



The International Forum to Advance First Responder Innovation

Capability Gap 2 “Deep Dive” Analysis Synopsis

September 2017



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**International Forum to Advance
FIRST RESPONDER INNOVATION**

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Introduction

This analysis activity intends to characterize markets and identify technology solutions relevant to the International Forum to Advance First Responder Innovation's (Forum) Common Global Capability Gaps List, to garner interest from researchers in industry and academia to develop affordable, innovative technology solutions addressing the various capability gaps for first responders. This publication represents a summary of analysis activity for **Capability Gap 2—The Ability to Detect, Monitor and Analyze Passive and Active Threats and Hazards at Incident Scenes in Real Time**. It is anticipated that the remaining capability gaps will be analyzed and published in a similar fashion.

Forum Background

Established in 2014, the Forum is an organization of government leaders from across the globe, focused on enhancing and expanding the development of affordable, innovative technology for first responders worldwide.

In order to respond more safely, efficiently and effectively to everyday and catastrophic emergencies, first responders around the globe need technologically advanced tools and equipment that are affordable. However, there is no centralized mechanism for responders to identify and discuss shared needs and requirements. In addition, overall purchasing of tools and equipment is fragmented into smaller quantities, which provides little incentive for industry to commercialize innovative technologies. Therefore, the lack of consolidated requirements for first responders, along with fragmented purchasing, results in an inadequate amount of affordable new technology being available. This leads to an insufficient amount of research and development (R&D) being conducted in the first responder market.

The Forum addresses this challenge 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 R&D initiatives and solutions.
3. Characterizing global first responder markets, to inform and guide industry and academia about market opportunities and to incentivize them to develop and produce innovative technology solutions to capability gaps.
4. Providing information about relevant and available first responder technologies to the first responder community, while not endorsing any specific technology, product or manufacturer.

Forum Membership

The Forum is currently composed of members from 13 different countries and the European Commission (EC), including Australia, Canada, Finland, Germany, Israel, Japan, the Netherlands, New Zealand, Singapore, Spain, Sweden, the United Kingdom and the United States. France and Mexico's participation in the Forum is pending.



Common Global Capability Gaps List Background

In 2016, the Forum agreed to a Common Global Capability Gaps list, presented below:

- Capability Gap 1** The ability to know the location of responders and their proximity to risks and hazards in real time
- Capability Gap 2** The ability to detect, monitor and analyze passive and active threats and hazards at incident scenes in real time
- Capability Gap 3** The ability to rapidly identify hazardous agents and contaminants
- Capability Gap 4** The ability to incorporate information from multiple and nontraditional sources (e.g. crowdsourcing and social media) into incident command operations

To arrive at this initial set of gaps, Forum participants conducted analyses of first responder capability gaps in their countries. Some of the Forum participants used the methodology presented in the U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T) Project Responder 4 (PR4) report, as a guide in their gap analyses. PR4 is the fourth in a series of studies that started in 2003 to focus on identifying capability needs, shortfalls and priorities for catastrophic incident response. The methodology is based upon discussions with federal, state and local first responders as well as technical subject matter experts.

After submission of gaps from Forum participants, a comparative analysis of all submitted gaps was conducted. The analysis found a significant level of overlap among the various countries' gaps, which resulted in the proposal and adoption of the Forum's Common Global Capability Gaps List. This publication represents a general characterization of the global industries and market trends, specifically regarding potential solutions to Capability Gap 2. The purpose for analyzing and presenting this data is to identify potential areas of R&D where there may be opportunity for industry and academia to market an innovative solution. It is anticipated that the remaining two gaps will be analyzed in a similar fashion. The following table presents the status of current and future Capability Gap "Deep Dive" Analyses publications:

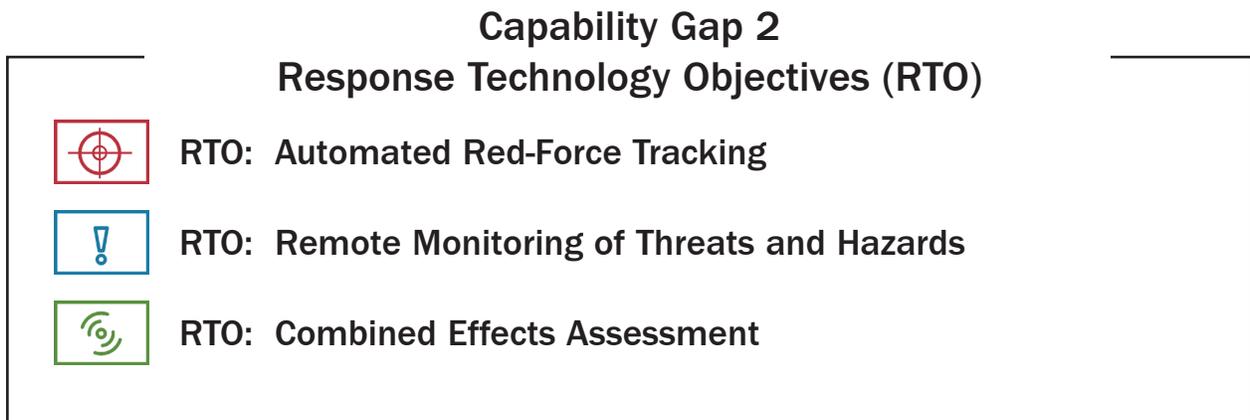
Capability Gap "Deep Dive" Analyses: Current and Future Publications	
Capability Gap 1	Published January 2017
Capability Gap 2	Published September 2017
Capability Gap 3	Published September 2017
Capability Gap 4	To be published in 2018

Capability Gap 2

The definition of Capability Gap 2 is **the ability to detect, monitor and analyze passive and active threats and hazards at incident scenes in real time**. This capability gap involves the development of responder-specific detection, monitoring and analysis solutions to enhance situational awareness at incident scenes. These solutions may also include subsequent software or devices enabled to display data and analysis on an intuitive user interface.

As Forum participants examined gaps within their countries, first responders consistently stated there is a need to continuously detect, monitor and analyze threats and hazards. During an incident, threats and hazards may increase, decrease or evolve over time, while new or unexpected risks can emerge, increasing the potential danger to both civilians and first responders. In order to improve first responder safety, efficiency and effectiveness, first responders need the ability to continuously detect, monitor and analyze passive and active threats and hazards at incident scenes in real time. The ability to detect, monitor and analyze threats and hazards, and understand real-time changes to these risks, may help to improve situational awareness and decision-making.

This analysis uses the Response Technology Objectives (RTOs) identified in PR4 as a starting point for further defining and segmenting Capability Gap 2. As stated in the PR4 report, RTOs translate capability statements or needs into actionable, technology-centric objectives. Each RTO identifies a high-level technology solution (or part of a solution) designed to improve the capabilities of the response community. Capability Gap 2 consists of three corresponding RTOs, presented below:



*Further definitions of these RTOs are provided in the Glossary.

Methodology

The following section provides a brief overview of the processes used to obtain and assess the findings presented in this synopsis.

Objective

The key objective of this analysis activity is to characterize the markets relevant to Capability Gap 2, to garner interest from researchers in industry and academia to develop affordable, innovative technology addressing the gap for responders. In other words, it is intended that this information will serve to inform and guide research and development efforts, supporting the overall goals of the Forum.

Research Methods

Data presented in this report was gathered primarily using secondary research methodologies. Research consisted of gathering publicly available information from various sources including market reports and company Web sites, among others. Secondary research methodologies were chosen for this analysis because information gathered using primary research would likely have been proprietary in nature and therefore not suitable for publishing. With that in mind, data presented in this report should not be considered exhaustive. Furthermore, regarding potential solutions, this analysis relies upon information that is publicly available from manufacturers' Web sites, but it does not validate the claims made thereon.

Market Definition and Segmentation

This analysis uses the Response Technology Objectives (RTOs) developed by PR4 as a starting point for further defining and segmenting Capability Gap 2. More specifically, relevant market segments for each RTO were identified through secondary research, with primary markets being identified for each one.

Market Quantification

All relevant markets are quantified utilizing overall revenue figures for the forecast period 2015 to 2020. The Compound Annual Growth Rate (CAGR) within each segment is used to measure growth within the forecast period and to extrapolate data when figures were not publicly available. As the first responder segments of these relevant markets appear to be underdeveloped, overarching market figures are present. Data for the primary markets is used in the aggregated findings presented in the body of this report.

Market Phase and Factors

Market phase is determined using factors in the Industry Life Cycle model. The adapted market phase definitions are as follows:

Nascent	New market need with dominant solutions not yet determined, growth begins increasing toward end of cycle
Growth	Dominant solutions begin to emerge, high growth rates
Mature	Typically fewer firms than growth phase, as dominant solutions continue to capture the majority of market share and market consolidation occurs, lower growth rates that are typically on par with the general economy
Decline	Further market consolidation, rapidly declining growth rates

Market factors are assessed by examining barriers to entry and market opportunities, as determined through secondary research.

Competitive Landscape

This analysis also examines the competitive landscape within each market, accounting for the total number of firms, along with the number of responder-specific solutions. Total number of firms was estimated using the number of key players given within publicly available market reports for each segment, while responder-specific solutions were identified using a more tailored search. This search included examining the key players listed by the publicly available market reports and conducting targeted keyword searches for solutions from companies not mentioned in these reports.

Dominant Solutions

Dominant solutions are determined by examining market share breakdown. Solutions capturing the majority of the market share are considered to be dominant.

Presentation

This synopsis begins by presenting a *Market Overview* that summarizes the overall market and provides the market quantification data for each segment. It then presents the key findings for each market segment in the *Market Highlights* section, with a one-page summary for each segment. Finally, the *Technology Landscape* section further categorizes the total number of firms participating in the market by segment and highlights responder-specific solutions available or in development.

Synopsis Overview

In order to meet its objectives of defining and publishing a global set of capability gaps and informing and guiding industry, the Forum has been conducting an ongoing global capability gaps market analysis. The key objective of this analysis activity is to characterize the markets relevant to Capability Gap 2, to garner interest from researchers in academia and industry to develop affordable, innovative technology addressing the gap for responders. This synopsis represents a summary of this activity to date.



Capability Gap 2

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

Market Definitions and Segmentation

This analysis activity begins by defining and segmenting the relevant markets for each Response Technology Objective (RTO) within Capability Gap 2. A primary market is identified for each RTO and is used for market quantification. Each RTO and its corresponding primary market is presented below:

Market Definitions and Segmentation

Response Technology Objective (RTO):

Primary Market:



Automated Red-Force Tracking

Physical Security Market



Remote Monitoring of Threats and Hazards

Remote Sensing Technologies Market



Combined Effects Assessment

Incident and Emergency Management Market

*Further definitions of these RTOs are provided in the Glossary.

Market Quantification

Each market, both primary and secondary, is quantified utilizing overall revenue figures. Growth is measured using Compound Annual Growth Rate (CAGR). In this analysis, it was found that the identified primary markets accounted for approximately **\$155.0 billion in revenue in 2015**.

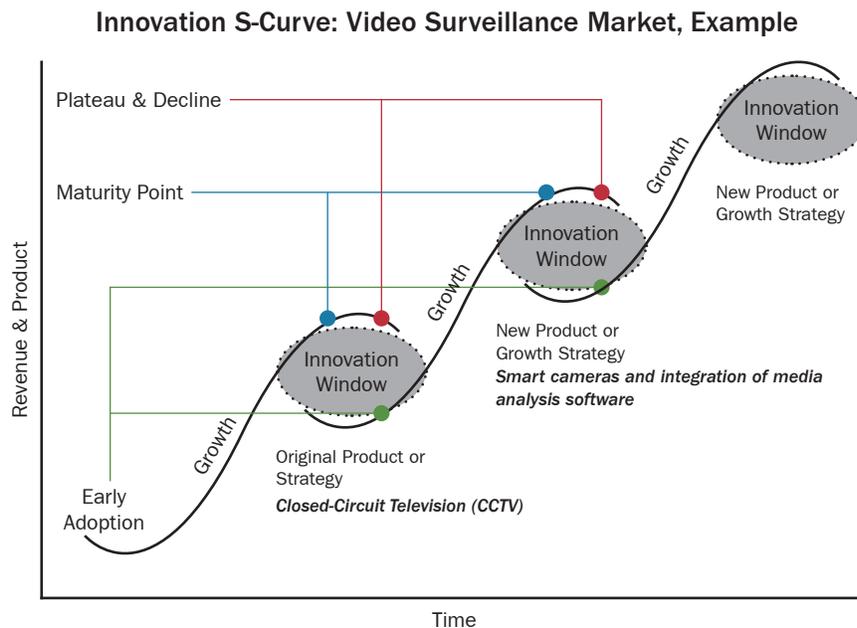
Competitive Landscape

In this analysis activity, it was found that there are 262 global firms, including innovators, working within these markets. However, the number of responder-specific solutions identified is comparably low. This presents an opportunity for those firms already developing solutions in the broader market, as in some cases they may be able to make slight adaptations to existing solutions, or those in development, to meet first responder needs. By engaging with responders, particularly on a global level through the Forum, firms can begin to further assess how close they are to providing meaningful solutions for responders.

Dominant Solutions, Market Factors and Market Phase

The aspects of each market, which include dominant solutions, market factors and market phase are summarized within the *Market Highlights* section of this synopsis. Notably, it appears that each market has a similar market phase, falling right within the innovation window of the S-Curve Life Cycle model. During an S-Curve life cycle, the performance of a new technology is poor and improve slowly to early adoption. Then, as the technology become more familiar, its performance improves rapidly during its growth phase. Eventually, the technology reaches a ceiling or maturity point and plateaus to a decline. However, an innovation window for a new wave or enhancement of the original technology exists during maturity and the cycle repeats.

All three of the primary markets examined by this assessment appear to be positioned within the S-curve innovation window, which is encouraging for new solutions. Within the Physical Security market, Closed-Circuit Television (CCTV) appears to have reached its maturity point, while enhancements, in the form of smart cameras and integration of media analysis software are making their way to market. Within the Remote Sensing Technologies market, conventional space-based sensing platforms, such as satellites, appear to be reaching their maturity point, while new products, such as unmanned vehicles are gaining popularity within the market. Finally, the Incident and Emergency Management market experiences this same phenomenon as dated incident simulation tools give rise to capabilities that integrate Geographic Information System (GIS) overlays to map potential threats and hazards on the incident scene in real-time. Given this information, each market phase is categorized as “Mature + Growth” because some subsegments of the market are mature, while other subsegments are in the growth phase.



Summary

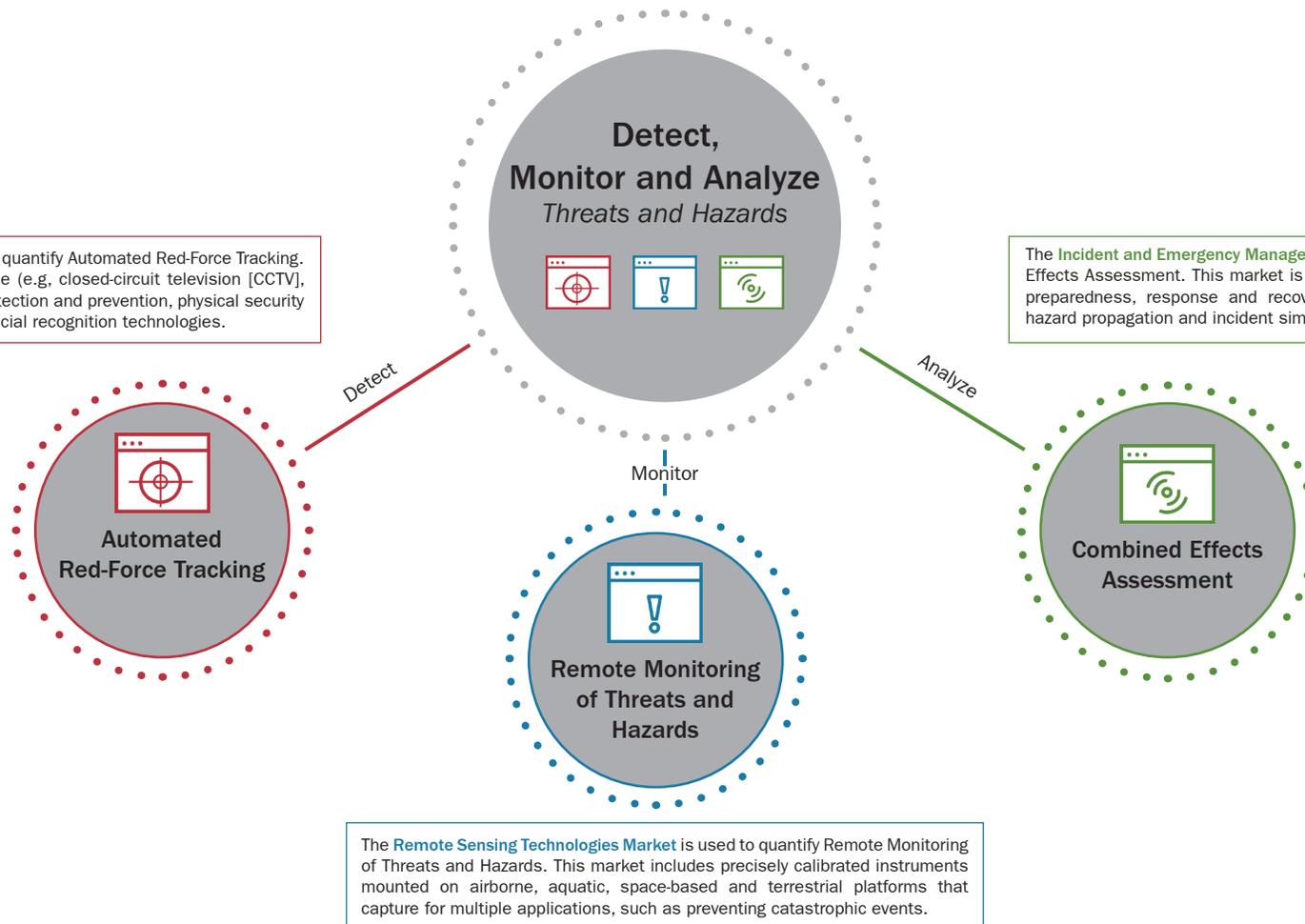
It appears that the number of first responder-specific solutions is low when compared with the total number of firms working on and providing solutions in the broader market. Therefore, in general, there is a potential opportunity for firms to adapt their solutions for responder needs. This opportunity appears to align with the current phase of the markets examined in this assessment. Each of the primary markets appears to have reached a period of potential innovation, during which improvement to current capabilities will be encouraged. Solutions that exhaust or replicate current capabilities are not expected to thrive in the market. Firms that provide new and innovative technologies that enhance existing capabilities of matured solutions will likely experience the greatest market opportunity. The factors impacting the ability to capture these opportunities varies by market and are depicted in the following sections of this synopsis.

Market Overview

Market Definition

Capability Gap 2 is defined as **the ability to detect, monitor and analyze passive and active threats and hazards at incident scenes in real time**. The corresponding RTOs identified for this gap align, in part, with detection, monitoring and analysis capabilities. The figure below presents the overarching segmentation of the Capability Gap 2 market, as identified in this analysis:

Market Segmentation

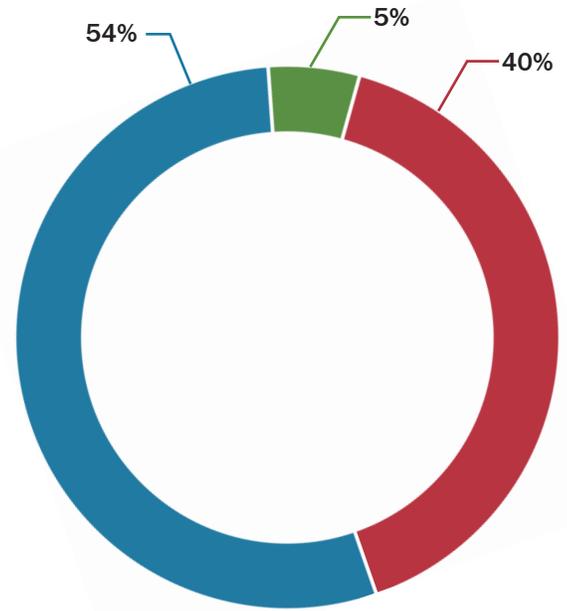
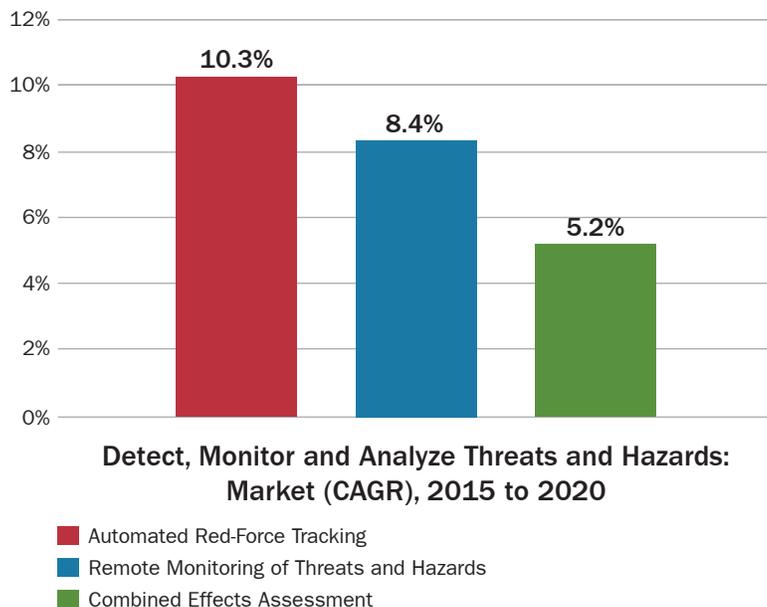


Capability Gap 2 - The Ability to Detect, Monitor and Analyze Passive and Active Threats and Hazards at Incident Scenes in Real Time

During an incident, threats and hazards may increase, decrease or evolve over time, while new or unexpected risks can emerge, increasing the potential danger to both civilians and first responders. First responders stated there is a need for the ability to continuously detect, monitor and analyze passive and active threats and hazards at incident scenes in real time. The ability to detect, monitor and analyze threats and hazards, and understand real-time changes to these risks may help to improve situational awareness and decision-making.

A myriad of detection, monitoring and analysis solutions currently exist within the market. However, there appears to be a limited number of technologies suitable for enhanced first responder use. It is acknowledged that the identified market figures and growth rates are likely to be more reflective of the broader threat and hazard detection, monitoring and analysis market among all industries, rather than the responder-specific market segment.

Remote Monitoring of Threats and Hazards appears to be the most mature market. However, included in this market are unmanned systems (e.g., UAVs, UGVs and UUVs). Unmanned systems are well suited to carry sensors that detect threats and hazards. However, use of these systems has been limited within the emergency response community. Adoption of these solutions will likely lead to new, dominating growth in the market:



Detect, Monitor and Analyze Threats and Hazards: Market, 2015

- Automated Red-Force Tracking
- Remote Monitoring of Threats and Hazards
- Combined Effects Assessment

Note: Figures may not add up, due to rounding.

The Public Safety Drones Market is expected to reach approximately \$1.15 billion in revenues by 2022, growing at an estimated CAGR of 102.5 percent between 2017 and 2022.

As of 2015, the market for Remote Monitoring of Threats and Hazards captures 54 percent of the market, followed by Automated Red-Force Tracking at 40 percent and Combined Effects Assessment at 5 percent.

Automated Red-Force Tracking is expected to grow at the highest CAGR of 10.3 percent during the forecast period of 2015 to 2020, followed by Remote Monitoring of Threats and Hazards at 8.4 percent and Combined Effects Assessment at 5.2 percent.

Market Figures

The following tables present the estimated revenue figures for the various sub-markets identified for each RTO segment within the Capability Gap 2 market. The figures in the colored rows represent the primary markets used to quantify each segment in this analysis activity.

Disclaimer

All figures have been rounded to the nearest hundred thousand. The market forecast period examined is 2015 to 2020. When a market value was not available, it was estimated using the corresponding CAGR given over the forecast period 2015 to 2020 to represent growth or decline.

For consistency, data that fell outside of the forecast period 2015 to 2020 has been extrapolated, as denoted by an asterisk (*). A more detailed explanation of how the extrapolated figures were estimated can be found in the Appendix at the end of this synopsis.

Automated Red-Force Tracking

	Revenue by Year (in \$1,000,000)						CAGR
	2015	2016	2017	2018	2019	2020	
Physical Security Market	\$62,600*	\$69,600	\$76,600	\$84,300	\$92,800	\$102,200	10.3%
Physical Security Information Management (PSIM) Market	\$823.1	\$976.5	\$1,200	\$1,400	\$1,600	\$1,900	18.2%
Facial Recognition Market	\$2,800*	\$3,400	\$3,900	\$4,500	\$5,100	\$5,900	16.1%
Video Surveillance Market	\$24,400*	\$30,400	\$35,400	\$41,200	\$47,900	\$55,800	17%
Video Analytics Market	\$1,100*	\$1,700*	\$2,600	\$3,500	\$4,700	\$6,200	41.3%
Border Security Systems Market	\$31,500*	\$33,900	\$36,500	\$39,300	\$42,400	\$45,600	7.7%
Military Electro-Optics/Infrared Systems Market	\$9,600*	\$10,200	\$10,700	\$11,400	\$12,000	\$12,700	5.8%
Augmented Reality (AR) Market	\$3,100	\$5,500	\$10,000	\$17,900	\$32,200	\$57,700	79.5%
Head-Mounted Display (HMD) Market	\$1,700	\$2,500	\$3,700	\$5,600	\$8,300	\$12,400	48.8%

Remote Monitoring of Threats and Hazards

	Revenue by Year (in \$1,000,000)						CAGR
	2015	2016	2017	2018	2019	2020	
Remote Sensing Technologies Market	\$8,400	\$8,900	\$9,700	\$10,600	\$11,600	\$12,600	8.4%
Market Segment: Space-Based (i.e., Conventional) Platforms	\$3,300	\$3,400	\$3,600	\$3,800	\$3,900	\$4,100	4.4%
Market Segment: Airborne (i.e., Unmanned) Platforms	\$503	\$648	\$834.9	\$1,100	\$1,400	\$1,800	29%
Market Segment: Other Platforms	\$4,600	\$4,800	\$5,300	\$5,800	\$6,300	\$6,700	7.8%
Security Robots Market	\$1,300	\$1,500	\$1,600	\$1,700	\$1,900	\$2,000	9%
Market Segment: Unmanned Aerial Vehicle (UAV) Market	\$1,000	\$1,100	\$1,200	\$1,300	\$1,400	\$1,600	9.9%
Market Segment: Unmanned Ground Vehicle (UGV) Market	\$116.8	\$125.3	\$134.6	\$144.5	\$155.2	\$166.6	7.4%
Market Segment: Unmanned Underwater Vehicle (UUV) Market	\$204.1	\$215.4	\$230.8	\$247.3	\$264.9	\$283.9	6.8%
3D Printing Market	\$3,700	\$5,000	\$6,300	\$7,700	\$9,300	\$11,200	24.8%
Market Segment: Aerospace Industry	\$723	\$945.7	\$1,200	\$1,400	\$1,700	\$2,100	23.8%
Video Surveillance Market	\$25,400*	\$30,400	\$35,400	\$41,200	\$47,900	\$55,800	17%
Video Analytics Market	\$1,100*	\$1,700*	\$2,600	\$3,500	\$4,700	\$6,200	41.3%

Combined Effects Assessment

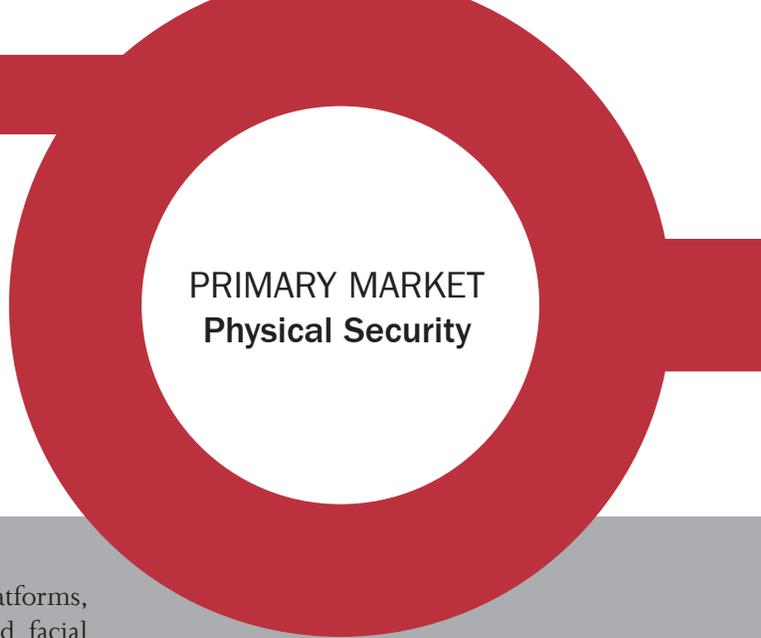
	Revenue by Year (in \$1,000,000)						CAGR
	2015	2016	2017	2018	2019	2020	
Incident and Emergency Management Market*	\$84,000*	\$88,600	\$93,200	\$98,000	\$103,100	\$108,400	5.2%
3D Mapping and 3D Modeling Market	\$1,900	\$2,900	\$4,600	\$7,100	\$11,000	\$17,000	55.0%
Computer-Aided Design (CAD) Market	\$8,800*	\$9,400	\$10,100	\$10,800	\$11,500	\$12,300	6.9%
Governmental Geospatial Intelligence (GEOINT) Solutions Market	\$10,500	\$11,400	\$12,300*	\$13,300*	\$14,400*	\$15,600*	8.2%
Geospatial Analytics Market	\$24,800*	\$30,700	\$36,600	\$43,600	\$52,000	\$62,000	20.1%
Geospatial Imagery Analytics Market	\$1,900*	\$2,800	\$3,600	\$4,700	\$6,100	\$7,900	33.0%
Geographic Information System (GIS) Market	\$8,500	\$9,500	\$10,600	\$11,800	\$13,100	\$14,600	11.4%

Market Highlights



Automated Red-Force Tracking

Automated Red-Force Tracking involves the automatic identification and surveillance of red forces. In the emergency response community, a red force may represent a specific threat or hazard, such as a person (e.g., active shooter, suspect) or an object (e.g., weapon, explosive device). In order to improve first responder safety, efficiency and effectiveness, responders need the ability to know the location and movement of red forces and their proximity to other response personnel, critical resources and infrastructure in real time. The ability to automatically identify and track red forces is likely to improve response situational awareness and decision-making.



Current Capability:

There appears to be little integrated capability to track red forces. First responders often use multiple platforms, including close-circuit television (CCTV) and other video cameras, social media, visual surveillance and facial recognition software to identify and track threats and hazards.

Market Quantification

Market Size (2015): \$62.6 Billion

Compound Annual Growth Rate (2015-2020): 10.3%

Competitive Landscape

Number of Firms: 103

Number of Responder-Specific Existing Solutions: 6

Number of Responder-Specific R&D Initiatives: 5

Dominant Solution

Video Surveillance and Analysis Platforms

Defined: Physical security can be defined as a combination of physical and procedural measures designed to prevent or mitigate threats or attacks against people, information and assets. Video surveillance and analysis platforms are often used to identify, monitor and track threats and hazards in this market.

Market Factors

OPPORTUNITIES

Integration with responder location/tracking systems and other situational awareness tools

Solutions that address accuracy, mobility, speed and cost

The evolution of “Smart Cities” and the Internet of Things (IoT)

Market Phase

Mature + Growth

BARRIERS

Legal and privacy concerns regarding facial recognition and other surveillance platforms

Device vulnerability and chances of systems being hacked

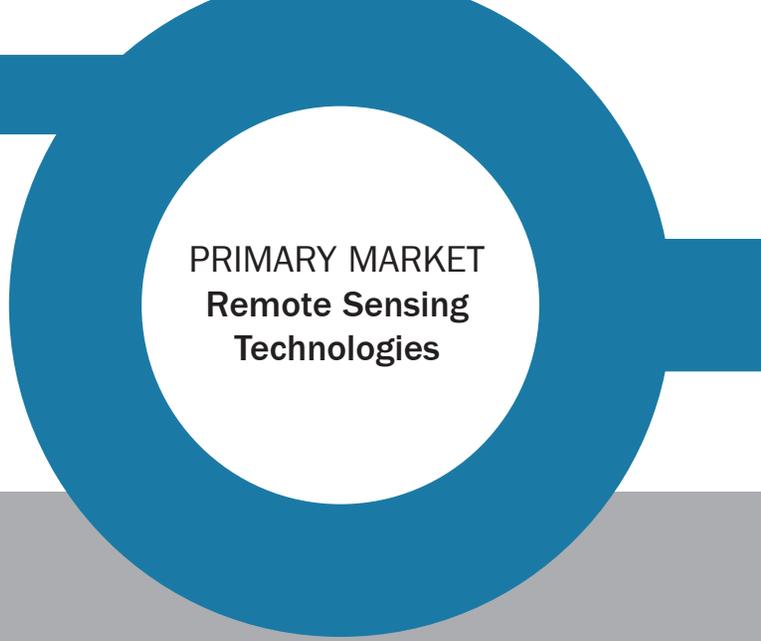
Lack of synergy among security solutions

Market Highlights



Remote Monitoring of Threats and Hazards

Remote Monitoring of Threats and Hazards focuses on the development of multiple platforms to support remote, ongoing surveillance and monitoring of threats and hazards on the incident scene and potentially affected areas. In order to improve first responder safety, efficiency and effectiveness, responders need the ability to continuously evaluate existing, emerging and potential threats and hazards in areas affected by an incident. Remote monitoring of threats and hazards can provide incident command with pertinent information throughout an incident, without exposing responders to additional risk.



Current Capability:

First responders appear to rely on multiple fixed and mobile platforms for remote monitoring of the incident scene, including sensor networks, traffic and surveillance cameras and unmanned systems.

Market Quantification

Market Size (2015): **\$8.4 billion**

Compound Annual Growth Rate (2015-2020): **8.4%**

Competitive Landscape

Number of Firms: **102**

Number of Responder-Specific Existing Solutions: **7**

Number of Responder-Specific R&D Initiatives: **6**

Dominant Solution

Space-based (i.e., conventional) Platforms

Defined: Remote sensing can be obtained through multiple platforms, such as space-based or satellite systems. Earth observation satellites are equipped with remote sensing instruments that capture a spectrum of imagery data, which can be used to detect, monitor and analyze potential threats and hazards.

Market Factors

OPPORTUNITIES

Development of free data and software platforms encouraged in the U.S. and Europe
 Potential widespread adoption of low cost drones and small satellite platforms
 The evolution of “Smart Cities” and the Internet of Things (IoT)

Market Phase

Mature + Growth

BARRIERS

Dominance of large, defense-related firms
 Legal restrictions, liability concerns and cost of unmanned systems

Figures for Competitive Landscape are not all encompassing; it is likely that additional firms and solutions exist.

Market Highlights



Combined Effects Assessment

Combined Effects Assessment involves the integration of data and analysis to inform incident command of potential secondary or cascading effects during an incident. In order to improve first responder safety, efficiency and effectiveness, responders need the ability to understand the potential for secondary effects, the conceivable impacts of all incident effects and how those effects combine to mitigate or exacerbate the situation. The availability of this data and analysis is likely to help incident command prioritize threats and hazards on the incident scene, allocate appropriate personal protective equipment (PPE) and support other response decision-making needs.

PRIMARY MARKET
Incident and Emergency
Management

Current Capability:

There appears to be little integrated capability to understand and assess combined incident effects. First responders often use pre-event assessment platforms to predict threats and hazards. These systems can be equipped with Geographic Information System (GIS) overlay to map potential threats and hazards on the incident scene. However, these systems do not provide incident-specific information based on real-time conditions.

Market Quantification

Market Size (2015): **\$84 Billion**

Compound Annual Growth Rate
(2015-2020): **5.2%**

Competitive Landscape

Number of Firms: **57**

Number of Responder-Specific
Existing Solutions: **7**

Number of Responder-Specific
R&D Initiatives: **4**

Dominant Solution

None, to date

The *Incident and Emergency Management Market* is used to quantify this segment

Defined: Incident and Emergency Management is composed of many emergency mitigation, preparedness, response and recovery solutions. Most notably, it includes hazard propagation and incident simulation tools.

Market Factors

OPPORTUNITIES

Situational awareness tools deployable for both daily and catastrophic incidents

Integration of social media with incident and emergency management

The evolution of “Smart Cities” and the Internet of Things (IoT)

Graphic-related enhancements to display interfaces

Market Phase

Mature + Growth

BARRIERS

There may be a disconnect between disaster risk reduction policy and emergency management in practice

Lack of seamless integration due to outdated Incident and Emergency Management infrastructure

Hardware infrastructure can be prone to single point of failure

Market Factors

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



Automated
Red-Force Tracking

Market Opportunities

- ✓ Integration with responder location/tracking systems and other situational awareness tools
- ✓ Solutions that address accuracy, mobility, speed and cost
- ✓ The evolution of “Smart Cities” and the Internet of Things (IoT)

Market Barriers

- x Legal and privacy concerns regarding facial recognition and other surveillance platforms
- x Device vulnerability and chances of systems being hacked
- x Lack of synergy among security solutions



Remote Monitoring
of Threats and
Hazards

Market Opportunities

- ✓ Development of free data and software platforms encouraged in the U.S. and Europe
- ✓ Potential widespread adoption of low cost drones and small satellite platforms
- ✓ The evolution of “Smart Cities” and the Internet of Things (IoT)

Market Barriers

- x Dominance of large, defense-related firms
- x Legal restrictions, liability concerns and cost of unmanned systems



Combined Effects
Assessment

Market Opportunities

- ✓ Situational awareness tools deployable for both daily and catastrophic incidents
- ✓ Integration of social media with incident and emergency management
- ✓ Graphic-related enhancements to display interfaces
- ✓ The evolution of “Smart Cities” and the Internet of Things (IoT)

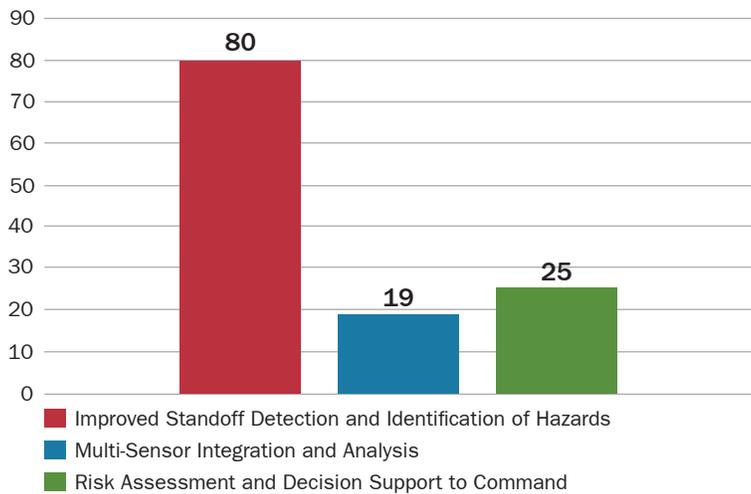
Market Barriers

- x There may be a disconnect between disaster risk reduction policy and emergency management in practice
- x Lack of seamless integration due to outdated incident and emergency management infrastructure
- x Hardware infrastructure can be prone to single point of failure

Competitive Landscape

A total of 262 global firms were recognized as key players and innovators within the primary and submarkets of Capability Gap 2. Specifically, the breakdown of each market is as follows:

**Detect, Monitor and Analyze Threats and Hazards Market:
Key Players and Innovators, 2015**



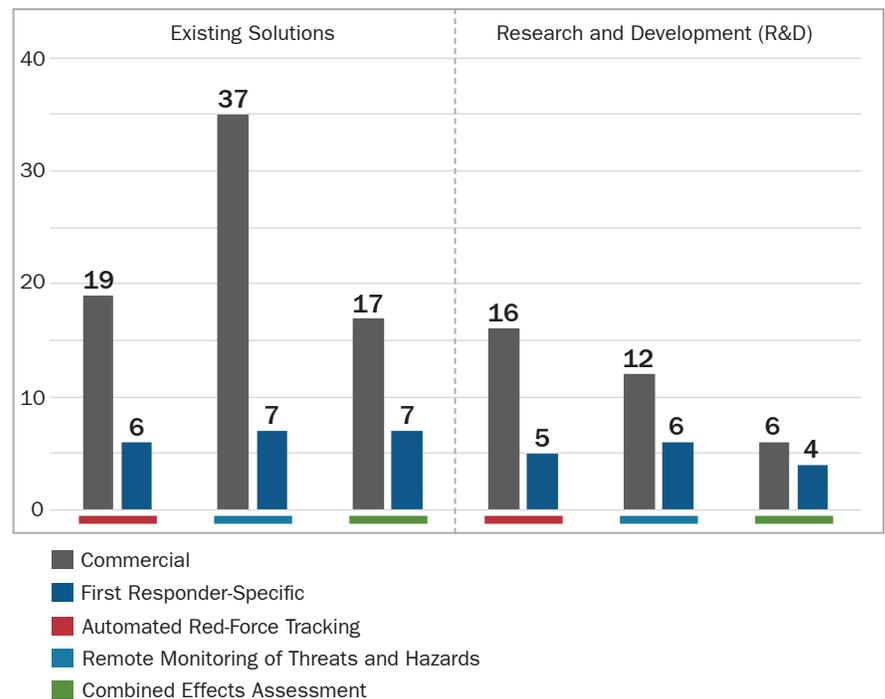
The following seven firms were identified as key players and innovators in at least two of the three market segments regarding rapidly identification and detection of hazardous agents and contaminants:

- BAE Systems plc (United Kingdom);
- Boeing Company (U.S.);
- General Dynamics Corporation (U.S.);
- General Electric Corporation (U.S.);
- Honeywell International Inc. (U.S.); and
- Raytheon Company (U.S.).

This analysis activity has identified a total of 71 existing solutions and 34 research and development (R&D) initiatives related to Capability Gap 2 - The Ability to Detect, Monitor and Analyze Passive and Active Threats and Hazards at Incident Scenes in Real Time.

Among the existing and developing solutions identified, 20 solutions appear to be readily deployable for first responder use and 15 solutions appear to be in development for first responder use.

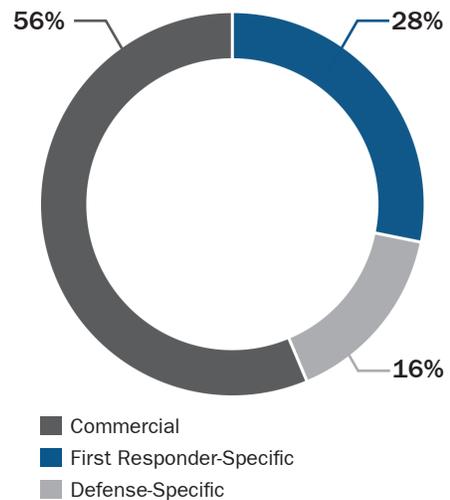
Technology Landscape Summary



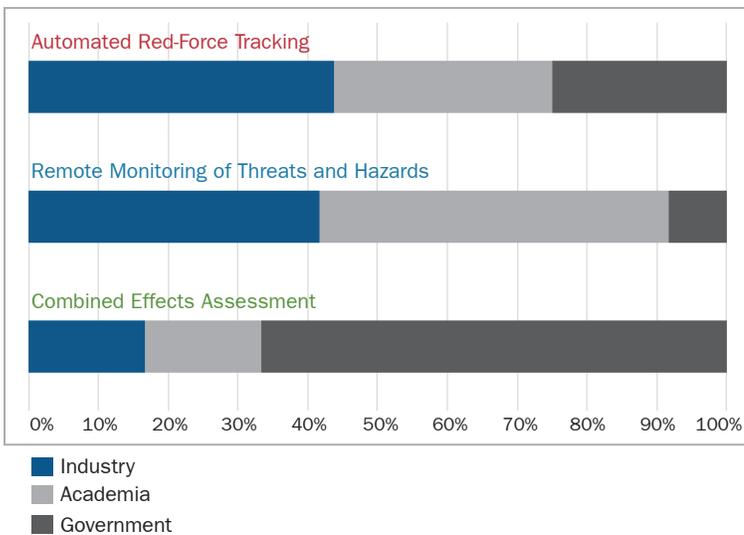
The majority (56 percent) of existing solutions identified by this analysis activity appear to be designed for various commercial industries, while 28 percent of solutions appear to be designed for first responder use and 16 percent of solutions appear to be designed for defense-related initiatives.

There may be an opportunity for firms, with existing commercial solutions, to compete in the first responder market by adapting existing solutions to meet the needs of first responders.

**Existing Solutions by Sector—
Commercial, First Responder-Specific, Defense-Specific**



**Research and Development (R&D) by Sector—
Industry, Academia and Government:**



This analysis activity identified 34 R&D initiatives related to Capability Gap 2 - The Ability to Detect, Monitor and Analyze Passive and Active Threats and Hazards at Incident Scenes in Real Time.

Among the developing solutions identified, 13 solutions (38 percent) appear to be initiated by industry firms, 12 solutions (35 percent) appear to be initiated by academic institutions and 9 solutions (26 percent) appear to be initiated by government organizations.

Based upon the data presented, there is a comparatively low number of responder-specific solutions identified, given the number of firms operating in each segment. This presents an opportunity for those firms already developing solutions in the broader market, as in some cases they may be able to make slight adaptations to existing solutions to meet first responder needs. By engaging with responders, particularly on a global level through the Forum, firms can begin to assess how close they are to providing meaningful solutions for responders. Furthermore, they can engage responders throughout their process to ensure that their developments will meet responder needs.

For questions or comments related to the information presented in this assessment, please contact the Forum at info@internationalresponderforum.org.

First Responder-Specific Technologies:

The following section presents some of the potential first responder-specific solutions by segment as identified by this assessment. It is likely that there are additional potential solutions that exist or are in development and therefore, this section should not be considered exhaustive. A complete list of solutions identified by this assessment can be found in the Appendix at the end of this synopsis.

The data presented in this section represents information that is publicly available from manufacturers' Web sites. This information is not further validated by this assessment.



Automated Red-Force Tracking

Airbox Systems Limited

Airbox Systems Limited (United Kingdom) is a computer software company that offers systems integration and consultancy to law enforcement, emergency services, military and search and rescue (SAR) organizations.

Airbox Systems states its Mission Optimized Situational Awareness Information & Collaboration (MOSAIC) application solution enables users to identify the location of team members, key assets, resources and infrastructure, as well as access full profile and visual details relative to a mission or incident location, including live video feeds.

In addition, MOSAIC appears to support various tracking capabilities, including blue force, red force and asset tracking.

Information regarding price and specific deployment within the first responder community does not appear to be publicly available for this solution.



Airbox Systems' MOSAIC

Domo Tactical Communications (DTC) Ltd.

Domo Tactical Communications (DTC) Ltd. (United States) offers customized solutions for emerging surveillance and situational awareness challenges within border control, internal security and critical infrastructure protection areas.

DTC states its Orion trackers provide law enforcement, military and intelligence agencies with a scalable technically advanced Radio Direction Finding (RDF) and Global Positioning System (GPS) solution to locate and track mission critical assets in challenging environments. RDF systems offer covert tagging, tracking and locating within a dedicated, secure network without a reliance on commercial infrastructure such as GPS, cellular or satellite foundations. The range of Orion tracking options and tags include body worn solutions, vehicle solutions, airborne solutions, fixed site solutions and city and country wide solutions.

Information regarding price and specific deployment within the first responder community does not appear to be publicly available for this solution.

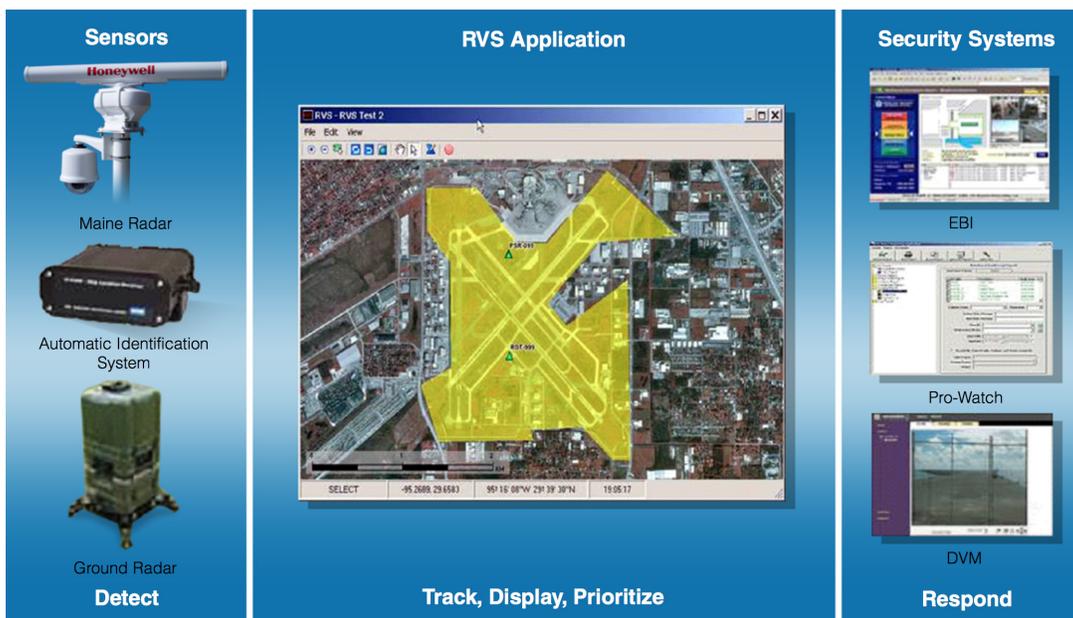
Honeywell International Inc.

Honeywell International Inc. (United States) is a Fortune 100 company that offers hardware and software solutions that address global energy, safety, security, productivity and urbanization challenges.

The Honeywell Radar Video Surveillance (RVS) solution is described as a wide area security system that provides advanced surveillance capabilities through the integration of ground or waterside radar, Global Positioning System (GPS), Automatic Identification System (AIS), video and thermal sensor data. RVS is often paired with Honeywell's Digital Video Manager (DVM) to leverage existing security infrastructure.

Honeywell's RVS radar sensors automatically detect potential threats in user defined Alarm Zones. Following detection, an alarm alerts security personnel and connected pan-tilt-zoom (PTZ) cameras are directed to identify and track the potential threats. Video recording is distributed over a Local Area Network to provide real-time situational awareness to security personnel.

The components of the RVS are presented in the figure below:



Honeywell International Inc. Radar Video Surveillance (RVS)

Information regarding price and deployment within the first responder community does not appear to be publicly available for this solution.

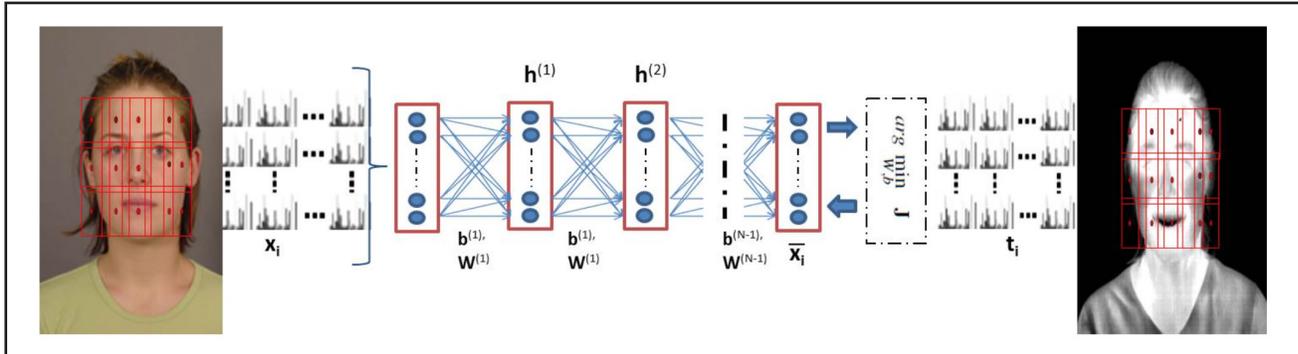
The Institute of Anthropometrics & Robotics at the Karlsruhe Institute of Technology

The Institute of Anthropometrics & Robotics at the Karlsruhe Institute of Technology (Germany) explores the science of symbiosis between human and humanoid. The Institute focuses on human-centered environments, with an aim to research and develop people-friendly systems using informatics. The Institute studies topics such as multimodal interaction of people with technical systems, humanoid robots, language understanding, image perception, learning, recognizing and understanding situations, generating knowledge through experience and processing biosignals.

Computer scientists from the Institute of Anthropometrics & Robotics developed a new type of facial-recognition system that uses nontraditional methods. Infrared spectrum, thermal signatures emitted by skin tissues can be captured through passive thermal sensors without using any active light source. Thus, images or faces can be identified in the dark

In the study, a “deep neural network” computer system analyzed numerous infrared images of individual faces and compared the images to a repository of photos taken in daylight. According to study results, the proposed approach improved the state-of-the-art by more than 10 percent. However, further accuracy is warranted. When presented with multiple comparative images, the system was accurate about 80 percent of the time, while when presented with one comparative image, the system was accurate about 55 percent of the time.

According to study results, the proposed approach improved the state-of-the-art by more than 10 percent. However, further accuracy is warranted. When presented with multiple comparative images, the system was accurate about 80 percent of the time, while when presented with one comparative image, the system was accurate about 55 percent of the time.



Deep Perceptual Mapping (DPM): Densely computed features from the visible domain are mapping through the learned DPM network to the corresponding thermal domain.

The study was partially funded by the German Federal Ministry of Education and Research (BMBF). Additional information regarding funding and Technology Readiness Level (TRL) does not appear to be publicly available for this project.

SRI International

SRI International (United States) is an independent, nonprofit research center that provide basic and applied research, development, deployment and commercialization services. SRI collaborates across various technical and scientific disciplines, including:

Biosciences, Health and Medical Systems;
Chemistry, Materials and Energy;
Computing and Information Technology;
Defense and Security;
Education and Learning;
Ocean and Space;
Robotics; and
Custom Solutions.

Researchers from SRI, the University of Leeds (United Kingdom) and the University of Maryland (United States) are developing a system to enhance remote threat surveillance. These efforts appear to be funded by the Mind's Eye Program, initiated by the U.S. Defense Advanced Research Projects Agency (DARPA). The Mind's Eye Program promotes the development of smart cameras for real-time threat detection and analysis.

The system under development, known as Visual Intelligence Grounded in Learning (VIGIL), combines vision analysis, automatic reasoning and machine learning to identify and report unusual interactions between people and objects. SRI states VIGIL is being designed to use probabilistic reasoning, statistical and relational learning, as well as other artificial intelligence approaches to detect, recognition and describe behavior and activities observed in video. The goal of the program is to construct a compact, field-portable system compatible for rapid, cost-effective deployment on unmanned vehicles. Additional information regarding funding and Technology Readiness Level (TRL) does not appear to be publicly available for this project.

Vidsys Inc.

Vidsys Inc. (United States) offers Converged Security Information Management (CSIM) software for various industry sectors including government, education, energy, transportation, enterprise, public safety and healthcare.

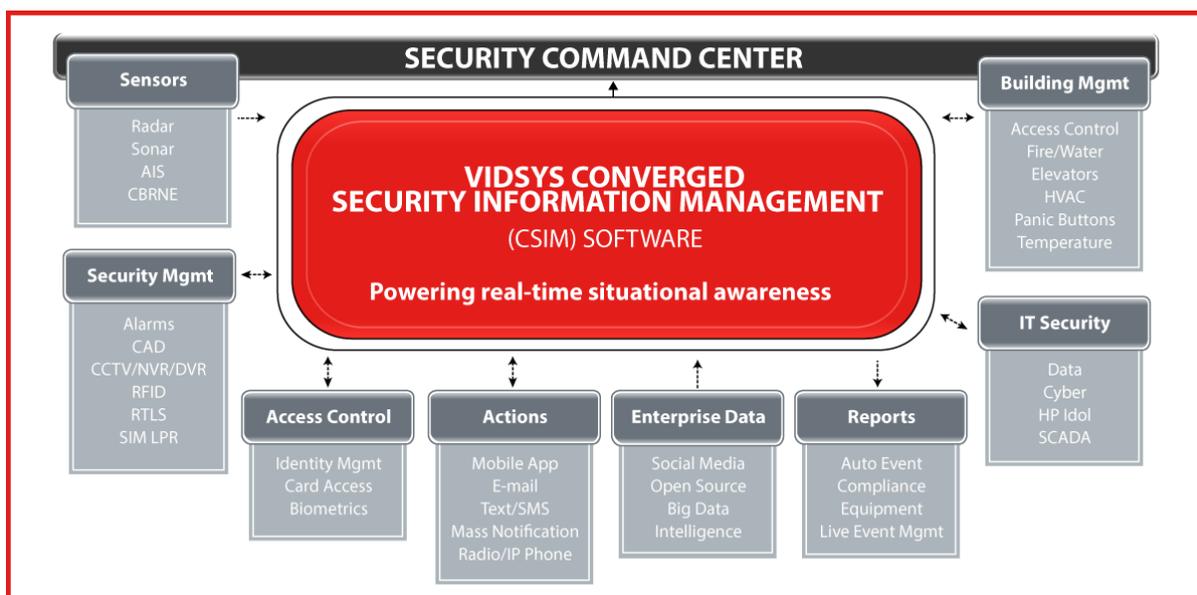
Vidsys CSIM software is described as a browser-based platform that collects, correlates and converts vast amounts of data into meaningful and action information based on a user's risk policy, standards and compliance requirements. The software can be rapidly deployed to provide real-time situational awareness and information management capabilities to remote users and first responders.

Vidsys states its CSIM software can provide the following advantages to public safety personnel:

Centralize security monitoring to enhance situational awareness among various agencies;
Provide more accurate details to first responders en route and on the scene;
Improve collaboration among state and local police, emergency medical service (EMS) responders and other agencies;
Improve response time by leveraging location based assets; and
Archive situation management for the purpose of training and after action analysis.

In 2014, Vidsys CSIM software was deployed in the City of Baltimore, Maryland for the “Star Spangled Spectacular”. This event was designated as a Level 2 Special Event by the U.S. Department of Homeland Security (DHS). In Baltimore, Vidsys CSIM software generated a common operating picture that connected nearly 50 local, state and federal agencies in one command center. Further, the platform integrated approximately 1,500 security cameras, mapping technology, weather alerts, social media monitoring, mass notification, radar and other technologies to enhance public safety and ensure rapid response.

Information regarding price does not appear to be publicly available for this solution.



Vidsys Converged Security Management (CSIM) Software



Remote Monitoring of Threats and Hazards

The Environment and Sustainability Institute (ESI) DroneLab at the University of Exeter

The Environment and Sustainability Institute (ESI) DroneLab at the University of Exeter (United Kingdom) designs, manufactures and tests lightweight fixed wing and multi-rotor aircraft and related systems.

According to ESI DroneLab, smartphones are equipped with a broad suite of sensors (e.g., cameras, microphones, light sensors, accelerometer, compass, gyroscope and Global Positioning System [GPS]) and on-board microcomputers. Therefore, there may be an untapped opportunity in converting smartphones into all-inclusive or self-containing remote sensing devices.

In 2016, scientists from the ESI DroneLab began development of an android-based smartphone application, programed to automatically capture aerial photographs and spatial metadata. The smartphone, equipped with the application, could then be fixed onto a lightweight, portable platform, such as a drone or a kite, for grassroots mapping scenarios. For example, ESI DroneLab states in the aftermath of a humanitarian disaster, the ability to rapidly and cheaply survey environmental damage and search for survivors is more readily achieved from a drone or a kite than from a piloted aircraft or satellite. In addition, the resolution of data from low-flying platforms such as drones and kites enables more useful and easily interpreted data.

All coding for the intial app is available via [GitHub](#). In addition, the app can be freely downloaded via the [Google Store](#). Initial funding to develop the app was provided by the European Social Fund. The Natural Environment Research Council (NERC) supported further testing and development through its “Impact Accelerator” fund. Additional information regarding funding, Technology Readiness Level (TRL) and deployment within the first responder community does not appear to be publicly available for this project.

FLIR® Systems Inc.

FLIR® Systems Inc. (United States) designs, develops, manufactures, markets and distributes solutions for enhanced perception and situational awareness. In 1978, FLIR® offered infrared imaging systems to be used for energy audits. FLIR® systems and components have since evolved for use in security (e.g., airborne and ground-based surveillance), condition monitoring, navigation, drug interdiction, transportation safety and efficiency, border and maritime patrol, environmental monitoring and chemical, biological, radiological, nuclear and explosives (CBRNe) threat detection.

Launched in 2016, the FLIR® Aerial First Responder Kit includes a DJI Inspire 1 drone, DJI Zenmuse XT thermal camera, DJI Zenmuse X3 4k visible light camera and a variety of accessories to provide fire fighters and first responders with airborne thermal imaging capabilities.

FLIR® states the solution offers incident commanders the ability to see through smoke and keep track of personnel in large fire-related incident scenes. In addition, the system can be deployed for search and rescue (SAR) missions, regardless of the time of day.



FLIR® Aerial First Responder Kit

FLIR® Aerial First Responder Kit package specifications are presented in the table below:

Model	FLIR® Aerial First Responder Basic Kit	FLIR Aerial First Responder Advanced Kit
Thermal Camera	DJI Zenmuse XT Thermal Camera & Stabilized Gimbal	DJI Zenmuse XT Thermal Camera & Stabilized Gimbal
Thermal Camera Configuration	6.8 mm lens (45° x 35°), 336 x 256 resolution	13 mm lens (45° x 37°), 640 x 512 resolution
Aircraft Type	DJI Inspire 1 (V 2.0)	DJI Inspire 1 (V 2.0)
Controller(s)	One	Two
Batteries Included	Three	Three
Color Video Camera	DJI Zenmuse X3 4k Video Camera & Stabilized Gimbal	DJI Zenmuse X3 4k Video Camera & Stabilized Gimbal
FLIR® Tools+ Image Analysis Software	Yes	Yes
Apple iPad Mini 4 (64GB, WiFi)	One	Two
Monitor Hood(s)	One	Two
Rugged Carrying Case	Yes	Yes
FLIR® Landing Pad	Yes	Yes

FLIR® Aerial First Responder Kits are available to purchase, starting at approximately \$10,450 per kit. Information regarding specific deployment within the first responder community does not appear to be publicly available.

Lockheed Martin Corporation

Lockheed Martin Corporation (United States) is a global security, innovation and aerospace company, with specialties in aeronautics, missiles and fire control, rotary and mission systems and space systems. The majority of Lockheed Martin’s business is with the U.S. Department of Defense (DoD) and U.S. federal government agencies. However, Lockheed Martin also engages with international government and commercial users.

The Lockheed Martin Procerus Technologies Indago quadrotor unmanned aerial system (UAS) provides military, civil and commercial users with aerial reconnaissance capabilities. The solution is adaptable to a variety of payloads for precision agriculture, mapping, surveying and inspection and reconnaissance. Lockheed Martin states the solution is collapsible, weighs less than five pounds and folds into a man-packable unit that requires no tools for assembly. In addition, the UAS solutions includes a weather-resistant wireless hand controller to provide an intuitive interface and untethered UAS operation.



Procerus Technologies Indago Quadrotor UAS Wireless Hand Controller

In regards to the first respond community, the Indago quadrotor UAS can be equipped with location antenna and tracking system capabilities. [Project Lifesaver International](#), a public safety nonprofit organization works with first responders to deploy the system to locate and track individuals with Alzheimer's diseases, Autism and Down syndrome.



Procerus Technologies Indago Quadrotor UAS

Information regarding price does not appear to be publicly available for this solution.

Mouser Electronics Inc.

Mouser Electronics Inc. (United States) is an authorized global distributor of semiconductors and electronic components for design engineers. In 2014, Mouser Electronics initiated its Empowering Innovation Together™ campaign. The campaign was founded in partnership with Grant Imahara, a celebrity engineer, best known for his roles on Mythbusters and Battlebots. To promote campaign initiatives, Grant Imahara hosts a series of webisode videos that highlight innovative and creative engineers worldwide, with new products and technical expertise. One such series features Mouser Electronics' Project First Responders.



The recently complete Project First Responders was an initiative to develop a fleet of connected drones for public safety applications. Specifically, Project First Responders showcased the proof of concept for an autonomous, cloud-based drone platform for use in search and rescue or surveillance operations. The developed network of drones were equipped with GlobalARC communication. GlobalARC (United States) offers a full service unmanned aerial vehicle (UAV) deployment and management system with integrated airspace compliance and live video feed from drones. The service enables autonomous robot communication (ARC) or peer-to-peer communication between autonomous vehicles via cellular networks.

During testing, the developed drone network was deployed in a wildfire scenario. Mouser Electronics states the solution provided key data to first responders, such as wind speed and direction, fuel types around existing fire and the location of trapped civilians.

Project First Responders is sponsored by Intel Corporation (United States) and TE Connectivity Ltd. (Switzerland). However, additional information regarding funding, Technology Readiness Level (TRL) and deployment within the first responder community does not appear to be publicly available.



Combined Effects Assessment

Environmental Systems Research Institute (Esri) Inc.

Environmental Systems Research Institute (Esri) Inc. (United States) is an information technology and services company, specialized in geographic information system (GIS) and mapping software. The company's premier solution, that appears to dominate the GIS industry, is ArcGIS. ArcGIS provides contextual tools for mapping and spatial reasoning that enable users to explore data and share location-based insights. Specifically, ArcGIS capabilities include:

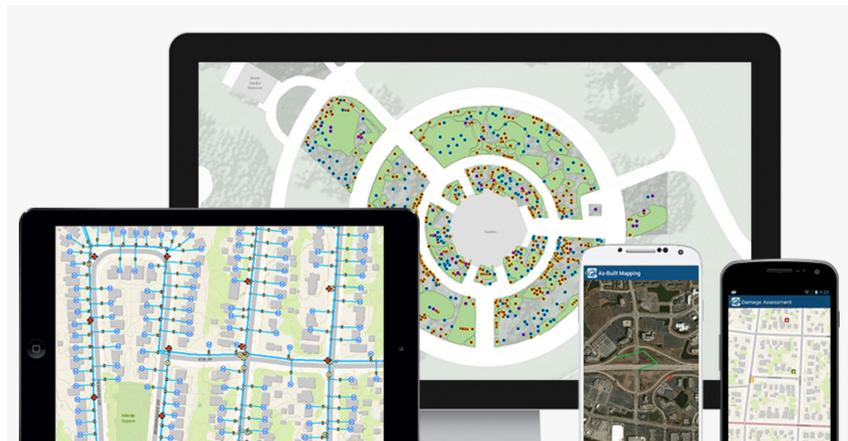
Spatial Analytics;

Mapping and Visualization;

3D and Real-Time GIS;

Imagery and Remote Sensing; and

Data Collection and Management.



ArcGIS Solutions

ArcGIS for Emergency Management includes multiple applications to map and model potential plans, determine their potential impacts, visualize critical vulnerabilities and plan for special events.

ArcGIS Capabilities

- | | |
|-----------------|---|
| PREDICT: | Overlay historical incidents with operational data to anticipate where future events are most likely to occur. |
| MODEL: | Run sophisticated what-if scenarios to understand how a chemical spill or sudden flood will affect a community and environment. |
| PREPARE: | Pre-position assets to the most vulnerable areas of a community to improve response when an incident occurs. |

Notably, ArcGIS for Emergency Management includes a CAMEO Tools application to import critical data for chemical emergencies. The Computer-Aided Management of Emergency Operations (CAMEO) software suite is used to prepare for and response to chemical emergencies. The solution was developed by the U.S. Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA). CAMEO Tools imports information from the CAMEO system into ArcGIS to support critical analysis and emergency management.

ArcGIS is available to multiple users on a subscription basis, ranging from \$450.00 to \$500 per year. Information regarding specific deployment within the first responder community does not appear to be publicly available for this solution.

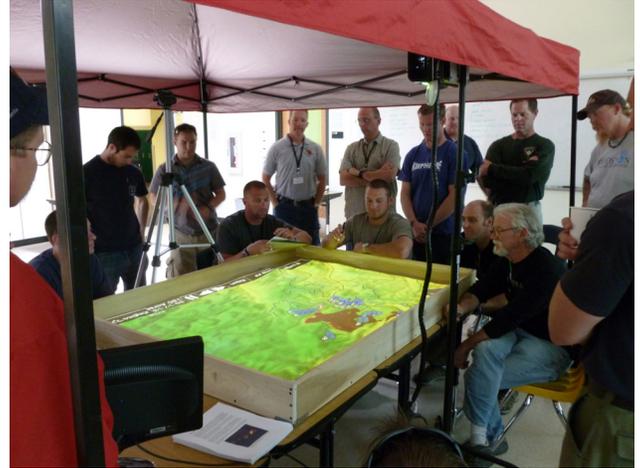
SimTable LLC

SimTable LLC (United States) provides agent-based modeling, distributed mobile computing and real-time Geographic Information System (GIS) platforms, as described below:

Agent-Based Modeling: SimTable develops agent-based modeling frameworks to explore and visualize complex scenarios for both physical and social incidents. Specifically, SimTable designs customized agent-based models based on local community data for wildfire, flood, evacuation, storms, airborne particulates, as well as biological and ecological behaviors.

Distributed Mobile Computing: SimTable enables mobile phone and tablet communication across disparate networks for real-time data sharing.

Real-Time Geographic Information System (GIS): SimTable enables the integration of GIS for use in simulation and planning applications.



SimTable, Training Exercise for Fire Services

In the U.S., Simtables are deployed in more than 85 city, state and federal agencies and academic institutions. In regards to pricing, each client is quoted individually. However, packages can range from \$35,000 to \$79,000 per client.

Appendix

The following section includes tables that list the potential first responder-specific solutions, both existing and in development, as identified by this assessment. It is likely that there are additional potential solutions in the market and therefore, this section should not be considered exhaustive.

Automated Red-Force Tracking

Existing Solutions	
Industry, Academia and Government	Solution
Airbox Systems Inc.	Mission Optimized Situational Awareness Information & Collaboration (MOSAIC)
Domo Tactical Communications (DTC) Ltd.	DTC Orion
International Business Machines Corporation (IBM)	Intelligent Operation Center for Emergency Management
ResponderX Inc.	ResponderX
Vidsys Inc.	Converged Security Information Management (CSIM)
Visual Semantics	Real-Time Intelligence

Developing (R&D) Solutions	
Industry, Academia and Government	Solution
Analog Devices	Sensor Fusion Approach to Precision Location and Tracking for First Responders
Commandwear Systems Inc.	CommandWear
Electronic Warfare Associates Inc.	Biometric Optical Surveillance System (BOSS)
National Aeronautics and Space Administration (NASA) Jet Propulsion Lab (JPL)	Precision Outdoor and Indoor Navigation and Tracking for Emergency Responders (POINTER)
University of Michigan (MconneX)	Weapons-Detecting Radars

Appendix

Remote Monitoring of Threats and Hazards

Existing Solutions	
Industry, Academia and Government	Solution
Covidence AS	Video Surveillance
FLIR® Systems Inc.	Aerial First Responder Kits (UAS)
	Aerial Thermal Imaging Kits
	KF6, Thermal Imaging Solution
HAAS Inc.	Intelligent Operation Center for Emergency Management
Lockheed Martin Corporation	ResponderX
SeSys Ltd.	Converged Security Information Management (CSIM)

Developing (R&D) Solutions	
Industry, Academia and Government	Solution
Aditya College of Engineering	Automatic Fire Alarm System based on Wireless Sensor
Mouser Electronics Inc.	Project First Responders
RAE Systems Inc.	Wirelessly-Connected Monitoring Equipment
Research Center on Software Technologies and Multimedia Systems for Sustainability (CITSEM) at Universidad Politécnica de Madrid (UPM)	Forest Fire Detection, Drones
The Environment and Sustainability Institute (ESI) DroneLab at the University of Exeter	Grassroots Remote Sensing Toolkit

Appendix

Combined Effects Assessment

Existing Solutions	
Industry, Academia, Government	Solution
Hexagon AB	Mobile Responder
	Public Safety Analytics
International Business Machines Corporation (IBM)	Intelligent Operation Center for Emergency Management
Lawrence Livermore National Laboratory	HotSpot
National Oceanic and Atmospheric Administration	Computer-Aided Management of Emergency Operations (CAMEO)
SimTable LLC	SimTable
U.S. Defense Threat Reduction Agency (DTRA)	Hazard Prediction and Assessment Capability (HPAC)

Developing (R&D) Solutions	
Industry, Academia, Government	Solution
Hendrix College	Detection of Atmospheric Infrasound with a Ring Laser Interferometer
Idaho National Laboratory	Robotics, 3D Mapping
Oak Ridge National Laboratory (ORNL)	Incident Management Preparedness and Coordination Toolkit (IMPACT)
TransVoyant LLC	Continuous Decision Intelligence™ (CDI™)

Market Figure Disclaimers

RTO: Automated Red-Force Tracking

Border Security System Market—the border security system market forecast period is 2016 to 2022 with a market figure available for 2022. The CAGR of 7.16 percent was used to estimate the revenue values for 2015 to 2020. The figure for 2015 was extrapolated outside of the forecast period of 2016 to 2022.

Facial Recognition Market—the facial recognition market forecast period is 2016 to 2021 with market figures available for 2016 and 2021. The CAGR of 15.3 percent was used to estimate the revenue values for 2015 to 2020. The figure for 2015 was extrapolated outside of the forecast period of 2016 to 2021.

Head-Mounted Display (HMD) Market—the HMD market forecast period is 2016 to 2020 with market figures available for 2015 and 2020. The CAGR of 48.9 percent (2015 to 2020) was used to estimate the revenue values for 2016 to 2019.

Military Electro-Optics/Infrared Systems Market—the military electro-optics/infrared systems market forecast period is 2016 to 2022 with market figures available for 2016 and 2022. The CAGR of 5.76 percent was used to estimate the revenue values for 2015 to 2020. The figure for 2015 was extrapolated outside of the forecast period of 2016 to 2022.

Physical Security Information Management (PSIM) Market—the PSIM market forecast period is 2016 to 2024 with market figures available for 2015 and 2024. The CAGR of 18.6 percent (2015 to 2024) was used to estimate the revenue values for 2016 to 2023.

Physical Security Market—the physical security market forecast period is 2016 to 2021 with market figures available for 2016 and 2021. The CAGR of 10.1 percent was used to estimate the revenue values for 2015 to 2020. The figure for 2015 was extrapolated outside of the forecast period 2016 to 2021.

Video Analytics Market—the video analytics market forecast period is 2017 to 2022 with market figures available for 2017 and 2022. The CAGR of 33.7 percent was used to estimate the revenue values for 2015 to 2020. The figures for 2015 and 2016 were extrapolated outside of the forecast period 2017 to 2022.

Video Surveillance Market—the video surveillance market forecast period is 2016 to 2022 with market figures available for 2016 and 2022. The CAGR of 16.4 percent was used to estimate the revenue values for 2015 to 2020. The figure for 2015 was extrapolated outside of the forecast period 2016 to 2022.

RTO: Combined Effects Assessment

3D Mapping & 3D Modeling Market—the 3D mapping & 3D modeling market forecast period is 2015 to 2020 with market figures available for 2015 and 2020. The CAGR of 55.0 percent was used to estimate the revenue values for 2016 to 2019.

Computer-Aided Design (CAD) Market—the CAD market forecast period is 2017 to 2021 with market figures available for 2016 and 2021. The CAGR of 7.0 percent (2016 to 2021) was used to estimate the revenue values for 2015 and 2017 to 2020. The figure for 2015 was extrapolated outside of the forecast period of 2016 to 2021.

Geospatial Analytics Market—the geospatial analytics market forecast period is 2016 to 2021 with market figures available for 2016 and 2021. The CAGR of 19.2 percent was used to estimate the revenue values for 2015 and 2017 to 2020. The figure for 2015 was extrapolated outside of the forecast period of 2016 to 2021.

Geospatial Imagery Analytics Market—the geospatial imagery analytics market forecast period is 2016 to 2021 with market figures available for 2016 and 2021. The CAGR of 29.8 percent was used to estimate the revenue values for 2015 and 2017 to 2020. The figure for 2015 was extrapolated outside of the forecast period of 2016 to 2021.

Governmental Geospatial Intelligence (GEOINT) Solutions Market—the GEOINT solutions market for defense and HLS market forecast period is 2015 to 2020 with market figures available for 2014 and 2016. The CAGR of 8.2 percent (2014 to 2026) was used to estimate the revenue values for 2015 and 2017 to 2020.

RTO: Remote Monitoring of Threats and Hazards

Remote Sensing Technologies Market—the remote sensing technologies market forecast period is 2016 to 2021 with market figures available for 2015, 2016 and 2021. The CAGR of 9.2 percent was used to estimate the revenue values for 2017 to 2020.

Security Robots Market—the security robots market forecast period is 2016 to 2022 with market figures available for 2015 and 2022. The CAGR of 8.4 percent (2015 to 2022) was used to estimate the revenue values for 2016 to 2020.

Unmanned Aerial Vehicle (UAV) Market—the UAV market was calculated as a percentage of the total security robots market, based on a publicly available market report.

Unmanned Ground Vehicle (UGV) Market—the UGV market was calculated as a percentage of the total security robots market, based on a publicly available market report.

Unmanned Underwater Vehicle (UAV) Market—the UUV market was calculated as a percentage of the total security robots market, based on a publicly available market report.

Video Analytics Market—the video analytics market forecast period is 2017 to 2022 with market figures available for 2017 and 2022. The CAGR of 33.7 percent was used to estimate the revenue values for 2015 to 2020. The figures for 2015 and 2016 were extrapolated outside of the forecast period 2017 to 2022.

Video Surveillance Market—the video surveillance market forecast period is 2016 to 2022 with market figures available for 2016 and 2022. The CAGR of 16.4 percent was used to estimate the revenue values for 2015 to 2020. The figure for 2015 was extrapolated outside of the forecast period 2016 to 2022.

Glossary

Compound Annual Growth Rate (CAGR)

The average annual growth rate when compounding is taken into account; its formula is as follows:

$CAGR = (FV/PV)^{(1/n)} - 1$, where FV is the future or ending value, PV is the present or starting value and n is the number of years between PV and FV.

First Responder

A person among those responsible for going immediately to the scene of an accident or emergency to provide assistance. The first responder market is to include law enforcement, fire services and emergency medical services.

Project Responder 4 (PR4)

The fourth in a series of studies that commenced in 2003 to focus on identifying capability needs, shortfalls and priorities for catastrophic incident response in the United States. Findings, including a set of enduring and emerging capability needs, technology objectives and state of science and technology to meet capability needs, are based on discussions with federal, state and local first responders as well as technical subject matter experts (SMEs).

Response Technology Objective (RTO)

A term used within Project Responder 4 (PR4) to translate a capability statement into an actionable, technology-centric objective.

RTO: Automated Red-Force Tracking

Automated Red-Force Tracking involves the automatic identification and surveillance of red forces. In the emergency response community, a red force may represent a specific threat or hazard, such as a person (e.g., active shooter, suspect) or an object (e.g., weapon, explosive device). In order to improve first responder safety, efficiency and effectiveness, responders need the ability to know the location and movement of red forces and their proximity to other response personnel, critical resources and infrastructure in real time. The ability to automatically identify and track red forces is likely to improve response situational awareness and decision-making.

RTO: Combined Effects Assessment

Combined Effects Assessment involves the integration of data and analysis to inform incident command of potential secondary or cascading effects during an incident. According to PR4, advances in technology for this RTO are primarily focused on the graphic display of threats and hazards for improved situational awareness. In order to improve first responder safety, efficiency and effectiveness, responders need the ability to “understand the potential for secondary effects, the conceivable impacts of all incident effects and how those effects combine to mitigate or exacerbate the situation”. The availability of this data and analysis is likely to help incident command prioritize threats and hazards on the incident scene, allocate appropriate personal protective equipment (PPE) and support other response decision-making needs.

RTO: Remote Monitoring of Threats and Hazards

This RTO focuses on the development of multiple platforms to support remote, ongoing surveillance and monitoring of threats and hazards on the incident scene and potentially affected areas. In order to improve first responder safety, efficiency and effectiveness, responders need the ability to continuously evaluate existing, emerging and potential threats and hazards in areas affected by an incident. Remote monitoring of threats and hazards can provide incident command with pertinent information throughout an incident, without exposing responders to additional risk.

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