


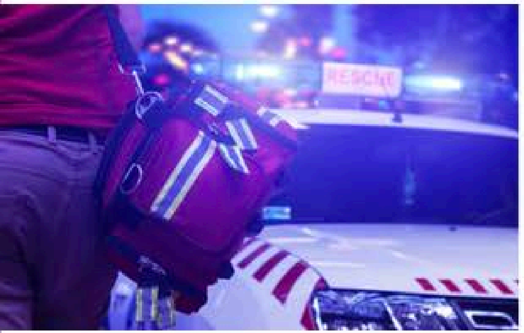
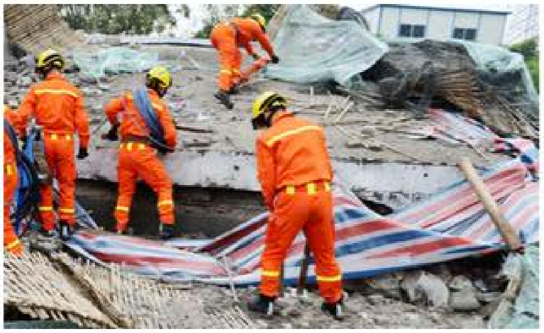
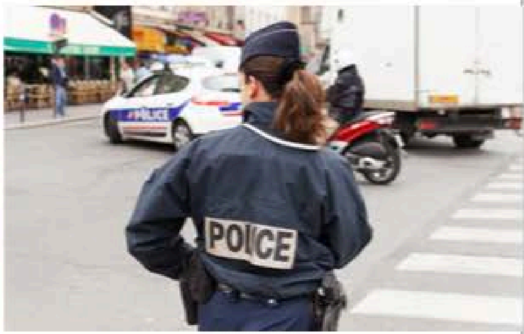
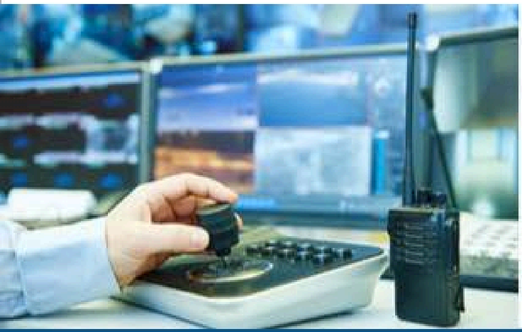

The International Forum to Advance First Responder Innovation

Statement of Objectives (SOO) for Technologies Related to: "The Ability to Detect, Monitor, and Analyze Passive and Active Threats and Hazards at Incident Scenes in Real Time"

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International Forum to Advance
FIRST RESPONDER INNOVATION

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This document has been checked for accuracy by the International Forum to Advance First Responder Innovation (IFAFRI) and accords with its aim to inform and guide industry and provide unbiased information on first responder technologies.

International Forum to Advance
FIRST RESPONDER INNOVATION

Statement of Objectives (SOO) for Technologies Related to: **"The Ability to Detect, Monitor, and Analyze Passive and Active Threats and Hazards at Incident Scenes in Real Time"**

Background

The International Forum to Advance First Responder Innovation (IFAFRI) is an organization of international government leaders from 13 countries and the European Commission, focused on enhancing and expanding the development of new technology for first responders worldwide.[1] IFAFRI does this by:

1. Working with the global first responder community to define a list of common, high priority capability gaps;
2. Providing a platform for international collaboration on innovative research and development (R&D) initiatives and solutions;
3. Characterizing global first responder markets to inform and guide industry and academia to develop and produce innovative technology solutions at affordable prices and
4. Providing information about relevant and available first responder technologies to the first responder community.

IFAFRI has reached consensus on four first responder capability gaps. These gaps represent the highest priority gaps common amongst the first responders represented by the IFAFRI member nations. These gaps are:

- The ability to know the location of responders and their proximity to risks and hazards in real time;
- The ability to detect, monitor, and analyze passive and active threats and hazards at incident scenes in real time;
- The ability to rapidly identify hazardous agents and contaminants and
- The ability to incorporate information from multiple and nontraditional sources (for example, crowdsourcing and social media) into incident command operations.

To arrive at this initial set of *Common Global Capability Gaps*, IFAFRI participants conducted analyses of first responder capability gaps in their countries.

[1] For the purpose of this document, the term "first responder" refers to those individuals who, in the early stages of an incident, are responsible for the protection and preservation of life, property, evidence and the environment, including law enforcement, fire service and emergency medical services.

IFAFRI is publishing this Statement of Objectives (SOO) to provide a technical overview of the global first responder need and direct the research, development, and manufacturing communities who may be interested in pursuing development of a solution. IFAFRI will assist with facilitating interactions between first responders and organizations pursuing development toward this capability gap. This particular SOO is focused on the second capability gap identified above:

"The ability to detect, monitor, and analyze passive and active threats and hazards at incident scenes in real time"

This capability gap is described as such: "Threats and hazards during an incident can change rapidly. Dangers detected at incident onset may increase, decrease or evolve over time, while new and unexpected hazards can emerge. Both passive and active threats and hazards can exist simultaneously on incident scenes, increasing the potential risk to civilians and responders. Responders need the capability to continuously detect, characterize, monitor and analyze threats and hazards. On-scene, rapid detection and timely alert of changes to the threat environment is critical for responders to take timely protective actions. Awareness and understanding of threats and hazards, and real-time changes to them, would inform response operation decisions."[2]

General Description of Operational Capability

The focus of this capability gap is the ongoing surveillance and monitoring of threats on an incident scene. Solutions developed to address this gap will allow responders to continuously evaluate existing, emerging and potential hazards. Areas that may need monitoring include a broad radius around an incident scene, areas where response and recovery actions are underway, or specific ingress/egress routes.[3] Addressing this gap includes a modular solution comprised of fixed and/or mobile platforms that carry sensor packages; software systems that integrate data, assess threats; and provide decision support; and a graphical user interface to display threat and hazard information.

The nature and inherent danger of threats and hazards change over the course of an incident. This is exemplified by the cascading effects following landfall of Hurricane Katrina. Mass flooding and leakage from chemical facilities significantly changed the nature of the response operations. Awareness of the threats and hazards that already exist on the scene, as well as those that have the potential to affect health, safety, or operations is critical.

Active threats and hazards are defined in this document as objects or persons existing on an incident scene that are currently or imminently dangerous to the life or health of responders, victims or the public. Examples include: active shooters, the presence of flammable or explosive chemicals in proximity to fire or gunfire, significant structural instability of buildings or debris in proximity to response operations, booby-traps, etc. Identification, geolocation and monitoring of these threats will allow responders and incident commanders to conduct operations more safely.

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[2] *Project Responder 4: 2014 National Technology Plan for Emergency Response to Catastrophic Incidents*, p. 24, https://www.dhs.gov/sites/default/files/publications/Project%20Responder%204_1.pdf

[3] Ibid, p. 44.

Passive threats and hazards are defined in this document as objects or persons that exist on an incident scene that are not currently or imminently dangerous to the life or health of responders, victims or the public. Examples include: the presence of household or industrial chemicals on an incident scene, the forecast of inclement weather in proximity to response operations, etc. The presence of objects or persons that may be dangerous does not mean that the danger will manifest, but it is essential to responders to know that they exist. Passive threats may become active during the course of the incident.

This second gap is distinct from the third gap: "The ability to rapidly identify hazardous agents and contaminants," which focuses on the rapid detection, identification and characterization of specific chemical, biological and radiological hazards. Solutions to address the gap described in this document may integrate some of the data from "The ability to rapidly identify hazardous agents and contaminants." However, this gap is distinct as it addresses the continuous monitoring and analysis of a wider array of threats, along with the integration and visualization of threat data.

Existing First Responder Gear

Current capabilities to detect active and passive threats include:

- Threat and hazard detection equipment in the following categories:
    - Handheld portable detection equipment;
    - Vehicle-mounted detection equipment;
    - Fixed-site detection equipment;
    - Mobile laboratory systems;
    - Fixed-site analytical laboratory systems;
    - Standoff detection systems;
- Camera feeds for visual identification;
- Acoustic-sensing gunshot detection and location technology;
- Manned and unmanned air and ground systems;
- Smartphones with related mobile applications (e.g., weather) and
- Helmet-mounted heads-up displays.

Operational Environment

The following list provides examples of operational environments that *may* be encountered by first responders on a daily basis. Tools and systems developed to address this capability gap should be, to the extent possible, used during routine operations.

- Single and multi-level buildings;
- Structures of varied construction materials (e.g., steel, concrete, wood frame, masonry, synthetic materials);
- Collapsed or threatened buildings;
- Extremely confined spaces;
- Subterranean and underground facilities;
- Wooded areas with dense vegetation;
- Rugged outdoor terrain;

- Areas with limited or no cellular and/or radio connectivity;
- Events with large crowds or numbers of people present;
- Extreme high and low temperatures and humidity;
- Wet conditions;
- Thermal radiation;
- Direct flame contact or exposure;
- Excessively noisy and smoky conditions in outdoor, indoor and/or subterranean areas;
- Lack of line-of-sight vision between commanders and deployed personnel and
- Underwater and maritime environments.

Target Objectives

1. Detects and continuously monitors threats and hazards on the incident scene in real time;
2. Assesses threat and hazard data to provide appropriate guidance and decision support to responders and commanders and
3. Provides visualization capability of threat locations and proximity to responders.

The following section provides responder-identified requirements for potential solutions. Not all requirements may be currently technically feasible. Responders would prefer incremental, continuous advancement of solutions instead of waiting for equipment that meets all of the requirements at the same time. As such, these requirements do not represent a minimum set of requirements that must be met before new tools, devices, platforms or systems can be released.

Detection, Monitoring and Analysis Requirements

Potential solutions should detect, assess and monitor active threats on the incident scene, to include: chemical, biological, radiological and explosive (CBRE) agents; suspicious behavior; fast-moving objects approaching the responder; and shots fired on the incident scene. Potential solutions should:[4]

- Provide information on detected CBRE agents;
- Detect persons within an agency-configurable distance from the responder;
  - Enable differentiation among and between responders and others present;
- Detect suspicious behavior on scene;
  - Provide information about suspicious behavior and persons on scene;
- Detect suspicious items within an agency-configurable perimeter;
- Detect objects (e.g., vehicles, dogs) moving in the trajectory toward a responder;
  - Provide information about fast-moving objects approaching the responder;
- Detect gunshots within agency-configurable distance from responder;
  - Provide information about the ballistic or explosive threat;
- Calculate the blast radius from liquid or compressed gas tanks and other hazardous materials;

[4] For the purpose of this document, the term "suspicious behavior" refers to someone or something involved in illegal activity or that may pose a threat to first responders, the public or infrastructure based on purposeful actions or features.

- Allow responders to identify and designate the location of threats and hazards (i.e., "drop a pin");
- Identify emerging threats and hazards;
- Determine structural stability (as related to safe entry into a building or structure) and
- Continuously monitor the status of identified threats and hazards on the incident scene.

Location Requirements

Potential solutions should geolocate threats and hazards within a set perimeter around response personnel. Potential solutions should:

- Geolocate detected CBRE agents and sensors, suspicious persons and items, the origin of ballistic and explosive activity, and objects moving towards a responder;
  - Indicate the distance of detected threats and hazards (from the responder);
  - Indicate the position of detected threats and hazards (in relation to the responder);
  - Calculate the trajectory of objects moving toward a responder;
- Use geographic information system (GIS) coordinates to mark the location of identified threats and hazards;[5]
- Allow agency to configure perimeter location and distances and
- Identify and transmit the proximity of hazardous agents and threats to on-scene personnel and responders when integrated with responder geolocation systems.

Visualization Requirements

Potential solutions should display threat and hazard data in a manner that is designed to minimize distraction and cognitive failure. Potential solutions should:

- Display the location of detected CBRE agents and sensors, suspicious persons and items, the origin of ballistic and explosive activity, and objects moving towards a responder;
- Integrate threat and hazard data on a geographic display of individual and combined hazards on a GIS-enabled building or street-level map (as appropriate);
- Differentiate between active and passive threats in the visualization;
- Display data using GIS-enabled maps or other visual aids;
- Allow user to customize the display of information;
- Allow the user to be able to select data they wish to visualize;
- Display the geolocation of responders when integrated with responder geolocation systems;
  - Differentiate between responders and other persons in the visualization;
- Display images and video pertinent to active and passive threats and hazards
- Allow the user to be able to review historical and predictive data sets;

[5] Geographic information system (GIS) is a computer system for capturing, storing, checking and displaying data related to positions on Earth's surface, https://www.nationalgeographic.org/encyclopedia/geographic-information-system-gis/

- Provide option for tactical mode display (e.g., silent, low-light, night vision compatible) and
- Be designed for visualization of threats in a heads-up display or utilize other hands-free solutions.

Alarm Feature Requirements

Potential solutions should generate an alert when active and passive threats and hazards are detected or evolve, based on agency-configured thresholds or parameters. Potential solutions should:

- Generate an alert for active and passive threats within an agency-configurable distance from a responder;
- Integrate aural, visual and/or haptic alerts;
- Provide option for tactical mode/covert alerts;
- Require a positive action to acknowledge receipt of the alert;
- Be discriminable and recognizable in environments that are excessively noisy and/or have reduced visibility;
- Generate an alert to notify a user when connection to the communications network is lost and
- Emit a low power source warning signal.

Transmission Requirements

Potential solutions should transmit threat and hazard data to authorized personnel (e.g., emergency managers, commanders, responders). Potential solutions should:

- Encrypt responder geolocation data prior to transmission;[6]
- Transmit data to intended destination;
- Transmit the proximity of hazardous agents and threats to authorized personnel when integrated with responder geolocation systems;
- Transmit location of detected threats and hazards using GIS coordinates;
- Transmit threat and hazard data in real time;
- Function in a communications-degraded environment:
    - Securely cache data intended for recipients when connection to a communication network cannot be made;
    - Securely transmit cached data to recipients when connection to a communications network is restored without affecting live data streaming;
- Be able to operate multiple components in a networked configuration and
- Store transmitted incident-related threat and hazard data for post-incident analysis.

Form Requirements

Potential solutions should be designed to minimize equipment burdens for the responder, while maintaining interoperability of components. Potential solutions should:

[6] Responders recognize that it may not be possible to encrypt solutions that rely on analog technologies.

- Utilize an internationally-recognized common hub or interface, allowing interchangeable component configuration;
- Be operable by users wearing personal protective equipment (PPE);
- Be designed to fit regardless of gender;
- Be portable and transportable by a single responder;
- Be integrated into existing equipment, integrated into a heads-up display or incorporate hands-free capabilities;
- Be minimum weight and
- Be minimum size.

Power Source Requirements

Potential solutions should use a non-proprietary power source that provides sufficient power for an operational period. Potential solutions should:

- Operate for a minimum of 24 operational hours and 48 stand-by hours;
- Be able to replenish power supply using non-proprietary technology;
- Utilize an easy-to-replenish power source;
- Power source should be replaceable with gloved hands and wearing protective clothing in a manner that reduces the potential for erroneous installation without interruption to operations, to extend operational life;
- Be compatible with renewable or sustainable energy sources and
- Be intrinsically safe.

Maintenance Requirements

Potential solutions should be easy to operate, calibrate and maintain throughout the service life. Potential solutions should:

- Allow for auto-calibration;
- Self-initialize, self-calibrate and execute self-diagnostics in less than one minute;
- Be modular to allow for upgrade and replacement of components;
- Maintain backwards compatibility after upgrade;
- Be rated for a service life of no less than five years;
- Be designed to reduce the time to repair;
- Be designed to minimize skills needed for maintenance (e.g., calibration, cleaning);
- Perform automated periodic virus detection and cybersecurity screening of software components;
- Allow for remote maintenance;
- Allow for remote upgrades;
- Provide live notification of a fault and
- Maintain a fault log.

Compatibility Requirements

Potential solutions should integrate with current data sets, model outputs, and emergency response software systems to remotely capture and monitor hazard-related data in multiple topographies (e.g., inside buildings, at varying depths and elevations, across different terrains). Potential solutions should:

- Comply with exchange standards for data transmission (e.g., National Information Exchange Model);
- Bi-directionally integrate with:
  - Sensor data from other hazard detection systems;
    - Continuously integrate captured data with GIS-configured location of sensor or platform;
  - Existing electronic situational awareness tools;
  - Existing electronic incident command systems;
  - Existing modeling systems (e.g., hazard models, contaminant migration models, explosive power/air blast models);
  - Responder geolocation systems;
  - Responder physiological monitoring systems;
  - Other incident-specific data sources (e.g., traffic cameras, weather projections);
  - Existing digital maps, blueprints and floorplans and
  - Transportation monitoring systems (e.g., rail chemical transportation System) to provide advanced notification when hazardous materials are entering a jurisdiction.

Robustness Requirements

Potential solutions should operate within multiple environments (e.g., smoke, humidity, temperature extremes and precipitation). Potential solutions should:

- Operate at temperature ranges typical of international climate (e.g., -30 degrees C to 50 degrees C);[7,8]
- Operate at temperature ranges typical of response activities (e.g., -100 degrees C to 500 degrees C);[9,10]
- Be ruggedized;
- Function after immersion in water;[11]
- Function at humidity of 100 percent;

[7] Average minimum temperature in Sweden was used to provide a minimum figure for international climate, https://www.weatheronline.co.uk/reports/climate/Sweden.htm

[8] Historic summer temperature in Phoenix, Arizona was used to provide a maximum figure for international climate, http://www.12news.com/article/weather/heat/hottest-day-ever-122-and-other-cool-phoenix-is-really-hot-facts/448964915

[9] *NIST Technical Note 1474: Thermal Environment for Electronic Equipment Used by First Responders*, p. 7 http://ws680.nist.gov/publication/get_pdf.cfm?pub_id=101375

[10] First responder participants of the SOO Validation Meeting (January 23-25, 2018 in Stockholm, Sweden) stated that operations may involve temperatures of -100 degrees C to 500 degrees C.

[11] Refer to IP68 of IEC 60529: Degrees of Protection Provided by Enclosures, https://webstore.iec.ch/publication/2452

- Function properly after exposure for five minutes at a maximum thermal radiation threshold of 500 degrees C;
- Resist air pollutants, dust, smoke, ash and sand;[12]
- Match the laundry life of garment or textile if components are integrated into garments or textiles;
- Have recyclable components;
- Be easy to decontaminate;[13]
- Be non-degradable due to wear or hazard;
- Not cause injury to the user if damaged;
- Be designed to prevent entanglement or entrapment and
- Function underwater.

Cost Requirements

Potential solutions should be designed to minimize price of system, consumables and maintenance. Potential solutions should:

- Be priced to affordably outfit the entire workforce and
- Be designed with inexpensive, replaceable parts.

Additional Considerations

As in other research and development endeavors, additional considerations should be evaluated by organizations wishing to pursue innovation toward this gap:

- Detailed test and evaluation strategy for the viability of system(s);
- Transition strategy to guide the prototype(s) into commercialization;
- Specifications to guide the development of viable commercial system(s);
- Standards, guidelines, other legal requirements and
- Stakeholder oversight/interaction, to ensure that the developed system meets the requirements identified by the first responder community.

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[12] Refer to IP68 of IEC 60529: Degrees of Protection Provided by Enclosures, https://webstore.iec.ch/publication/2452

[13] Refer to NFPA 1841: Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting, https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=1851