



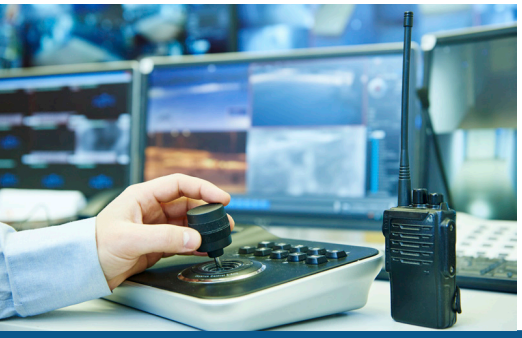

The International Forum to Advance First Responder Innovation

Capability Gap 5 “Deep Dive” Analysis

September 2019

International Forum to Advance
FIRST RESPONDER INNOVATION

Homeland Security

Science and Technology

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Analysis Conducted By:

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International Forum to Advance
FIRST RESPONDER INNOVATION

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This report accords with the International Forum to Advance First Responder Innovation's (IFAFRI) aim to inform and guide industry and provide unbiased information on first responder technologies. However, the views and conclusions contained herein are those of the authors and should not be interpreted as necessarily representing the official policies either expressed or implied by IFAFRI. While this material has been through an IFAFRI quality assurance process, IFAFRI does not accept responsibility for the content contained herein.

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Introduction

Background

The International Forum to Advance First Responder Innovation (IFAFRI) is an organization of government leaders from across the globe, focused on enhancing and expanding the development of affordable and innovative technology for first responders worldwide.

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 the global first responder markets, to inform and guide industry and academia about market opportunities and to incentivize these actors to develop and produce innovative technology solutions to first responder capability gaps; and
4. Providing information about relevant and available first responder technologies to the first responder community, while not endorsing any specific technology, product, or manufacturer.

In order to respond more safely, efficiently, and effectively to everyday and catastrophic incidents, first responders around the world need technologically advanced tools and equipment that are affordable and innovative. However, there is no centralized mechanism for first 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 for first responder use.

The purpose of this document is to characterize the markets and identify technology solutions relevant to IFAFRI's Capability Gap 5: *The ability to maintain interoperable communications with responders in any environmental conditions.* IFAFRI is publishing this information to identify potential areas of R&D where there may be opportunity for industry and academia to develop innovative solutions. Further, it is intended to provide industry and academia with key data points and analysis that will inform their decision on entering or expanding into related markets.

IFAFRI Membership

IFAFRI is currently composed of members from 13 different countries and the European Commission, including Australia, Canada, Finland, Germany, Israel, Japan, the Netherlands, New Zealand, Singapore, Spain, Sweden, the United Kingdom, and the United States. The figure below illustrates the global composition of IFAFRI.[1]

[1] Note, IFAFRI membership for France and Mexico is pending.

IFAFRI *Common Global Capability Gaps*

This document is focused on the fifth of ten Common Global Capability Gaps identified by IFAFRI. The list of current gaps includes:

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 into incident command operations
Capability Gap 5	The ability to maintain interoperable communications with responders in any environmental conditions
Capability Gap 6	The ability to obtain critical information remotely about the extent, perimeter, or interior of the incident
Capability Gap 7	The ability to conduct on-scene operations remotely without endangering responders
Capability Gap 8	The ability to monitor the physiological signs of emergency responders
Capability Gap 9	The ability to create actionable intelligence based on data and information from multiple sources
Capability Gap 10	The ability to provide appropriate and advanced personal protective equipment

The first four capability gaps on this list were adopted by IFAFRI in 2016. To arrive at this initial set of capability gaps, the IFAFRI membership conducted analyses of first responder capability gaps in their countries. Some of the IFAFRI participants used the methodology presented in the U.S. Department of Homeland Security (DHS) Science and Technology Directorate's (S&T) Project Responder 4 (PR4) report, as a guide in their analyses. Project Responder 4 is the fourth in a series of studies that focuses 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 first responder capability gaps from IFAFRI 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 first four *Common Global Capability Gaps* in 2016.

Between 2016 and 2018, IFAFRI's Capability Gaps Committee further refined and formalized its process for adding capability gaps to the list. In 2018, individual countries solicited national capability gaps from first responders in their countries and submitted these to the Capability Gaps

Committee. In total, 78 national capability gaps were received from IFAFRI countries. These gaps were then synthesized to eliminate redundancy and provide overarching gaps that aggregate multiple similar gaps when needed, which resulted in a set of 45 gaps. Three of the gaps corresponded to the initial four *Common Global Capability Gaps*, leaving 42 gaps for prioritization. The prioritization process resulted in the addition of the Capability Gaps 5-10 to the *Common Global Capability Gaps* list.

To date, similar "deep dive" analyses have been conducted for each of IFAFRI's *Common Global Capability Gaps*. Each of these documents has been published to the IFAFRI Web site, and is available for download. It is important to note that continued market research will be required to ensure awareness of current efforts and account for new actors in these capability gap areas.

Capability Gap 5

The ability to maintain interoperable communications with responders in any environmental conditions

This capability gap is described as follows: "[s]ome environments are conducive to sending and receiving communications, however, others pose significant challenges. For example, communications can be difficult inside buildings, tunnels or underground spaces. Communications may also be degraded if equipment and infrastructure have been damaged by the incident or overwhelmed by call volume. Regardless of the operating environment, emergency responders must be able to seamlessly send or receive orders and information, provide tactical updates, request help and receive warnings about hazardous or changing conditions. Therefore, the need to ensure verbal and digital communication through all physical and electronic environments is essential."[2]

While there is a high level of public and private funding for advancing technology for interoperable communications, emergency responders in IFAFRI nations continue to face challenges. Many factors contribute to this lack of progress, such as country size and degree of centralized response functions, but the main obstacle is a lack of a comprehensive, affordable solution.

While there are a number of solutions in use by responders, these solutions still have shortcomings when considering the state of technology today for communications. Many responders are currently using push-to-talk land mobile radio (LMR) devices, many of which are limited to transmitting and receiving voice communications and only at certain frequencies. Commercial smartphones can provide additional access to video, text and data, but most are not ruggedized to withstand responder-type environments (i.e. extreme temperature, inclement weather or fire). Additionally, networks are often overwhelmed by the volume of message and data traffic during incident operations causing delay or disturbance for communications.

During the Project Responder 4 study, responders discussed the need for devices that allow clear, successful and secure bi-directional communications. These devices also must provide data needed for situational awareness and conducting incident operations. To address this capability gap, the solution may involve a system of devices, network software and infrastructure equipment that can provide interoperable communications during incident response operations.

This study uses the list of existing first responder gear in the SOO document for Gap 5. This list encompasses the current methods of communication available for first responders. Each method was considered a "technology type" with a corresponding, relevant market. There are 12 technology types for this capability gap:

- Push-to-talk land mobile radio (LMR) systems;
- Smart cellular phones;
- Satellite phones;
- Tablets and other mobile devices (vehicle-mounted and man-portable);
- Radio frequency (RF)-based communications (e.g., very high frequency (VHF), ultra high frequency (UHF)); includes LMR and LTE
- Television signal datacasting;
- Deployable/mobile cell sites (e.g., cell-on-wheels (COWs), cell-on-light-trucks (COLTs));
- Mesh networks;
- Interoperability gateway devices;

- Repeater networks;
- Dedicated public safety broadband networks; and
- Face-to-face communications.

Methodology

This section provides a brief overview of the processes used to obtain and assess the findings presented in this report.

Research Methods

The data presented in this report was gathered from publicly-available information sources, including market reports and company web sites. The study team conducted a global scan of existing and in-development technology solutions with the aim of identifying and assessing the primary market for technologies related to this gap. However, the data presented in this report should not be considered exhaustive. This document does not contain any proprietary data, nor does it endorse or advocate for any of the technology solutions described herein. Further, the study team did not validate any of the manufacturers' claims found in their product descriptions.

Market Quantification

All relevant markets are quantified utilizing overall global revenue figures, unless otherwise noted, for the forecast period 2019 to 2023. 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. Data for the primary market 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 presented in the following table.[3] Market factors are assessed by examining barriers to entry and market opportunities, as determined through secondary research.

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	Often 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

Competitive Landscape

This study 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. Responder-specific solutions were identified using a more tailored search. This search included examining the product offerings of key players listed in publicly available market reports to determine their relevance to the capability gap and conducting targeted keyword searches in order to identify solutions from additional companies.

Presentation

This report includes a “Market Overview” that summarizes the overall market and provides the market quantification data for each segment. The report also presents the key findings for each market segment in the “Market Highlights” section, with a one-page summary for each segment. In addition, the “Competitive Landscape” section further categorizes the total number of firms participating in the market by segment and highlights responder-specific solutions currently available or in-development.

Synopsis Overview

IFAFRI has been conducting an ongoing global capability gaps market analysis in order to meet its objectives characterizing global first responder markets to inform and guide industry and academia. The key objective of this study is to characterize the markets relevant to Capability Gap 5. This synopsis highlights key data and analysis identified as part of this study.

Market Definitions and Segmentation

This study uses the list of existing first responder gear in the *Statement of Objectives 5* (SOO 5) document to further define and segment the relevant markets for Capability Gap 5. For the 12 types of gear given for this capability gap, it was determined that the *Global Critical Communications* market best represents these technology types, and therefore only one primary market was selected. This primary market is used for market definition, segmentation, quantification and further assessment.

Market Quantification

The primary market is quantified utilizing overall revenue figures derived from global markets. Growth is measured using an estimated CAGR. The Global Critical Communications Market is estimated to be worth more than **$11 billion USD in 2016** and is projected to grow at a Compound Annual Growth Rate (CAGR) of 8.0% through 2023. This equates to a market value of more than $20 billion USD in 2023.

Competitive Landscape

Based upon third-party market research reports, there are seven key players and innovators identified within the global, primary market for Capability Gap 5. These key global players and innovators appear to offer solutions that address, in part, the ability to maintain interoperable communications with responders in any environmental conditions. However, none of the solutions identified within this assessment appear to meet all of first responders' target objectives for this gap.

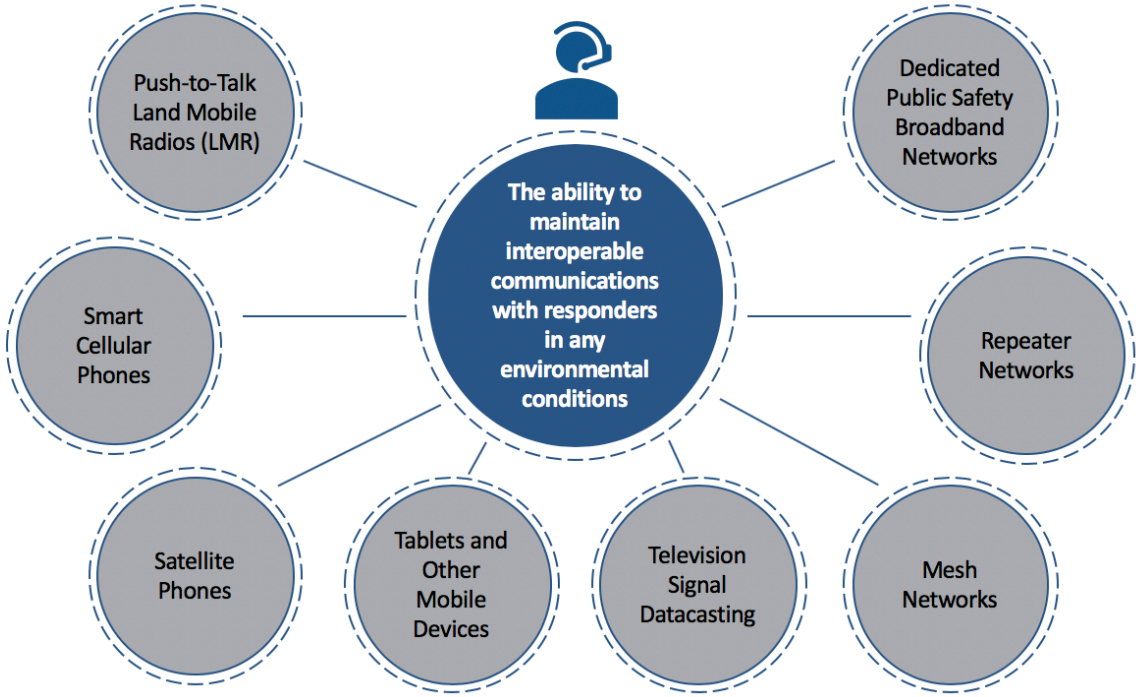
Summary

In summary, the primary market identified to represent this capability gap is relatively large and growing. This growth in and of itself presents a great opportunity for new solutions to enter the market. When examining 158 existing solutions and seven developing solutions in this assessment, none fulfilled all of the objectives for this gap. Therefore, any solutions that address these target objectives and allow continuous, interoperable communication will likely have the greatest commercial potential.

Market Overview

Capability Gap 5 is **the ability to maintain interoperable communications with responders in any environmental conditions**. This gap is largely focused on responders being able to constantly communicate with each other and with incident command regardless of environment.

Market Segmentation



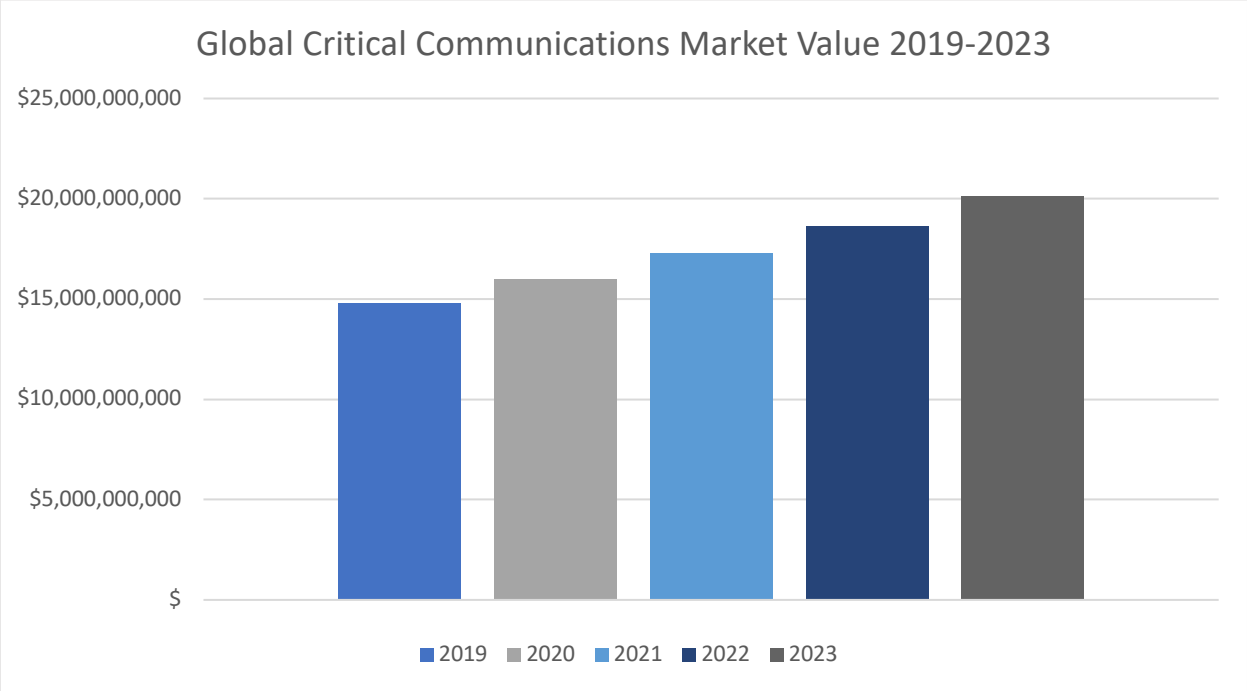
The ***Global Critical Communications Market*** was used to quantify market figures for this capability need. This market includes command and control systems, infrastructure equipment, and end-user devices.

Capability Gap 5 – The ability to maintain interoperable communications with responders in any environmental conditions

First responders need continuous communications with each other and with incident command during an incident. When responders work in areas with limited access to different networks, they face significant challenges to do their jobs more safely and effectively. Regardless of the operating environment, responders need continuous communication with each other and incident commanders to send or receive orders and information, provide tactical updates, request help and receive warnings about hazardous or changing conditions. Having this capability will likely improve responders' abilities to help during incident response.

A myriad of interoperable communications solutions currently exist within the market. However, not one of these solutions appears to meet all of responders' target objectives, which include continuous, interoperable communication with all parties involved and in any environmental conditions.

The Global Critical Communications Market is used to define, quantify and assess the various types of solutions available. This market was worth more than $11 billion USD in 2016 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 8.0% through 2023. This equates to a market value of more than $20 billion USD in 2023.



Market Figures

The following table presents the estimated revenue figures for the various sub-markets identified for the Capability Gap 5 market. The colored row represents the primary market used to quantify this gap in this study.

Disclaimer

Note, all figures have been rounded to the nearest hundred thousand. The market forecast period examined is 2019 to 2023. When a market value was not available, it was estimated using the corresponding CAGR given over the forecast period to represent growth or decline. For consistency, data that fell outside of the forecast period has been extrapolated, as denoted by an asterisk (*). A more detailed explanation of how the extrapolated figures were estimated can be found in Appendix C of this report.

Interoperable Communications in Any Environment

	Revenue by Year (in $1,000,000 USD)					CAGR
	2019	2020	2021	2022	2023	
Global Critical Communication Market[4]	$14,803.3	$15,983.6	$17,258.1	$18,634.2	$20,120.0	8.0%
Global Land Mobile Radio (LMR) Market[5]	$8,734.6	$9,684.4	$10,737.4	$11,904.9	$13,199.5	10.9%
Global Ultra-Secure Smartphone Market[6]	$1,489.0	$1,818.1	$2,219.9	$2,710.5	$3,309.5	22.1%
Global Mobile Satellite Services Market[7]	$4,543.5	$4,877.7	$5,236.4	$5,621.5	$6,034.9	7.4%
Global Rugged Handheld Devices Market[8]	$3,401.9	$3,575.2	$3,757.4	$3,948.8	$4,150.0	5.1%
Global Broadcast Equipment Market[9]	$4,777.4	$5,019.1	$5,273.0	$5,539.8	$5,820.0	5.1%
Global Wireless Mesh Network Market[10]	$5,830.9	$6,515.4	$7,280.3	$8,134.9	$9,090.0	11.7%

Global Signal Repeater Market[11]	$483.0	$632.9	$829.4	$1,086.9	$1,424.2	31.0%
Global Public Safety LTE & Mobile Broadband Market[12]	$1,411.6*	$1,877.4*	$2,496.9*	$3,320.9*	$4,416.9*	33.0%
Global Push-To-Talk Over Cellular Market[13]	$3,219.8	$3,489.5	$3,781.8	$4,098.5	$4,441.8	8.4%

Market Highlights

The ability to maintain interoperable communications with responders in any environmental conditions describes the need for emergency responders to seamlessly send or receive orders and information, provide tactical updates, request help and receive warnings about hazardous or changing conditions in all of the challenging environments they work in.

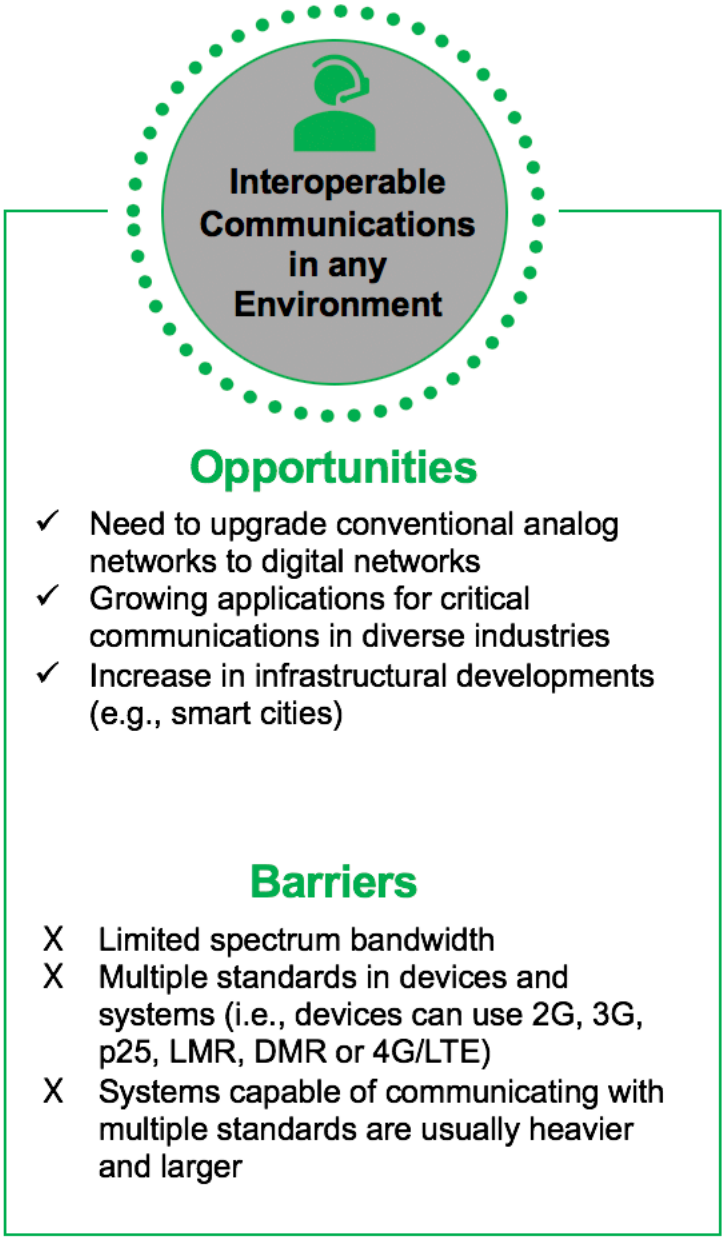
Interoperable Communications in any Environment

Current Capability: Many responders are currently using push-to-talk land mobile radio (LMR) devices, many of which are limited to transmitting and receiving voice communications and only at certain frequencies. Commercial smartphones can provide additional access to video, text and data, but most are not ruggedized to withstand responder-type environments. Additionally, networks are often overwhelmed by the volume of message and data traffic during incident operations causing delay or disturbance for communications.

Market Quantification	**Market Size (2019):**	**$14,803.3 million**	**Compound Annual Growth Rate (2016-2023):**	**8.0%**
Competitive Landscape	**Number of Firms:**	**7**	**Number of Responder-Specific Solutions:**	**37**
Market Phase	**GROWTH**			

Market Factors

The figure below summarizes the market factors associated with the collection, integration, and validation of data from multiple sources[2].



[2] https://www.marketsandmarkets.com/Market-Reports/critical-communication-market-95862445.html

Competitive Landscape

A total of seven firms were recognized as key global market players within the Global First Responder Interoperable Communications Market, including:

- AT&T (United States)
- Firetide (United States)
- Harris Corporation (Sweden)
- Iridium Communications (United States)
- Motorola Solutions (United States)
- Sierra Wireless (Canada)
- Simoco Wireless Solutions (United Kingdom)

Within this study there are a total of 158 existing solutions and seven research and development (R&D) initiatives with relevance to Capability Gap 5 identified. This landscape is non-exhaustive, as the number of solutions is vast and ever-changing at a rapid pace.

Among the existing and developing solutions identified, 37 solutions (24 percent) appear to have first responder applications and two solutions (29 percent) appear to be in development for first responder use. These numbers may indicate that industry is not as aware as it could be that a first responder need exists within this technology space. However, when examining how existing solutions meet responders' needs related to this capability gap, it does not appear that any existing solution meets all of responders' target objectives. These objectives include:

1. Interoperable communication of voice, audio, video and data among authorized responders and command, regardless of agency, service, and/or jurisdiction;
2. Communication through all environments, including inside buildings, underground, and through physical barriers; and
3. Disaster-resilient or rapidly-deployable communications systems to support incident operations regardless of location or incident effects.

It appears that the greatest gap exists for systems capable of communicating through all environments. Most of the existing solutions are either a radio or smartphone system, which have limitations for communicating when a network is not available.

While the greatest number of existing solutions (113) identified in this assessment appear to have commercial

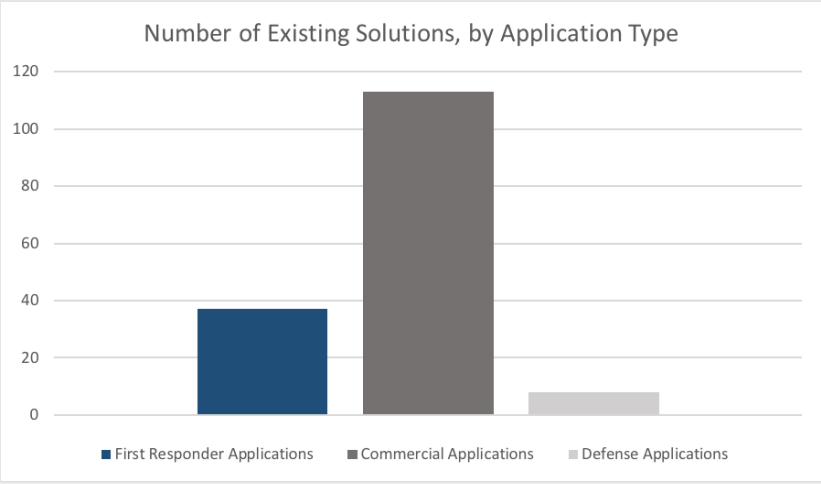


Figure 1: Number of Existing Solutions, by Application Type

applications, 37 solutions have first responder applications and eight have defense applications.

There are also a total of 7 R&D initiatives related to Capability Gap 5 identified in this assessment. Among the developing solutions identified, industry is involved in the development of two solutions, academia is not involved, and government is involved in the development of five solutions. Two developing solutions are focused on first responder applications, one is focused on commercial applications and four are focused on defense applications.

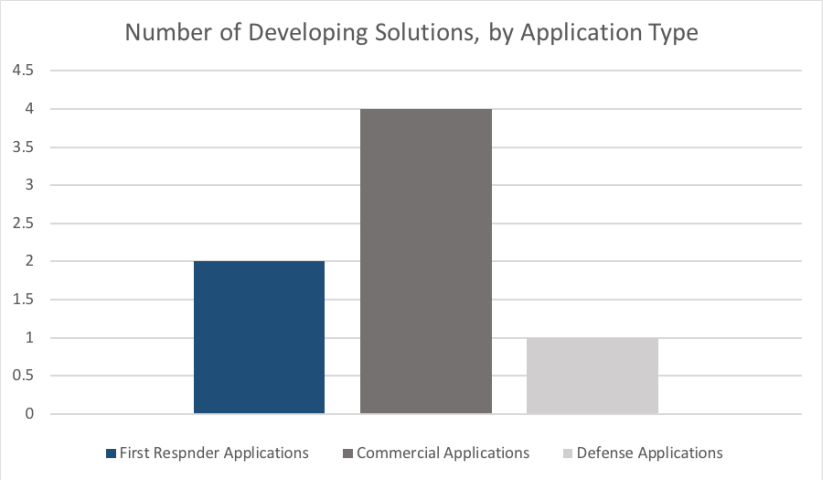


Figure 2: Number of Developing Solutions, by Application Type

Based upon the data presented, less than one quarter of all existing and developing solutions appear to be targeting first responder applications. Therefore, industry is likely not aware that a first responder need exists within this technology space.

Looking more closely at these solutions, the ability of any identified existing or in development solutions would not meet all the needs of responders' target objectives cited previously. More specifically, the ability for responders to communicate through any environment is particularly underserved. This presents any opportunity for industry to develop solutions that can fit all of the target objectives, with a special focus on object two.

For questions or comments about the information presented in this assessment, please contact IFAFRI at info@internationalresponderforum.org.

First Responder-Specific Technology Solutions

The following section presents a selection of the first responder-specific technology solutions that align with responder requirements for this gap. The responder requirements are identified in the IFAFRI-developed Capability Gap 5 Statement of Objectives (SOO) document. None of the solutions identified during this study meet all of the requirements detailed in the SOO document. However, those presented below offer increased levels of integration or newer features than what is generally used by response agencies currently. There are a large number of potential solutions that exist or are in-development and therefore this section should not be considered exhaustive. Further, additional concepts exist in academic literature but these are not included in this study. A complete list of responder-specific technology solutions identified during this study can be found in Appendix B of this report.

The data and information provided in this section is publicly available from manufacturers' web sites. The study team did not validate product claims made by the manufacturers.

Applications

MENTURA Group

MENTURA GROUP (Finland) is a provider of advanced and intelligent software solutions for Critical Operations. Mentura was founded in 2000 and produces products for professional organizations, authorities and first responders to manage their operations and security using Critical Communications networks.[14]

MENTURA offers **COREMOTE Mobile** an application for smartphones, satellite phones, tablets and computers that offers professional communication between devices. It provides users with collaboration and tactical capabilities needed in field operations. Some features this application offers include:[15]

- Real-time situational awareness for the office and control room users,
- Real-time location reporting of field units,
- Unit availability status,
- GPS status with a map view,
- Speed of mobile users,
- A map view of the entire operational field, including all users, user status and ongoing tasks,
- Task management from the field, and
- Information sharing capabilities (messages, pictures, video).

Figure 3: COREMOTE Mobile

Simoco Wireless Solutions

Simoco Wireless Solutions (United Kingdom) provides complete wireless solutions from initial consultancy, system design and project delivery to ongoing operational support. These systems allow organizations to transmit mission-critical voice and data securely. Simoco networks keep devices connected across borders and on the move, in some of the most challenging environments.[16]

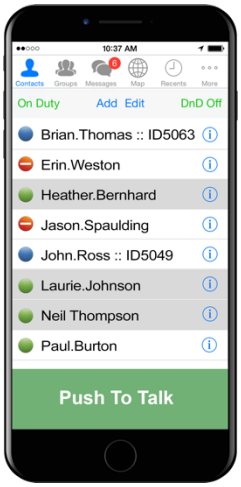


Figure 4: Simoco Push

Simoco Wireless Solutions offers **Simoco Push** a land mobile radio (LMR) and push-to-talk (PTT) over cellular application that uses the internet for communication. Communication types include voice, group text, images, and the application also tracks user's location. Users can communicate via cellular, Wi-Fi, and digital mobile radio (DMR) networks. The application will still work with DMR networks even if not integrated by using an AIS Gateway with the Push server. This solution works with Android and iOS systems and is designed for management, emergency services, operational, security, logistics and administrative personnel. The application boasts potential cost savings for organizations by eliminating the need to purchase LMRs for every team member and instead allowing those members to use their smartphones.[17]

Cellphones

Sonim Technologies

Sonim Technologies (United States) is a provider of ultra-rugged mobility solutions designed workers physically engaged mission-critical roles in potentially adverse work environments. Sonim specializes in workforce-critical communication and connectivity tools for industrial enterprises and public sector agencies such as construction, energy and utility, hospitality, logistics, manufacturing, public safety and transportation. Sonim solutions fall into three main categories: ultra-rugged mobile devices; industrial-grade accessories; and cloud-based software and application services. Somin offers its solutions through the world's leading mobile carriers.[18]

Sonim Technologies offers **Sonim XP8** a rugged smartphone designed to work regardless of situation or environment. The XP8 is Band 14/FirstNet enabled along with standard LTE, cellular and Wi-Fi bands. Users have full communication capabilities, including SMS, MMS and video calling, and the device is GPS, GLONASS and BeiDou capable. The device is designed with industry-leading rugged performance standards, military 810G certified and has a 5" puncture-resistant and glove compatible touch screen. One the sides of the device are one touch PTT and SOS buttons for quick access to help and volume buttons to make speaker communication easier. Sonim's proprietary device-provisioning and management application, SCOUT, can be integrated to make the XP8 an Enterprise IT solution as well.[19]

Figure 5: Sonim XP8

Motorola Solutions

Motorola Solutions (United States) is focused on mission-critical communications. Motorola Solutions deliver technology platforms in communications, command center software, video security solutions, and managed and support services. Enterprise and public safety customers rely on the communications ability these platforms provide.[20]

Motorola Solutions offers the **LEX L11 Mission Critical LTE Device** a rugged smartphone designed for first responders. The phone is designed with first responders in mind with dedicated PTT and SOS buttons, a dedicated talk group switch and two programmable buttons for a customized solution. The LEX also features noise-cancelling technology and front facing speakers for better audio quality. With MIL-STD-810G and waterproof capabilities, the LEX is able to work in harsh environments. The device uses an end-to-end encryption and a mobile virtual private network (MVPN) for secure usage and data transmission.[21]

Figure 6: Motorola LEX L11

Interoperable Gateway Device

C-AT® Communications

C-AT® Communications (United States) designs and manufactures communications equipment that addresses technical and physical requirements faced by civilian and military agencies. The company's radio interoperability products bridge dissimilar equipment, bands and frequencies, allowing homeland security, public safety, and military first-responders to have immediate, on-scene tactical communications. C-AT®'s intercom and wireless radio systems are designed for extreme environments such as hazardous, biological and nuclear cleanup, and for personnel operating in armored vehicles, mobile command posts, crewed boats, and aircraft. C-AT® products are designed for quick and simple deployment, without requiring specialized training or excessive maintenance.[22]

C-AT® Communications offers the **ICRI Interoperability Communications System** designed for mutual aid operations and incident response communications device connection for municipal, state and federal agencies. The Bridge can connect radios, land-line and satellite phones, devices running on the 700Mhz, 800Mhz, UHF, VHF and VoIP frequencies, TETRA devices and cellphones. The ICRI is available in a wide range of operational configurations for customization.[23]

Figure 7: ICRI

L3Harris

L3Harris (United States) is an aerospace and defense technology company that delivers end-to-end solutions that meet customers' mission-critical needs. The company provides advanced defense and commercial technologies across air, land, sea, space and cyber domains. L3Harris produces wireless equipment, tactical radios, electronic systems, night vision equipment and both terrestrial and spaceborne antennas for use in the government, defense and commercial sectors.[24]

L3Harris offers the **Harris Interoperability Gateway** a multi-channel analog voice interface designed for OpenSky, NetworkFirst and Project 25 (Phase 1 and 2) packet-switched digital networks. The gateway supports up to 12 audio channels for analog equipment, such as consoles and analog voice base stations, to the internet protocol (IP) digital network. Each gateway receives and transmits packetized digital voice over an ethernet interface. When used to provide interoperability with other communications systems, network users are automatically connected to legacy system users by selecting them as designated voice groups. For secure transmissions, the digitized voice within the digital network is coded using advanced multiband excitation (AMBE) for OpenSky systems or improved multiband excitation (IMBE).[25]

Figure 8: Harris Interoperability Gateway

Network: Dedicated

At&T Communications

AT&T Communications (United States) is a telecoms company, the second largest provider of mobile services, and the largest provider of fixed telephone services in the US. The company provides pay-TV services through DirecTV. AT&T also uses its network to offer peripheral services, including disaster recovery.[26]

AT&T offers the **First Responder Network Authority (FirstNet),** established by the U.S. Congress in 2012, a dedicated network designed for first responder-related users and communications. To continue to stay up to date with the needs of first responders, representatives from FirstNet continuously consult with federal, state, local and tribal public safety agencies across the countries.[27] Along with the network, AT&T designed a suite of public-safety driven solutions for first responders. Current solutions include:

- Tools to help improve team communication, workflow, and situational awareness,
- Device security and mobile device management to manage and help protect mobile devices,
- Highly secure connections when connecting to critical public safety applications,
- Cloud services to help optimize agency computing, storage, and network resources, and
- Highly reliable satellite solutions (including satellite phones, transportable broadband solutions, and full network recovery capabilities).

AT&T also plans to add a number of future products to further help responder's efforts. These products may comprise:[28]

- Situational awareness and detection (including geo-location, enhanced location services, and mobile sensors),
- Video surveillance (including body worn cameras, image recognition, and drones),
- Mobile CAD and integrated CAD solutions,
- GIS mapping and location,
- Records management system,
- Cybersecurity and fraud detection,
- Internet of Things and Smart City initiatives, mass notifications,
- Telemetry/telemedicine,
- Mission-critical voice and video, and
- Multi-agency communication and collaboration (dynamic chat groups, text, voice, images, video) for emergency operations.

BlackBerry Limited

BlackBerry Limited (Canada) specializes in enterprise software and the Internet of things. The company was originally known as Research In Motion (RIM). Blackberry is best known to the general public as the former developer of the BlackBerry brand of smartphones, and tablets.[29]

BlackBerry offers the **BlackBerry AtHoc,** a FedRAMP-authorized emergency mass communication solution, it is a crisis communication solution for a variety of needs. According to BlackBerry, AtHoc protect 70% of U.S. Federal Government employees and helps meet specific government requirements. AtHoc helps unify crisis communications to connect people, devices and external organization during emergencies. Through this network, users are able to track their location, send mass emergency notifications, communicate with all team members and gather critical information from all people involved.[30]

Network: Mesh

Firetide

Firetide Inc. (United States) is a provider of wireless mesh network technology. The company designs and sells hardware and software for network management and wireless infrastructure. Firetide's products have been used in over 2000 installations in 40 countries.[31]

Figure 9: HotPort 7000

Firetide offers the **HotPort 7000 Wireless Mesh Nodes** a multipoint to multipoint, ad hoc wireless mesh network for first responder uses. The deployable nature of the HotPort allows rapid deployment of large-scale networks. This mesh technology provides users with bandwidth needed to expand the reach of their existing networks while adding a variety of fixed and mobile applications. Some applications include:[32]

- City-wide video surveillance,
- Traffic management and intelligent transportation systems,
- Wi-Fi access for mobile city workers, and
- Wireless broadband for underserved areas.

Network: Mobile Cell

Sierra Wireless

Sierra Wireless (Canada) is a wireless communications equipment designer and manufacturer. Sierra Wireless sells 2G, 3G and 4G mobile broadband wireless modems, routers and gateways as well as software, tools, and services.[33]

Sierra Wireless offers the **AirLink MG90** an LTE-advanced vehicle-mounted network platform built for mission-critical applications in public safety, transit and field services. The AirLink has multi-network connectivity capabilities for LTE-advanced radios, LMR and satellite systems. The system is also FirstNet ready, supporting the 700MHz band 14. Through pre-input user settings, the MG90 selects the best available network and can switch between WAN connections for uninterrupted communications.[34]

Figure 10:AirLink MG90

Network: Repeater

Cel-Fi by Nextivity

Nextivity (United States) developed a family of baseband processors to power its flagship multi-core Cel-Fi® Smart Signal Booster®. Nextivity's proprietary and custom-designed third-generation signal processor is the driving force behind its Cel-Fi PRO and Cel-Fi DUO all-digital Smart Signal Boosters designed for use on 3G, 4G and LTE (including VoLTE) networks.[35]

Cel-Fi offers the **Cel-Fi GO RED** a smart signal booster that repeats cellular coverage in buildings for first responder communications. Cel-Fi works both as a single solution or alongside existing equipment to provide a wider coverage area for the FirstNet network. Cel-Fi works by placing various components and antennas inside and outside of buildings to provide coverage. Cel-Fi is also a member of the Safer Buildings Coalition, an independent organization focused on advancing policies, ideas and technologies that ensure communications for public safety personnel inside buildings.[36]

Figure 11: Nextivity Cel-Fi GO RED

SureCall

SureCall (United States) specializes in the design and manufacture of cell phone signal boosters, amplifiers and accessories. The company's cellular signal boosters have been proven to improve cellular reception for businesses, homes, vehicles and watercraft. SureCall's flagship product line of FCC-approved cell phone signal boosters enhance the range and reception of almost any cellular transmission, including voice or 4G data.[37]

Figure 12: SureCall Responder 80 dB

SureCall offers the **Responder 80 dB** a public safety band amplifier for FirstNet signals indoors. Equipped with a dual-band booster with a maximum gain of 80 dB on the public safety frequency bands, the Responder supports 700 MHz and 800 MHz. The Responder comes equipped with 7-pin alarming capabilities, UPS and an ethernet port for remote monitoring. The Responder also features an energy-saving option to allow bands to remain dormant when not in use.[38]

Radio

Motorola Solutions Inc.

Motorola Solutions, Inc. (United States) is a leader in global mission-critical communications. It offers technology platforms in communications, command center software, services and video security and analytics. The company focuses on public safety and security as its technologies are used in an effort to make cities safer.[39]

Figure 13: APX 8000HXE

Motorola Solutions offers the **APX 8000HXE** one of over a dozen models of first-responder designed radios for field communications. More specifically, the 8000HXE is designed for hazardous conditions, certified to Div1 HazLoc standards for working in environments with unknown chemicals and gases. The Radio transmits and receives on all commonly used frequencies to allow communications with different agencies using the same radio. The APX also features:[40]

- A water-tight design,
- A drop-resistant battery latch,
- Pressure-tested tempered glass,
- Shock-absorbing aluminum alloy endoskeleton, and
- An adaptive audio engine for loud and clear audio in any environment.

L3Harris

L3Harris (United States) is an aerospace and defense technology company that delivers end-to-end solutions that meet customers' mission-critical needs. The company provides advanced defense and commercial technologies across air, land, sea, space and cyber domains. L3Harris produces wireless equipment, tactical radios, electronic systems, night vision equipment and both terrestrial and spaceborne antennas for use in the government, defense and commercial sectors.[41]

Figure 14: Harris XL-200P

L3Harris offers the **XL-200P** a ruggedized land mobile radio (LMR) with LTE capabilities. The XL-200P operates on multiple bands, including 700 MHz, 800 MHz, very high frequency and ultra-high frequency bands. With LTE capabilities, the XL-200 can transmit and receive voice and data via Wi-Fi or cellular networks, and the user can turn the radio into a Wi-Fi hotspot for other Wi-Fi capable devices. The device is also Band 14 ready and has P25 interoperability, allowing for communication with other LMR systems. Built to several industry specifications, the XL-200 can also withstand harsh environments, such as flames or contaminated fluids.[42]

Satellite Phones

Iridium Communications Inc.

Iridium Communications Inc. (United States) offers mobile satellite communications services. The company operates satellites in a low-earth orbit and provides global coverage. Parent company Iridium Holdings offers voice and data communications services to governments, businesses, non-governmental organizations, and consumers.[43]

Iridium Communications offers the **Iridium Extreme PTT** a ruggedized satellite phone designed for emergency responders. With PTT features, the Extreme is designed for team usage by allowing communication with the push of a button. The device works globally and has a built-in GPS sensor to track the users location in real time. The Extreme is also designed to withstand harsh conditions, such as drops, submersion, dust and extreme temperatures. Along with the PTT communications, users can make and receive voice calls and SMS messages and send an SOS signal with a dedicated man down button. Users must purchase a separate calling plan to use the iridium network.[44]

Appendix A

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

All-Source Collection, Integration and Validation of Data		
Existing Solutions		
Solution	**Solution Provider(s)**	**Country**
AirLink MG90 High Performance Multi-Network Vehicle Router	Sierra Wireless	Canada
AirLink MP70: LTE Router	Sierra Wireless	Canada
APX 1000 P25 Radio	Motorola Solutions	United States
APX 6000 P25 Radio	Motorola Solutions	United States
APX 6000XE P25 Radio	Motorola Solutions	United States
APX 8000 All-Band P25 Radio	Motorola Solutions	United States
APX 8000H All-Band P25 Radio	Motorola Solutions	United States
APX 8000HXE All-Band P25 Radio	Motorola Solutions	United States
APX 8000XE All-Band P25 Radio	Motorola Solutions	United States
BBM Enterprise	BlackBerry	Canada
BlackBerry AtHoc	BlackBerry	Canada
Cel-Fi GO RED	Nextivity	United States
CG-X4	Clear-Com	United States
COREMOTE Mobile	Mentura Group	Finland
FirstNet	AT&T	United States
Hot Shot Waterproof Speaker Mic	codeRED	United States
HotPort 7000 Wireless Mesh Nodes	FireTide	United States
HT Series Firefighter	Radio Holland	Netherlands
ICRI Radio Interoperability Gateway/Bridge	C-AT Communications	United States
Interoperability Gateway	Harris Corporation	United States
Iridium Extreme PTT	Iridium	United States
Kyway Terminal	Kymeta Corporation	United States
LEX L11 Mission Critical LTE Device	Motorola Solutions	United States
Mesh Camera	Motorola Solutions	United States

MeshTrack	Motorola Solutions	United States
Mutualink EDGE@Team	Mutualink	United States
Responder	SureCall	United States
Sailor 3965 UHF Fire Fighter	Radio Holland	Netherlands
Savox C-C550 Remote Speaker Microphone	Savox	Finland
Savox XG PTT-1	Savox	Finland
Signal 21 Speaker Microphone	codeRED	United States
Simoco Push	Simoco Wireless Solutions	United Kingdom
Sonim XP5s	Sonim Technologies	United States
Sonim XP8	Sonim Technologies	United States
Tactical Collaboration Node	Mutualink	United States
Tait Team PTT	Tait Communications	United States
ViTrust Public Safety Solution	Nokia	United States
XL-200P Multiband Portable Radio	Harris Corporation	United States
Zinwave Distributed Antenna System	Zinwave	United States

In-Development Solutions		
Solution	**Solution Developer(s)**	**Country**
Public Safety Communications Research (PSCR) Program	National Institute of Standards and Technology	United States
AT&T COW	AT&T	United States

Appendix B

The following section includes notes (where applicable) regarding extrapolation methods for some of the revenue figures presented in the "Market Figures" section of this report. In addition, there are instances when the CAGR cited by a third-party data source does not equate to the market figures presented. In these cases, the CAGR as calculated based upon the market figures presented is utilized.

- Global Public Safety LTE & Mobile Broadband Market
  A market figure was available for 2016. A CAGR of 33% was used to estimate the revenue values for 2019 through 2023. Market figures were rounded to the nearest hundred million.

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	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.
Project Responder 4	The fourth in a series of studies that focuses 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.

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