




# The International Forum to Advance First Responder Innovation

## Statement of Objectives (SOO) for Technologies Related to: "The Ability to Know the Location of Responders and Their Proximity to Threats and Hazards in Real Time"

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International Forum to Advance
FIRST RESPONDER INNOVATION

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# Statement of Objectives (SOO) for Technologies Related to: **"The Ability to Know the Location of Responders and Their Proximity to Threats and Hazards 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.

[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 fire service, law enforcement, and emergency medical services.

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

IFAFRI is publishing this Statement of Objectives (SOO) to provide a technical overview of the global first responder need and direct researchers 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 first capability gap identified above:

**"The ability to know the location of responders and their proximity to risks and hazards in real time"**

This capability is described as the following: "[i]ncident commanders and team leaders need a tool that displays the location of responders and their proximity to threats and hazards. During an incident, responders may operate over an extensive geographic area without adequate knowledge of the hazards and threats. The ability to geolocate responders (identify their location on the incident scene tied to latitude, longitude and altitude coordinates or area-specific designations such as a street address), in all environments (in other words, indoors, outdoors and maritime), combined with simultaneous awareness of incident hazards, could greatly improve the safety of emergency responders."[2]

## General Description of Operational Capability

Across IFAFRI member nations, first responders consistently stated that there is a need to precisely identify the location of responders in real time. Further, commanders expressed a need for a tool that displays the location of responders and their proximity to potential threats. The ability to geolocate first responders in all environments, especially when coupled with simultaneous awareness of incident risks and hazards and responder distress, could potentially improve the safety, efficiency, and effectiveness of response operations.

Addressing this capability gap involves the development of tools that capture the precise location of responders (i.e., x, y, and z coordinates) indoors, outdoors, and below ground, and the graphical display of the location on an intuitive user interface. It further involves the identification and display of threats and hazards in proximity to on scene responders when integrated with sensors and other detection systems.

This capability is largely unavailable to date. Current capabilities are limited to visual tracking of responders and self-report of location using hand-held radios. Some public safety radio systems include global positioning system (GPS) reporting of location, but infrastructure and network requirements constrain the use of this feature. Commercially available GPS signals cannot penetrate building walls and are not ruggedized for the hazards on an incident scene.

A robust and flexible capability is needed to help commanders and tactical decision makers accurately locate and track first responders anywhere on the incident scene. This capability is also necessary to allow them to rapidly and effectively direct rescue missions for at-risk

[2] *Project Responder 4: 2014 National Technology Plan for Emergency Response to Catastrophic Incidents*, p. 23, https://www.dhs.gov/sites/default/files/publications/Project%20Responder%204_1.pdf

personnel, as well as understand and respond to the consequences of potential threats to responders in real time.

## Existing First Responder Gear

Current capabilities to locate responders on the incident scene include:

- Paper tag and tally systems;
- Land mobile radio systems; and
- Vehicle-based Global Positioning System (GPS) solutions.

## 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. Accurate, real-time three-dimensional location of first responders on the incident scene;
2. Graphical display of first responder location and tracking information on an incident-specific geospatial map for commanders; and
3. Integrated with situational awareness systems and data sources.

The following section provides responder-identified requirements for potential solutions. They do not represent a minimum set of requirements that must be met before new tools, devices, platforms or systems can be released. 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.

## Accuracy Requirements

Potential solutions should provide accurate geolocation of responders in three dimensions. Potential solutions should:

- Geolocate responders to within <one> meter for x, y, and z coordinates;
- Passively determine the location of responders on the incident scene at least every <3> minutes;
- Provide accurate responder geolocation across operational environments:
    - Inside and outside building structures of varying sizes and composition;
    - In outdoor environments and remote areas; and
    - Below ground and in confined areas (e.g., basements, tunnels).
- Geolocate responders over an area of <25> square miles on the incident scene;
- Geolocate responders that are up to <50> feet below ground;
- Incorporate a confidence level to indicate accuracy of location; and
- Function in the absence of digital information about the incident scene (e.g., Google maps, building data).

## Transmission Requirements

Potential solutions should provide real-time and recurring transmission of responder location and tracking at all times. Potential solutions should:

- Securely transmit responder geolocation data to incident command;
- Transmit responder location using geographic information system (GIS) coordinates;
- Transmit responder location 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; and
    - Securely transmit cached data to recipients when connection to a communications network is restored without affecting live data streaming.
- Encrypt responder geolocation data prior to transmission; and
- Store incident-related threat and hazard data for post-incident analysis.

## Visualization Requirements

Potential solutions should provide a graphic display of the location of selected responders on the incident scene. Potential solutions should:

- Display data using GIS-enabled incident-specific maps;
- Display the location of all or selected responders on three-dimensional incident-specific map;
- Differentiate between responder types and roles;
- Display the proximity of all or selected responders when integrated with display of incident threats and hazards;
- Provide a "bread-crumb" feature, allowing the responder to retrace their steps; and
- Allow user- or agency-configuration of display features.

## Compatibility Requirements

Potential solutions should integrate with existing and future emergency response software systems and applications. Potential solutions should:

- Comply with exchange standards for data transmission (e.g., National Information Exchange Model [NIEM]);
- Integrate with:
    - Existing communications devices;
    - Electronic situational awareness tools;
    - Electronic incident command systems;
    - Dispatch systems;
    - Model prediction and forecast systems;
    - Responder geolocation systems;
    - Incident-specific maps;
    - Digital building information;
    - Digital terrain information;
    - Responder-specific physiological data;
    - Responder-specific equipment data; and
    - Responder safety alarms.
- Allow sharing of responder geolocation data across response agencies.

## Form Requirements

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

- Be operable by users wearing personal protective equipment (PPE);
- Be integrated into existing equipment, integrated into a heads-up display, or incorporate hands-free capabilities;
- Be designed to prevent deactivation by responder during an incident;
- Be minimum weight; and
- Be minimum size.

## Alarm Feature Requirements

Potential solutions should generate an alert based on agency-configured thresholds or parameters. Potential solutions should:

- Generate an alarm when a responder is within agency-configurable distance from identified threats or hazards when integrated with threat and hazard monitoring systems;
- 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*.

## 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 <12> 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; and
- Be intrinsically safe.

## Maintenance Requirements

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

- Self-initialize in less than <one> minute;
- Be modular to allow for replacement of power sources and components as necessary for maintenance or repairs;
- Maintain backwards compatibility after upgrade;
- Be rated for a service life of no less than <5> 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; and
- Maintain a fault log.

## Robustness Requirements

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

- Operate at temperature ranges typical of international climate (e.g., <-30> degrees C [<-22> degrees F] to <50> degrees C [<122> degrees F]);[3,4]
- Operate at temperature ranges typical of response activities (e.g., Thermal Class II <100> degrees C [<212> degrees F] to <160> degrees C [<320> degrees F]);[5,6]

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

[4] 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

[5] *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

[6] 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 (-148 degrees F).

- Be ruggedized;
- Function after immersion in water;[7]
- Function at humidity of <100>%;
- Function properly after exposure for 5 minutes at a maximum thermal radiation threshold of <260> degrees C [<500> degrees F];[8]
- Resist air pollutants, dust, smoke, ash, and sand;[9]
- Match the laundry life of garment or textile if components are integrated into garments or textiles;
- Have recyclable components;
- Be easy to decontaminate from contaminants;[10]
- Be non-degradable due to hazard;
- Not cause injury to the user if damaged;
- Comply with existing federal and/or international standards and guidelines; 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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[7] Refer to IP68 of IEC 60529: Degrees of Protection Provided by Enclosures, https://webstore.iec.ch/publication/2452

[8] Refer to NFPA 1971: Standard on 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=1971

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

[10] 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