






The International Forum to Advance First Responder Innovation

Statement of Objectives (SOO) for Technologies Related to:
“The Ability to Obtain Critical Information Remotely About the Extent, Perimeter, or Interior of the Incident.”

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International Forum to Advance
FIRST RESPONDER INNOVATION

Statement of Objectives (SOO) for Technologies Related to: **"The ability to obtain critical information remotely about the extent, perimeter, or interior of the incident"**

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.

To arrive at a set of *Common Global Capability Gaps*, IFAFRI members conducted analyses of first responder capability gaps in their respective countries. IFAFRI then assessed those gaps to identify those that were common across multiple member nations. The gaps with the highest commonality amongst member nations were presented to all IFAFRI members for consensus. IFAFRI has reached consensus on six first responder capability gaps:

- 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;
- The ability to incorporate information from multiple and nontraditional sources 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.

- The ability to maintain interoperable communications with responders in any environmental conditions; and
- The ability to obtain critical information remotely about the extent, perimeter, or interior of the incident.

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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 6th bulleted capability gap identified above:

"The ability to obtain critical information remotely about the extent, perimeter, or interior of the incident"

Some incidents are broad and encompass many square miles, while others may be very localized and contained within a single building or area. Yet, incidents of many types pose problems for responders in obtaining situational awareness of what is occurring in and around the incident scene. Smoke, extreme weather, building infrastructure, large numbers of people, unstable debris, destroyed transportation infrastructure, flooding, and other hazards can all hinder the ability of responders to obtain situational awareness of their incident. During wildfires, for example, conditions on the ground and in the air may hinder the ability of responders to determine the location of the fire line and its proximity to homes and infrastructure. This may result in responders not being able to launch air assets or other resources, which could significantly endanger residential areas. In hostage situations or large crowds, responders may not be able to distinguish between suspects or perpetrators and/or between victims or bystanders. This capability need addresses the ability of responders to determine the perimeter of the incident scene, the extent of damage or incident effects, and the location of hazards or critical infrastructure within the scene.[2]

General Description of Operational Capability

Responders need the ability to obtain and maintain real-time, continuous surveillance of the incident scene. Improved situational awareness would allow responders and command to identify potential hazards, prioritize incident operations, and improve the safety of responders and affected populations in and around the scene. The Moore, Oklahoma (United States) tornado created a path of destruction more than one mile (1.6 km) wide and 17 miles (27.4 km) long. In this instance, it was critical for responders to quickly comprehend the magnitude and the

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[2] *Canadian Next Generation First Responder: Preliminary Capability Assessment CNG-1R,* (Ottawa: Defence Research and Development Canada,) March 2017, 7. http://cradpdf.drdc-rddc.gc.ca/PDFS/unc274/p805347_A1b.pdf

geographical location of their incident scene. It was critical for on-scene responders to understand the scope and location and to recognize that a hospital and two elementary schools were within the path of destruction.

Addressing this capability gap involves platforms to conduct surveillance and integration of outputs into an incident-specific visualization for responders and command. Current capability to conduct surveillance is generally reliant on airborne assets (primarily helicopters or airplanes) that may be limited by incident conditions in their ability to approach the incident scene. Some jurisdictions are able to use unmanned ground systems (e.g., bomb robots) to observe locations that may be hazardous to responders. However, there are barriers that impact extended use of current solutions, including cost and policy issues.

Existing First Responder Capabilities

Current capabilities to obtain information about the incident scene include:

- Aircraft-based surveillance;
- Unmanned aerial system (UAS)-based surveillance;
- Unmanned ground system (UGS)-based surveillance;
- Unmanned underwater systems;
- Thermal imaging devices;
- Radio-wave imaging devices;
- Gunshot triangulation devices;
- Digital and paper maps;
- Incident-specific data sources (e.g., weather data);
- Historical data;
- Camera systems (e.g., body-mounted, fiber optic);
- Sensor systems (e.g., chemical, biological, pollution, acoustic)
- Radio Detection and Ranging (RADAR)
- Light Detection and Ranging (LIDAR)
- Sonar; and
- Social media feeds.

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 able to be 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;
- Confined spaces;
- Subterranean and underground facilities;
- Wooded areas with dense vegetation;
- Rugged outdoor terrain;

- Areas with limited or no cellular and/or radio connectivity;
- Extreme high and low temperatures and humidity;
- Wet conditions;
- Thermal radiation [3];
- 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. Remotely capture incident-related data in multiple topographies (e.g., inside buildings, at various depths and elevations, over rubble and across different terrains); and
2. Visualization of surveillance outputs to provide actionable information.

The following section provides responder-identified requirements for potential solutions. It is understood that 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.

System Requirements

Systems that remotely obtain and maintain situational awareness include unmanned ground, maritime and aerial systems. Responders need these systems in a variety of sizes and configurations. Potential solutions should:

- Capture real-time video, images, and audio:
    - Capture video: 720-degree, high-definition, zoomable, remote camera control;
    - Capture still images;
    - Provide multiple camera options (e.g., infrared, multispectral);
    - Provide a view for duration ranging from 20 minutes (tactical) to 12 hours or more (strategic);
- Be able to overlay images from different sensors (e.g. thermal over video);
- Carry modular payloads, including threat, hazard and biometric sensors, lighting, and communications equipment;
- Use a common hub or interface for sensors and imagers;
- Integrate data feeds when a new system is rotated into operation to maintain a continuous picture of the scene for as long as needed;
- Pose low risk for operators, responders and civilians;
- Rapidly deployable;

[3] Thermal radiation, one of three methods of heat transfer, causes increase in temperature from electromagnetic waves. Thermal radiation can cause flashover within a room, causing all contents to raise to their ignition temperature and engulf the room from floor to ceiling. Thermal radiation can also increase the temperature of firefighter garments, damaging the gear and causing potential harm to the responder.

- Be suitable to mission:
    - Deploy in all weather conditions;
    - Operate in confined spaces, indoors and outdoors;
    - Operate within multiple environments (e.g., smoke, humidity);
    - Operate in covert or highly visible mode;
    - Appropriate size, weight, and power (SWP);
- Be able to adjust or tune sensors for different environments (e.g., smoke, steam);
- Calculate measurements between objects using video and image data (photogrammetry);
- Continuously integrate captured data with geographic information system (GIS) location of system;
- Be resistant to interference with functionality.

Visualization Requirements

The ability to depict incident-specific information provides context for decision-making and response operations. Potential solutions should:

- Provide three-dimensional (3-D) or other appropriate graphical depiction of incident scene;
- Create and update visualization products in real time;
- Allow user to view changes in incident scene over time; both historical and within the incident;
- Integrate with digital images and video of the incident scene;
- Provide spatially accurate representation;
- Incorporate incident-specific data into visualization, such as:
    - Existing data sources (e.g., building information modeling data or fire dynamics simulators);
    - Critical infrastructure data;
    - Responder geolocation and hazard data;
    - Digital building blueprints;
    - Indoor and outdoor infrastructure data (e.g., location of hydrants, gas lines);
    - Maps; and
- Allow user to define which data is displayed.

Transmission Requirements

Potential solutions should provide real-time transmission of voice, audio, video and incident-specific data among responders, command, dispatch, and other intended destinations. Potential solutions should:

- Encrypt voice, audio, video and data prior to transmission[4];
- Transmit incident perimeter and interior data:
    - To intended destination;
    - In real time;

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

    - With metadata indication of source;
    - With metadata indication of GIS coordinates;
- Automate data routing, storage, and processing;
- 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; and
- Store incident perimeter and interior data for post-incident analysis.

Power Source Requirements

Potential solutions should use a non-proprietary power source that provides sufficient power to support duration of monitoring (variable by platform). Potential solutions should:

- Be powered using multiple sources including those on the incident scene;
- Incorporate interchangeable battery systems;
- Incorporate power systems that can be safely and compliantly carried on commercial aircraft;
- Be able to replenish power supply using non-proprietary technology;
- Utilize an easy-to-replenish power source; and
- Be compatible with renewable or sustainable energy sources.

Compatibility Requirements

Potential solutions should integrate incident perimeter and interior data with other response systems. Potential solutions should:

- Comply with exchange standards for data transmission (e.g., National Information Exchange Model (NIEM)); and
- Integrate with:
    - 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);
    - Existing incident documentation systems;
    - Responder geolocation systems;
    - Responder physiological monitoring systems;
    - Other incident-specific data sources (e.g., traffic cameras, weather projections); and
    - Existing digital maps, blueprints and floorplans.

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 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 malware detection and cybersecurity screening of software and firmware components;
- Allow for remote maintenance;
- Allow for remote upgrades;
- Provide live notification of a fault; 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 to 50 degrees C);[5,6]
- Operate at temperature ranges typical of response activities (e.g., -100 degrees C to 500 degrees C);[7,8]
- Be ruggedized;
- Resistant to effects of electromagnetic pulse (EMP);
- Function after immersion in water;[9]
- Function at humidity of 100%;
- 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;[10]
- Match the laundry life of garment or textile if any components are integrated into garments or textiles;
- Have recyclable components;
- Be easy to decontaminate;[11]

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

[6] 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

[7] *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

[8] 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.

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

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

[11] 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

- Be non-degradable due to wear or 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, training, and maintenance. Potential solutions should be priced to be affordable to all response agencies and should be designed for daily use.

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.