	Deployable Technology	0.92			0.92
28	Standardized national program for emergency management	Performance Standards		0.89		0.89
29	Hands-free Radio Intercom	Deployable Technology	0.88			0.88
30	Structure Fire / IDLH Escape Respirator	Deployable Technology			0.88	0.88
31	Less Harmful/Safer more effective human capture and restraint devices	Deployable Technology		0.84		0.84
32	Redaction of Imagery from Body Worn, Vehicle, or Surveillance Cameras for Public Release	Software and Hardware Integration Gap		0.33	0.48	0.81
33	Modeling, Simulation & Simulation Software Evaluation Tool	Training / Standards	0.81			0.81

34	Natioanl Standardized suite of risk assessment tools	Performance Standards		0.80		0.80
35	Proactive Training Resource (PTR) Initiative	Training / Standards	0.77			0.77
36	Responder / Receiver Mental Health and Wellness	Training / Standards			0.72	0.72
37	Rapid, Universal, Battery Charger for Portable In-Home Medical Devices	Deployable Technology		0.38	0.32	0.70
38	Automated CBRNE Event Isolation and Evacuation	Software and Hardware Integration		0.66		0.66
39	Multi-meter for bomb technicians	Deployable Technology			0.65	0.65
40	Implementation of protective ballistic gear for fire and medical responders	Training / Standards	0.65			0.65
41	Sampling kit for clothing / equipment contamination identification	Deployable Technology	0.64			0.64
42	Field Detection/Analysis Devices for Fire Vapors, Gases and Particulates in Post-Fire Operations and Investigations	Deployable Technology	0.62			0.62
43	Vehicle Borne Improvised Explosive Device (VBIED) Render Safe Tool	Deployable Technology	0.54			0.54
44	Interactive Simulator for Command Center Training (Virtual Playbook)	Performance Standards		0.52		0.52
45	Smart Response Vehicles	Deployable Technology	0.50			0.50
46	Develop model procedures and/or lessons learned from first responders to atypical emergencies	Training / Standards	0.46			0.46
47	Non-Burning Treatment System for Illegal Fireworks	Performance Standards		0.19	0.24	0.43
48	Modems and Routers for use between Personal Area Networks (PAN) Devices Land Mobile Radios	Performance Standards	0.31			0.31
49	Efficacy of Fusion Centers at the Local/State/Federal Level	Performance Standards		0.28		0.28

50	Body-Worn Video Analytics	Software and Hardware Integration		0.23		0.23
51	Collision Avoidance Systems for Response Vehicles	Software and Hardware Integration			0.16	0.16
52	Develop a Fully Integrated SCBA/Seatbelt System for Fire Apparatus	Deployable Technology		0.14		0.14
53	Device for Standoff Casualty Triage	Deployable Technology	0.12			0.12
54	Data Interace Between Nemsis Compliant, Patient Care Reports & Hosptial Medical Records	Performance Standards		0.09		0.09
55	Vessel Penetration Sampling Device	Deployable Technology			0.08	0.08
56	Equipment / Supply Guide for Relocating Special Needs Evacuees	Training / Standards	0.08			0.08
57	Standardized Model for Population Response to Disaster Events	Research		0.05		0.05
58	Emergency Responder Body Worn Integrated Electronics System	Software and Hardware Integration	0.04			0.04
59	Small Portable Decon Kit for VIP	Performance Standards		0.00		0.00
60	Guide for Stress Management After Incidents	Training / Standards	0.00			0.00

Appendix C: Complete 2016 Priority List

2016 Priority #1: Indoor 3-D Tracking of Personnel

Targeted End User: First Responders

Short Description: There is a need for priority development of technologies for tracking operating personnel in a 3-D environment indoors. Indoor tracking defined as urban type infrastructures such as a high-rise building to include XYZ coordinates. The research and development of 3-D tracking systems needs to continue until these systems are fielded. Integrated with the portable radio so it integrates with all responders.

Detailed Description: The R & D Item has two components. The first is a transmitting device carrier by a first responder that allows an electronic signal to be located to within 3 feet on both a horizontal and vertical access. This component could be integrated into equipment that is already carried by the first responder (I.e. radio, scba, PPE). This device would need to be able to communicate with a second component that could be several hundred meters away and out of line-of-sight. The second component is a computer that receives the signal and displays it, allowing an incident commander to observe in real time the location of 1st Responders operating on the incident. This system must work inside large buildings in some levels of below grade occupancies. The system must be able to be used for each incident in police and fire disciplines. The system must adapt to locally used GIS Systems and where possible allow the location of the first transmitting device to be transposed onto building blueprints.

Known Key Constraints: Must be lightweight (less than 8 ounces) and not interfere with responder's ability to perform mission. Preferred that it integrate into an already existing system (radio). It must be usable in an operational environment providing capability to locate a responder within a radius of 5 feet (threshold) and 3 feet (objective) within three-dimensional coordinate axes (x, y, z). Needs to have a distance capability of at least three hundred (300) meters. The cost should be less than $300. The device needs to be able to speak to each other (indoor/outdoor). Should have IP protocol type output, communicating a device ID as well as XYZ coordinates. Should be able to operation up to 500 degrees.

Description of the Gap: An Incident Commander needing real-time geospatial depiction of deployed assets during an incident in a high-rise building

Operational Scenario: Having the ability to track responders in an operational environment will allow for redirection away from known or developing hazards and location of personnel in all environments. It would also allow Law Enforcement commanders to track personnel in active shooter events and inform tactical decisions.

Commonality of the Problem: This system would be deployed on all fires and similar situations across the response community. Portions of these fires are home fires; U.S. fire departments responded to an estimated average of 357,000 home structure fires per year during 2009-2013. (Source http://www.nfpa.org/news-and-research/fire-statistics-and-reports/fire-statistics/fires-by-property-type/residential/home-structure-fires) In 2015, 1 of 68 firefighter deaths were due to the firefighter

becoming lost in the structure (source: http://www.nfpa.org/news-and-research/fire-statistics-and-reports/fire-statistics/the-fire-service/fatalities-and-injuries/firefighter-fatalities-in-the-united-states)

How this will benefit Civilians / First Responders: This product will allow the incident commander to improve accountability on the fire ground, in the event of a problem quickly locate, and rescue firefighters who are lost or entrapped.

Are there other products available to meet this need? No

A complete solution to Identified Problem? Completely

Fully compatible / interoperable with existing systems? Somewhat

Cost effective approach to addressing the identified need? Somewhat

Effective means to protect critical infrastructure? Not much

A feasible and implementable solution to the problem? Completely

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury:

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life:

Improved Emergency Response Infrastructure:

Improved Productivity: X

Active Shooter: X

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident:

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.): X

Hazmat Event-Biological (infectious diseases, etc.): X

Illicit Laboratory Events (IED, drugs, etc.):

Natural Disaster: X

Discipline: Communications

S&T Response - APPROVED or NOT APPROVED: NOT APPROVED (9/6)

2016 Priority #2: Law Enforcement use of Unmanned Aircraft Systems (UAS)

Targeted End User: Law enforcement agencies with an interest in using UAS

Short Description: Many law enforcement agencies are recognizing the benefits that can be achieved through the appropriate and effective use of UAS. UAS are Federal Aviation Administration (FAA)-regulated devices of either a fixed-wing or a rotary-wing configuration. The use of UAS would allow for aerial observation and interaction by law enforcement agencies of incidents that would be impractical or cost prohibitive with the use of aircraft. Research and development of UAS-related tools and standards for use will help law enforcement agencies start and maintain an effective UAS program.

Detailed Description: Research and development of advanced UAS-related tools (i.e. thermal imaging cameras for search and rescue, or 2-way communication between the UAS operator at a command post and an individual in close proximity to the UAS) that would allow for more effective and efficient operations. Cost-benefit analysis of UAS use for activities that do not necessitate aircraft (e.g. aerial observation, as opposed to personnel transport). Initial cost and maintenance of a UAS are significantly less than for an aircraft, as are operator training and operation expenses. UAS can be operated at low altitudes and confined areas, allowing for observation vantage points not achievable by aircraft.

Research and development of standards for the operation of UAS (i.e. standard operating procedures, or maintenance of audio and video recordings for later use) that would allow law enforcement agencies to safely use them in compliance with relevant Federal and state laws, while providing the public confidence that they will be used appropriately.

Known Key Constraints: -UAS are defined by FAA regulation and their use must comply with FAA regulations, as well as applicable state laws, if any.
-Aircraft used by law enforcement agencies can have an initial cost of $250,000 at the low end to over $10,000,000, plus maintenance costs of thousands of dollars per year and fuel costs of thousands of dollars per year. Most UAS that would be utilized by law enforcement agencies have an initial cost between $500 and $20,000, plus maintenance costs of a few hundred dollars per year and fuel (electricity) costs of a few dollars per year.
-Non-recreational UAS operators must have a pilot certification from the FAA.
-Most UAS are powered by a battery, frequently a proprietary rechargeable type. UAS tools must be compatible with the UAS power source.
-Additional weight added to a UAS will affect both its flight characteristics and flight time. UAS tools must add as little weight as possible in order to limit its detrimental influence.

Description of the Gap: Law enforcement agencies frequently need the capability to observe or effect an incident from an aerial perspective, even when financial or operational conditions may limit their ability to utilize aircraft.

Operational Scenario: A mountainous area would limit aircraft use in search and rescue operations, but a UAS would be able to get closer to the ground and its use would eliminate any risk to operators.

Commonality of the Problem: There are many types of law enforcement incidents that could benefit from the use of a UAS every year, including search and rescue, foot pursuits, and warrant services, to name a

few. (Examples: The Clackamas County (OR) Sheriff Office Search and Rescue team has responded to an average of 96 missions per year since 2007. The Virginia Department of Emergency Management Search and Rescue Unit responded to 107 missions in 2012 and 101 missions in 2013.)

Having standards for use of UAS will allow for an increase in their effective and efficient use, while decreasing liability faced by law enforcement agencies and increasing public support.

How this will benefit Civilians / First Responders: UAS-related tools and standards will allow for improved capability for law enforcement agencies and reduced exposure to hazards for law enforcement personnel. The public will also benefit from the capabilities presented by UAS and the reduced cost as opposed to aircraft.

Are there other products available to meet this need? No

A complete solution to Identified Problem? Completely

Fully compatible / interoperable with existing systems? Somewhat

Cost effective approach to addressing the identified need? Completely

Effective means to protect critical infrastructure? Somewhat

A feasible and implementable solution to the problem? Completely

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury: X

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life: X

Improved Emergency Response Infrastructure: X

Improved Productivity: X

Active Shooter: X

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident: X

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.): X

Hazmat Event-Biological (infectious diseases, etc.): X

Illicit Laboratory Events (IED, drugs, etc.): X

Natural Disaster: X

Contract E-mail: david.isaacson@hq.dhs.gov

S&T Response - APPROVED or NOT APPROVED: APPROVED (9/6)

2016 Priority #3: Handheld Standoff Chemical & Explosive Identifier

Targeted End User: HazMat, EOD, but in reality could be any and all first responders

Short Description: The ability to respond to an incident staying at a safe distance without specialized chemical or explosive PPE and determine whether it is safe to go any further without donning PPE. First on scene or a patrol supervisor rolls up on scene can deploy this equipment and pass on findings to dispatch and mitigate the hazards to the public and first responders sooner.

Detailed Description: Instrument capable of detecting and identifying chemical substances (e.g. chemical warfare agents TIC's) and explosives from outside of exposure or contamination zone, at standoff distances (need to specify the standoff distance(s) -this will bound the problem). This item must be intrinsically safe, able to withstand temperature and humidity changes, and must be ruggedized to field use, be simple to learn and operate all of this giving accurate results in a time expedient manner.

Known Key Constraints: Handheld comfortably ergonomic, lightweight (maximum weight 2 kilograms) Intrinsically safe, able to operate in temperatures 4 to 150 Celsius and humidity 15 – 100%, and must be ruggedized to field use (withstand 5 G's, water resistant), be simple to learn and operate (maximum training required 2 hours operable with gloved hands) all of this while giving accurate results in a time expedient manner (10 minutes) from a minimum distance of 1 meters away. Maximum cost per unit $5,000.

Description of the Gap: This instrument would reduce the dangers of the unknowns when responding to an incident. First on scene or supervisors could make more knowledgeable fact/information driven assessments of the incident. Would allow for more timely requests for special units to mitigate the incident.

Operational Scenario: Dispatch gets a foul odor call first on scene is a patrol officer he/she breaks out this instrument and knows whether HazMat Team is required to respond as oppose to a Hazmat duty person responding to the scene to assess whether to activate the entire team. Hazmat OOD's response times are generally longer then a patrol units.

Commonality of the Problem: If it was inexpensive, patrol units could carry them or their supervisors and both are usually going to be able to respond faster than Hazmat personnel and many times fire. However, these instruments ideally would also be deployed with fire and HazMat.

How this will benefit Civilians / First Responders: Faster response times means mitigating the incident quicker addressing life safety issues more quickly and going back to business as usual, less overall expense.

Are there other products available to meet this need? No

A complete solution to Identified Problem? Somewhat

Fully compatible / interoperable with existing systems? Somewhat

Cost effective approach to addressing the identified need? Somewhat

Effective means to protect critical infrastructure? Somewhat

A feasible and implementable solution to the problem? Somewhat

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury: X

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life: X

Improved Emergency Response Infrastructure: X

Improved Productivity: X

Active Shooter: X

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident: X

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.): X

Hazmat Event-Biological (infectious diseases, etc.): X

Illicit Laboratory Events (IED, drugs, etc.): X

Natural Disaster:

Discipline: Hazmat

S&T Response - APPROVED or NOT APPROVED: NOT APPROVED (9/6)

2016 Priority #4: 3-D X-Ray

Targeted End User: Bomb Squads

Short Description: Need the ability to take multiple x-rays of a package and develop into a 3-D image, preferably with only one trip downrange.

Detailed Description: This technology will likely require an apparatus to capture x-ray images from different angles within a single plane and then process those images in a computer to generate 3-D images that can be viewed from a computer screen.

Known Key Constraints: The system must be capable of being hand carried or deployed by a robot. The system must produce readable 3-D images within 10 minutes.

Description of the Gap: Bomb squads routinely work with 2-dimension x-ray images, which do not reveal the depth of items within a package. A 3-dimensional x-ray would vastly improve the bomb technician's ability to evaluate an IED and develop a render safe plan for it.

Operational Scenario: A bomb squad responds to a suspicious package, and uses the 3D X-ray to determine the proper render safe procedure for the device

Commonality of the Problem: If the technology were available, 3-D x-ray would likely be used on every suspect package.

How this will benefit Civilians / First Responders: Bomb technicians could be more efficient, effective, safe, and accurate with a transition from 2-D to 3-D x-ray.

Are there other products available to meet this need? No

A complete solution to Identified Problem? Completely

Fully compatible / interoperable with existing systems? Somewhat

Cost effective approach to addressing the identified need? Somewhat

Effective means to protect critical infrastructure? Completely

A feasible and implementable solution to the problem? Completely

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury: X

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life: X

Improved Emergency Response Infrastructure: X

Improved Productivity:

Active Shooter:

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident:

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.):

Hazmat Event-Biological (infectious diseases, etc.):

Illicit Laboratory Events (IED, drugs, etc.): X

Natural Disaster:

Discipline: EOD

S&T Response - APPROVED or NOT APPROVED: APPROVED (9/6)

2016 Priority #5 Outdoor 3-D Tracking of Personnel

Targeted End User: First Responders

Short Description: There is a need for priority development of technologies for tracking operating personnel in a 3-D environment outdoors. Outdoor tracking defined as the wildland and hazmat environments (out of line of sight) to include XYZ coordinates being automatically transmitted, if preferred (such as in the fire service). Integrated with the portable radio so it integrates with all responders.

Detailed Description: The R & D Item has two components. The first is a transmitting device carrier by a first responder that allows an electronic signal to be located to within 3 feet on both a horizontal and vertical access. This component could be integrated into equipment that is already carried by the first responder (I.e. radio, scba, PPE). This device would need to be able to communicate with a second component that could be several hundred meters or miles away and out of line-of-sight. The second component is a computer or other display device that receives the signal and displays it, allowing an incident commander to observe in real time the location of first Responders operating on the incident. This system must work outdoors. The system must be able to be used for each incident in police and fire disciplines. For hazmat use, would allow command to keep track of entry teams beyond line-of-sight. Would have an interface to plot Hazmat meter reading at an incident, allowing better location of zones, and tracking of product release.

Known Key Constraints: Must be lightweight (less than 8 ounces) and not interfere with responder's ability to perform mission. Preferred that it integrate into an already existing system (radio). It must be usable in an operational environment providing capability to locate a responder within a radius of 5 feet (threshold) and 3 feet (objective) within 3 dimensional coordinate axes (x, y, z). Needs to have a distance capability of at least three hundred (300) meters. The cost should be less than $300. The device needs to be able to speak to each other (indoor/outdoor). Should have IP protocol type output, communicating a device ID as well as XYZ coordinates. Should be able to operation up to 500 degrees.

Description of the Gap: An Incident Commander needing real-time geospatial depiction of deployed assets during an incident during a wildland fire situation.

Operational Scenario: Having the ability to track responders in an operational environment will allow for redirection away from known or developing hazards and location of personnel in all environments. It would also allow Law Enforcement commanders to track personnel in active shooter events and inform tactical decisions.

Commonality of the Problem: This system would be deployed on all fires and similar situations across the response community. Portions of these fires are home fires; U.S. fire departments responded to an estimated average of 357,000 home structure fires per year during 2009-2013. (Source http://www.nfpa.org/news-and-research/fire-statistics-and-reports/fire-statistics/fires-by-property-type/residential/home-structure-fires) In 2015, 1 of 68 firefighter deaths were due to the firefighter becoming lost in the structure (source: http://www.nfpa.org/news-and-research/fire-statistics-and-reports/fire-statistics/the-fire-service/fatalities-and-injuries/firefighter-fatalities-in-the-united-states)

How this will benefit Civilians / First Responders: This product will allow the incident commander to improve accountability on the fire ground, in the event of a problem quickly locate, and rescue firefighters who are lost or entrapped.

Are there other products available to meet this need? No

A complete solution to Identified Problem? Completely

Fully compatible / interoperable with existing systems? Somewhat

Cost effective approach to addressing the identified need? Somewhat

Effective means to protect critical infrastructure? Not much

A feasible and implementable solution to the problem? Completely

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury:

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life:

Improved Emergency Response Infrastructure:

Improved Productivity: X

Active Shooter: X

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident:

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.): X

Hazmat Event-Biological (infectious diseases, etc.): X

Illicit Laboratory Events (IED, drugs, etc.):

Natural Disaster: X

Discipline: Communications

S&T Response - APPROVED or NOT APPROVED: NOT APPROVED (9/6)

2016 Priority #6: HME Neutralization

Targeted End User: Bomb Squads

Short Description: Bomb squads need the capability to neutralize HME, changing it from an explosive hazard to an inert material.

Detailed Description: Bomb technicians responding to clandestine HME labs encounter HME in many forms and conditions, including piles of powder on tables, in open containers, and within closed jars. A method is needed to apply to these HME materials that will change them from an explosive material to inert material that is safe to transport and dispose of.

Known Key Constraints: Must be a method that can be carried on the bomb truck. For example, if the method requires dilution with very large volumes of liquid, this may not be practical.

Description of the Gap: Bomb technicians responding to clandestine HME labs encounter HME in many forms and conditions, including piles of powder on tables, in open containers, and within closed jars. A method is needed to apply to these HME materials that will change them from an explosive material to inert material that is safe to transport and dispose of.

Operational Scenario: Bomb squads respond to clandestine HME labs and are required to identify, remove, and dispose of very sensitive explosive materials.

Commonality of the Problem: Bomb technicians deal with sensitive HME frequently.

How this will benefit Civilians / First Responders: Bomb technicians could be more efficient, effective, safe, and accurate with a method of neutralizing HME.

Are there other products available to meet this need? No

A complete solution to Identified Problem? Completely

Fully compatible / interoperable with existing systems? Completely

Cost effective approach to addressing the identified need? Completely

Effective means to protect critical infrastructure? Completely

A feasible and implementable solution to the problem? Completely

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury: X

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life: X

Improved Emergency Response Infrastructure: X

Improved Productivity: X

Active Shooter:

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident:

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.):

Hazmat Event-Biological (infectious diseases, etc.):

Illicit Laboratory Events (IED, drugs, etc.): X

Natural Disaster:

Discipline: EOD

S&T Response - APPROVED or NOT APPROVED: APPROVED (9/6)

2016 Priority #7: Noise Filtering Digital Speaker/microphone for SCBA Face Piece

Targeted End User: Any first responder whose job requires them to wear an SCBA

Short Description: Communication in most responses/emergencies is always a problem that arises – there is a need for better communications. This is due to numerous reasons - in this case wearing an SCBA creates noise that affects your ability to be understood when speaking as well as the ability to hear.

Detailed Description: Through whatever innovative method possible – most likely digital means sound cancelling/neutralization of the SCBA air passing in and out allowing the user to hear what is being said on the radio as well as being clearly understood when speaking.

Known Key Constraints: Must be lightweight, intrinsically safe, and integrate with current SCBA face-pieces and a variety of helmets (Fire, Ballistic, EOD, or Hard Hats). Power supply should last a minimum of several cycles or entries up to 12 hour battery life (or charge) minimum 6 hour battery life (or charge) under full load. Maximum operating weight is 300 grams, operating temperatures 0 - 260 degrees Celsius with humidity levels between 25 – 100%. Training for use should be no more than 2 hours hands-on beyond basic communications training for responders. Understanding that this will be worn under helmets and or an SCBA, needs to accommodate the weight and pressure from variety of helmets. Human diversities; size and weight has to be taken into consideration. Controls/knobs need to be ergonomic for different hand sizes as well as gloved hands. Water-resistant. Cost no more than $500 a unit.

Description of the Gap: Command/responders will be able to communicate more clearly and efficiently back and forth stop confusion and the need to repeat dialogue/instructions.

Operational Scenario: HazMat team is working on a railcar due to an Ammonia leak. Even though the tracks were supposed to be closed to all trains until the incident is complete, a train is coming on a neighboring track. Command needs to communicate the danger immediately for their team to move off the tracks immediately. The HazMat Teams impaired senses: sight, hearing, and less agility to move quickly minimizes the time required to get a message to the team they can understand. Though there are probably better examples because of the type of work that is being conducted minimizing any impairment to the responder and making their job easier is always important.

Commonality of the Problem: Every time a responder puts on an SCBA and the problem is further exacerbated by adding a chemical ensemble.

How this will benefit Civilians / First Responders: Command and control is made easier when communication is straightforward and not muffled or misinterpreted due to outside interference. The more efficient first responders are the better it is for the public as the problem that called them out goes away quicker.

Are there other products available to meet this need? No

A complete solution to Identified Problem? Somewhat

Fully compatible / interoperable with existing systems? Somewhat

Cost effective approach to addressing the identified need? Somewhat

Effective means to protect critical infrastructure? Somewhat

A feasible and implementable solution to the problem? Somewhat

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury: X

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life: X

Improved Emergency Response Infrastructure: X

Improved Productivity: X

Active Shooter:

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident:

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.): X

Hazmat Event-Biological (infectious diseases, etc.): X

Illicit Laboratory Events (IED, drugs, etc.): X

Natural Disaster:

Discipline: Hazmat

S&T Response - APPROVED or NOT APPROVED: NOT APPROVED (9/6)

2016 Priority #8: Research to support development of performance requirements and test methods for ballistic – resistant body worn armor for women

Targeted End User: Primarily female law enforcement officers and soldiers; potentially female fire fighters and emergency medical service personnel

Short Description: Research is necessary to address the needs and requirements of female law enforcement officers (LEOs) and soldiers who wear soft body armor to ensure that the equipment meets their protection and coverage requirements. This includes research to understand the unique needs of female body armor wearers, to test construction and features of shaped body armor designed for females, to develop appropriate performance metrics and test methods, to validate test methods, and to subsequently revise existing body armor standards.

Detailed Description: Performance and coverage (i.e., form, fit, and function) of body armor for female LEOs and soldiers has not been sufficiently addressed by any existing standards. Testing of shaped (non-planar) soft body armor panels has not been addressed in enough detail to ensure all test labs are following the same procedures. Therefore, it is not known how the shaping or construction details affect the performance of the armor. Surveys and workshops of female LEOs reveal that:

- >60% feel that they have never had an armor that fit properly.
- Majority say that current armor does not fit well and that they have issues in terms of abrasion, pain, numbness, and other discomfort.
- Many wear armor designated as gender neutral.

Some initial research has been conducted. However, a comprehensive review and approach is needed in order to understand the issues being faced by female body armor wearers, to examine results of testing to date, identify additional needed research, develop appropriate test methods, and establish performance requirements.

Known Key Constraints: As written, this question does not apply to R&D required for the development of standards.

Description of the Gap: Research into the performance of shaped (non-planar) soft body armor against ballistic threats will facilitate the development of test methods and establishment of performance requirements for this type of body armor. Research into the unique needs of female body armor wearers will help to ensure proper coverage.

Operational Scenario: There is a case of a female officer being shot in the breast area. The bullet was stopped by the body armor, but she experienced severe behind-armor blunt trauma that resulted in her needing to undergo a mastectomy and reconstructive surgery. Research is required to determine whether the vest characteristics or construction (i.e., material; design; weak points in the shaping of the bust area, such as darts or seams) contributed to the severe trauma and to identify what is needed to prevent such trauma in the future. This research should also determine appropriate testing procedures to properly investigate the vest characteristics or construction.

Commonality of the Problem: LEOs and soldiers face the possibility of being shot at any time while on duty. Women held approximately 12% of all US law enforcement jobs in 2008, and women made up 14%

of active duty troops deployed to Afghanistan (2012). As of July 20, 2016, LEO deaths due to gunfire have risen by 94% over the previous year.

How this will benefit Civilians / First Responders: Women officers facing the risk of being shot need to be afforded the same protection as male officers and soldiers. This is a fixable officer safety issue. Ensuring ballistic vests properly protect female LEOs and soldiers is essential in protecting their lives and providing them the same level of protection as their male counterparts.

Are there other products available to meet this need? No

A complete solution to Identified Problem? Completely

Fully compatible / interoperable with existing systems? Completely

Cost effective approach to addressing the identified need? Completely

Effective means to protect critical infrastructure? Completely

A feasible and implementable solution to the problem? Completely

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury:

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life:

Improved Emergency Response Infrastructure:

Improved Productivity: X

Active Shooter: X

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident: X

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.):

Hazmat Event-Biological (infectious diseases, etc.):

Illicit Laboratory Events (IED, drugs, etc.): X

Natural Disaster:

Discipline: Law Enforcement

S&T Response - APPROVED or NOT APPROVED: APPROVED (9/6)

2016 Priority #9: Portable (hand held), ruggedized, bio detection and identification kit (rapid)

Targeted End User: EMS, First Responders/Receivers, Mobile-integrated Healthcare, Hazmat

Short Description: The ability to respond to an incident with minimal effort, learn that you have or do not have a potential Biological hazard. Rapid advanced field grade PCR or other technology that can deliver reliable and sensitive identification, detection of biological pathogens (bio-threat, food/water and environmental) – FDA approved.

Detailed Description: Features include: Compact portable unit, durable, accurate test results in no more than 10 minutes; must test at a minimum: Anthrax, Plague, Smallpox, Ricin (clinical); Food/Water: Campylobacter, Salmonella, Listeria, E.coli, O157:H7, Shigella; Environmental: B. Cerius, Norovirus, Botulism, Brucells, Tularemia, and Coxiella

Known Key Constraints: Handheld/compact, lightweight <15 lbs.; durable intrinsically safe, powered by AC/DC power (rechargeable battery) source internal and outside capable, Bluetooth and Wi-Fi compatible, barcode readers/scanner, freeze dried (lyophilized reagents), capable of accurately operating in hot, humid and cold environments, and simple to learn and operate.

Description of the Gap: PCR or other technology based rapid detection and identification of biological pathogens, independently in the field without referral lab (Objective). Confirmatory laboratory requirement (Threshold). Minimal sample prep that can be executed by a single individual (responder) without extensive laboratory or clinical background. Sample prep should require little consumable use and should be able to be complete in a few minutes.

Operational Scenario: 1) Respond to the scene with the potential exposure to an "unknown" substance or the claim of exposure. Given the potential impact to public health, you need to rapidly DETECT and ID (preliminary and confirmatory) the substance(s). This detect and ID must occur quickly, ideally before patients/victims are transported from the scene for deacon, treatment and/or triage. 2) Individual presents with clinical symptoms (remote area or in unit currently "deployed") that the clinician believes could be exposure to a harmful biological agent. Rapid detection and identification is required for timely/accurate treatment, implementation of prudent public health measures (isolation/restriction of movement), etc.

Commonality of the Problem: This would be considered an urgent need. Unable to quantify who would commonly use this device, but it is certainly a required device for most "responder/receiver" units and has been discussed as an urgent need for years. Dependent upon the scenarios and "agent" of suspect - this could affect thousands to millions of civilians. A large number of First Responders/Receivers would be impacted.

How this will benefit Civilians / First Responders: Eliminating the false negatives will mean faster response times and mitigation. Includes lower responder exposure, reduced healthcare cost, increases protection of infrastructure, and reduces potential loss of life first responders/civilians. Also will provide more than "preliminary" test results in the field. In the (3) stages of testing, preliminary, confirmation and definitive (few labs do this in US), this will provide P and C detect and ID in the field.

Are there other products available to meet this need? No. Some devices provide "some" of the capability.

A complete solution to Identified Problem? Completely

Fully compatible / interoperable with existing systems? Somewhat

Cost effective approach to addressing the identified need? Completely

Effective means to protect critical infrastructure? Somewhat

A feasible and implementable solution to the problem? Completely

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury: X

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life: X

Improved Emergency Response Infrastructure: X

Improved Productivity: X

Active Shooter: X

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident: X

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.): X

Hazmat Event-Biological (infectious diseases, etc.): X

Illicit Laboratory Events (IED, drugs, etc.): X

Natural Disaster: X

Discipline: Health & Medical

S&T Response - APPROVED or NOT APPROVED: NOT APPROVED (9/6)

2016 Priority #10: Improved Microclimate Cooling System for Down Range Use

Targeted End User: Personnel using high heat stress inducing personal protective equipment

Short Description: Current person worn cooling devices (e.g. vests) have been demonstrated to be ineffective in maintaining body core temperatures at acceptable levels. In addition, perspiration collecting in PPE can cause compromise to forensic operations and body substance safety.

Detailed Description: There exists a need for an improved cooling garment that can be worn during extended down range operations in PPE, particularly chemical protective ensembles.

Known Key Constraints: The device must be wearable under current PPE, not needing a different size of design of PPE to fit. The device may not be powered by the SCBA worn by the responder, as this would contradict current air standards. Battery powered, using easily replaceable/rechargeable batteries. Total weight not to exceed 5 kilos.

Description of the Gap: Current cooling vests have been shown to be ineffective and possibly dangerous to responders by tricking the bodies response to cold into shunting blood away from the extremities to the core, exacerbating the cooling problem, and increasing the bodies core temp; exactly the wrong thing needed. The device needs to work differently, possibly by evaporation, in order to keep the body functioning normally.

Operational Scenario: Hazmat responders have to respond to a spill in 90º temperatures on an asphalt highway. Temperatures quickly reach dangerous levels inside of the responder's PPE.

Commonality of the Problem: This is likely anytime responders have temperatures that exceed comfortable levels.

How this will benefit Civilians / First Responders: Improved safety for responders, so they can provide greater response for civilians.

Are there other products available to meet this need? No

A complete solution to Identified Problem? Completely

Fully compatible / interoperable with existing systems? Completely

Cost effective approach to addressing the identified need? Completely

Effective means to protect critical infrastructure? Completely

A feasible and implementable solution to the problem? Completely

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury:

Reduction in First Responder Loss of Life:

Reduction in Civilian Loss of Life:

Improved Emergency Response Infrastructure:

Improved Productivity:

Active Shooter:

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident:

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.):

Hazmat Event-Biological (infectious diseases, etc.):

Illicit Laboratory Events (IED, drugs, etc.):

Natural Disaster:

Discipline: Hazmat

S&T Response - APPROVED or NOT APPROVED: APPROVED (9/6)

2016 Priority #11: Mission Critical Voiceover LTE

Targeted End User: Fed, State and local First Responders

Short Description: As Long-Term Evolution (LTE), Wi-Fi and other network technologies become ubiquitous among First Responders, collaborative devices will be used to proxy mission critical voice traffic over non-LMR networks. There is a challenge in providing security, routing, and priority of voice packets over non-LMR networks that have yet to be resolved.

Detailed Description: Available LMR (Land Mobile Radio - P25)bandwidth can be diminished during a large CBRNE event. The use of collaborative devices (LTE subscribers, phone, Wi-Fi subscribers, etc.) to proxy voice over non-LMR networks will be used to handle overflow traffic. Issues that exists with this are prioritizing and securing voice with end-to-end encryption. LTE release 10 will have the concept of tiering users and prioritizing traffic, but hardening sites and providing redundancy will still be an issue.

Known Key Constraints: Service providers must include this functionality at a low incremental cost to each user. This ability will not increase the LMR/LTE subscriber's weight or reduce battery life.

Description of the Gap: Seamlessly routing group voice traffic between LMR and LTE using the same encryption is not currently available.

Operational Scenario: During a CBRNE or other large incident involving multiple agencies, some agencies may only have LTE subscribers and others may only have P25 (LMR) subscribers. Currently these agencies would not be able to communicate with end-to-end encrypted voice/data.

Commonality of the Problem: Currently not a predominant issue until more agencies migrate to LTE

How this will benefit Civilians / First Responders: Without end-to-end encryption, voice traffic can be spoofed, intercepted, etc.

Are there other products available to meet this need? Yes

A complete solution to Identified Problem? Completely

Fully compatible / interoperable with existing systems? Completely

Cost effective approach to addressing the identified need? Completely

Effective means to protect critical infrastructure? Completely

A feasible and implementable solution to the problem? Completely

Benefits:

Reduction in First Responder Injury:

Reduction in Civilian Injury:

Reduction in First Responder Loss of Life:

Reduction in Civilian Loss of Life:

Improved Emergency Response Infrastructure: X

Improved Productivity:

Active Shooter:

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident: X

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.): X

Hazmat Event-Biological (infectious diseases, etc.): X

Illicit Laboratory Events (IED, drugs, etc.):

Natural Disaster:

Discipline: Communications

S&T Response - APPROVED or NOT APPROVED: NOT APPROVED (9/6)

2016 Priority #12: Meta-Analysis of Preventable Causes of Death for Law Enforcement

Targeted End User: Law Enforcement -Field Staff

Short Description: Conduct research to identify a comprehensive meta-analysis of the preventable causes of death for law enforcement officers, including death by weapons and vehicles (i.e. lack of training, poor tactics, etc.). The study also needs to include attributional factors and long-term effects of wellness issues such as cardiac complications, health and wellness, depression, PTSD (post-traumatic stress disorder), environmental hazards and cancer.

Detailed Description: Create a document or series of documents that summarize the most common causes of preventable death and identify the leading casual factors and what can/should be done to mitigate the problem. This can be done with a review data on correlations between: diet, shift work, exposure to chemicals, and physical fitness as they relate to cardio vascular disease and LE deaths. The study also needs to include: a comprehensive review of LE killed in the line of duty, to include but not limited to, by vehicles (all vehicular deaths), weapons and assault behavior as well as identify causal or contributing factors and recommend specific mitigating behaviors and actions.

Known Key Constraints: Compiling this report will require significant expertise and resources.

Description of the Gap: A comprehensive review of the literature related to the most common, preventable causes of death or impairment to LE. For example, there is minimal information available about correlations between cardiovascular disease and death in LE. The FBI puts out great deal of info on LE deaths but the summaries are vague and tables have enormous amounts of info. We need help navigating through all the info to identify trends and find what is most important to trainers and administrators so they can act on the facts. This information is not easily accessible to law enforcement risk management or the officers themselves. The loss of human life and productivity in LE community is not well documented and is therefore difficult to effectively respond to.

Operational Scenario: There is a lot of anecdotal evidence for the reasons LE are killed, but a systematic review is not readily available. We can give hundreds of examples of LE being killed in situations that could have been prevented such as when officers are killed by motorists as they conduct roadside enforcement actions but this information is also valuable when a LE risk manager is attempting to improve health and wellness within their agency. There is no comprehensive report to identify the greatest risk to their force and how to respond to it. LE officers unnecessarily expose themselves to health risks and danger because they are not clearly identified and articulated.

Commonality of the Problem: Given that "less than 20% of the law enforcement officers who died over the last three years died as a result of an assault," officers are killed for a variety of reasons. 1,439 law enforcement officers died in the line of duty during the past 10 years, which is roughly 144 deaths per year. In the study, "Life Expectancy in Police Officers: A Comparison with the U.S. General Population," the authors suggest that future studies should develop a larger database on police mortality including variables such as date and age at death of each deceased officer. They also discuss how there is need for data on ethnic and gender mortality among police officers (Violanti 2013). Having data on this and conducting a comprehensive analysis would help identify the preventable deaths.

How this will benefit Civilians / First Responders: Identifying preventable causes of death and addressing those problems with law enforcement will reduce the number of deaths and improve quality of life and job performance.

Are there other products available to meet this need? N/A

A complete solution to Identified Problem? Somewhat

Fully compatible / interoperable with existing systems? Somewhat

Cost effective approach to addressing the identified need? Completely

Effective means to protect critical infrastructure? Somewhat

A feasible and implementable solution to the problem? Somewhat

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury:

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life:

Improved Emergency Response Infrastructure:

Improved Productivity: X

Active Shooter: X

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident: X

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.): X

Hazmat Event-Biological (infectious diseases, etc.): X

Illicit Laboratory Events (IED, drugs, etc.): X

Natural Disaster: X

Discipline: Law Enforcement

S&T Response - APPROVED or NOT APPROVED: APPROVED (9/6)

2016 Priority #13: Wearable Intrinsically Safe Miniaturized Multi-Detector Sensors

Targeted End User: Hazmat, all first responders if it is made simple enough to operate with minimal training

Short Description: Responder able to have a more comprehensive understanding of the hazards they are encountering as they go about their job of mitigating whatever incident they are responding to. Incident Command post would be able to monitor responders with this equipment on as a further safeguard.

Detailed Description: Platform that Transmits multiple, wearable sensors that can be integrated into a single platform with wireless communication capability. Platform could be a vest with plug-and play detection ports and a common power source and controlled via software wirelessly connected to a laptop in the support zone. Detectors should also provide visual and audio alarms to alert the wearer.

Known Key Constraints: Platform that incorporates multiple wearable sensors that can be integrated into a single platform with wireless communication capability. Platform could be a vest weighing not more than 2 kilograms with plug-and-play detection ports (interchangeable detectors for the perceived threat). Should be durable and capable of operating at temperatures ranging from 4 – 65 Celsius, 15 – 100% humidity, water resistant and withstand 3 G's. No more than $1,000 a unit. Detection ports should be integrated into the garment as to not draw attention to the garment. Power sources should be easily acquired, rechargeable an option, with minimum 12 hour charge/use under a load (sensing and transmitting). Controlled by the wearer and/or controlled via software wirelessly connected to a laptop and or control center system at dispatch or the Incident Command Post. The data supplied as a base line would be the individuals position, what is being detected and at what levels. Detectors/sensors would be at optimized positions on the vest/garment (front, back, sides, shoulders, and waist). Comfortably worn/integrated with regular clothes/uniforms to include PPE (ballistic vests) should also provide visual and audio alarms, (using a system resembling a cell phone if not an actual cell phone) using specific ring tones to alert the wearer if dangerous levels exist.

Description of the Gap: I see this garment being used for events and after incidents occur. Three examples that come to mind would be; #1 a high visibility vest an officer directing traffic or present for crowd control could wear this at an event Super bowl, Rose Parade, Presidential motorcades, or after an industrial release putting out fixed sensors or perimeter control #2. A garment resembling a photographer's vest so people could go into crowds and not stand out for the same events #3 potentially integrated into plate carriers for law enforcement or others needing ballistic protection. The detector would provide responders with information that could save their life and provide necessary data to the Incident Command Post. This concept would allow first responders to have a clearer idea what may be in the environment they are working in and allowing responders to direct others to leave the area if necessary. The information could factor into saving /protecting the life's of the first responders and the public they protect. This would also allow the responder to use both hands without being encumbered by a hand held instrument.

NOTE: Data should be uploaded to a central location (state/national) for further analysis for trends and or anomalies that could help responders in the future. In-addition the data should be stored dated for long-term impacts to responders.

Operational Scenario: Responder arrives on scene performing assessment/inspection of a facility not in PPE other than the normal daily work uniform and something is detected that would endanger the responder and all personnel in the immediate area.

Commonality of the Problem: I am not sure of the viability of this when wearing a chemical ensemble, however, for performing worksite/facility assessments/inspections or placing the air monitoring equipment this would be good to have on to let you know if the warm/hot zone has shifted.

How this will benefit Civilians / First Responders: Eliminate further uncertainty about the safety of an area/cold zone during or after an incident.

Are there other products available to meet this need? No

A complete solution to Identified Problem? Somewhat

Fully compatible / interoperable with existing systems? Somewhat

Cost effective approach to addressing the identified need? Somewhat

Effective means to protect critical infrastructure? Somewhat

A feasible and implementable solution to the problem? Somewhat

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury: X

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life: X

Improved Emergency Response Infrastructure: X

Improved Productivity: X

Active Shooter: X

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident: X

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.): X

Hazmat Event-Biological (infectious diseases, etc.): X

Illicit Laboratory Events (IED, drugs, etc.): X

Natural Disaster: X

Contract E-mail: Eimhof@comcast.net

S&T Response - APPROVED or NOT APPROVED: NOT APPROVED (9/6)

2016 Priority #14: Robotic X-ray Integration

Targeted End User: Bomb Squads

Short Description: Need to integrate x-ray equipment into the robot instead of always being attached externally.

Detailed Description: Develop an x-ray capability for existing bomb squad robots that will incorporate key components of the x-ray system into the robot frame and communications system, so that when source and imager components are added, they attach and plug into the robot in a way that the x-ray system can be managed by the robot operator.

Known Key Constraints: Must be compatible with the most common bomb squad robots.

Description of the Gap: Need to integrate x-ray equipment into the robot instead of always being attached externally.

Operational Scenario: Bomb squad response to suspect packages using robots can more easily include x-ray as an option.

Commonality of the Problem: Most bomb squad responses to suspect packages in which robots are used.

How this will benefit Civilians / First Responders: Bomb squads would benefit by making x-ray a normal option for robot operations, rather than just exceptional cases.

Are there other products available to meet this need? No

A complete solution to Identified Problem? Somewhat

Fully compatible / interoperable with existing systems? Somewhat

Cost effective approach to addressing the identified need? Completely

Effective means to protect critical infrastructure? Somewhat

A feasible and implementable solution to the problem? Somewhat

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury:

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life:

Improved Emergency Response Infrastructure:

Improved Productivity: X

Active Shooter:

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident:

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.): X

Hazmat Event-Biological (infectious diseases, etc.):

Illicit Laboratory Events (IED, drugs, etc.):

Natural Disaster: X

Discipline: EOD

S&T Response - APPROVED or NOT APPROVED: NOT APPROVED (9/6)

2016 Priority #15: Inexpensive, portable ruggedized point-of-care lab testing device

Targeted End User: Pre-hospital medical providers

Short Description: Develop a hand held device for point-of-care testing of bloodwork. It must be inexpensive with a maximum cost of $500, rugged to be able to function outdoors in temperature ranges from 60 - 100 degrees, rugged to be able to be dropped from a height of 3-5 feet without damage, rechargeable with a battery life of at least 8 hours, rapid results<10 minutes) and must have high sensitivity/specificity of lab based blood tests.

Detailed Description: Other features: Wide range of blood tests, customizable to end user needs; ease of use, simple testing process; low cost of upkeep; simple calibration and simple QA/QI process to ensure proper functioning. Must meet standards set by the Clinical Laboratory Improvement Amendment of 1988.

Known Key Constraints: As listed in prior description, must cost less than $500, be environmental (water, heat, cold 60-100 degrees range) and impact (fall from 5 feet) resistant, provide rapid results (<10 minutes) with a simple, easy to use interface. Should be powered by a rechargeable battery with a battery life of at least 8 hours. Must have a wide range of high sensitivity/specificity of lab-based blood tests customizable to end user needs. Upkeep including calibration and QA/QI of the machine should be easy and quick (<10 minutes). Must meet standards set by the Clinical Laboratory Improvement Amendment of 1988.

Description of the Gap: Ability to make advanced field care decision and diagnosis - will play into triage, mode of transport decision, and advanced field medical management.

Operational Scenario: Firefighter collapses during a fire- point of care blood test within 10 minutes of rescue shows elevated lactate levels indicating cyanide exposure. Treatment initiated immediately.

Commonality of the Problem: Every Fire/EMS agency will use daily; has uses in patient care, FF rehab and safety

How this will benefit Civilians / First Responders: Allow for more rapid and accurate field diagnosis and directed medical care. Will enable accurate triage decisions (e.g. Troponin) and earlier initiation of care (e.g. antibiotics in sepsis).

Are there other products available to meet this need? Yes

A complete solution to Identified Problem? Completely

Fully compatible / interoperable with existing systems? Completely

Cost effective approach to addressing the identified need? Completely

Effective means to protect critical infrastructure? Somewhat

A feasible and implementable solution to the problem? Completely

Benefits:

Reduction in First Responder Injury:

Reduction in Civilian Injury:

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life: X

Improved Emergency Response Infrastructure: X

Improved Productivity: X

Active Shooter: X

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident: X

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.): X

Hazmat Event-Biological (infectious diseases, etc.):

Illicit Laboratory Events (IED, drugs, etc.): X

Natural Disaster: X

Discipline: Health & Medical

S&T Response - APPROVED or NOT APPROVED: NOT APPROVED (9/6)

2016 Priority #16: Cost Effective Means of Storing Video and Redacting Imagery

Targeted End User: LE, Fire, EMS, Hospitals

Short Description: Capability to redact imagery from body worn, vehicle, or surveillance cameras for public release. Current public safety work requires the use of large, and ever increasing, amounts of video recording, which has resulted in large volumes of data. Public safety needs the ability to manage, redact, edit, store, and release to the public. Provide technology tool to assess imagery for information and images that contain personally identifiable information that cannot be shared publicly and redact the information for public release for FOIA (Freedom of Information Act) requests or other public safety interest.

Detailed Description: There needs to be a method to blur images within recorded video for redaction purposes of persons whose identity must be kept secure for whatever purpose. Right now, the user must first carefully review the video and then manually edit the video to correct redaction misses, boundary errors, and false alarms. Most people have said that this process is LESS efficient than starting from scratch. Public safety agencies need the ability to manage large amounts of data, which has been increasing in recent years from body worn cameras, vehicle mounted cameras, and other video sources. Due to technology and cost restraints, this data significantly challenges agencies. Agencies need the ability to reproduce, edit this data for court, public use and other reasons. Released videos may need to be redacted (blurring faces and removable of PI information) prior to release. These large amounts of data have created storage issues as well. Videos should be capable of being stored in a non-proprietary manner yet CJIS (Criminal Justice Information Services) compliant.

Known Key Constraints: Software tool should operate on currently available operating systems that cost less than $100K and can be operated with minimal training (self-help, on-line). An operator should be reasonably competent with 8 hours of training. Must cost less than $100K, be able to store large amounts (petabytes), function on all operating systems (cite examples Windows or Mac compatible, define systems) and operated with minimal training (self-help, online). In the future, redaction-editing tools should be made which are more user friendly and efficient and will reach user-in-the-loop efficiencies that make it feasible to use them over manual systems. Because of this, critical metrics are likely to include time to redact, possibly also clicks, moves, erasures, and boundary draws (physical steps).

Description of the Gap: Imagery collected by body worn, car mounted, or surveillance cameras collect personally identifiable information (PII) needs to be redacted in any freedom of Information Act (FOIA) requests. There is no cost effective way to store the large amounts of video that are currently being produced. There is no basic platform developed to redact video possessed by public safety agencies.

Operational Scenario: With the onset of recorded video, the requests for that video have dramatically increased. Automatic facial recognition of underage persons on video, and blurring of those faces should be an option on preparation for the video for release to the media or public. Currently video managers are having difficulty-storing video, which has been developed without removing older videos from their system, which they are legally required to maintain. Agencies will now have the ability to store video data in a cost effective manner. Redacted information can be released in hours rather than weeks or days. There should be an option in video engines where all faces in recorded video can be blurred automatically

for FOIA releases. There should be a second option that allows operators to select time spans in release video to not blur faces where needed.

Commonality of the Problem: Video in vehicles and on law enforcement officers has become a common practice. Video is also being recorded in public safety buildings. Storing this information becomes more challenging every day for the public safety agencies.

How this will benefit Civilians / First Responders: Utilizing video by public safety has demonstrated the ability to identify dangerous individuals who have not been apprehended yet. As a result of these videos being released to the public, these individuals have been apprehended and taken off the streets making it a safer community for both the public and public safety. These recordings need to be maintained as evidence and cannot be destroyed until authorized by state statute.

Are there other products available to meet this need? N/A

A complete solution to Identified Problem? N/A

Fully compatible / interoperable with existing systems? N/A

Cost effective approach to addressing the identified need? N/A

Effective means to protect critical infrastructure? N/A

A feasible and implementable solution to the problem? N/A

Benefits:

Reduction in First Responder Injury:

Reduction in Civilian Injury:

Reduction in First Responder Loss of Life:

Reduction in Civilian Loss of Life:

Improved Emergency Response Infrastructure:

Improved Productivity:

Active Shooter:

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident:

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.):

Hazmat Event-Biological (infectious diseases, etc.):

Illicit Laboratory Events (IED, drugs, etc.):

Natural Disaster:

Discipline: Law Enforcement

S&T Response - APPROVED or NOT APPROVED: NOT APPROVED (9/6)

2016 Priority #17: Thermal Imaging Camera Training and Use Catalogue

Targeted End User: Fire Service

Short Description: Research how thermal imagers are being utilized in the fire service, what additional applications thermal imagers have in improving responder safety and efficiency and develop training to incorporate these uses into firefighter training programs.

Detailed Description: Research through surveys of response personnel how thermal imagers are currently used in emergency response. Conduct market survey of manufacturers to discuss additional capabilities and uses of thermal imagers in emergency response. Crosswalk the results to determine opportunities of expanding use of thermal imagers on the fire ground to increase responder safety and efficiency through improved situational awareness. Identify limiting equipment factors, policy constraints and regulatory factors to implementing increased use of thermal imaging cameras. Identify equipment changes that would result in increased end user use.

Known Key Constraints: The benefit of this product is increased firefighter safety, but the manufacturers of thermal imaging cameras would receive a direct financial benefit. As a result, this might legitimately be considered market researching and advertisement; if this is true, the cost for this process should be borne by the various manufacturers.

Description of the Gap: The First Responder of the Future program identifies future needs of first responders as

- Ability of responder to hear, see, comprehend, and provide instruction/guidance to compensate for loss of hearing, sight, or comprehension
- Relay info to first responder and command center
- Helmets that incorporate a heads up display including thermal imagery and camera capabilities

Operational Scenario: A firefighter is working in a large building and becomes lost in smoke, utilizing the thermal imaging camera he is able to quickly locate a hose line (because it is colder than the environment) and through the camera able to determine the direction to safety by observing the couplings. This use of a thermal imaging camera is not widely taught in firefighting curriculums, which focus on thermal imagery as a rescue, hazardous materials or overhaul tool. This use of thermal imaging would be much more likely if thermal imaging were more widely deployed and the cameras / displays were incorporated into the SCBA

Commonality of the Problem: The benefits of the research, training development and changes to the usage and design of thermal imaging cameras would benefit all fire fighters and as described in the First Responder of the Future Report, become an essential component of a firefighter's safety equipment.

How this will benefit Civilians / First Responders: This proposal seeks to find ways to increase firefighter safety and efficiency, which would decrease injuries and enable firefighters to perform their jobs more quickly and with less collateral property loss.

Are there other products available to meet this need? N/A

A complete solution to Identified Problem? Somewhat

Fully compatible / interoperable with existing systems? Completely

Cost effective approach to addressing the identified need? Completely

Effective means to protect critical infrastructure? N/A

A feasible and implementable solution to the problem? Somewhat

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury: X

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life: X

Improved Emergency Response Infrastructure: X

Improved Productivity: X

Active Shooter:

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident:

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.):

Hazmat Event-Biological (infectious diseases, etc.):

Illicit Laboratory Events (IED, drugs, etc.):

Natural Disaster:

Discipline: Fire Service

S&T Response - APPROVED or NOT APPROVED: APPROVED (9/6)

2016 Priority #18: Multi-Meter for Bomb Technicians

Targeted End User: Bomb Squads

Short Description: Manual entry scenarios requiring electronic detonator and switch diagnostics. Need a comprehensive multimeter tool that measures (1) DC current (in-line and indirect current probe), (2) DC voltage, (3) continuity for the purpose of detonator/switch diagnostics.

Detailed Description: A multimeter with integrated indirect current probe and voltage meter, ammeter and continuity tester. Color coded probes should be optimized for taking voltage and current measurements through the insulation of detonator leg wires. The tool should provide actions based on meter readings and have programmable thresholds. Operators should be able to easily take indirect current measurements using an integrated current probe whose readings are automatically converted to units of amperes. Device should have protections to prevent operator from inadvertently configuring the probes incorrectly to measure voltage or current.

Known Key Constraints: The input in impedance of the voltmeter should be at least 1 Giga-ohm. The in-line current measurement should have a resolution of .1 micro amps and indirect current probe 10 micro amps. Voltmeter should have a resolution of 1 mV. Probes should have extensions to insert 12 inches (with expansion capability to go further) through a one-inch hole. Need positive lock for extensions.

Description of the Gap: Manual entry scenarios requiring electronic detonator and switch diagnostics. Need a comprehensive multimeter tool that measures (1) DC current (in-line and indirect current probe), (2) DC voltage, (3) continuity for the purpose of detonator/switch diagnostics.

Operational Scenario: Bomb squads routinely work with multimeters designed for other applications. A multimeter designed specifically for bomb squads would reduce risk and make operations more efficient.

Commonality of the Problem: Bomb technicians could be more efficient, effective, safe, and accurate with a dedicated multimeter that meets their needs.

How this will benefit Civilians / First Responders: Bomb technicians could be more efficient, effective, safe, and accurate with a method of neutralizing HME.

Are there other products available to meet this need? No

A complete solution to Identified Problem? Completely

Fully compatible / interoperable with existing systems? Completely

Cost effective approach to addressing the identified need? Completely

Effective means to protect critical infrastructure? Completely

A feasible and implementable solution to the problem? Completely

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury: X

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life: X

Improved Emergency Response Infrastructure: X

Improved Productivity: X

Active Shooter: X

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident:

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.):

Hazmat Event-Biological (infectious diseases, etc.):

Illicit Laboratory Events (IED, drugs, etc.): X

Natural Disaster:

Discipline: EOD

S&T Response - APPROVED or NOT APPROVED: NOT APPROVED (9/6)

2016 Priority #19: Post Incident Decontamination-Use of Wipes for the Neck

Targeted End User: Fire Service & First Responders

Short Description: Research is needed to definitively conclude whether "baby wipes" are an effective means of post-decontamination for first responders. Specifically, is using wipes around the head and neck area 1) an efficient means of decontamination, 2) does the use of wipes increase the absorption potential for carcinogens after their use and 3) are there variances in the safety and efficacy of the different types of wipes available in the marketplace?

Detailed Description: While it is assumed that the use of wipes is an effective means of decontamination, I have seen no research that proves this assumption. The IAB recently made the recommendation to use wipes post-exposure in the Recommended Actions Related to Reducing the Known Risk of Cancer in Fire Fighters and other groups have made similar recommendations without definitive proof that liquid used to moisten the wipes does not perpetuate absorption of residues that remain on the skin.

Known Key Constraints: N/A

Description of the Gap: Current on-scene decontamination options are limited for cleaning. Cancer rates in fire fighters and other first responder's continue to rise and effect the long-term health of the first responder community. Many safety advocate groups (including the IAB) have recommended the use of wipes without scientific data supporting their use. Common sense would suggest that their use would be advantageous, but definitive data should be attained. Existing wipe options contain less desirable ingredients in some of the wipe options (check out: https://gimmethegoodstuff.org/safe-product-guides/diaper-wipes/). There are also a few companies marketing products directly to the fire service (firewipes.com, rescuewipes.com) with no validation. This option could also be researched further to explore the efficacy of the various different street deacon methods being suggested, as well as station-level deacon. There are varied and conflicting recommendations being made to the fire service… hot water, cold water; mild soap, dish soap, exfoliating soap…

Operational Scenario: Firefighters go through deacon procedures (a water rinse) while still in full PPE, including SCBA. When they remove their PPE (coats, hood, helmet) it is not uncommon to have products of combustion evidence on their skin, particularly around the neck area. Firefighters will then use a wipe to clean the products off the skin.

Commonality of the Problem: This scenario is played out numerous times every day across the nation. With the advocacy of the use of wipes as a deacon solution by the different groups, the frequency will increase dramatically.

How this will benefit Civilians / First Responders: This will provide scientific data that will identify the reduction of carcinogens through the early implementation of deacon and, hopefully, reduce the cancer rate in firefighters.

Are there other products available to meet this need? N/A

A complete solution to Identified Problem? Somewhat

Fully compatible / interoperable with existing systems? Somewhat

Cost effective approach to addressing the identified need? Completely

Effective means to protect critical infrastructure? Not much

A feasible and implementable solution to the problem? Completely

Benefits:

Reduction in First Responder Injury:

Reduction in Civilian Injury:

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life:

Improved Emergency Response Infrastructure:

Improved Productivity:

Active Shooter:

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident:

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.): X

Hazmat Event-Biological (infectious diseases, etc.):

Illicit Laboratory Events (IED, drugs, etc.):

Natural Disaster:

Discipline: Leadership Team

S&T Response - APPROVED or NOT APPROVED: APPROVED (9/6)

2016 Priority #20: Structure Fire/IDLH Escape Respirator

Targeted End User: Fire Service

Short Description: Explore existing or new technologies for escape from a Structure Fire in the event of depletion or failure of the primary air source (SCBA) Technology must provide adequate protection against actual threats.

Detailed Description: It is envisioned that the escape system could be a filter that attaches to the SCBA face piece (replacing the SCBA regulator) and protects against toxins found in fires. A different approach would be to add an oxygen-generating component to the system. This system would be deployable by the SCBA wearer in the event of air depletion (cause of depletion could be failure or use).

Known Key Constraints: The respirator should be small enough to fit into a turnout coat pocket (dimensions roughly 8 inches by 8 inches by 4 inches), weight should be less than one pound, cost under $100, and sustainability should be 3-5 year shelf life. The performance criteria should be the same as an escape hood, able to filter products of combustion when oxygen level is within normal range to include carbon dioxide, carbon monoxide, sulfur dioxide, nitrogen oxides, lead, and particulate matter. The difference between this product and an escape hood would be that it works with firefighter existing SCBA.

Description of the Gap: SCBA are the primary respiratory protection used in a structure fire. In the event of that, a firefighter depletes their air supply, no back up or escape system exists. Firefighter asphyxia remains a significant cause of firefighter FF death.

Operational Scenario: In the event of that, a firefighter depletes their air supply, no back up or escape system exists. Firefighters must remove their face pieces and helmets to retreat to safety. (Because the face piece and regulator assembly do not allow air into the mask in the event of air depletion.) To save themselves, firefighters can often retreat to areas where atmospheric oxygen is sufficient or moderately low but other toxins in smoke cause asphyxia and airway irritation.

Commonality of the Problem: In 2015 - 9 of 68 (13%) of all firefighters that died in the line of duty died of asphyxia / smoke inhalation (source: http://www.nfpa.org/news-and-research/fire-statistics-and-reports/fire-statistics/the-fire-service/fatalities-and-injuries/firefighter-deaths-by-cause-and-nature-of-injury)

How this will benefit Civilians / First Responders: This tool would provide a last chance opportunity for firefighters to save themselves in the event of an unexpected air supply problem.

Are there other products available to meet this need? N/A

A complete solution to Identified Problem? N/A

Fully compatible / interoperable with existing systems? N/A

Cost effective approach to addressing the identified need? N/A

Effective means to protect critical infrastructure? N/A

A feasible and implementable solution to the problem? N/A

Benefits:

Reduction in First Responder Injury:

Reduction in Civilian Injury:

Reduction in First Responder Loss of Life:

Reduction in Civilian Loss of Life:

Improved Emergency Response Infrastructure:

Improved Productivity:

Active Shooter:

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident:

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.):

Hazmat Event-Biological (infectious diseases, etc.):

Illicit Laboratory Events (IED, drugs, etc.):

Natural Disaster:

Discipline: Fire Service

S&T Response - APPROVED or NOT APPROVED: NOT APPROVED (9/6)

2016 Priority #21: Responder / Receiver Mental Health and Wellness

Targeted End User: All first receivers and first responders

Short Description: Responder / Receiver menu driven suite of mobile apps providing pre-event stress inoculation, post event psychological first aid, and post event self-assessment and referral for occupational stress exposures and the continuum of stress responses. Data on stress inoculation and psychological first aid mobile apps would be available to supervisors to document training compliance. Anonymous mobile app data on post event self-assessment and triage would be available for supervisors monitoring of employee welfare trend analysis.

Detailed Description: Mobile apps that provide training in psychological first aid and stress inoculation independent of internet connection but downloads user data when internet connectivity becomes available. Mobile app to provide for self-assessment and referral for stress responses, again independent of internet connectivity yet connects and downloads user identify scrubbed data when internet connectivity becomes available. App should work on IOS, Android, and Microsoft platforms.

The menu driven would allow responder / receivers to allow organizations to customize the app to their unique needs based upon event type, (e.g. CBRNE, flood, fire, hurricane, earthquake, responder / receiver discipline type, (e.g. law enforcement, fire, emergency medical system personnel, public health, doctors, nurses, ancillary staff) and employee role in the organization, (e.g. first responder, supervisors, senior leadership).

Known Key Constraints: Cost basis should be framed similar to other commonly distributed apps at a very low cost per user (e.g. less than $5 per user with free updates and free Apple and PC computer user interface for data analysis) with training modules available online and utilizing a train the trainer model if organizations desires to have in person training.

Description of the Gap: Responder Receivers currently have no readily available, evidenced based mobile app that is customizable to their roles and event variability to enhance training and resiliency in order to prevent and or mitigate occupational stresses as well as facilitate early self-assessment that would identify stress responses that would benefit from further follow-up.

As a result, it is expected that severity and duration of responder / receivers stress responses would be reduced, operational readiness would be preserved, and families of responders and receivers would more quickly would not be left as the primary support for their loved ones as they process the occupational stressors they are exposed to.

Operational Scenario: Firefighters, law enforcement, Emergency Medical System responders all tasked with responding to a rapidly expanding fire, with erratic winds and difficult terrain. Multiple evacuation shelters are opened, and both large and small animals are evacuated. The fire would eventually consume over 75,000 acres, destroying almost 2000 structures, including 1200 homes, physically injuring multiple responders and causing the death of 4 residents, and numerous domestic animals and wildlife, lasting over 30 days until contained. Early on there was significant chance of the fire out pacing evacuations and fire containment lines that could lead to even further responder and civilian injury and death.

This was the Valley Fire in 2015 in California, where agencies from across the state and nation came together and effectively dealt with this catastrophic destruction of life and property but with little if any coordinated attention to the mental health needs of responders, healthcare workers, shelter personnel, and community leaders who faced unprecedented trauma to their communities, friends, and colleagues. Accessibility to the app described above would have been a significant asset to assisting these responders, their families, and the broader community develop pre-event resiliency and recover from traumas they were exposed to.

Commonality of the Problem: Traumas of this nature occur annually across the country, the more common occupational stresses associated with work in the fields of first responders, and receivers occur in the daily lives of these public servants.

How this will benefit Civilians / First Responders: Responders, receivers, and their families will have better tools to prepare for and respond to common work related stresses decreasing responder and receiver suffering and disability and enhancing operational resiliency.

Are there other products available to meet this need? No

A complete solution to Identified Problem? Completely

Fully compatible / interoperable with existing systems? Completely

Cost effective approach to addressing the identified need? Completely

Effective means to protect critical infrastructure? Completely

A feasible and implementable solution to the problem? Completely

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury: X

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life: X

Improved Emergency Response Infrastructure: X

Improved Productivity: X

Active Shooter: X

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident: X

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.): X

Hazmat Event-Biological (infectious diseases, etc.): X

Illicit Laboratory Events (IED, drugs, etc.): X

Natural Disaster: X

Discipline: Health & Medical

S&T Response - APPROVED or NOT APPROVED: APPROVED (9/6)

2016 Priority #22: Non-Burning Treatment System for Illegal Fireworks

Targeted End User: Bomb Squads and Commercial Contractors tasked with the destruction of pyrotechnic items

Short Description: Develop an EPA approved mobile treatment unit for treatment, recycle/reuse, and destruction of fireworks, other explosives, and pyrotechnics that are safe and protective of human health and the environment.

Detailed Description: Develop an EPA approved tractor/trailer size mobile treatment unit that could travel to the point-of-storage of fireworks for on-site, safe reduction to a desensitized slurry that can be hauled away to a central processing plant for treatment, recycle/reuse, and destruction of fireworks, explosives, and pyrotechnics, converting the material into a product that is safe for human health and the environment. Technologies to consider for this include (1) fluid jet cutting, for the initial breakdown of boxes full of pyrotechnic materials and (2) humic acid or other chemicals that can convert the pyrotechnic material and its container (cardboard) into fertilizer or other environmentally acceptable product. This would be a phased approach with the first phase involving a feasibility study with research into the methods of dealing with heavy metals found in pyrotechnics that may need to be extracted from the slurry generated in the reduction process. The study would also indicate whether a process outlined in this requirement is possible. If study proves that the process is feasible, the second phase would commence to involve a proof of concept to make the mobile treatment unit.

Known Key Constraints: Provisions will need to be made for the development of a program to fund, administer, and operate this fireworks disposal process nationwide, including (1) mobile processing units that go to the points of storage of the pyrotechnic material to convert it into a liquid suitable for transporting without danger, and (2) centralized processing plants where the mobile units will discharge the desensitized slurry and convert it into fertilizer or other environmentally friendly material. The total cost for operations and equipment for this national level program is certain to be significant (several million dollars), but impossible to quantify until research and development of the technology is complete.

Description of the Gap: Public safety bomb squads and explosive specialists routinely destroy large quantities of these dangerous materials. According to a survey by the National Bomb Squad Commanders Advisory Board (NBSCAB), public safety bomb squads and the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) destroy more than 300,000 pounds of fireworks annually. Handling, storing, transporting, and treating these fireworks present a number of safety, security, environmental, technical, and procedural challenges. The principle issue of concern is that the primary method of safe disposal employed by public safety bomb squads and explosive specialists, open burning and detonation, can place these public safety officers in a position of potential violation of EPA regulations. Efforts are needed to develop technologies to provide alternative methods that can replace open burning and detonation of fireworks, other explosives, and pyrotechnics.

Operational Scenario: Bomb squads in California are dealing with a crisis involving the storage and destruction of thousands of pounds of seized fireworks. Between the U.S. EPA and California EPA, they are facing an end to burning as a method of destroying fireworks. Other bomb squads around the U.S. will follow. An alternative method for destroying fireworks must be developed.

Commonality of the Problem: As mentioned above, public safety bomb squads and the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) destroy more than 300,000 pounds of fireworks annually.

How this will benefit Civilians / First Responders: A number of bomb technicians and explosives contractors have been injured or killed in fireworks disposal operations. The proposed method would make the process completely safe. The massive storage of fireworks and other explosives threaten civilians, as bomb squads and explosives contractors wait for approvals to destroy them.

Are there other products available to meet this need? No

A complete solution to Identified Problem? Completely

Fully compatible / interoperable with existing systems? Not much

Cost effective approach to addressing the identified need? Somewhat

Effective means to protect critical infrastructure? Somewhat

A feasible and implementable solution to the problem? Completely

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury: X

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life: X

Improved Emergency Response Infrastructure: X

Improved Productivity: X

Active Shooter:

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident:

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.):

Hazmat Event-Biological (infectious diseases, etc.):

Illicit Laboratory Events (IED, drugs, etc.):

Natural Disaster:

Discipline: EOD

Contact Name: Martin Hutchings

Contract E-mail: mhutchings@sacsheriff.com

S&T Response - APPROVED or NOT APPROVED: NOT APPROVED (9/6)

S&T Response - APPROVED or NOT APPROVED: APPROVED (9/6

2016 Priority #23: Rapid, universal, battery charger for portable in-home medical devices

Targeted End User: First responders performing visits to home bound special needs population

Short Description: A rapid battery charger for portable in-home medical devices.

Detailed Description: A battery charger that would rapidly charge the backup batteries of in-home medical devices when electricity is unavailable in the home. Some home acute care medical devices would include infusion pumps, ventilators, apnea monitors, etc.

Known Key Constraints: Unit needs to be portable (easily transportable), intrinsically safe, extended operation; possibly solar charged. Single operator, easy to use, minimal training involved, and able to fully charge a home medical device battery within an hour. Needs to be compatible with the rechargeable battery types commonly used as a power source for the devices mentioned in the description. There are numerous types of batteries in use for these devices so multiple connectors would be necessary.

Description of the Gap: With loss of power, special needs patient dependent on life sustaining at home medical devices normally need to be transported to a medical facility or specially outfitted shelter.

Operational Scenario: Natural disaster, loss of electric grid, summer outage, transformer failure, etc.

Commonality of the Problem: Frequent event with natural and manmade disasters based on special needs population impacted by power failure.

How this will benefit Civilians / First Responders: Civilians: stay in home environment; Responders: less transport; faster and fewer; Responses: option for non-medical personnel

Are there other products available to meet this need? No

A complete solution to Identified Problem? Completely

Fully compatible / interoperable with existing systems? Completely

Cost effective approach to addressing the identified need? Completely

Effective means to protect critical infrastructure? Somewhat

A feasible and implementable solution to the problem? Completely

Benefits:

Reduction in First Responder Injury:

Reduction in Civilian Injury:

Reduction in First Responder Loss of Life:

Reduction in Civilian Loss of Life:

Improved Emergency Response Infrastructure: X

Improved Productivity: X

Active Shooter:

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident:

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.):

Hazmat Event-Biological (infectious diseases, etc.):

Illicit Laboratory Events (IED, drugs, etc.):

Natural Disaster: X

Discipline: Health & Medical

S&T Response - APPROVED or NOT APPROVED: NOT APPROVED (9/6)

2016 Priority #24: Collision Avoidance Systems for Response Vehicles

Targeted End User: Fire, Police and EMS

Short Description: This is a system (smart phone application) that would notify civilian vehicles and pedestrians, via smartphone or dashboard device, about emergency vehicles approaching.

Detailed Description: This system would capitalize on existing mapping and communication systems. It would be an "opt in" program that would allow willing recipients to be alerted about the approach of emergency vehicles/apparatus, either by a Proximity alarm, or expected location along a predetermined response route. The goal of the technology would be to enhance safety of responders and the motoring/walking/cycling public.

Known Key Constraints: The technology would be an "app" style program that would be relatively simple (similar in nature to any other app currently found on smartphones today like Uber, Lyft, Google Maps). Users would register or sign-up by downloading through an app store on their phone. The functionality would involve users receiving an alert or notification (with unique sound) that alerts them to an approaching emergency vehicle. The program could suggest an alternate route or safe route to notify the driver to pull to the right and stop (as an example). Moving forward the notification could be part of a smart vehicle as opposed to part of a cell phone.

App should be inexpensive by being available to users by a couple of methods, either by downloading to their smartphone device via an app store (less than $15) or incorporated into new passenger vehicles (less than $200 feature).

Description of the Gap: First responders being killed/injured in vehicular accidents responding to/returning from alarms remains a top cause of injury and LODD (Line of Duty Deaths).

Operational Scenario: Downtown response. Citizens can hear sirens, but due to canyon effect of high-rise buildings, cannot determine from which location the apparatus are responding. Also provides some extra warning time to safely pull to the right and stop.

Commonality of the Problem: Source http://www.nfpa.org/news-and-research/fire-statistics-and-reports/fire-statistics/the-fire-service/fatalities-and-injuries/firefighter-fatalities-in-the-united-states
Crashes usually account for the second highest share of yearly firefighter deaths, but in 2015, crashes in road vehicles accounted for the second lowest number of deaths in the past 39 years (6 deaths in 4 crashes).

How this will benefit Civilians / First Responders: Enhanced safety

Are there other products available to meet this need? Yes

A complete solution to Identified Problem? Somewhat

Fully compatible / interoperable with existing systems? Somewhat

Cost effective approach to addressing the identified need? Completely

Effective means to protect critical infrastructure? Not much

A feasible and implementable solution to the problem? Somewhat

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury: X

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life: X

Improved Emergency Response Infrastructure:

Improved Productivity:

Active Shooter:

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident:

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.):

Hazmat Event-Biological (infectious diseases, etc.):

Illicit Laboratory Events (IED, drugs, etc.):

Natural Disaster:

Discipline: Fire Service

S&T Response - APPROVED or NOT APPROVED: NOT APPROVED (9/6)

2016 Priority #25: Vessel Penetration Sampling Device

Targeted End User: Hazmat Teams

Short Description: A portable, hand-held device to "drill" into containers (glass, metal, plastic, etc.) to obtain samples for field analysis or/and a light beam such as with Laser Induced Breakdown Spectroscopy to identify the substance.

Detailed Description: Something akin to an intraosseous infusion needle (I/O) drill that penetrates containers and introduces a sample collector. A hand held, and/or remote operable device that will drill into materials such as plastic, soft metal, and glass either simultaneously introducing a pipette or swab, or air sampling tube (head space), or allowing a follow-on action to introduce same to withdraw materials for analytical testing.

Known Key Constraints: Battery operated, intrinsically safe. Introduces sample collection materials. Cost in the neighborhood of 5-8k, portable within 2-5 lbs., training limited, and evidence system incorporated within the collection system. In other words, you apply the device, and it automatically sets the sample and creates a chain of custody process.

Description of the Gap: Ability to obtain samples from vessels with minimal disruption to the substance.

Operational Scenario: A suspicious package that has been cleared by EOD contains a vessel that contains an unknown substance that needs to be sampled.

Commonality of the Problem: The problem becomes more common as analytical capabilities increase. Either this type of incident occurs often within the first response community any time other evidence leads the responder down a path that the vessel can be opened or it becomes evident that the substance is not hazardous. Analysis would assist the responders in this type of scenario.

How this will benefit Civilians / First Responders: Allows rapid hazard assessment with minimal disruption.

Are there other products available to meet this need? No. It can be accomplished with small battery operated drill, but at a high risk to the operator.

A complete solution to Identified Problem? Somewhat

Fully compatible / interoperable with existing systems? Somewhat

Cost effective approach to addressing the identified need? N/A

Effective means to protect critical infrastructure? Somewhat

A feasible and implementable solution to the problem? Completely

Benefits:

Reduction in First Responder Injury: X

Reduction in Civilian Injury: X

Reduction in First Responder Loss of Life: X

Reduction in Civilian Loss of Life: X

Improved Emergency Response Infrastructure:

Improved Productivity: X

Active Shooter:

Civil Unrest/Mass Panic/ Mass Casualty (Riot, Stampede, Multi-Vehicular Incident:

HazMat Event – Chemical (Gases, Smoke, Toxins, etc.): X

Hazmat Event-Biological (infectious diseases, etc.): X

Illicit Laboratory Events (IED, drugs, etc.): X

Natural Disaster:

Discipline: Hazmat

S&T Response - APPROVED or NOT APPROVED: NOT APPROVED (9/6)

Appendix D: Complete 2015 Priority List

2015 Priority #1: Use of UAV Systems by Law Enforcement

Discipline: Law Enforcement

Description: Research & development into specific uses of UAVs by law enforcement. Research into both conventional uses and possible uses by law enforcement.

Constraints: UAV must fall into the micro-uav platform size. Not require commercial pilot license.

Need or Gap: 1) Conventional: For use when air details are unavailable or not deployable. 2) Allows multiple end-users low cost/risk alternative.

Scenario: A suspect is observed fleeing a business of an in-progress crime. A perimeter is quickly set. Air detail is unavailable. A witness describes someone seen on top of adjacent building. UAV deployed to search rooftops for suspect.

Benefits: Expedited search/clear/location of suspect. Lower risk to LE/K-9 from concealed subject/tactical advantage.

Frequency: Daily request go unanswered for air detail unavailable.

2015 Priority #2: National Incident Collaboration System

Discipline: Emergency Management

Description: An open source, electronic platform that collects and displays need-to-know information for response decision and management support from any and all sources that impact the emergency services sector information sphere. This system would provide a platform to empower connectivity of operational information between all layers of government and other trusted partners, as well as permit users to access pertinent and essential data and collaborate with each other without regard to their originating information technology platforms. Should be made available for analysis to display information generated by and used by responders at all levels of government (a baseline for everyone).

Constraints: Free-to-responder system that is nationally-supported (Federal sponsorship) persistent capability.

Need or Gap: A system to do this does not exist currently. Numerous major incidents, as well as many day-to-day operations, demand this capability in order to efficiently, effectively and safely accomplish mission requirements.

Scenario: Wildland fire incidents that cross numerous states which require response assests from across the US (and sometimes internationally) to operate within a large perimeter together. There are many

other scenarios, such as severe weather, civil disturbances, large gatherings, etc. which demand this capability and currently is accomplish either suing a disparate set of proprietary systems, and/or done without the benefit of efficiency-gaining technology.

Benefits: Having a uniform access to appropriate situation awareness information protects responders from unnecessary risk and injury, and empowers response leadership to make informed decisions which directly impacts the safety and wellbeing of the public.

Frequency: Daily events.

2015 Priority #3: High Fidelity, Immersive, Virtual Simulation Training System (HF/IVS) for Civilian First Responders

Discipline: Medical

Description: A training system using virtual reality technology which completely "surrounds" all senses (vision, touch, smell, temperature perception, proprioception) of the trainee. A training environment that mimics reality is created to permit exceptionally realistic training and learning in a relatively safe environment.

Constraints: None at this time

Need or Gap: Current education and training constrained by inability to safely create realistic environment that mimics the environment of the real-life activities of first responders. The aircraft industry can put pilots into flight simulations, the military can put inexperience warriors into training that closely mimics the firefight and surgical trainees perform virtual surgery before operating on a living person. Parts of the first response community are still trained and tested using static exercises that omit team performance, performance under physical and emotion duress and training and testing of performance in harsh environments. This item would address this gap by training and testing in an environment that is at least as demanding as the harshest circumstance encountered on a real response to an emergency.

Scenario: Infrequent responses involving personnel who change teams routinely. Many large fire departments have constant change in crew membership, with resultant performance degradation of team coordination, anticipation of needed activities and confidence in leadership. Any low frequency, high intensity, LE/EMS/Fire response. It is very difficult to train for these responses because of difficulty (cost, logistics) of creating the training. Active Shooter, rescue of trapped persons from active fire, multiple causalities in physically dangerous environment.

Benefits: First responders will by physically and emotionally equipped with a much larger "slide set" of scenarios and how to manage them successfully. This will improve outcomes and safely for civilians and first responders. The Marine Corps has studied officer performance before and after high intensity training and found more realistic training has a positive correlation with real performance.

Frequency: Daily occurrence in any large department.

2015 Priority #4: Automated GPS Tracking and Universal Symbology for Large Area Search Events and Widespread Disasters

Discipline: Emergency Management

Description: Automated GPS tracking and data logging via smartphone or other devices with the ability to input universal symbology and download into a master system to get data picture at a disaster.

Constraints: Easy to use, automated, minimal training or refresher training.

Need or Gap: Complete and accurate documentation of a disaster area. Identify follow-up visit sites as well as, adequate victim count, etc.

Scenario: Tornado hits, first responders respond to the affected area open tracklog and start primary search. They get to an affected structure, input universal symbology, finish assistance and it automatically downloads to planning section.

Benefits: Ease of proper documentation and improves accuracy.

Frequency: Any major disasters

2015 Priority #5: Develop Performance Requirements & Test Methods for Ballistic-Resistant Body Armor for Women

Discipline: Law Enforcement

Description: Research is needed to support the development of performance requirements and test methods for shaped (non-planar) body armor worn by women.

Constraints: NIJ and the US Army must be involved in any research and development related to body armor for women.

Need or Gap: The actual performance of shaped body armor against ballistic threats is not known.

Scenario: A female officer wearing armor with a shaped front planar panel is hit by a bullet on a feature of the armor that provides the shaping in the bust area (such as a dart or seams), and the bullet goes through because that portion of the armor design was not appropriately evaluated during certification testing.

Benefits: This will enhance the safety of all women officers and soldiers.

Frequency: Officers face the possibility of being shot any time while on duty. Per statistics, women held ~12% of all law enforcement jobs in 2008, and women made up ~14% of active duty troops deployed in Afghanistan (2012).

2015 Priority #6: Research into the Effects of Blast Overpressure from an Explosive Device

Discipline: HazMat or EOD

Description: Research is needed to address protection of a bomb technician (wearing a bomb suit) from blast overpressure caused by an explosion. NIJ Standard-0117.00 addresses protection from fragmentation, impact, and flame. Research is needed to address the additional hazard of blast overpressure and its effects on the human body in terms of blast head trauma, blast thoracic injury, blunt thoracic injury, blunt lower neck trauma, other neck injury, and blast ear injury.

Constraints: The current threat specific in the NIJ standard is a pipe bomb filled with black powder. For consistency, blast overpressure caused by this threat should be examined. Other threats could also be examined.

Need or Gap: Assessment of blast pressure damage to the technician was an early requirement in the NIJ Standard but it was determined at the time that adequate test equipment did not exist to measure blast pressure on a human. The National Bomb Squad Commanders Advisory Board has determined that blast pressure damage assessment to a technician is still a requirement because every explosion has blast pressure but not every explosion has fragmentation.

Scenario: Every explosion has a blast wave associated with it. A bomb technician wearing a bomb suit approaches an IED to preform render-safe procedures. The IED explodes, and the resulting blast wave kills or seriously injures the bomb technician. Although his/her bomb suit holds together, the blast wave could still kill or injure the person inside.

Benefits: This can prevent the death of serious injury of a bomb technician.

Frequency: This is not an everyday occurrence but is a very high risk life and death situation when it occurs. There have been at least two recorded instances when blast overpressure has killed a bomb technician.

2015: Priority #7: Mission Critical Secure Communication over Non-LMR Networks

Discipline: Communications

Description: As LTE, WiFi and other network technologies become more ubiquitous among first responders, collaborative devices will be used to proxy mission critical voice traffic over non-LMR networks. There is a challenge in providing security, routing, and priority of voice packets over non-LMR networks that have yet to be resolved.

Constraints: Service providers must include this functionality at a low incremental cost to each user. This ability will not increase the LMR/LTE subscriber's weight or reduce battery life.

Need or Gap: Seamlessly routing group voice traffic between LMR and LTE suing the same encryption is not currently available.

Scenario: During a CBRNE or other large incident involving multiple agencies, some agencies may only have LTE subscribers and others may only have P25 (LMR) subscribers. Currently these agencies would not be able to communicate with end to end encrypted voice/data.

Benefits: Without end to end encryption, voice traffic could be spoofed, intercepted, etc.

Frequency: Currently not a predominate issue until more agencies migrate to LTE.

2015 Priority #8: Structural Firefighter PPE Interface Improvements to Reduce Contamination

Discipline: Fire Service

Description: An effort to examine the interfaces between existing firefighter PPE, specifically the coat to hood, hood to SCBA facepiece, facepiece to helmet, coat to trouser, and trouser to boot. The effort should provide tangible, actionable recommendations to modify these interfaces for better protection.

Constraints: Constraints for this project are that recommendations for improving the interfaces must be applicable to currently certified NFPA 1971 Structural Fire Fighter PPE.

Need or Gap: Current Strucutral Firefighter PPE is a hodgepodge of items (SCBA, Hood) that have been added to the firefighter over 3 decades and the interfaces have not been evaluated with an eye to improving the level of dermal protection and reducing the garment bulk. An effort to evaluate the interfaces is needed to ensure the firefighter has protection from hazards as identified in the newest research by NIOSH and TSWG partners. Firefighters are currently responding to structure fires with the same level of dermal protection as they have for 25 years and the materials in today's homes have changed.

Scenario: A fire department responds to a report of a structure frim at 0300 on a Sunday, units respond to a home that was built in 2012. Donning NFPA 1971 Compliant Structural Fire Fighter PPE and NFPA 1981 Compliant SCBA enroute, they conduct an aggressive interior fire attack in conjunction with the search and rescue of 2 occupants. Firefighters are gross deconned with a red line after interior operations, prior to rehab. During the firefighters annual medical examination several years later, 2 firefighters are diagnosed with cancer that may have been caused by repeated dermal exposure to PAH's etc.

Benefits: The benefit to firefighters is reduced morbidity and mortality. The benefit to civilians is a reduction in cost of workers compensation costs and reduced cost in delivery of services, resulting in lower taxes.

Frequency: Every structure fire response in the United States and Canada.

2015: Priority #9: Isolating Specialized Systems to Improve Security

Discipline: Communications

Description: First responder systems are highly specialized systems with significant confidentiality, integrity, and availability considerations. This effort seeks tools and technology to harden first responder systems at the end point and during transmission, develop detective devices to identify anomalous activity network and host-based, and evaluate techniques and technology to assist first responder IT professionals to more effectively secure the system.

Constraints: The technology should be able to address various hosts, including vehicle, mobile, traditional workstations, and network devices.

Need or Gap: Current efforts to securing these environments consist of general control guidance based on the Cyber Security Framework. Identify, detect, respond, and recover general statements without any direct guidance on how to accomplish. The challenge is you cannot implement the stated controls within an environment that is not clearly defined nor controlled.

Scenario: Current first responder networks are flat, lack proper monitoring controls and are plagued with challenges in proper system maintenance regarding updated systems and patching. As a result these systems go unpatched and are vulnerable to compromise disrupting first responders' ability to adequately and efficiently respond.

Benefits: With a more secure system in place, agencies will be less vulnerable and can focus on their mission.

Frequency: This gap exists in all IT systems that support police, ambulatory, fire and 911. The problem is exacerbated with the increasing reliance on technology. New systems are being introduced into the environment adding to the complexity of protecting these systems and negatively impacts the ability to properly maintain these systems based on traditional IT processes. Mobility and the internet of things will further increase the attack surface and risk posed to these systems.

2015 Priority #10: Research into Improved Method for Assessing Helmets for Protection Against Ballistic Blunt Impact

Discipline: Law Enforcement

Description: Research is needed to support development of a test method to assess the performance of law enforcement helmets against behind-helmet deformation caused when a bullet strikes the helmet but does not perforate.

Constraints: None. However, development of test method should cost no more than $500,000 because there is a promising head form that has been used in research but has not been validated.

Need or Gap: There is currently a standard being developed to assess the performance of ballistic helmets. However, that standard uses a historically accepted head form that only allows for straight-on

shots/impacts at specified locations on the helmet. It is highly unlikely that an officer will be shot straight-on in one of the tested locations on the helmet. In addition to that, the use of the accepted head form leads to the opportunity for unscrupulous manufacturers to add extra protection at the specified shot locations (i.e. gaming the test). Research is needed to validate a head form that will allow impacts at any location on the helmet at any angle of attack, allow multiple impacts, and allow recording of helmet deformation caused by those impacts.

Scenario: Officers responding to an active shooter, tactical entries, hostage rescue, and riot control.

Benefits: Benefits first responders that wear helmets because it will provide a better evaluation of helmet's ballistic capabilities.

Frequency: Helmets are routinely worn by officers responding to incidents involving a criminal act. NIJ requires helmets to be tested using a historically accepted head form. An improved test method using a better head form will result in more realistic testing.

2015 Priority #11: Decontamination of Law Enforcement After a Crime Scene

Discipline: Law Enforcement

Description: Law enforcement is typically the first to respond and the last personnel to leave. They conduct long investigations in the fire scenes and are typically contaminated as much if not more than firefighters.

Constraints: Training required for law enforcement/EMS/morgue personnel/crime scene units etc. One time in-service training to inform all who are affected.

Need or Gap: The gap in LE finally being given guidance on when/how to decon by either changing clothes/showering, etc. This is needed so that law enforcement/fire investigators and others who spend hours in a fire scene will know the likelihood of being contaminated and the long-term effects it has on their health.

Scenario: LE officer arrives on a scene of a fire at the start of the shift – they are contaminated and stay in contaminated clothing for the rest of the 12-hour shift.

Benefits: First responders will be healthier/live longer and not be exposed to deadly toxins. First responders will have the justification needed to set protocols, that after a fire scene, they should be authorized to change clothing/shower and take preventive measures.

Frequency: Every day. For each fire that a firefighter responds to a law enforcement officer responds. Additionally, based upon the type of scene there will be crime scene/EMS/morgue personnel who will also be contaminated. Hundreds of first responders are breathing in deadly fire toxins on a daily basis.

2015 Priority #12: Challenges of Filtering Facepieces

Discipline: Fire Service

Description: Provide a disposable air-purifying, filtering facepiece respirator that provides protection to the user from infectious disease.

Constraints: Most filtering facepiece respirators do not provide a good facepiece seal. It is difficult to determine if seal is adequate in actual use (after a fit test).

Need or Gap: A performance standard on a disposable filtering facepiece respirator for infection control protection.

Scenario: Unknown emergency response to a victim that may have an infectious disease, and providing protection to a patient with a known infectious disease.

Benefits: A proper facepiece filtering respirator designed and certified for infectious disease protection will provide first responders, first receiver and others providing medical care with a level of protection from acquiring such a disease from exposure to a patient/victim with such a disease.

Frequency: Filtering facepiece respirators are worn daily by individuals providing medical care.

2015 Priority #13: Standardized National Training Program for Emergency Management

Discipline: Emergency Management

Description: Develop a series of terminal and enabling objectives for audiences at all levels in response, recovery and mitigation of federal disaster programs.

Constraints: Utilize experience, knowledgeable EMS to support the course as outlined above.

Need or Gap: The current training programs are outdated.

Scenario: The lack of experience and training of EMS at all levels due to attrition.

Benefits: Improved coordination, communication and understanding of the EM mission and vision.

Frequency: This is a nationwide problem encountered by the EMS at all levels.

2015 Priority #14: Less Harmful/Safer and More Effective Human Capture and Restraint Devices

Discipline: Law Enforcement

Description: Police and corrections need more effective, safer yet less harmful technologies to capture humans in flight as well as restrain them for prolonged periods of time. New technologies must reduce physical and psychological harm potential while increasing the safety and efficiency of LE/Corrections operations.

Constraints: The device (or system) will permit a single operator the ability to apply the device in a safer manner than current handcuffs/shackles/hobbles permit, and ideally could be applied with one hand only.

Need or Gap: The current design and composition of restrain devices has remained relatively similar for centuries, while the legal environment/standards of human dignity among the public has changed over time. Moreover, the legacy designs are constantly defeated by detainees and their accomplices, leading to greater safety risks and escape potential in detention scenarios. Detainers share a common desire with detainees: no one wants restraints to cause injury. Currently, their desire cannot be easily realized. The objective technology will ideally embody a redesign of the concept of a restraint system in form, function, material construction and reduced defeat potential such that the known deficiencies of current restraint devices/systems are fully addressed.

Scenario: A police officer is attempting to detain a combative subject in a civil disturbance situation. The officer should be able to apply the restraint with one hand so as to permit the other's use for control and defense. Should the crowd overwhelm the officer and seize the arrestee, they would not be able to free the subject from the restraint without the affirmative compliant action of the officer – thus making defeat extremely difficult.

Benefits: Responders will enjoy increased safety, efficiency of operations, reduced liability and improved compliance from detainees. Civilians will enjoy the benefits of safer / less harmful detention situations, reduced violence as a result of escape / pursuit of absconding detainees and a reduction in negative police encounters.

Frequency: Common/ every day.

2015 Priority #15: National Standardized Suite of Risk Assessment Tools

Discipline: Emergency Management

Description: Develop a common risk assessment criteria, policies and protocols for conducting, analyzing and disseminating information. Review and assessment of existing risk assessment tools (e.g., MSRAM) to develop a common set of criteria to analyze standard types of critical infrastructure and potential threats for local, state, and federal authorities.

Constraints: Must work across multiple operating systems.

Need or Gap: Currently too many assessment tools used by too many agencies, placing a burden on local jurisdictions and private industry.

Scenario: Having to go out to facilities multiple times and using different forms for different types of assessments.

Benefits: Improved productivity and ease in integration of plans.

Frequency: Frequency dependent on number of critical infrastructure and potential hazards.

2015 Priority #16: Research into Test Method for Assessing Fragmentation Protection of Ballistic Shields

Discipline: Law Enforcement

Description: Research is needed to support development of a test method to assess the performance of ballistic shields against fragments from an improvised explosive device.

Constraints: N/A

Need or Gap: There are no existing standards for ballistic shields. Although a test method is currently being developed to assess ballistic protection against bullets, there is no test method for assessing protection of ballistic shields against fragmentation from an IED. There is an operational knowledge gap that exists because officers are using shields for shrapnel protection without any indication they will work.

Scenario: An officer has to approach a subject who is in possession of an IED in an effort to stop the suspect from entering a populated area and detonating the device. The officer approaches the subject with a ballistic shield thinking that it will provide protection if the IED detonates. Another scenario is an officer dealing with a pipe bomb that is designed to produce shrapnel.

Benefits: It will provide officers are confidence they need to approach/disarm/remove a perceived threat providing public safety.

Frequency: It is not a common occurrence that offices must approach a suspect with an IED' however, that situation is likely to occur more often in the future. And when it occurs, the risk is very high.

2015 Priority #17: Wearable Intrinsically Safe Miniaturized Multi-Detector Sensor Platform that Transmits Data through Integrated Wireless or Any Existing Communication System

Discipline: Communications

Description: Multiple sensors that are preferably miniaturized and wearables (e.g. % LEL, PID, FID, IMS, FPD, et.al.) that can be integrated into a single platform with wireless communication capability or that can transmit data through any existing communication system. Platform could be a vest with plug and play detector ports and a common power source controlled via software wirelessly connected to a laptop in the support zone. Detectors should also provide visual and audio alarms to alert the wearer.

Constraints: Two tiered training should be available for the wearer (minimal hours) and the operator (40 hrs maximum).

Need or Gap: Initial and subsequent entries into a hot zone must be made by multiple personnel carrying multiple instruments and detectors until the containment is identified and then mitigated. Alternatively, multiple personnel can move multiple detectors/instruments into the hot zone with a wheeled device such as a shopping cart. Personnel can free up hands to carry other items and complete other tasks.

Scenario: Unknown hazmat incident. Entry teams must protect themselves, survey the scene, conduct air monitoring, collect samples and evidence, and initiate containment and mitigation procedures. Eliminating and minimizing multiple personnel entries will speed-up the response and minimize heat or cold stress and fatigue.

Benefits: Should save lives and personnel energy in responses. Costs should be similar to nonintegrated and individual detector systems. Decisions should be made in a timelier manner with better information.

Frequency: Common all over the U.S. in hazmat responses and anywhere personnel are employed addressing unknown or CBRNE events.

2015 Priority #18: Automated CBRNE Event Isolation and Evacuation

Discipline: HazMat or EOD

Description: Portable device and V2V (vehicle to vehicle) network application that automatically isolates a CBRNE event from civilians and provides a clear path for first responders to incident.

Constraints: V2V networks will be common in the next few years so this priority will leverage those networks already in place and no additional cost for infrastructure will be needed. Costs will be for developing the software applications to support priority.

Need or Gap: Currently the information broadcast in an emergency does not give specific instructions for each civilian individual/vehicle to egress an area safely or instructions to provide a coordinated ingress path for responders.

Scenario: A dirty bomb detonates in an urban area during rush hour. The system automatically detects the radiation, wind direction, and other data. The system then redirects traffic flowing into the area, evacuates traffic in the area and isolates the current and future contaminated areas from civilians, while routing first responders to the leeward side of the event.

Benefits: By giving specific instructions to individuals, civilians will have a clear path to egress an incident as well as aiding responders with a clear ingress path. This will also help to contain the incident and minimize/eliminate additional victims.

Frequency: CBRNE events are not common but system can be used for major accidents and other incidents enabling a faster response.

2015 Priority #19: Portable (hand-held), Ruggedized, Rapid Biodetection Kit

Discipline: Medical

Description: Rapid, advanced, field grade PCR-based technology to deliver reliable and sensitive ID and detection of biological pathogens (biothreat, Food/Water, and environmental); FDA approved.

Constraints: Weight < 15 lbs, rechargeable battery (possibly solar), Bluetooth/WiFi, barcode reader/scanner and freeze-dried.

Need or Gap: PCR-based rapids detection and ID of biological pathogens in the field (not using referral lab).

Scenario: Ruggedized, field-deployable, rapid (< 10 min) biological pathogen detection and ID (environmental, food/water, clinical)

Benefits: Decreased responder exposure/loss of life, decreased health care cost, increased protection of infrastructure, and decreased civilian loss of life.

Frequency: Urgent need – frequent

2015 Priority #20: Meta-Analysis of Preventable Causes of Death of Law Enforcement

Discipline: Law Enforcement

Description: A comprehensive analysis of the preventable causes of death including death by weapons and vehicles (i.e. lack of training, poor tactics…) as well as wellness issues such as cardiac and cancer. Review data on correlations between: cardio vascular disease and LE deaths, LE killed in the line of duty by vehicles in preventable situations, LE killed by weapons in preventable situations (using poor tactics, accidental discharge, not trained properly). Create a document or series of documents that summarizes the most common causes of preventable death and help identify what leads to them and what can/should be done to mitigate the problem.

Constraints: Reviewing the data would take a lot of time but there is no cost associated with purchasing hardware.

Need or Gap: A comprehensive review of the literature related to the most common, preventable causes of death to LE. For example, there is minimal info available about correlations between cardiovascular disease and death in LE. There is a great deal of info put out by the FBI on LE deaths but the summaries are vague and tables have enormous amounts of info. We need help navigating through all the info to find what is most important to trainers and administrators so they can act on the info.

Scenario: There is a lot of anecdotal evidence of the reasons LE are killed, but a systematic review is not readily available. We can give hundreds of examples of LE being killed in situations that could have been prevented.

Benefits: If the specific causes of preventable death in LE are known actions can be taken to implement the change.

Frequency: Hundreds of officers are killed every year for various reasons, and the FBI puts out an annual report on the violent deaths but nothing has been done on preventable deaths (vehicle collisions, cancer, etc.).

2015 Priority #21: Interactive Simulator for Command Center Training (Virtual Playbook)

Discipline: Emergency Management

Description: Develop a recommended process to allow disciplines to theoretically respond to and operate at major emergencies which allow for any decision making and infrastructure protection. The program would automatically monitor and provide feedback upon the actions or lack of actions of the respective disciplines. Feedback based upon input from lessons learned and experienced responders from the respective disciplines.

Constraints: CS400 or equivalent per the authority of the jurisdiction (AHJ). Cost should not exceed $3 million. Must be capable of running on a portable or desktop PC on a wide area network.

Need or Gap: To date there is no program or system that is standardized, peer reviewed, and provides competent feedback to the participants in the scenario.

Scenario: San Andreas earthquake requiring massive response.

Benefits: Program will provide simulated experiences to responders in order to better serve the community.

Frequency: Evaluate lessons learned from past incidents to insure they are incorporated into the program.

2015 Priority #22: One-Time Use Torso Cooling Undergarment for Short Duration Operations

Discipline: Law Enforcement

Description: Development of a non-battery powered, non-refrigerant lightweight torso cooling garment to be worn under a bomb suit or heavy ballistic vest.

Constraints: Must keep torso cool for at least 30 minutes; should be one-time use (i.e., disposable after use); should not require training to use.

Need or Gap: Officers wearing body armor, bomb suits, or similar protective equipment become fatigued and could suffer heat-related injury.

Scenario: Bomb technician must perform render safe procedure that takes 15 to 30 minutes while wearing a bomb suit, and taking a break is not possible.

Benefits: This will benefit first responders who have to wear heavy protective equipment for a short duration.

Frequency: Bomb technicians often have to wear a bomb suit for a very short duration, 15-20 minutes, and need a method to keep their torso cool on a hot day in a bomb suit.

2015 Priority #23: Inexpensive, Portable, Ruggedized Point-of-Care Lab Testing Device

Discipline: Medical

Description: Develop a hand-held device for point-of-care testing of bloodwork. It must be inexpensive, rugged, rapid (results < or equal to 10 mins) and must have high sensitivity/specificity of lab based blood tests.

Constraints: Cost less than $500, environmental and impact resistant, rapid results (< or equal to 10 mins) and ease of use.

Need or Gap: Ability to make advanced field care decision and diagnosis – will play into triage, mode of transport decision, and advanced field medical management.

Scenario: Firefighter collapses during a fire- point-of-care blood test within 10 minutes of rescue shows elevated lactate levels indicating cyanide exposure. Treatment initiated immediately.

Benefits: Allow for more rapid and accurate field diagnosis and directed medical care. Will enable accurate triage decisions (e.g. Troponin) and earlier initiation of care (e.g. antibiotics in sepsis).

Frequency: Every Fire/EMS agency will use daily; has uses in patient care, firefighter rehab and safety.

2015 Priority #24: Rapid, Universal, Battery Charger for Portable In-Home Medical Devices

Discipline: Medical

Description: A rapid battery charger for portable in-home medical devices. A battery charger that would rapidly charge the back-up batteries of in-home medical devices when electricity is unavailable in the home.

Constraints: Unit needs to be portable (easily transportable), intrinsically safe, extended operation; possibly solar charged. Single operator, easy to use, minimal training involved, and able to fully charge a home medical device battery within an hour.

Need or Gap: With loss of power, special needs patient depended on life sustaining at home medical devices normally need to be transported to a medical facility or specially outfitted shelter.

Scenario: Natural disaster, loss of electric grid, summer outage, transformer failure, etc.

Benefits: Civilians: stay in-home environment; Responders: less transport; faster and fewer; Responses: option for non-medical personnel.

Frequency: Frequent event with natural and manmade disasters based on special needs population impacted by power failure.

2015 Priority #25: Redaction of Imagery from Body Worn, Vehicle, or Surveillance Cameras for Public Release

Discipline: Communications

Description: Provide technology tool to assess imagery for information and images that contain personally identifiable information that cannot be shared publicly and redact the information for public release if FOIA (Freedom of Information Act). There must be a method to blur images within recorded video for redaction purposes of person who's identify must be kept secure for whatever purpose.

Constraints: Software tool should operate on currently available operating systems that costs less than $100K and can be operated with training (self-help, on-line) in 2 hours or less.

Need or Gap: Imagery collected by body worn, car mounted, or surveillance cameras collect personally identifiable information (PII) and needs to be redacted in any FOIA requests.

Scenario: With the onset of recorded video requests dramatically increasing, automatic facial recognition of underage persons on video and blurring of those faces should be an option in preparation for the video release to the media or public.

Benefits: Redacted information can be released in hours rather than weeks or days. There should be an option in video engines where all faces in recorded video can be blurred automatically for FOIA release. A second option should allow operators to select time spans in release video to no blur faces where needed.

Frequency: As the use of cameras grows, the amount of imagery collected will increase well beyond the ability of human observers to review and redact PII.

2015 Priority #26: Efficacy of Fusion Centers at the Local/State/Federal Level

Discipline: Emergency Management

Description: Fusion centers have grown in size and scope; however, metrics or assessment methodologies do not exist to determine efficacy of fusion operations of products. Assessment metrics of measurement tool based on common & established criteria.

Constraints: Training would be required on tool (assuming software based) and cost for process development and integration.

Need or Gap: Resource Management, Operations, Support, Intelligence Oversight, Information Sharing.

Scenario: Fusion center expands resources (Time, Personnel, or Funding) to create time-sensitive products that do not follow operational requirements or timelines.

Benefits: Efficient utilization of scarce resources provide operational support at right time and place.

Frequency: Very likely.

2015 Priority #27: Body-Worn Video Analytics

Discipline: Law Enforcement

Description: Create video analytics for body-worn video devices to make the devices more useable/intuitive i.e. automatic BOLO (Be On LookOut) detection, plate/ID recognition and processing, and gesture deciphering.

Constraints: Should interpret live video with little perceptible delays and analytics engine should be portable and contained in a portable body-worn device the size of a remote speaker microphone. Cost should not exceed $500.

Need or Gap: Will enable policing crowds safer and identifying threats quickly.

Scenario: Cameras scanning crowds could quickly identify a suspect matching a BOLO description. Face gestures could be read and threats identified.

Benefits: By using video analytics to continuously evaluate the user's environment for threats, violations etc. the public safety officer could focus on other priority tasks.

Frequency: Device would be used in day-to-day policing.

2015 Priority #28: Non-Burning Treatment System for Illegal Fireworks

Discipline: Hazmat or EOD

Description: Develop an EPA approved mobile treatment unit for treatment, recycle/reuse, and destruction of fireworks, other explosives, and pyrotechnics that are safe and protective of human health and environment.

Constraints: Provisions will need to be made for the development of a program to fund, administer, and operate this fireworks disposal process nationwide.

Need or Gap: Public safety bomb squads and explosive specialists routinely destroy large quantities of these dangerous materials. According to a survey by the National Bomb Squad Commanders Advisory Board (NBSCAB), public safety bomb squads and the Bureau of Alcohol Tobacco, Firearms, and Explosives (ATF) destroy more than 300,000 pounds of fireworks annually. Handling, storing, transporting, and treating these fireworks present a number of safety, security, environmental, technical, and procedural challenges. The principle issue of concern is that the primary method of safe disposal employed by public safety bomb squads and explosive specialists, open burning and detonation, can place these public safety officers in a position of potential violation of EPA regulations. Efforts are needed to develop technologies to provide alternative methods that can replace open burning and detonation of fireworks, other explosives, and pyrotechnics.

Scenario: Bomb squads in California are dealing with a crisis involving the storage and destruction of thousands of pounds of seized fireworks. Between the U.S. EPA and California EPA, they are facing an end to burning as a method of destroying fireworks. Other bomb squads around the U.S. will follow. An alternative method for destroying fireworks must be developed.

Benefits: A number of bomb technicians and explosives contractors have been injured or killed in fireworks disposal operations. The proposed method would make the process completely safe. Civilians are threatened by the massive storage of fireworks and other explosives, as bomb squads and explosives contractor wait for approvals to destroy them.

Frequency: As mentioned above, public safety bomb squads and the ATF destroy more than 300,000 pounds of fireworks annually.

2015 Priority #29: Develop a Fully Integrated SCBA/Seatbelt System for Fire Apparatus

Discipline: Fire Service

Description: A SCBA/seatbelt that allows the firefighter to securely and safely don the SCBA while being buckled into the apparatus.

Constraints: Would require standards change along with R&D for creation of product. A change in SCBA components & seatbelt configuration would be costly. Integrating SCBA and seatbelt will be challenging. A focus on a seatbelt and seat combination.

Need or Gap: Firefighters are challenged to be fully bunked and don SCBA while being seat belted. This challenge leads to many not safely securing into the apparatus.

Scenario: Firefighters responding to emergency requiring the donning of SCBA while in the cab. Firefighter able to don SCBA with a separate seatbelt component.

Benefits: Increased survivability for the firefighter when responding to emergencies. The ease of use would allow firefighter to don SCBA without an additional component that can be cumbersome while in full PPE. Firefighter would be able to respond to emergencies safely and potentially reduce the line of duty injuries or fatalities when responding.

Frequency: Common in all firefighters in the fire service. This product would be utilized on every fire related response in which an in-cab SCBA would be indicated.

2015 Priority #30: Data Interface Between NEMSIS Compliant, Patient Care Reports & Hospital Medical Records

Discipline: Communications

Description: Most states require EMS providers to document patient encounters using electronic patient care reports. The National EMS Information System (NEMSIS) is the national database developed by the Office of EMS in the National Highway Traffic Safety Administration and now maintained to collect EMS data from almost all states. To facilitate this process, virtually all commercially available electronic patient care reports use the NEMSIS format and data dictionary. As federally mandated, hospitals have (or are in the process of) converting to electronic medical records. There are a handful of EMR systems that have been adopted by the vast majority of hospitals throughout the country. Prior to conversion to EMS electronic patient care reports and hospital EMRs, the paper record of the EMS patient encounter was left with the patient at the hospital, and was available to the clinicians who assumed care of the patients. Since the conversion, there is an almost universal problem that ePCRs are completed using laptop computers, but cannot be imported or integrated into the hospital EMR because the platforms are incompatible and there is no existing system to support this function. There is no longer any way for the record of EMS care to follow the patient to the hospital.

Constraints: Product must provide bi-directional data-sharing across the most common PCR (e.g. ESO, MEDS, ZOLL, etc.) & EMR platforms (e.g. EPIC, SOARIAN, EMPOWER, PICGd's). Business model could be either turnkey software with implementation guidance (could cost more), or per-chart transfer service maintained by vendor/developer.

Need or Gap: Ever since EMS started using ePCR's and hospitals were required to convert to EMR's there has been complete inability to transfer and access EMS PCR by ED and hospital staff, including special programs that are required to have and review the data.

Scenario: Technology could be used with every single patient transported to hospital by EMS.

Benefits: A 1-way data interface (ePCR to EMR) benefits patients (civilians) and hospital staff by making the out-of-hospital findings, observations, treatments and responses available to the subsequent care providers. In addition to the 1-way advantages, a 2-way data interface (hospital data visible to EMS providers as well as EMS data available to hospital providers) benefits patients and EMS providers by making prior hospital information (e.g., allergies, medical histories, current medications, recent surgeries) available to EMS providers at the time they are caring for the patient. It also allows EMS providers to obtain follow-up on patients they've cared for, and to use outcome data for more robust surveillance and service quality improvement programs.

Frequency: Very frequent.

2015 Priority #31: Standardized Model for Population Response to Disaster Events

Discipline: Emergency Management

Description: This model will represent the reactions of various segments of the populace to inputs representing the unfolding of the disaster event and the response to the disaster. It will allow representation of various sized groups as stand-alone populations or as parts of a larger population. Will include the data set that can define various attributes of the population representing size, confidence in leadership, affinity with different leaders, affinity with other populations, predisposition to violence, and other behaviors of interest. It will also identify which population characteristics are of most importance to the disaster response.

Constraints: No cost/logistical constraints identified. A version, possibly streamlined, should be available for real-time modeling, while a more advanced model should be available to support scenario development and advanced planning.

Need or Gap: There is no objective method available to statistically predict population responses to the many factors impacting a disaster and the development of the response.

Scenario: Properly developed, this system could have, for instance, better predicted the evacuation response for hurricane Katrina.

Benefits: The primary benefit for both civilians and responders would be to improve the effectiveness of response by helping to clarify when and where particular capabilities and resources are required.

Frequency: Common from planning perspective as more effort goes into planning for large-scale events.

2015 Priority #32: Small Portable Decon Kit for VIP

Discipline: Law Enforcement

Description: An FDA approved for skin decon kit. No items are currently FDA approved for use on human skin. Other kits stat "under FDA consideration" not FDA approved.

Constraints: Less than $100.

Need or Gap: Police, fire, and EMS encountering a person or self that is contaminated and have no water etc. to clean up from CBRNE materials.

Scenario: VIP shaking hands with somebody who has Ricin on their winter gloves.

Benefits: It would be used on civilians and responders who cannot carry a lot of gear but may carry a few slim packets.

Frequency: This is a low cost item that only effects responders dealing with VIP protection and decon but would have other uses.

Appendix E: Complete 2014 Priority List

2014 Priority #1: 3-D Tracking of Personnel

End User: Responders

Brief Description: There is a need for priority development of technologies for tracking operating personnel in a 3-D environment. The research and development of 3-D tracking systems needs to continue until these systems are fielded.

Detailed Description:

Constraints: Must be lightweight and not interfere with responder's ability to perform mission. It must be usable in an operational environment providing capability to locate a responder within a radius of 5 feet (threshold) and 3 feet (obj) within 3 dimensions.

Need/Gap:

Scenario 2: An Incident Commander needing real-time geospatial depiction of deployed assets during an incident in a high-rise building

Benefits: Having the ability to track respondersin an operational environment will allow for redirection away from known or developing hazards as well as knowing exactly a person is if they are injured.

Frequency: It is a daily occurrence.

Other Products Available: Yes

Other Products Insufficient: Harris G-100 and TRX Systems NEON solution are two developing products to look at

Complete Solution: Completely

Not Complete Solution Reason:

Not Compatible Existing: Somewhat

Not Compatible Existing Reason: This would depend on what the final product looks like. Hopefully it would be a complete solution.

Cost Effective: Somewhat

Cost Effective Explanation: This will depend on the final cost of any product, but saving the lives of responders cannot have a price tag placed on it

Protect Critical Infrastructure: N/A

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; Reduction in first responder loss of life; improved productivity

Other:

SubGroup: Information Management & Communications SubGroup

Requirement Priority Ranking: 1

Approved: TRUE

2014 Priority #2: Enhance communications in environments that interfere with radio transmissions

End User: Responders

Brief Description: Portable network extension of current radio capabilities into areas where coverage is hampered by environment/terrain (e.g. tunnels, canyons, large structures, ships, etc.).

Detailed Description: Enhance communications in environments that interfere with radio transmissions.

Constraints: The system must be lightweight and not interfere with the responder's ability to perform their mission. It must be usable in tunnels, high-rise building environments, enclosed spaces, etc.

Need/Gap: The need exists to create wireless ad-hoc data and voice networks using "Zero Configuration" battery powered field deployable devices. The devices must be able to be operated for a minimum of 24 hours (confined space) or 72 hours (wildland environment). The minimum distance between devices in the ad-hoc network should be a minimum of 100 feet linear and 20 feet vertical (confined space) or 2 miles (wildland environment). The device size should not exceed <0.25 cubic feet (confined space) or 4.5 cubic feet (wildland environment) and the weight cannot exceed <10 pounds (confined space) or 95 pounds (wildland environment). They must be able to be deployed without requiring any configuration in the field. These devices must support analog and standards based digital voice and data standards (Project 25, LTE, GSM, CDMA, 802.11, etc.). The device must support currently available public safety narrow, wide and broadband spectrum space. It is highly desirous that the Backhaul between devices be industry standard. Proprietary backhaul would be acceptable but not optimal. Backhaul and control plan traffic must be encrypted and authenticated and cannot compromise end-to-end network traffic. The backhaul network must be self-configurable and self-healing. It is highly desirous that the backhaul mesh network create redundant network paths. Redundant paths can be used for traffic management.

Scenario 2: Responders entering tunnels, building basements, high-rises, etc. have difficulty establishing normal radio communications, are often in "dead zones", and are unable to establish radio communications.

Benefits: Establishing communications in those areas that have none will allow that responders to request support provide situational updates and operate in a safer manner.

Frequency: This happens across the nation on a daily basis.

Other Products Available: No

Other Products Insufficient:

Complete Solution: Completely

Not Complete Solution Reason:

Not Compatible Existing: Somewhat

Not Compatible Existing Reason: This depends on the product that is submitted.

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: N/A

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; Reduction in first responder loss of life; Reduction in civilian injuries; Reduction in civilian loss of life; improved productivity

Other:

SubGroup: Information Management & Communications SubGroup

Requirement Priority Ranking: 2

Approved: TRUE

2014 Priority #3: Hands-free Radio Intercom

End User: Responders

Brief Description: Portable radio/accessory combination, which allows hands-free, intercom style comms via portable radios among small groups in close proximity (30'), simultaneous ability to listen to and talk on command channel when keying a microphone

Detailed Description:

Constraints: Must accommodate 6-8 users and operate within a 30-60 foot area. The system must support secure encrypted communications.

Need/Gap: Tactical channel saturated. Company channels are inhibited. Need to be able to listen to tactical channels but still need to be able to communicate on tactical channels.

Scenario 2: A fire suppression unit operating at a house fire or a law enforcement team deployed on a tactical mission has unfettered communications among team members. If any team member wishes to talk to command or another group, they can easily key the microphone.

Benefits:

Frequency: All first responders

Other Products Available: Yes

Other Products Insufficient: Scott has a product manufactured by ClearCalm, which has a wireless hands-free intercom along with a PTT (Push-to-Talk) microphone. Battery life was identified as an issue in testing.

Complete Solution: Somewhat

Not Complete Solution Reason: Depends on what is produced

Not Compatible Existing: Somewhat

Not Compatible Existing Reason: This will all depend on the manufacturer.

Cost Effective: Somewhat

Cost Effective Explanation: Depends on final pricing model.

Protect Critical Infrastructure: N/A

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Improved emergency response infrastructure; improved productivity; Reduction in first responder injury; Reduction in first responder loss of life

Other:

SubGroup: Information Management & Communications SubGroup

Requirement Priority Ranking: 3

Approved: TRUE

2014 Priority #4: Noise-filtering Digital Speaker/Microphone for SCBA facepiece

End User:

Brief Description: This envisions an accessory for a portable radio which allows hands-free, "intercom" style communications (VOX) between small groups of users located in close proximity (up to 1/16th of a mile) to each other while being able to simultaneously monitor and transmit with a push to talk button on a priority channel or talk group.

Detailed Description: The system must support different "intercom" channels for different groups of users operating within a given geographical areas. Users must be able to configure the system to select both the "intercom" channel and the priority channel. Communications between users in "intercom" mode should be full duplex in nature and voice operated. All users on a given channel should be able to hear each other. When a transmission occurs on the priority channel all users, monitoring that priority channel will hear the priority transmission over the "intercom" traffic. The system can use solely the user's primary portable radio or a secondary radio to support the "intercom" functionality. If a secondary radio is used to provide the intercom communications, the size of the secondary radio cannot exceed 0.5"Hx2"Wx3.0"D with an appropriate weight. If the user is primary radio is used for both communications path, priority sampling is not acceptable (both "intercom" and priority channel audio needs to be delivered simultaneously). The priority radio channel may be analog or digital and conventional or trunked. "Intercom" communications may be analog or digital but must support the option of encryption for the "Intercom".

Constraints: Needs to be light enough to not hinder the wearing of the SCBA/APR face piece. Has to be cost effective, water resistant, and has to plug into existing SCBA/APR systems.

Need/Gap: There is a need to transmit intelligible communications while wearing SCBA/APR face piece.

Scenario 2: Any emergency responder wearing an SCBA/APR while attempting to communicate over their digital radio's speaker microphone in a high noise environment has severely distorted audio.

Benefits: It will make transmissions easier to understand.

Frequency: While improvements have been made in off the shelf radios, a high noise environment results in severely distorted audio when operating in the digital format.

Other Products Available: Yes

Other Products Insufficient: Improvements are being made, but advancements still need to be made.

Complete Solution: Completely

Not Complete Solution Reason:

Not Compatible Existing: Completely

Not Compatible Existing Reason:

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: N/A

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Improved emergency response infrastructure; Reduction in first responder injury; Reduction in first responder loss of life; improved productivity

Other:

SubGroup: Information Management & Communications SubGroup

Requirement Priority Ranking: 4

Approved: TRUE

2014 Priority #5: Modeling, Simulation & Simulation Software Evaluation Tool

End User: Emergency Preparedness Trainers and Planners

Brief Description: The proposed software tool will allow users to (a) search for a model, simulation, or simulator appropriate for their particular operational and/or training requirements and (b) receive recommendations based on the criteria developed, the user's constraints, and ranking of importance. This would build upon the MS&S White paper and web-based e-tool that has previously been developed.

Detailed Description: Software program / tool that can be used by first response agencies to search for and evaluate modeling and simulation tools specifically targeted towards the first responder community.

Constraints: Costs would be based upon software development and programming time. Tool should have the ability to be easily modified and updated as new technology and MS&S tools come onto the training marketplace.

Need/Gap: Existing web-based software technology should be leveraged and modified to support the development of the selection tool. Current simulation database efforts do not satisfy the robust criteria required for civilian and first responder decision makers to research and evaluate MS&S options.

Scenario 2: AHJ is using grant dollars to acquire an active shooter MS&S tool to facilitate both individual and organizational training. AHJ's are limited to information provided by the product manufacturer, and have limited access to information and recommendations that could facilitate their research and evaluation process before acquiring the product.

Benefits: (1) Facilitates more effective use of available funding dollars; (2) use of MS&S tools can help AHJ address training challenges in a more efficient and cost-effective manner.

Frequency: Initial acquisition costs for MS&S tools is typically relatively high, and the costs of poor MS&S selection processes can result in the non-efficient utilization of limited funding resources.

Other Products Available: No

Other Products Insufficient:

Complete Solution: Somewhat

Not Complete Solution Reason: Given the wide scope and range of technology-based tools that exist, this options attempt to develop a more informed and educated first responder "consumer" of modeling and simulation tools. Given new technology and innovation, this area is constantly evolving and changing as new technology presents itself.

Not Compatible Existing: Completely

Not Compatible Existing Reason:

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: Somewhat

Protect Critical Explanation: Facilitates the training of first responders who may respond to incidents involving CI/KR facilities.

Implementable Solution: Somewhat

Implementable Solution Explanation:

Outcomes: Other; improved productivity; Reduction in first responder injury; Reduction in first responder loss of life

Other: Facilitates more effective utilization of grant and training funds for the acquisition of modeling, simulation and simulators.

SubGroup: Training & Exercises SubGroup

Requirement Priority Ranking: 2

Approved: TRUE

2014 Priority #6: Proactive Training Resource (PTR) Initiative

End User: Emergency response training agencies (all hazards)

Brief Description: Compendium / resource that accepts all types of emergency response reports (AAR, lessons learned, IP's, threats), identifies training strengths & challenges, generates a PTR that identifies trends & facilitates targeted guidance, training or protocols.

Detailed Description:

Constraints: Ability to accept inputs from a variety of emergency response sources, and to allow a user to easily query the resource to access available information.

Need/Gap: Facilitates getting information on emerging trends, issues and response scenarios to the response community (all hazards) in a timelier manner. Currently, training curriculums and SOP's often lag behind field response experience and emerging trends due to the focus on day-to-day activities.

Scenario 2: Previous Responder Knowledge Base (RKB) data showed users searched "training aid" 522 times in an 18-month period. "Training guidance" searches made 3,887 times. Users do not have clear training outputs and resources, especially to reflect emerging trends and issues.

Benefits: Training curriculums & SOP has often lag behind response experience & trends due to focus on day-to-day activities. PTR initiative & output should assist responders in ID response trends, training gaps and needs, etc. with minimal organizational impacts.

Frequency:

Other Products Available: Yes

Other Products Insufficient: Lessons Learned Information Sharing (LLIS.gov) is an example of a PTR system, but is limited to information provided through the Federal govt. and does not accept information from a wide range of sources.

Complete Solution: Somewhat

Not Complete Solution Reason: Facilitates easier and more rapid access to new threat information.

Not Compatible Existing: Somewhat

Not Compatible Existing Reason: Should be able to draw from currently existing systems and provide the user with trends and facilitates the need for targeted emergency responder guidance, training or protocols.

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: Completely

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Reduction in civilian injuries; Reduction in first responder injury; Reduction in first responder loss of life; Reduction in civilian loss of life; Improved emergency response infrastructure; Other

Other: Get information on new or emerging threats and issues to the response community in a timelier manner. Achieving that goal also affects all of the other outcomes noted.

SubGroup: Training & Exercises SubGroup

Requirement Priority Ranking: 3

Approved: TRUE

2014 Priority #7: Sampling kit for clothing/equipment contamination identification

End User: All first responders that encounter chemical/biological contamination

Brief Description: Many first responders that may be exposed to hazardous substances cannot determine levels of contamination and if items, including body armor, radios, etc., are safe for reuse. Practical approaches to field sampling may allow identification and detection of contaminants that can then be used if item can be decontaminated.

Detailed Description: The proposed item would entail the necessary supplies and instructions for collection samples nondestructively from clothing and equipment items. These samples would include the necessary preservatives while instructions would indicate the procedures to be supplied that enable the appropriate analysis techniques.

Constraints: Kit must be portable, simple to use, and allow for replenishment of used supplies. Kit should be supported by written instructions and online information. No analytical experience should be required for use of kit.

Need/Gap: Currently first responder organization lack capabilities to assess levels of contamination and my assume clothing and equipment be exposed as suspected contamination. Sampling kit and associated procedures would enable informed decisions for decontamination and reuse, particular for customized items such as body armor.

Scenario 2: First responders encounter accidental or intentional spill of hazardous substance. Similarly, first responders encounter bio agent through emergency medical or bioterrorism activities. Level of contamination is uncertain and items must be quarantined after gross decontamination awaiting future disposition.

Benefits: The capability to assess contamination nondestructively will permit first responder organizations to make informed decisions if contamination has occurred, if decontamination is effective, and if items must be disposed of. This capability prevents unwarranted disposal of reusable clothing and equipment items and safe reuse without continued exposure of first responder or civilian community.

Frequency: Firefighters, EMS providers, and law environment personnel commonly encounter contaminants in everyday responses. Recent studies by TSWG, DHS/FEMA, and NIOSH show persistent contamination in some types of protective clothing.

Other Products Available: No

Other Products Insufficient:

Complete Solution: Somewhat

Not Complete Solution Reason: There may be some contaminants that are difficult to collect nondestructively.

Not Compatible Existing: Completely

Not Compatible Existing Reason:

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: Completely

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; Reduction in civilian injuries; improved emergency response infrastructure; improved productivity

Other:

SubGroup: Equipment SubGroup

Requirement Priority Ranking: 5

Approved: TRUE

2014 Priority #8: Implementation of Unmanned Aerial Vehicles (UAVs)

End User: Law Enforcement / Fire Personnel

Brief Description: There is a need for priority development towards the Implementation of unmanned aerial vehicles (UAVs) for local law enforcement/fire departments. The R&D of Laws, policies, procedures, testing and selecting appropriate technology, training, equipment maintenance, etc. is greatly needed.

Detailed Description: The advent and proliferation of unmanned aerial vehicles presents new challenges for emergency responders working in prevention and response modes. There are no "best practices" for acquiring, training or deploying such tools and there are numerous disparate laws from state to state governing their use. There is no compendium of existing policies and procedures for referential use. Research into what the best uses are for such vehicles in the realm of emergency response, as well as details on the challenges of creating such a resource at the state and local level is needed.

Constraints: Much is undetermined, to include permits, licenses, maintenance, etc. compilation of FAA and FCC requirements, associated costs and limitations to be determined.

Need/Gap: Lack of guidance, policies and best practices leaves many local and state response agencies struggling to determine whether or not they should implement such a program, expending resources researching on their own the costs to complement, train and maintain such a program. There is also little empirical evidence to support whether such a program demonstrates a return on investment in increased operational support or responder safety.

Scenario 2: First Responders struggle to incorporate and implement UAVs into use. Many departments have purchased these assets and they are unable to utilize them.

Benefits: Having the understanding of the factors involved with implementing UAVs will allow departments to properly utilize this capability.

Frequency: Varied accounts - tens to low hundreds estimated.

Other Products Available: No

Other Products Insufficient:

Complete Solution: Somewhat

Not Complete Solution Reason: The laws and politics will vary by state/jurisdiction. Common and Best practices may be possible.

Not Compatible Existing: Somewhat

Not Compatible Existing Reason: The laws and politics will vary by state and jurisdiction. Common and Best practices are possible.

Cost Effective: Somewhat

Cost Effective Explanation: Will vary by jurisdiction. Common and Best practices are possible.

Protect Critical Infrastructure: Somewhat

Protect Critical Explanation: It has potential.

Implementable Solution: Somewhat

Implementable Solution Explanation: A common approach is possible.

Outcomes: Improved emergency response infrastructure; Improved productivity

Other:

SubGroup: Strategic Planning SubGroup

Requirement Priority Ranking: 2

Approved: TRUE

2018 Priority #9: Implementation of protective ballistic gear for fire and medical responders

End User: Responders

Brief Description: Ballistic personal protective equipment.

Detailed Description: Access to, and use of, PP&E will facilitate improved interoperability among law enforcement and EMS/fire personnel during IED and active shooter incidents. Currently, body armor used by most civilian personnel will not consistently protect against fragmentation and blast exposure from IEDs. Further research on the effectiveness of PP&E in IED incidents is, and should remain, ongoing. The first responder community requires recommendations for improved protection, as they become available. Policies, procedures, training, effectiveness and maintenance are all issues.

Constraints: Policies, procedures, training, effectiveness and maintenance are all issues.

Need/Gap: Current technology does not address weight and coverage issues.

Scenario 2: Access to, and use of, ballistic PP&E will facilitate improved interoperability among responders during IED and active shooter incidents although policies, procedures, training, and maintenance issues are unclear to implement the equipment.

Benefits: Responders require clear guidance in order to properly utilize and implement ballistic PP&E.

Frequency: This is a high consequence topic, but low frequency (increasing) occurrence. Hot topic issue across the nation.

Other Products Available: No

Other Products Insufficient:

Complete Solution: Somewhat

Not Complete Solution Reason: Will vary by jurisdiction and situation.

Not Compatible Existing: Somewhat

Not Compatible Existing Reason: Will vary by jurisdiction and situation.

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: Completely

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; Reduction in civilian injuries; Reduction in first responder loss of life; Reduction in civilian loss of life; Improved emergency response infrastructure; Improved productivity

Other:

SubGroup: Strategic Planning SubGroup

Requirement Priority Ranking: 1

Approved: TRUE

2014 Priority #10: Field Detection/Analysis Devices for Fire Vapors, Gases and Particulates in Post-Fire Operations and Investigations

End User: Fire Service, Law Enforcement, Fire Origin and Cause Investigators, Arson Investigators

Brief Description: Many response personnel are exposed to dangerous carcinogens, toxic gases and particulates after the fire is extinguished. In addition, command and support personnel are exposed in the area surrounding the fire area.

Detailed Description: Hand held or "man portable" device that will detect and quantify levels of toxic gases, vapors & particulates commonly found in the post-fire environment.

Constraints: Cost effective (under $5K), easily used in the field by response personnel safety officers and investigators. Battery powered. Resistant interfering environmental factors such as heat and humidity.

Need/Gap: Fire service and fire origin/cause and arson investigators need this type of hand held hazards detection device to determine what level of respiratory protection is required during post-fire (over haul) operations and fire origin/cause investigations. Instruments such as four gas meters are not adequate in determining hazard levels such as vapors, gases and particulates.

Scenario 2: Fire origin/cause investigators commonly do not were respiratory protection during scene investigation and do not have adequate hand-held hazard detection instruments. They are being exposed to inhalation hazards that will cause acute and chronic health issues.

Benefits: This would enhance first responder safety and health by reducing or preventing occupational inhalation hazards.

Frequency: Post-fire (overhaul) operations and fire origin/cause investigations are being conducted continuously across the country.

Other Products Available: No

Other Products Insufficient:

Complete Solution: Completely

Not Complete Solution Reason:

Not Compatible Existing: Completely

Not Compatible Existing Reason:

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: N/A

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; Reduction in first responder loss of life; improved productivity

Other:

SubGroup: Equipment SubGroup

Requirement Priority Ranking: 1

Approved: TRUE

2014 Priority #11: Handheld Standoff Chemical and Explosive Identifier

End User: Law Enforcement, Bomb Squads, Fire Service, Hazmat Teams, Border Patrol, DHS

Brief Description: Instrument capable of detecting & identifying chemical substances (CWAs, TICs) & explosives from outside of exposure or contamination zone, at standoff distances. Must be intrinsically safe; withstand temperature & humidity changes, ruggedized for field use.

Detailed Description: The instrument should be portable, hand-held, battery operated, include an extensive internal library for HMEs, TICs, TIMs, and CWAs. The unit must be usable by first responders with little training. Should be able to detect at 50 to 200 feet

Constraints: Portable, hand-held, battery operated, include an extensive internal library for HMEs, TICs, TIMs, and CWAs. The unit must be usable by first responders with little training. Should be able to detect at 50 to 200 feet.

Need/Gap: To have the ability to identify chemical/explosive hazards from a safe distant.

Scenario 2: A HazMat Team is deployed to chemical release with casualties and assigned the mission to identify a possible chemical agent from a position outside of the exclusion zone.

Benefits: Will keep first responders safer in the course of their duties.

Frequency:

Other Products Available: No

Other Products Insufficient:

Complete Solution: Completely

Not Complete Solution Reason:

Not Compatible Existing: Completely

Not Compatible Existing Reason:

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: Completely

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; Reduction in civilian injuries; Reduction in first responder loss of life; Reduction in civilian loss of life; Improved emergency response infrastructure

Other:

SubGroup: Equipment SubGroup

Requirement Priority Ranking: 2

Approved: TRUE

2014 Priority #12: Vehicle Borne Improvised Explosive Device (VBIED) Render Safe Tool

End User: Bomb Technicians and Squads (Local, State, Federal & Military)

Brief Description: A potential VBIED's is a high threat to the U.S. population and bomb mitigation and disposal teams, and emergency responders. There is currently no tool that can be rapidly deployed to render safe these types of explosive devices.

Detailed Description: Tool will effectively and quickly enter/examine/diagnose/render safe a potential VBIED.

Constraints: The tool needs to be easily stored on a small response vehicle and rapidly deployable by medium size robot. The device should be usable on a variety of different device sizes. Desired cost of less the $5K each.

Need/Gap:

Scenario 2:

Benefits:

Frequency:

Other Products Available: No

Other Products Insufficient:

Complete Solution: Completely

Not Complete Solution Reason:

Not Compatible Existing: Completely

Not Compatible Existing Reason:

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: Completely

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; Reduction in civilian injuries; Reduction in first responder loss of life; Reduction in civilian loss of life; Improved emergency response infrastructure

Other:

SubGroup: Equipment SubGroup

Requirement Priority Ranking: 3

Approved: TRUE

2014 Priority #13: Smart Response Vehicles

End User: All Responders

Brief Description: An intelligent emergency response system that uses a networked approach to enable emergency response vehicles to safely respond to emergencies while reducing response times.

Detailed Description: The system envisions utilizing the vehicle GPS, sensor networks, and available data sources, to include but not limited to, traffic network information, historical traffic network resistance data, computer aided dispatch information, real-time traffic data from systems, streaming video sources and crowd sourced data to respond as quickly and safety to a scene as possible while minimizing congestion.
The system should be integrated with Intelligent Traffic Systems (ITS). When a call for service is received, a unit is assigned to the call and dispatch. Unit assignment is based upon the closest available and appropriate unit. The "closest" unit is calculated using the street network, historical traffic network resistance histories based on day, time and weather conditions and real-time information collected from numerous data sources and other known factors such as temporary road closures. These data sources are used to calculate estimated response times and determine the closest available unit based upon response time vs. current methods that use location and street network to determine linear distance. Available environmental sensors may be integrated into the network indicating a hazardous condition or atmosphere will also affect the response routing calculus to help units avoid a response path into a hazard space.

Once the closest available and appropriate units have been, dispatch recommend by the CAD system, the units. Using the vehicles' location and rate of travel, as determined by the GPS in the responding vehicle, the system actively controls traffic control signals at the appropriate time based on the location and speed. The system changes the signal in such a way to provide for appropriate cycles of yellow to red in the restricted entrance into the intersection. This is down in such a way to allow for as unimpeded a response as possible to the responding emergency vehicles. As the system knows the location of all vehicles in response and their suggest route, the system will warn responding vehicles when multiple emergency vehicles are approaching the same intersection. After responding assets have passed through a given intersection, the system then uses available sensors sources to continue adjusting traffic flow via the ITS to mitigate the non-emergency traffic flow as quickly as possible.
The application in the vehicle also presents a geospatial representation of the area to include current location, projected route and incident location. It also visually presents all other responding and non-responding emergency vehicles in the display space.

Constraints: Utilizing GPS, sensors, traffic networks, etc., to minimize congestion and potential accidents with emergency vehicles should be prioritized.

Need/Gap: Current CAD systems only use starting point and ending point and the street network to determine closest unit. The current systems do not take into account traffic in real time or historical data. Current systems do not use closed loop feedback mechanisms to actively adjust traffic systems using the unit's locations. Many systems exist that use the approach of the vehicle and change the traffic signal using RF, visual or optic sensors. These systems do not attempt to mitigate congestion that was caused by the changing of a signal.

Scenario 2: See description in Block 4

Benefits: This is a possible solution to minimizing injury and death through safer emergency response to incidents.

Frequency: This solution has the potential minimize injury and death of the public and responders through safer emergency response to incidents while simultaneously reducing response times and mitigating the traffic congestion caused by traditional emergency traffic signal control systems.

Other Products Available: No

Other Products Insufficient:

Complete Solution: Completely

Not Complete Solution Reason:

Not Compatible Existing: Completely

Not Compatible Existing Reason:

Cost Effective: Somewhat

Cost Effective Explanation: This technology would require the building of a comprehensive network capable of managing traffic patterns & vehicles.

Protect Critical Infrastructure: Completely

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; Reduction in civilian injuries; Reduction in first responder loss of life; Reduction in civilian loss of life; Improved emergency response infrastructure

Other:

SubGroup: Science & Technology SubGroup

Requirement Priority Ranking: 2

Approved: TRUE

2014 Priority #14: Develop model procedures and/or lessons learned from first responders to atypical emergencies

End User: First Responders

Brief Description: As the world becomes more complex, integrated police, fire and EMS responses will be necessary to mitigate more and more emergencies. Recognizing this and capturing lessons learned will be critical for future development of this capability.

Detailed Description:

Constraints: Needs to be accessible to all responders.

Need/Gap: Law Enforcement and Fire Service are finding that more and more they are working in environments that require simultaneous operations. The ability to learn lessons from past incidents that would allow a greater mutual response.

Scenario 2: We have seen an influx of national response scenarios where capturing procedures or lessons learned would assist responders that find themselves facing similar situations.

Benefits:

Frequency: This is a daily problem, with the influx of mass shootings, terrorism and complex incidents.

Other Products Available: No

Other Products Insufficient:

Complete Solution: Completely

Not Complete Solution Reason:

Not Compatible Existing: Completely

Not Compatible Existing Reason:

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: N/A

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; Reduction in civilian injuries; improved productivity; Reduction in civilian loss of life; Reduction in first responder loss of life

Other:

SubGroup: Science & Technology SubGroup

Requirement Priority Ranking: 3

Approved: TRUE

2014 Priority # 15: Virtual Reality Training Simulation

End User: First Responders

Brief Description: A Virtual Reality Training Simulation devise that allows first responders to train in a virtual environment.

Detailed Description: Time management/resources is an ongoing challenge within each agency, this would allow for repetitive reinforcement of skill sets, SOPs, equipment operation and maintenance.

Constraints: Open source, open standards, interoperable, globally interactive, SCORM compliant

Need/Gap: Ability to train users/operators on equipment without having equipment on hand, possibly damaging the equipment, or using up valuable consumable resources.

Scenario 2: A firefighter on his/her daily shift would have the ability to gain proficiency in day-to-day operational equipment and equipment that is not used as often.

Benefits: Improve and maintain a high level of operational readiness and proficiency.

Frequency: Training to maintain proficiency/certification is a common need.

Other Products Available: No

Other Products Insufficient:

Complete Solution: Completely

Not Complete Solution Reason:

Not Compatible Existing: Completely

Not Compatible Existing Reason:

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: N/A

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Improved productivity; Reduction in first responder injury; Reduction in first responder loss of life; other

Other: Building competencies in the use of operational equipment.

SubGroup: Science & Technology SubGroup

Requirement Priority Ranking: 1

Approved: TRUE

2014 Priority #16: Handheld field deployed Biological detection

End User: First Responders

Brief Description: Continued development and deployment of handheld bio detection equipmentfor first responders.

Detailed Description:

Constraints: Must be handheld in size, lightweight and durable. False positive & negative must be nonexistent or very rare. Samples collected from device must be able to be automatically packaged for transport to a laboratory for positive identification and confirmation.

Need/Gap: Provides an in-the-field detection capability for responders to determine whether an exposure to biological agents has occurred and to determine geographical boundaries of contamination.

Scenario 2: Universal adversary has established a means to produce sufficient quantities of weaponized biological agent and releases it into a populated area or special event. On-site responders monitoring event recognize an alert for hand held bio detection unit and are able to quickly process sample for further investigation while alerting command to possible exposure incident.

Benefits: Other than prevention of the incident entirely, early detection is the best defense against the release of a biological weapon. This allows for more immediate treatment and prophylaxis of potentially exposed individuals.

Frequency:

Other Products Available: Unknown

Other Products Insufficient:

Complete Solution: 100%

Not Complete Solution Reason:

Not Compatible Existing: Unknown

Not Compatible Existing Reason:

Cost Effective: Unknown

Cost Effective Explanation: it is unknown what this solution will cost to manufacture, implement, and train and maintain

Protect Critical Infrastructure: N/A

Protect Critical Explanation:

Implementable Solution: Unknown

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; Reduction in civilian injuries; Reduction in civilian loss of life; Reduction in first responder loss of life

Other:

SubGroup: Strategic Planning SubGroup

Requirement Priority Ranking: 3

Approved: TRUE

2014 Priority #17: Improved Filtering Facepiece Respirator (FFR)

End User: Health, EMS, Law Enforcement, Fire (all responders)

Brief Description: Develop new generation form fitting respiratory protective equipment for particulate materials, including biologicals, exposures. Re-evaluate current RP nomenclature to describe consistent protection and determine method for achieving improved face seal.

Detailed Description: Current FFR (e.g. N,R & P, N-95, N-99, P-100) respirator nomenclatures are confusing to end users and may result in the selection and use of inappropriate devices particular in cases of biological events and emerging diseases. These classifications should be re-evaluated, re-defined and simplified to reduce confusion. In addition, improved face seals and test methods must be developed to insure consistent wearer fit. Current FFR standards may be protective, but classification is confusing.

Constraints: May result in increased cost by increasing unit cost but may also decrease cost if individual FFRs are issued and re-usable rather than disposable.

Need/Gap: Many disposable FFR currently used provide wearer fit issues that cannot be detected by the wearer during use. Therefore, improved fit devices (e.g. polymer units) would likely reduce fit failures that are currently encountered.

Scenario 2: A responder currently can don a FFR in a manner different from that of when fit testing was conducted. This improper donning will result in exposure. Improved FFR should limit this problem.

Benefits: Reduction of infection and transmission of diseases.

Frequency: Affects all responders and can be encountered on a daily basis.

Other Products Available: Yes

Other Products Insufficient: Confusing nomenclature and poor fit.

Complete Solution: Completely

Not Complete Solution Reason:

Not Compatible Existing: Completely

Not Compatible Existing Reason:

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: Completely

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; Reduction in civilian injuries; Reduction in first responder loss of life; Reduction in civilian loss of life; improved emergency response infrastructure;#Improved productivity

Other:

SubGroup: Equipment SubGroup

Requirement Priority Ranking:

Approved: TRUE

2014 Priority #18: Modems and Routers for use between Personal Area Networks (PAN) Devices Land Mobile Radios (LMR)

End User: Fire, Police, EMS

Brief Description: Develop equipment and protocols to route PAN data (e.g. location, physiologic status, voice, et.al.) from multiple connected devices from different manufacturers in a coordinated manner to insure uniform delivery

Detailed Description: To be completed

Constraints: To be completed

Need/Gap: To be completed

Scenario 2:

Benefits:

Frequency:

Other Products Available:

Other Products Insufficient:

Complete Solution: Completely

Not Complete Solution Reason:

Not Compatible Existing: Completely

Not Compatible Existing Reason:

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: Completely

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; Reduction in civilian injuries; Reduction in first responder loss of life; Reduction in civilian loss of life; improved emergency response infrastructure; improved productivity

Other:

SubGroup: Equipment SubGroup

Requirement Priority Ranking:

Approved: TRUE

2014 Priority #19: Wearable intrinsically safe miniaturized multi-detector sensor platform that's transmits data through integrated wireless or any existing communication system

End User: Fire, Hazmat, Law Enforcement, or any other hot zone personnel.

Brief Description: Multiple sensors that are preferably miniaturized and wearable (e.g. % LEL, PID, FID, IMS, FPD, et.al.) that can be integrated into a single platform with wireless communication capability. Platform could be a vest with plug and play detector ports and a common power source and controlled via software wirelessly connected to a laptop in the support zone. Detectors should also provide visual and audio alarms to alert the wearer.

Detailed Description: Detectors (%LEL, CO, H2S, other electrochemical sensors, PID, FID, IMS, FPD, assorted radiation detectors, chemical detector tube arrays, Raman, FTIR, GC-MS, LIBs, MS-MS) that can be plugged into assorted ports in a wearable platform or vest with a common power source, that can communicate wirelessly with an integrated or any existing communication system, and can be controlled via software and a laptop that remains in the support zone. Plug and play capability can be

adapted to different situations utilizing different detectors. All detectors should provide visual and audio alarms at pre-set levels to alert the wearer and team members. Point detectors should be removable by wearer to investigate suspicious materials. Start up and calibration procedures for all detectors should be automated and quickly accomplished by one person, with an integrated standby mode to keep detectors and instruments on line until personnel are ready to enter the hot zone. The wearable platform should be intrinsically safe, and detectors should be as small as practicable and rugged. Platform could be placed on robot, UAV, or other remotely operated vehicle or device. Easily replaceable, rechargeable, or common battery power source should last a minimum of 2 hours with multiple detectors running. Detectors and communications components should meet or exceed existing standards, with minimal false positive and false negative rates. Interfering compounds should be identified. System should function in a variety of environments, from hot to cold, humid to dry, urban to remote, and industrial to residential. Initial costs of the platform system, detectors, and software should be within reason and similar to existing individual systems. 35-pound maximum weight distributed around the shoulders and waist and able to fit over a fully encapsulated ensemble, bunker gear, or other protective ensemble.

Constraints: Two tiered training should be available for the wearer (minimal hours) and the operator (40 hours maximum).

Need/Gap: Initial and subsequent entries into a hot zone must be made by multiple personnel carrying multiple instruments and detectors until the contaminant is identified and then mitigated. Alternatively, multiple personnel can move multiple detectors/instruments into the hot zone with a wheeled device such as a shopping cart. Personnel can free up hands to carry other items and complete other tasks.

Scenario 2: Unknown hazmat incident. Entry teams must protect themselves; survey the scene, conduct air monitoring, collect samples, collect evidence, and initiate containment and mitigation procedures. Eliminating or minimizing multiple personnel entries will speed up the response and minimize heat or cold stress and fatigue.

Benefits: Should save lives and personnel energy in responses. Costs should be similar to non-integrated and individual detector systems. Decisions should be made in a timelier manner with better information.

Frequency: Common all over the U.S. in hazmat responses and anywhere personnel are employed addressing unknown or CBRNE events.

Other Products Available: No

Other Products Insufficient:

Complete Solution: Completely

Not Complete Solution Reason:

Not Compatible Existing: Completely

Not Compatible Existing Reason:

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: Completely

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; Reduction in first responder loss of life; improved emergency response infrastructure; improved productivity

Other:

SubGroup: Equipment SubGroup

Requirement Priority Ranking:

Approved: TRUE

2014 Priority #20: Improved Microclimate Cooling System for Down Range Use

End User: Personnel using high heat stress inducing personal protective equipment

Brief Description: Current person worn cooling devices (e.g. vests) have been demonstrated to be in effective in maintaining body core temperatures at acceptable levels. In addition, perspiration collecting in PPE can cause compromise to forensic operations and body substance safety

Detailed Description: There exists a need for an improved cooling garment that can be worn during extended down range operations in PPE, particularly chemical protective ensembles.

Constraints: To be completed

Need/Gap: To be completed

Scenario 2:

Benefits:

Frequency:

Other Products Available: Yes

Other Products Insufficient:

Complete Solution: Completely

Not Complete Solution Reason:

Not Compatible Existing: Completely

Not Compatible Existing Reason:

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: Completely

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury

Other:

SubGroup: Equipment SubGroup

Requirement Priority Ranking:

Approved: TRUE

2014 Priority #21: Protective shields research and testing

End User: Law enforcement, Corrections, Emergency Medical Services (EMS), and Fire fighters

Brief Description: Law enforcement, Corrections, EMS, and Fire fighters are in need of a standard for protective shields to address ballistic threats and fragments/shrapnel from explosions. These responders purchase and carry use both ballistic and non-ballistic shields as needed in the course of their duties. Many manufacturers claim that these shields are capable of protecting against specific firearm rounds and fragments, but there currently is no U.S. standard by which to demonstrate ballistic protection or explosives protection of shields. Additionally, these shields are stored in uncontrolled conditions (e.g., vehicle trunks) and endure drops and other impacts during use. Protective shields need to be evaluated to a performance standard so that responders have confidence that the shield will perform as expected. Development of such a standard will require research and testing.

Detailed Description: Research and testing are needed for assessing shields against fragmentation threats caused by common improvised explosive devices (IEDs) and homemade explosives. This testing needs to include different types of fragmentation materials and different types of explosive charges.

Research and testing are needed for assessing these shields against secondary projectiles, such as door and building materials, launched during explosive breaching activities. Traditionally, the standoff distance during explosive breaching activities is less than the standoff distance at a suspect explosive device incident.
Research and testing are needed to understand how body parts touching or in close proximity to the shield are impacted by a non-penetrating round. For example, if a projectile hits the shield at the location of the arm holding the shield, what level of blunt trauma can be withstood while allowing the arm to still function? Once an acceptable level for back face deformation is set, then a test method will

need to be developed.
Research and testing are needed to determine how/if shields' protective capabilities are impacted by (1) storage in various environmental conditions (e.g., storing in a vehicle or on a boat) and (2) exposure to physical impacts, drops and vibrations (e.g., transport in vehicles, dropping during training and use). A testing protocol needs to be developed for these shields against threats following exposure to environmental and mechanical conditioning. Results of this research would inform the development of protective shield standards.

Constraints: None.

Need/Gap: Protective shields are available and in use, and manufacturers claim certain levels of protection, but there is currently no method for verifying the claims.

Scenario 2: Law enforcement and EMS working a hostage situation involving injured officers or victims.

Benefits: Shields provide more coverage for responders facing ballistic and/or fragmentation threats than is available with body armor.

Frequency: Shields are used daily during activities such as high-risk warrant entry, hostage rescue, negotiation, active shooter response, explosive breaching entry, suicide bomber approach, explosive device perimeter activities, officer/victim rescue, tactical entry, cell extraction, barricaded subject, and crowd control.

Other Products Available: No

Other Products Insufficient:

Complete Solution: Completely

Not Complete Solution Reason:

Not Compatible Existing: Completely

Not Compatible Existing Reason:

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: N/A

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; Reduction in first responder loss of life

Other:

SubGroup: Standards Coordination SubGroup

Requirement Priority Ranking: 1

Approved: TRUE

2014 Priority #22: Female ballistic-resistant body armor research and testing

End User: Female law enforcement officers, female soldiers

Brief Description: Test methods and performance requirements specific to body armor designed for female wearers have not been sufficiently addressed to date.

Detailed Description: Valid data does not exist that can address the questions:

- What is needed to protect female wearers of armor?
- What aspects of the armor should be tested? For example, what features giving the armor shape should be tested (e.g., darts, gores, gussets, shaped carriers)?
- What performance requirements, such as back face signature limits, are appropriate?
- What should the characteristics of the backing material (such as shape) behind the armor test panel be?
- What number of shots, shot placement, and shot angles are necessary to sufficiently assess an armor model?
- Does an air gap between body armor and the wearer affect the efficacy of the body armor? Alternatively, does an air gap increase the risk of projectile penetration? How does a ballistic impact in the breast area affect the wearer?

Constraints: None.

Need/Gap: 15 to 25% of officers are women, and the research questions previously indicated remain unanswered resulting in nearly ¼ of law enforcement and corrections possibly being insufficiently protected and improperly fitted. Surveys and workshops involving female body armor wearers have revealed that more than 60% of females feel that they have never had an armor that fit properly.

Scenario 2: Female law enforcement officer shot in the chest area – Will the armor stop the bullet if it affects at an air gap? If yes, can the officer continue to fight after this impact, and will the officer sustain a long-term injury due to behind-armor blunt trauma?

Benefits: Standards addressing female body armor will result in increased officer safety and confidence in their protective gear

Frequency: Female officers wear body armor daily during a shift.

Other Products Available: No

Other Products Insufficient:

Complete Solution: Completely

Not Complete Solution Reason:

Not Compatible Existing: Completely

Not Compatible Existing Reason:

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: N/A

Protect Critical Explanation:

Implementable Solution: Completely

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; improved productivity; Reduction in first responder loss of life

Other:

SubGroup: Standards Coordination SubGroup

Requirement Priority Ranking: 2

Approved: TRUE

2014 Priority #23: Device for Standoff Casualty Triage

End User:

Brief Description: A portable device that provides the capability for standoff casualty triage that is needed and that locates patients that are still viable.

Detailed Description: Possible methods of accomplishing this include, CO2 around nose and mouth or movement of the chest to indicate respiratory attempts and function or sensing pulse. Currently, the most promising means for determination of casualty viability is laser doppler vibrometry - measuring the chest cavity deflections.

Constraints: Unit should be Non-invasive (possibly IR or laser) detector, detecting viable patients. Unit needs operative range of 30 meters up to 300 meters objective & handheld, backpack portable or belt mounted. It must be durable & operate on rechargeable power.

Need/Gap:

Scenario 2: In the event of a mass casualty incident, responders need equipment to rapidly, from a safe distance, determine the viability of victims with a non-invasive body systems scan.

Benefits:

Frequency:

Other Products Available: No

Other Products Insufficient:

Complete Solution: Somewhat

Not Complete Solution Reason:

Not Compatible Existing: Somewhat

Not Compatible Existing Reason:

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: Not Much

Protect Critical Explanation:

Implementable Solution: Somewhat

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; Reduction in first responder loss of life; Reduction in civilian loss of life; improved productivity

Other:

SubGroup: Health, Medical & Responder Safety SubGroup

Requirement Priority Ranking: 1

Approved: TRUE

2014 Priority #24: Equipment/Supply Guide for Relocating Special Needs Evacuees

End User:

Brief Description: This requirement is for an equipment & supply guide for the transport and relocation of individuals in nursing homes, homecare, or with special medical needs, with emphases on safety, performance & planning standards, and sources for collaboration & reference.

Detailed Description: The breakdown should include chapters on specific special-needs considerations such: Pediatrics, Disabled, Language, Guide Animals, Etc.

Constraints: Address considerations contained w/in HSPD-22. Recognize & address difficulty of timely patient evacuation due to financial constraints. Address public transportation systems that are not equipped to handle large numbers of individuals w/ limited mobility.

Need/Gap:

Scenario 2: A region is expecting to be severely impacted by a major storm causing wide-area precautionary mass evacuation prior to storm landfall or impact.

Benefits:

Frequency:

Other Products Available: No

Other Products Insufficient:

Complete Solution: Somewhat

Not Complete Solution Reason:

Not Compatible Existing: Somewhat

Not Compatible Existing Reason:

Cost Effective: Somewhat

Cost Effective Explanation:

Protect Critical Infrastructure: Not Much

Protect Critical Explanation:

Implementable Solution: Somewhat

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; Reduction in civilian loss of life; improved productivity

Other:

SubGroup: Health, Medical & Responder Safety SubGroup

Requirement Priority Ranking: 4

Approved: TRUE

2014 Priority #25: Emergency Responder Body Worn Integrated Electronics System

End User:

Brief Description: Development of a body worn electronics system integrating enhanced communications capabilities, locations and tracking capabilities, situational awareness and environmental sensing capabilities, physiological status monitoring capabilities, and respiratory protective equipment status. This system would require the development of a Personal Area Network (PAN) appropriate for emergency response operations.

Detailed Description: This requirement is for a Electronics Platform and Personal Area Network (PAN) that is capable of integrating:

- Personal Alert Safety System
- 3D Personal Locator
- Physiological Sensors
- Environmental Sensors (temperature and exposure hazards)
- Personal Air Monitoring
- Multi-device Communication
- Respiratory Protective Equipment Status (pressures)

The system should be adaptable to multiple emergency responders mission areas such as EOD, hazmat, SWAT, structural/proximity firefighting and technical/search & rescue.

The body-worn physiological monitors could be a stand-alone unit, integrated into the SCBA, or integrated into the turnout gear (structural ensemble). It must have a ruggedized design for fire ground operations. Warning of high temperature exposure could be integrated into SCBA heads up display (HUD). The sensor should have an integrated data logging and downloading capability to track fire fighter and PPE thermal exposure and incident investigations.

Needs to support a variety of wearer microphones and earpieces arrangements depending upon mission and personal protective equipment. In some cases a boom microphone with headset might be used, in other cases a microphone in a respirator face piece may be needed. Should be switchable from PPT or VOX. When not using PTT or VOX then the interface needs to provide full duplex communications to nearby team members (e.g. 30 feet).

Range of system should be wide including High Rise building operations.

Cost of system should be reasonable to outfit emergency responders.

Constraints: System must address weight limitations, minimize electronics heat generation & be able to operate for 2-4 hrs. on body worn power supply. System must be lightweight & not interfere w/ responder's ability to perform mission. Usable in all environments.

Need/Gap:

Scenario 2: An operator will synchronize their portable radio to their PPE and SCBA with the use of a "blue tooth like" technology. By doing this they have now created a personal area network that will receive information from multiple device such as PASS, Physiological monitors, air monitors, and 3D tracking systems. The information received will then be transferred by the portable radio to a command post. The user should also be able to have full duplex communication to other users within close proximity.

Benefits:

Frequency:

Other Products Available: No

Other Products Insufficient:

Complete Solution: Completely

Not Complete Solution Reason:

Not Compatible Existing: Completely

Not Compatible Existing Reason:

Cost Effective: Completely

Cost Effective Explanation:

Protect Critical Infrastructure: Not Much

Protect Critical Explanation:

Implementable Solution: Somewhat

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; Reduction in first responder loss of life; improved productivity; Reduction in civilian injuries; Reduction in civilian loss of life

Other:

SubGroup: Health, Medical & Responder Safety SubGroup

Requirement Priority Ranking: 2

Approved: TRUE

2014 Priority #26: Guide for Stress Management after Incidents

End User:

Brief Description: Utilization of stress management techniques or systems for incident stress management or mental health is currently a prime focus for the nation's workforce. First responders face an inordinate amount of exposure to potentially traumatic incidents as part of their job. This occurs in the face of shift work and stress-provoking or potentially life-threatening incidents on a near daily basis. Current methods or techniques available to organizations and individuals vary in their focus, and potentially, in their effectiveness. This requirement is to validate current methods or techniques against industry standards.

Detailed Description: Output from the IAB Stress Management session to be held 19 June in Norfolk should be helpful. Partner with other stakeholders for this effort (e.g., VA, DOD, SAMHSA, and DHS)

Constraints: Current standards for effective stress management screening.

Need/Gap:

Scenario 2: A first responder will utilize a web-based system to provide initial screening of current stress levels, risk for further mental health issues, and identify need for further assistance.

Benefits:

Frequency:

Other Products Available: No

Other Products Insufficient:

Complete Solution: Somewhat

Not Complete Solution Reason:

Not Compatible Existing: Somewhat

Not Compatible Existing Reason:

Cost Effective: Somewhat

Cost Effective Explanation:

Protect Critical Infrastructure: Not Much

Protect Critical Explanation:

Implementable Solution: Somewhat

Implementable Solution Explanation:

Outcomes: Reduction in first responder injury; Reduction in first responder loss of life; improved productivity

Other:

SubGroup: Health, Medical & Responder Safety SubGroup

Requirement Priority Ranking: 3

Approved: TRUE

Appendix F: Authors Bios

Brant D. Mitchell, **MPA**, is the Director of the Stephenson Disaster Management Institute at LSU. He serves as the principal investigator on all major research projects and manages SDMI's Disaster Lab and development of decision support tools that provide critical information to decision makers during disasters. Brant has his Masters in Public Administration from LSU and is currently pursuing his PhD in Geography. His research for his dissertation is being partially funded by DHS through the University of North Carolina's Coastal Resilience Center, a DHS Science and Technology Center of Excellence. His research interests include the development of decision support tools that integrate social vulnerability, hazard mapping and operational models to include the Advanced Circulation and Storm Surge Model (ADCIRC) and the Advanced Surge Guidance System (ASGS). Mitchell is currently serving as the PI for SDMIs engagement in the Stevens Institute of Technology Maritime Security Center, which has been designated as a DHS Center of Excellence. Past performance includes research for the National Emergency Management Association and the United States Agency for International Development – Office of Foreign Disaster Assistance. Current projects include several Geographic Information System based projects and the updating of 55 parish hazard mitigation plans as part of local requirements to secure funding from FEMA's Hazard Mitigation program. Prior to working for SDMI, Brant served as the Deputy Director for Interoperability at the Louisiana Governor's Office of Homeland Security and Emergency Preparedness where he also served as the Chairman of the Statewide Interoperable Executive Committee. In this capacity, he was responsible for building the nation's largest statewide 700 MHz radio system which currently serves over 90,000 first responders in Louisiana. Brant is currently a Lieutenant Colonel in the Army Reserves where he is assigned to the Department of Homeland Security's National Cyber and Communications Integration Center.

Greg Trahan, Greg Trahan serves as LSU's Director of Economic Development in the Office of Research & Economic Development, working to build partnerships by connecting business and industry to LSU's expert research, knowledgeable faculty, extensive assets, and considerable capabilities. He also serves as a Program Manager in the Transformational Technology and Cyber Research Center. Prior to joining LSU, he was Director of Business Development at Louisiana Economic Development, representing Louisiana nationally in external business and economic development efforts in software, technology, and defense-related sectors. He was directly involved in projects that to date have generated over 2,500 announced technology new jobs in Louisiana. He began his career at then-startup Legacy.com, now one of the most visited sites in the U.S.; his work at Legacy.com resulted in a Webby Award nomination for his work with newspapers nationwide and the Department of Defense in building personal memorials for those lost in Iraq and Afghanistan. He has more than 15 years' experience in web and software development, design, analytics, product development and management, business development, and strategy. He is a graduate of LSU with a B.S. in Biochemistry.

Travis Johnson has served in the National Guard and Reserve forces for over 27 years, beginning in the US. Marine Corps in 1990 and transitioning to the Air National Guard in 2001, where he currently serves as a Master Sergeant in the 236th Combat Communications Squadron. During this time he served in

various roles including communications, security, and civil support in New Orleans during and after Hurricane Katrina 2005 through 2006, providing communications support to coalition forces in northern Iraq in 2008, serving as Squadron First Sergeant of the 445th Air Advisory Squadron and NATO Frequency Coordinator in Western Afghanistan 2011-2012, leading communications efforts for NATO air training missions in Bulgaria in 2014, and Non-Commissioned Officer in Charge off communications support for headquarters element, Task Force DC for the 2016 presidential inauguration in Washington DC. In his civilian career Mr. Johnson spent 10 years with the state of Louisiana in various communication roles including Statewide Interoperability Coordinator and Emergency Communications Lead for the State Emergency Operation Center. He responded to numerous disasters providing communications support during the BP Oil Spill, the historic 2016 "thousand year flood event" in south Louisiana, and several hurricanes. In addition Mr Johnson was tasked by the US State Department to participate in a 4 person team deployed to Haiti after the 2010 earthquake to construct emergency radio stations in Ft. Liberte and Ouanaminthe allowing local authorities to broadcast critical relief information to the public. Mr Johnson currently resides in Baton Rouge with his wife, Blythe Johnson, and his four children.

Lauren Stevens: Prior to joining SDMI, Ms. Stevens served in multiple supervisory and Section Chief positions at the Louisiana Governor's Office of Homeland Security and Emergency Preparedness (GOHSEP) from 2005-2012. While at GOHSEP, Ms. Stevens most notably supervised the overall coordination for the planning, exercise and training programs for the State of Louisiana as the Preparedness Section Chief. This section of the State of Louisiana's Emergency Management and Homeland Security Office was mainly responsible for coordination with local, State, Tribal and Federal authorities; private-sector partners; and nonprofits to prepare for, prevent, respond to, recover from and mitigate against future emergencies and disasters both natural and manmade through statewide planning/training/exercise mandates and programs. Also under her supervision was the Radiological Group, State of Louisiana Critical Infrastructure Program, and Intelligence Branch. She was responsible for administering and executing these programs in accordance with federal guidelines, as well as management and budget of all associated grant programs (SHSP, BZPP, EMPG, HSGP). Under her program management, the State of Louisiana all-hazards exercise program became one of the largest programs within FEMA Region 6, and also recognized nationally. Her attention to the overall development and implementation of the comprehensive Homeland Security Exercise and Evaluation Program Multi-year Plan to address the Department of Homeland Security exercise requirements to be consistent with the State Homeland Security Strategy led to a highly successful program and well prepared State. Ms. Stevens has extensive experience in liaison work between federal, state and local agencies, as well as years of fostering relationships at all levels. Ms. Stevens has 12 years of designing, developing, conducting and evaluating all hazards exercises and is a certified Master Exercise Practitioner (MEP) through FEMA. In 2011, she teamed with the Naval Post Graduate School Executive Education Program to design and deliver Louisiana's first Cybersecurity Tabletop Exercise. This was the first of its kind for NPS, as well as Louisiana executive leadership.

Christopher Rippetoe has over 4 years of experience professional work experience with SDMI, including 3 years as a GIS analyst. During this time, Mr. Rippetoe assisted in the creation and data collection of a 143,000-point critical infrastructure database. He also aided in the development and data collection and verification for a 9-1-1 address database for multiple parishes in Louisiana. Mr. Rippetoe has also completed several independent study courses related to Emergency Management and Hazard Mitigation through FEMA's Emergency Management Institute. Prior to his time at SDMI, Mr. Rippetoe was employed as a Database Manager in the Quality Assurance department of Electronic Arts' Baton Rouge studio. He

was responsible for maintaining and auditing issues entered into the database, as well as creating reports pertaining to both individual and team production.

Graduate Assistants

Robert Iles has been a GIS Analyst at LSU-SDMI since May, 2014 after having served in a similar role as graduate assistant at LSU-SDMI from August, 2013. At LSU-SDMI, Mr. Iles has assisted in a variety of projects in addition to managing two GIS projects: the 9-1-1 Database development project for rural Louisiana parishes and the St. Bernard School Safety Planning Project. Altogether, he has over 5 years combined GIS experience using ESRI ArcGIS with additional experience in AutoCAD integration with ArcGIS. Mr. Iles will receive a Master of Science in Oceanography from the LSU College of the Coast & Environment in May, 2017. His master's thesis research involves the study of the ecological impact of the Bonnet Carré Spillway on the Lake Pontchartrain Basin with specific emphasis on development of refined satellite remote sensing algorithms for coastal and estuarine Louisiana waters. The project employs both GIS and remote sensing techniques using NASA's SeaDAS software in addition to ArcGIS.