





The International Forum to Advance First Responder Innovation

Capability Gap 6 “Deep Dive” Analysis

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International Forum to Advance
FIRST RESPONDER INNOVATION

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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 6: *The ability to obtain critical information remotely about the extent, perimeter, or interior of the incident.* 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 6

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

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

While there is a high level of public and private funding for advancing technology for surveillance and situational awareness, 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 surveillance and situational awareness. Responders need the ability to obtain and maintain real-time, continuous surveillance of the incident scene. Improved situational awareness would allow responders and command to identify potential hazards, prioritize incident operations, and improve the safety of responders and affected populations in and around the scene. The Moore, Oklahoma (United States) tornado created a path of destruction more than one mile (1.6 km) wide and 17 miles (27.4 km) long. In this instance, it was critical for responders to quickly comprehend the magnitude and the geographical location of their incident scene. It was critical for on-scene responders to understand the scope and location and to recognize that a hospital and two elementary schools were within the path of destruction.

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

This study uses the list of existing first responder gear in the SOO document for Gap 6. This list encompasses the current methods of surveillance and situational awareness available for first responders. Each method was considered a “technology type” with a corresponding, relevant market. There are 16 technology types for this capability gap:

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

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 2019-2023. 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.

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 6. 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 6* (SOO 6) document to further define and segment the relevant markets for Capability Gap 6. Due to the disparity of the 16 types of gear given for this capability gap, one overarching market representing these technology types was not identified. Thus, multiple markets were identified to represent these technology types. These markets are used for market definition, segmentation and further assessment.

Market Quantification

These multiple markets are quantified utilizing overall revenue figures derived from global markets. Growth is measured using an estimated CAGR. As stated above, a primary market was not identified. Please refer to the Market Overview and Market Figures sections below.

Competitive Landscape

Based upon third-party market research reports, a total of 301 firms were identified as operating in the markets included in this analysis. 22 of these firms are considered key global market players for Capability Gap 6. These key global players and innovators appear to offer solutions that address, in part, the ability to obtain critical information remotely about the extent, perimeter or interior of the incident. However, none of the solutions identified within this assessment appear to meet all of first responders' target objectives for this gap.

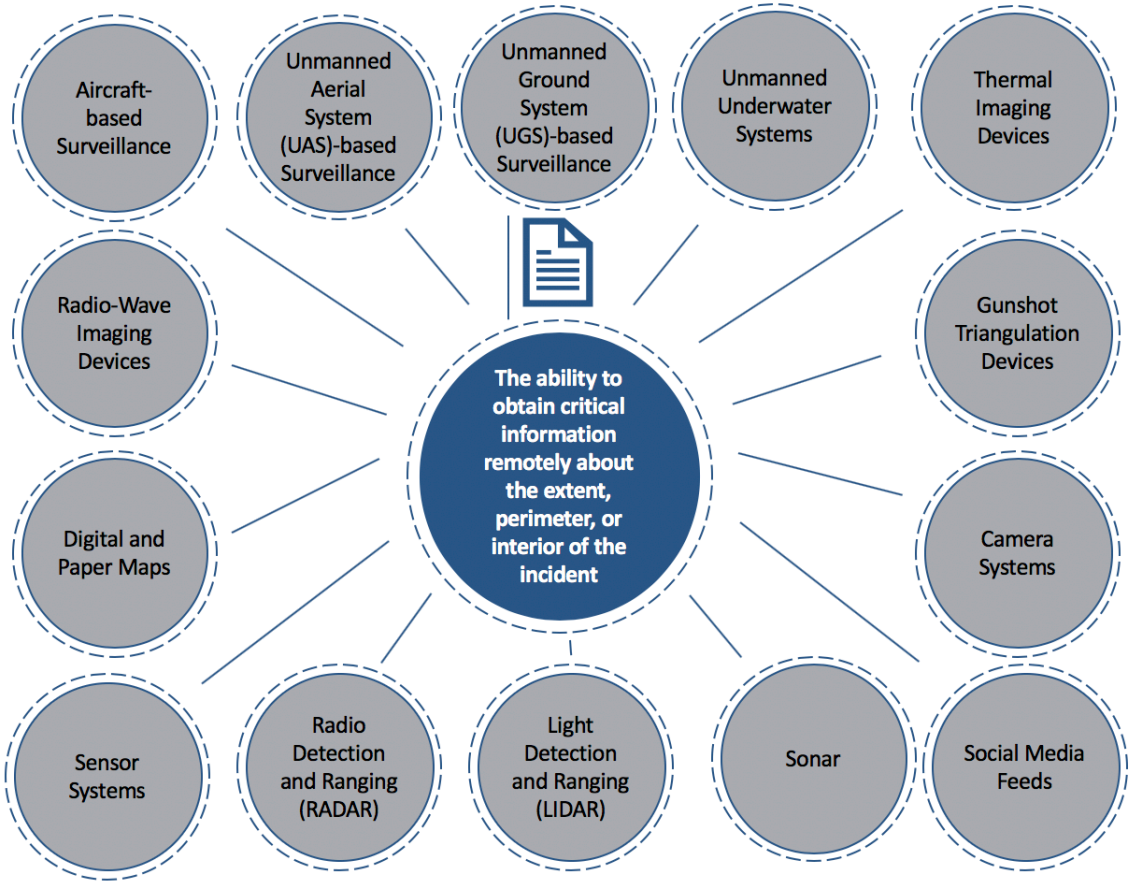
Summary

In summary, although there was no primary market identified, the related markets all appear to be growing. This growth in and of itself presents a great opportunity for new solutions to enter the market. When examining 189 existing solutions and 18 developing solutions in this assessment, none fulfilled all of the objectives for this gap. Therefore, any solutions that address these target objectives and allow remote data collection will likely have the greatest commercial potential.

Market Overview

Capability Gap 6 is **the ability to obtain critical information remotely about the extent, perimeter, or interior of the incident**. This gap is largely focused on the ability to obtain and maintain real-time, continuous surveillance of the incident scene.

Market Segmentation



Due to the broadness of this gap, one overarching market was not able to be identified.

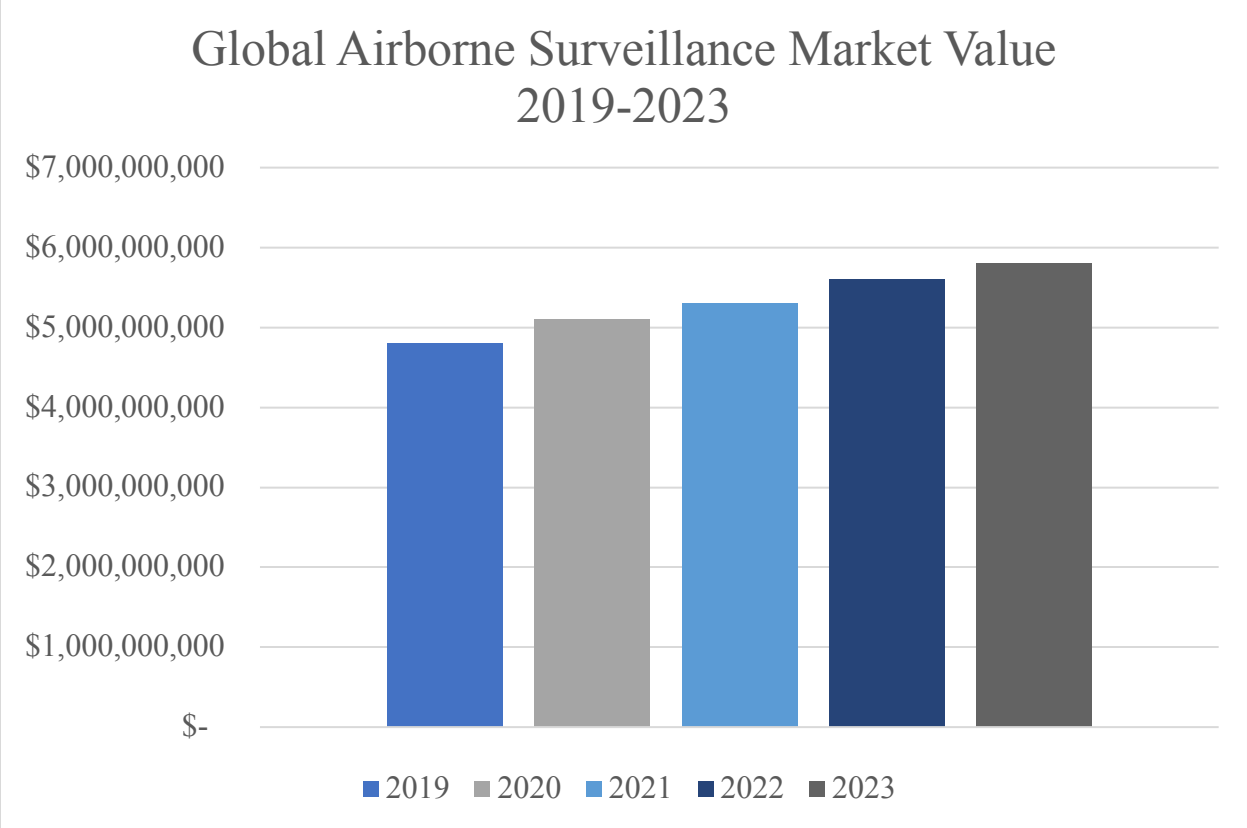
Capability Gap 6 – The ability to obtain critical information remotely about the extent, perimeter, or interior of the incident

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

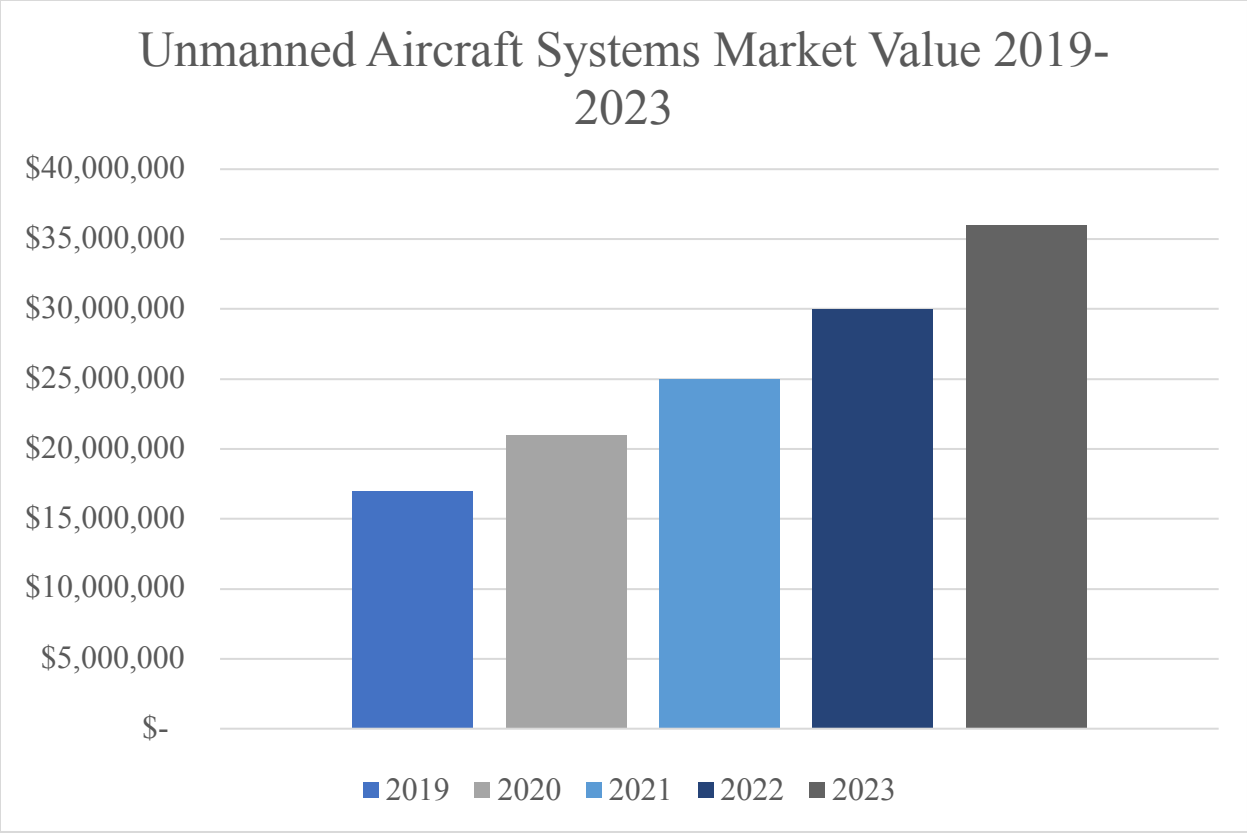
A myriad of surveillance and situational awareness solutions currently exist within the market. However, not one of these solutions appears to meet all of responders' target objectives, which include remote collection of critical on-scene information.

Due to the disparity of the market segments contained with this capability gap, one, all-encompassing primary market was not able to be identified. Therefore, multiple markets are used for market quantification.

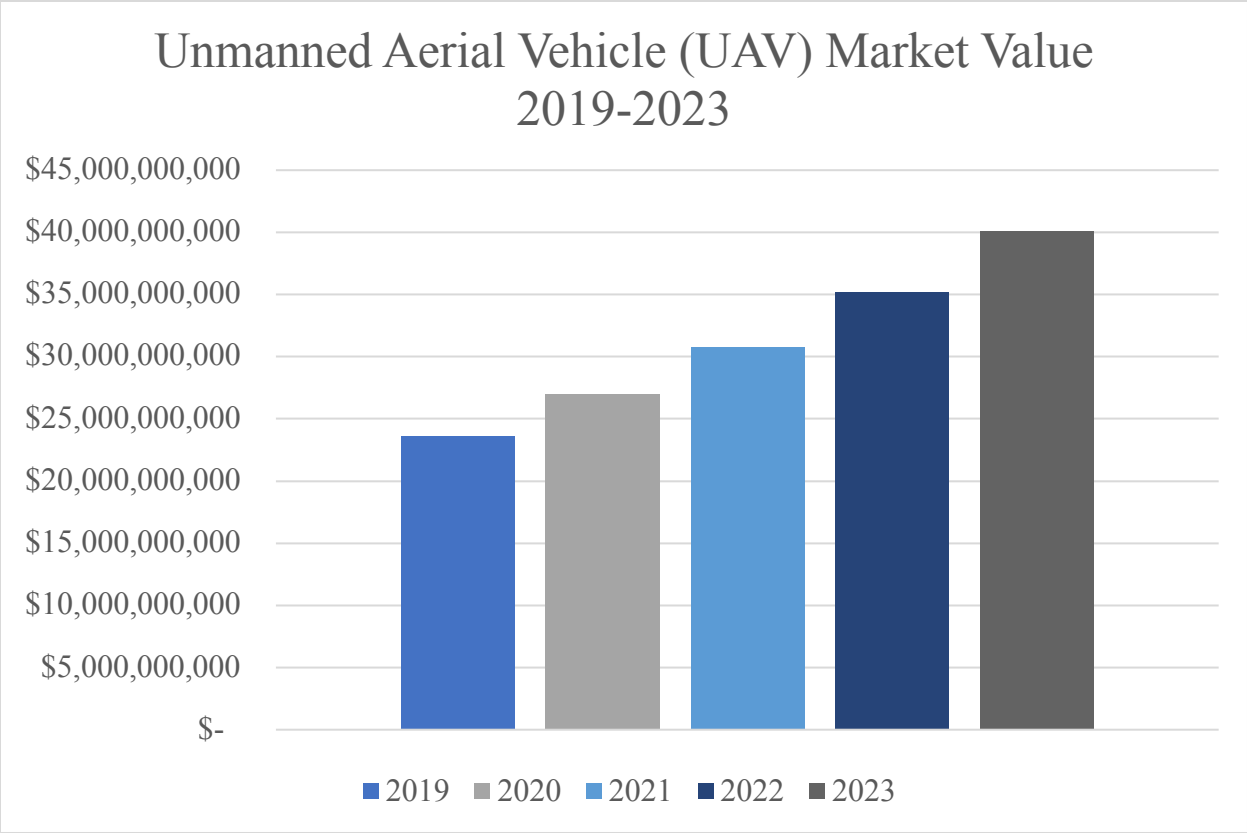
The Global Airborne Surveillance Market is used to define, quantify and assess the various types of solutions available. This market was worth $4.4 billion USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 4.7 percent through 2023. This equates to a market value of $5.8 billion USD in 2023.



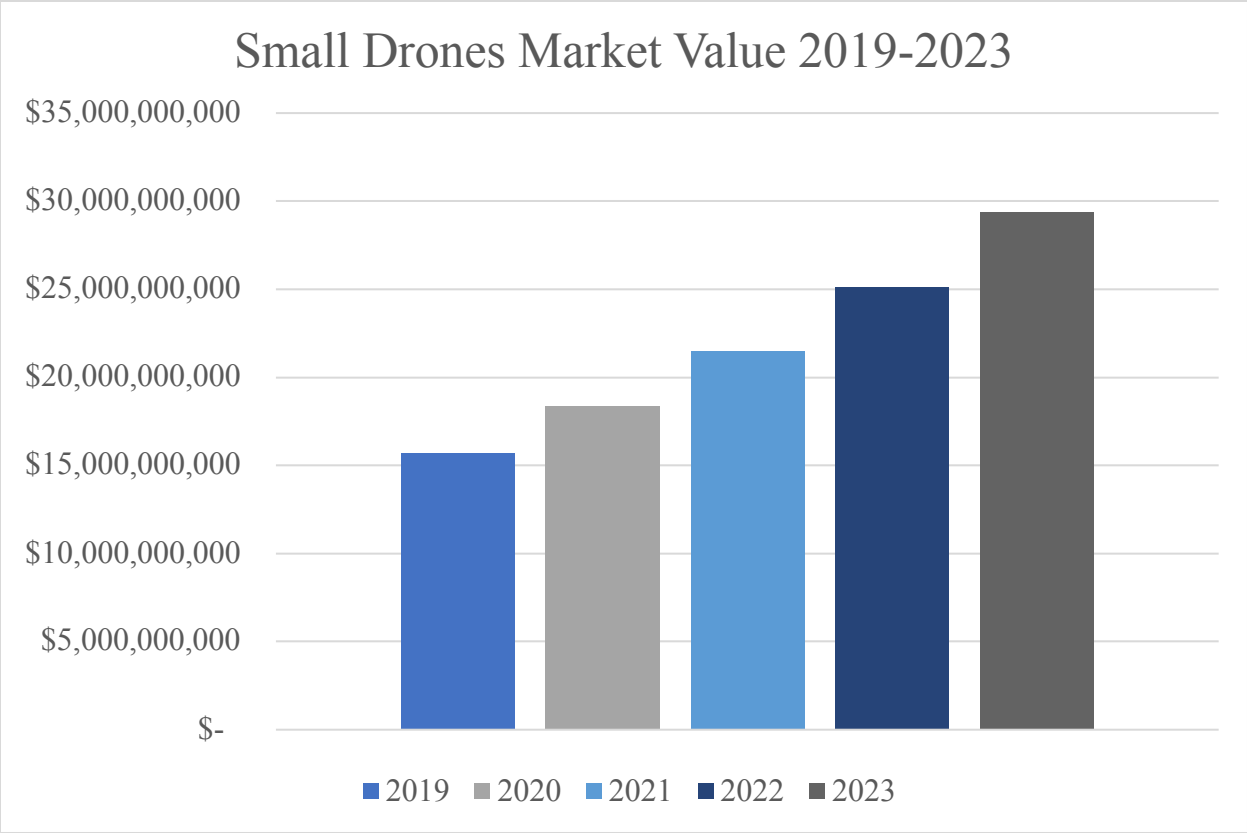
The Unmanned Aircraft Systems Market is used to define, quantify and assess the various types of solutions available. This market was worth $12.1 million USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 19.7 percent through 2023. This equates to a market value of $35.6 million USD in 2023.



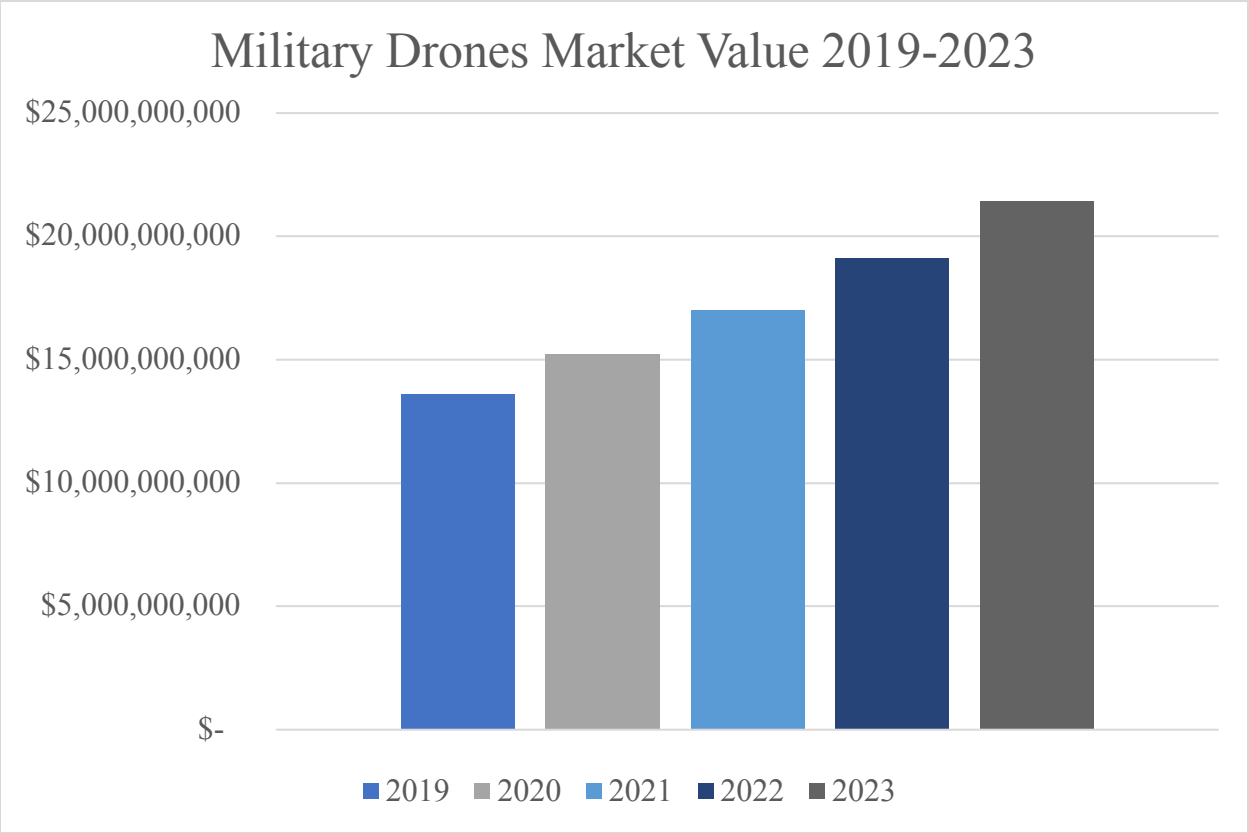
The Unmanned Aerial Vehicle (UAV) Market is used to define, quantify and assess the various types of solutions available. This market was worth $18.1 billion USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 14.2 percent through 2023. This equates to a market value of $40.1 billion USD in 2023.



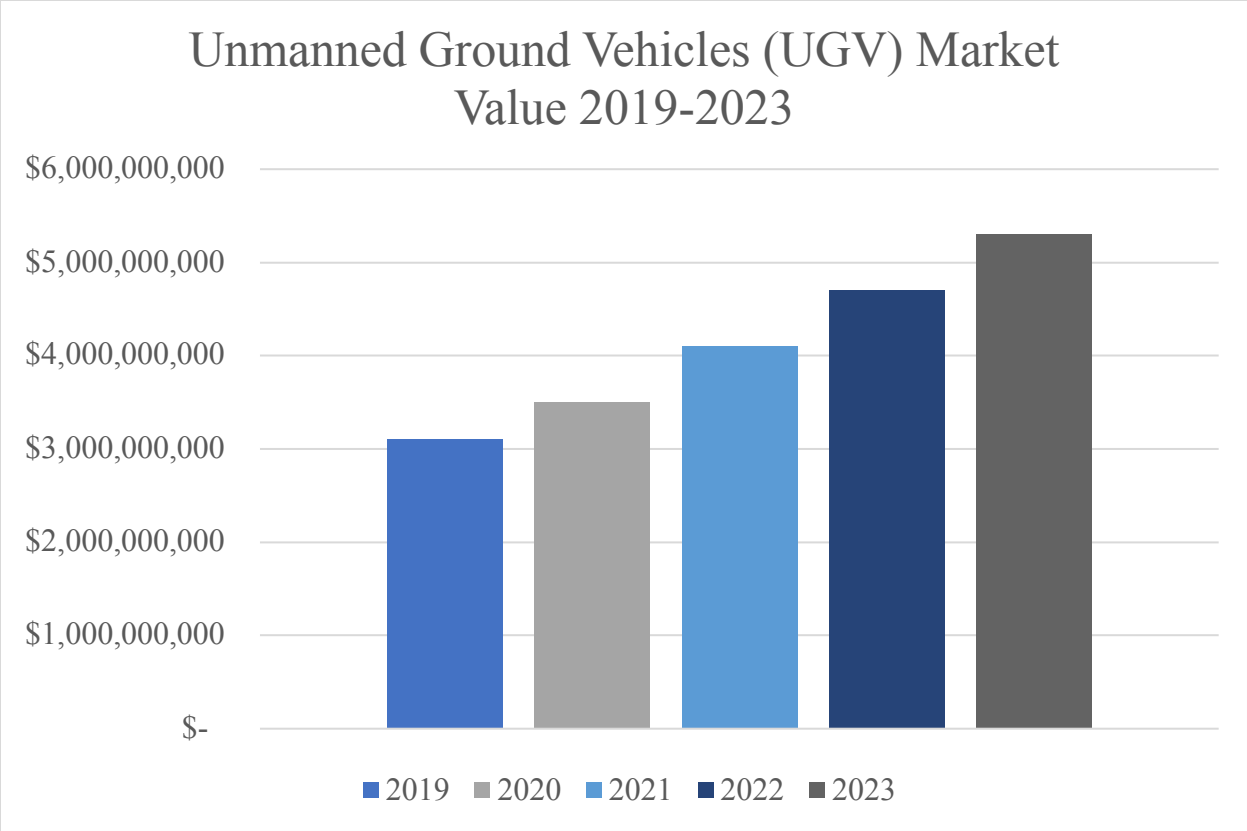
The Small Drones Market is used to define, quantify and assess the various types of solutions available. This market was worth $13.4 billion USD in 2018 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 17.0 percent through 2023. This equates to a market value of $29.4 billion USD in 2023.



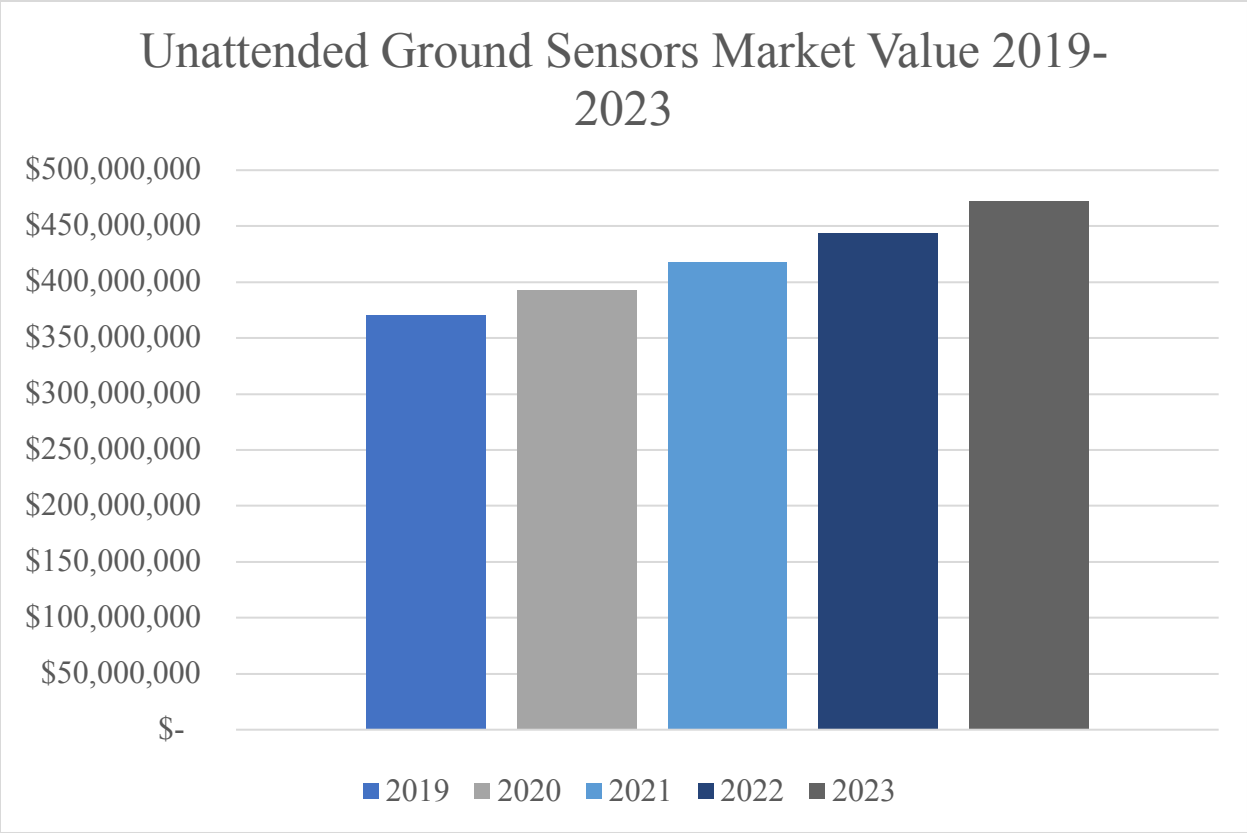
The Military Drones Market is used to define, quantify and assess the various types of solutions available. This market was worth $12.1 billion USD in 2018 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 12.0 percent through 2023. This equates to a market value of $21.4 billion USD in 2023.



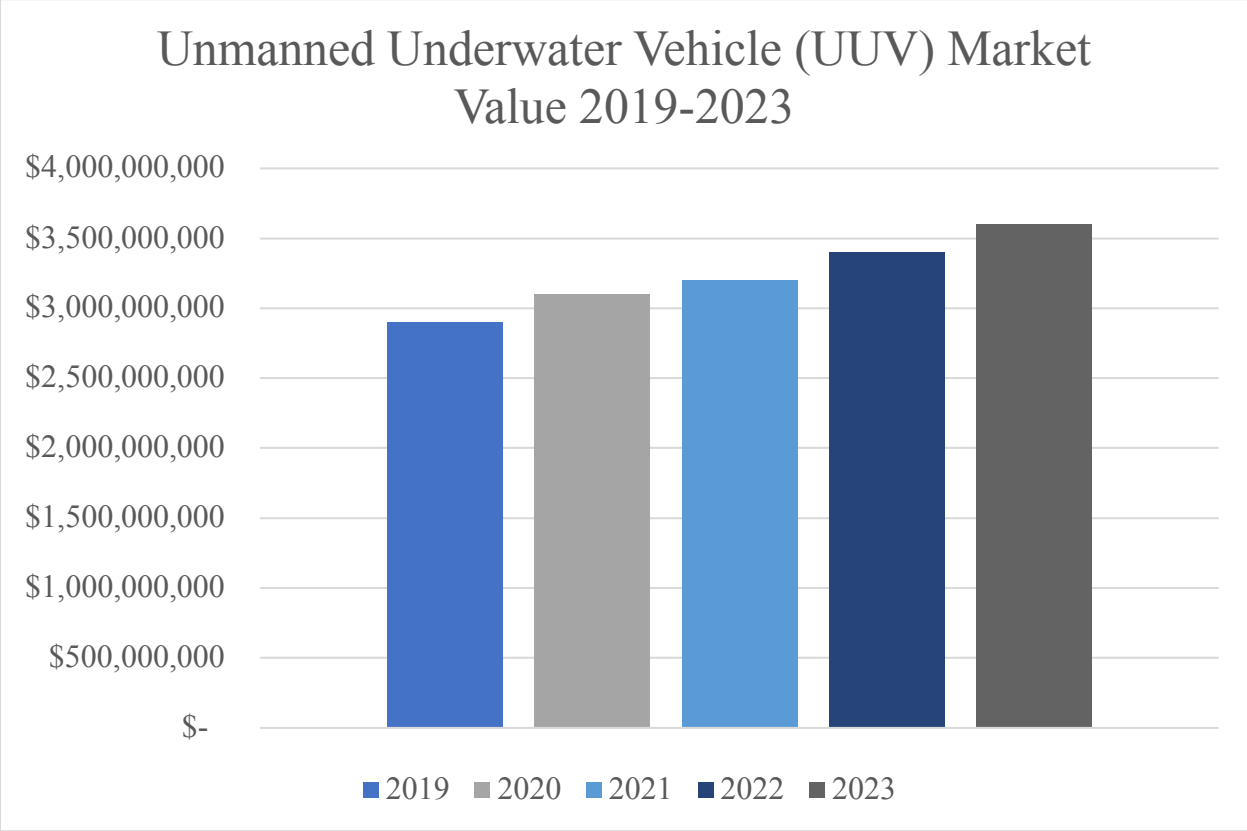
The Unmanned Ground Vehicles (UGV) Market is used to define, quantify and assess the various types of solutions available. This market was worth $2.7 billion USD in 2018 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 14.6 percent through 2023. This equates to a market value of $5.3 billion USD in 2023.



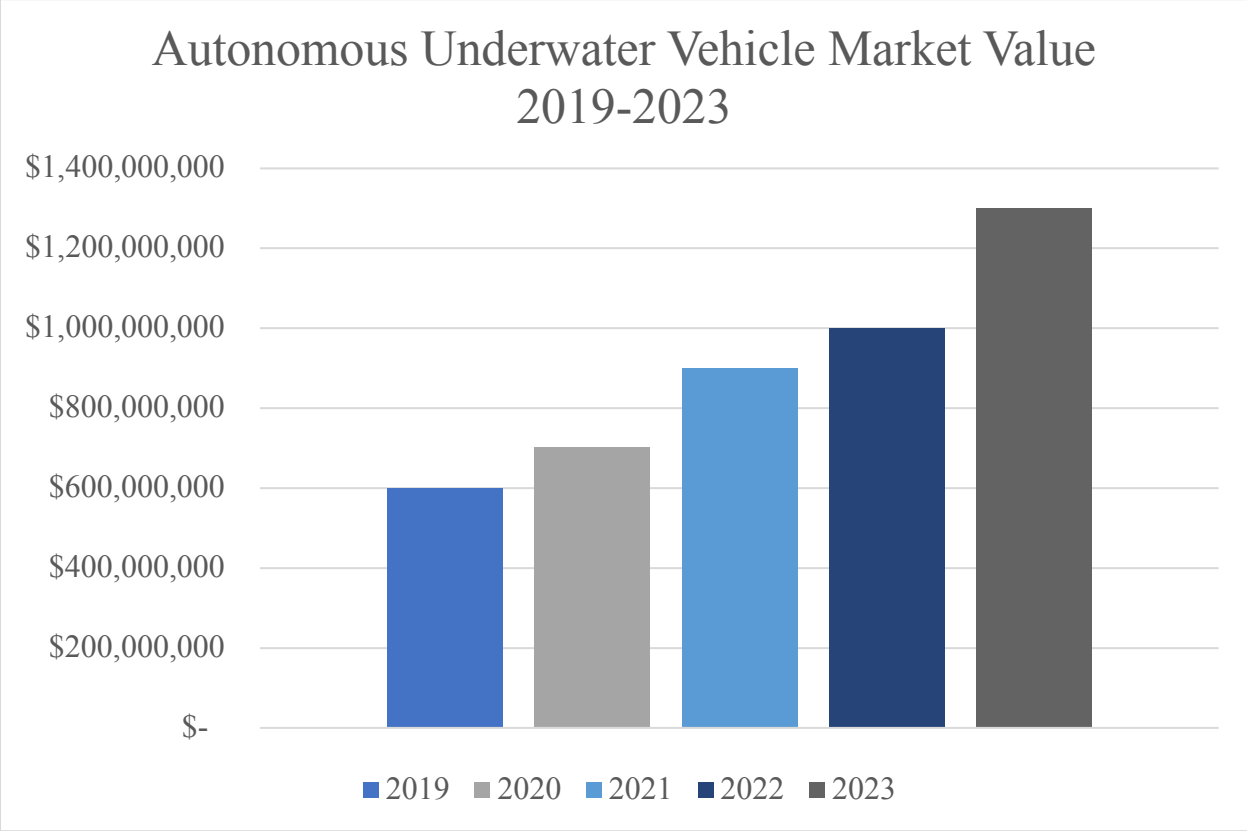
The Unattended Ground Sensors Market is used to define, quantify and assess the various types of solutions available. This market was worth $328.2 million USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 6.2 percent through 2023. This equates to a market value of $471.5 million USD in 2023.



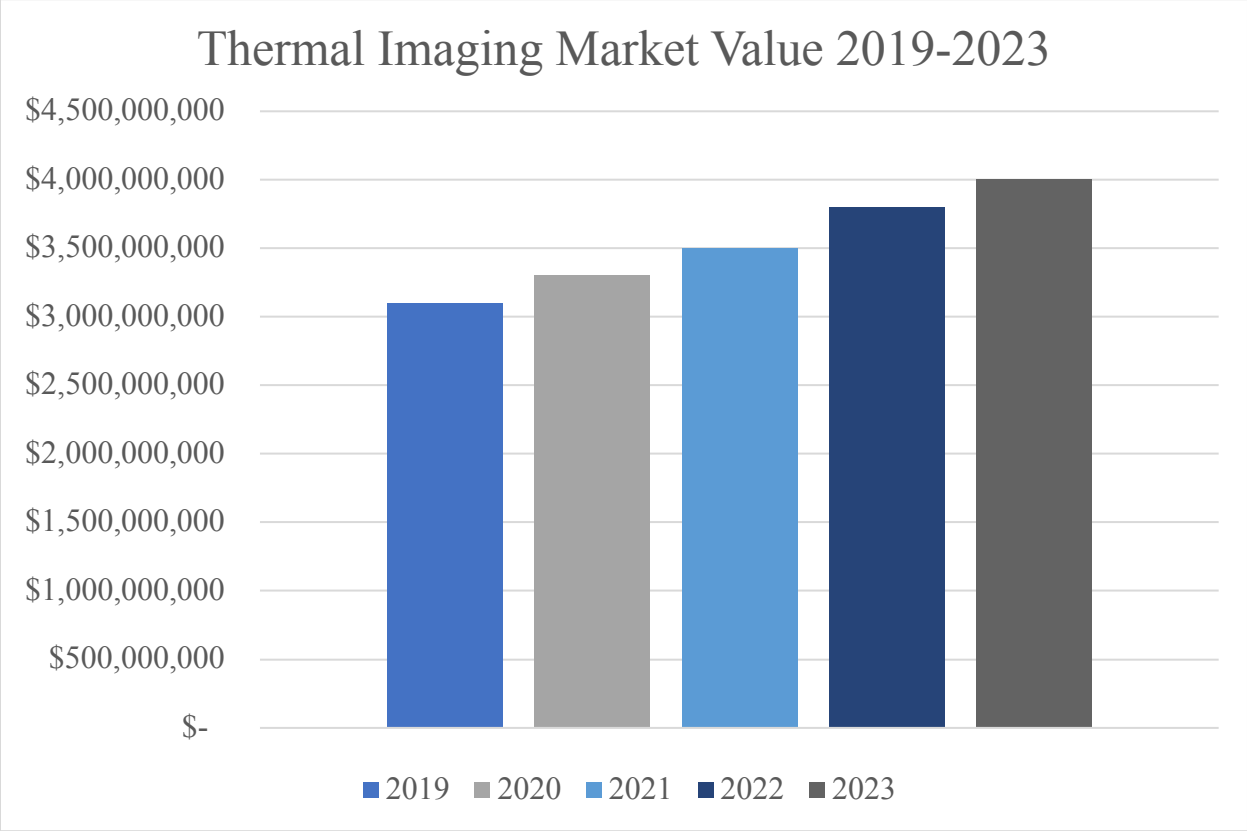
The Unmanned Underwater Vehicle (UVV) Market is used to define, quantify and assess the various types of solutions available. This market was worth $2.6 billion USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 5.3 percent through 2023. This equates to a market value of $3.6 billion USD in 2023.



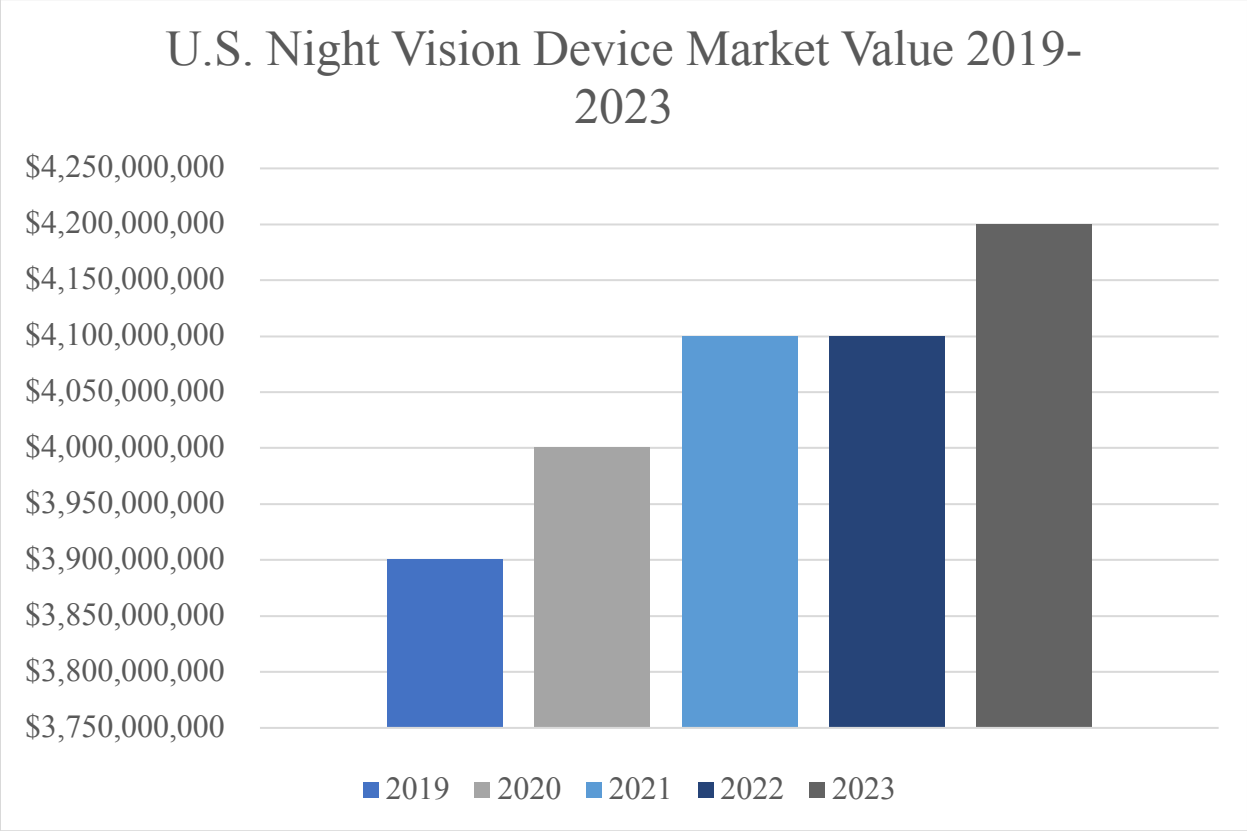
The Autonomous Underwater Vehicle Market is used to define, quantify and assess the various types of solutions available. This market was worth $312.2 million USD in 2016 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 22.3 percent through 2023. This equates to a market value of $1.3 billion USD in 2023.



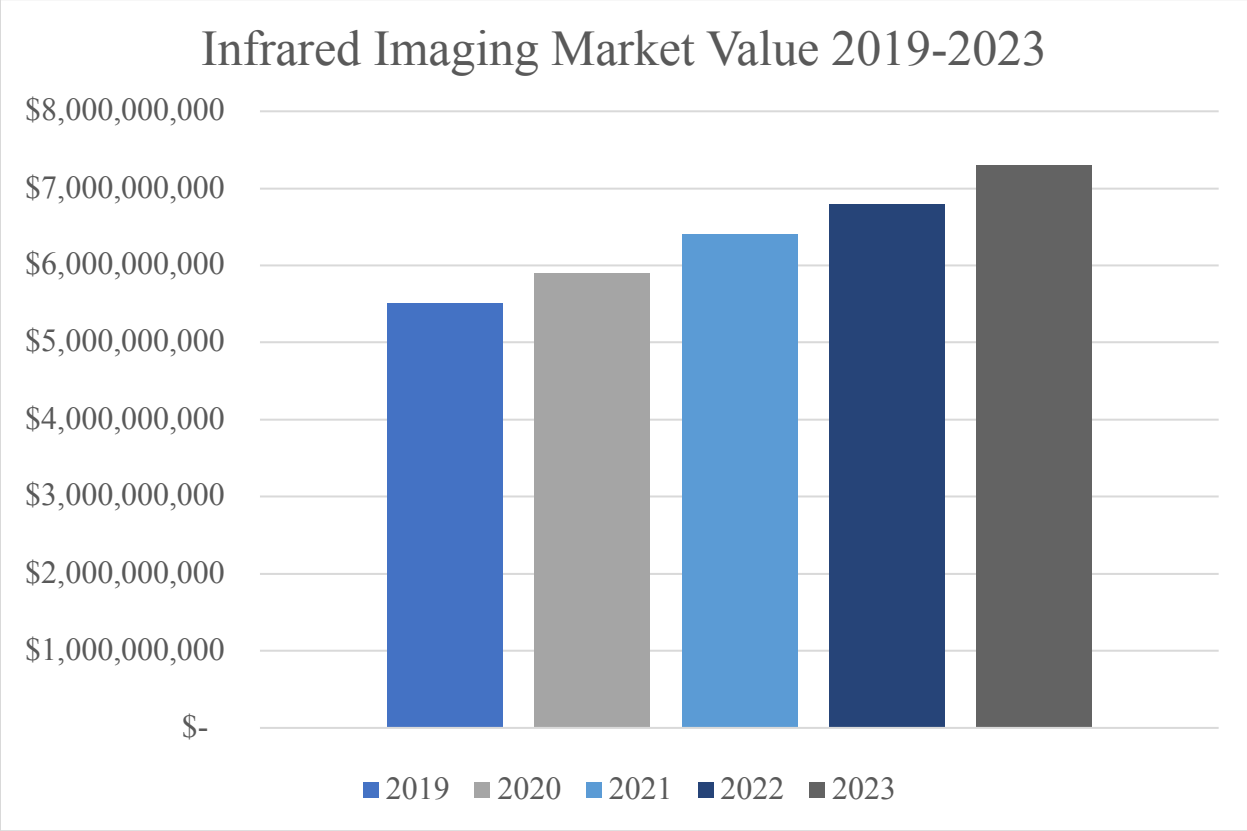
The Thermal Imaging Market is used to define, quantify and assess the various types of solutions available. This market was worth $2.7 billion USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 6.8 percent through 2023. This equates to a market value of $4.0 billion USD in 2023.



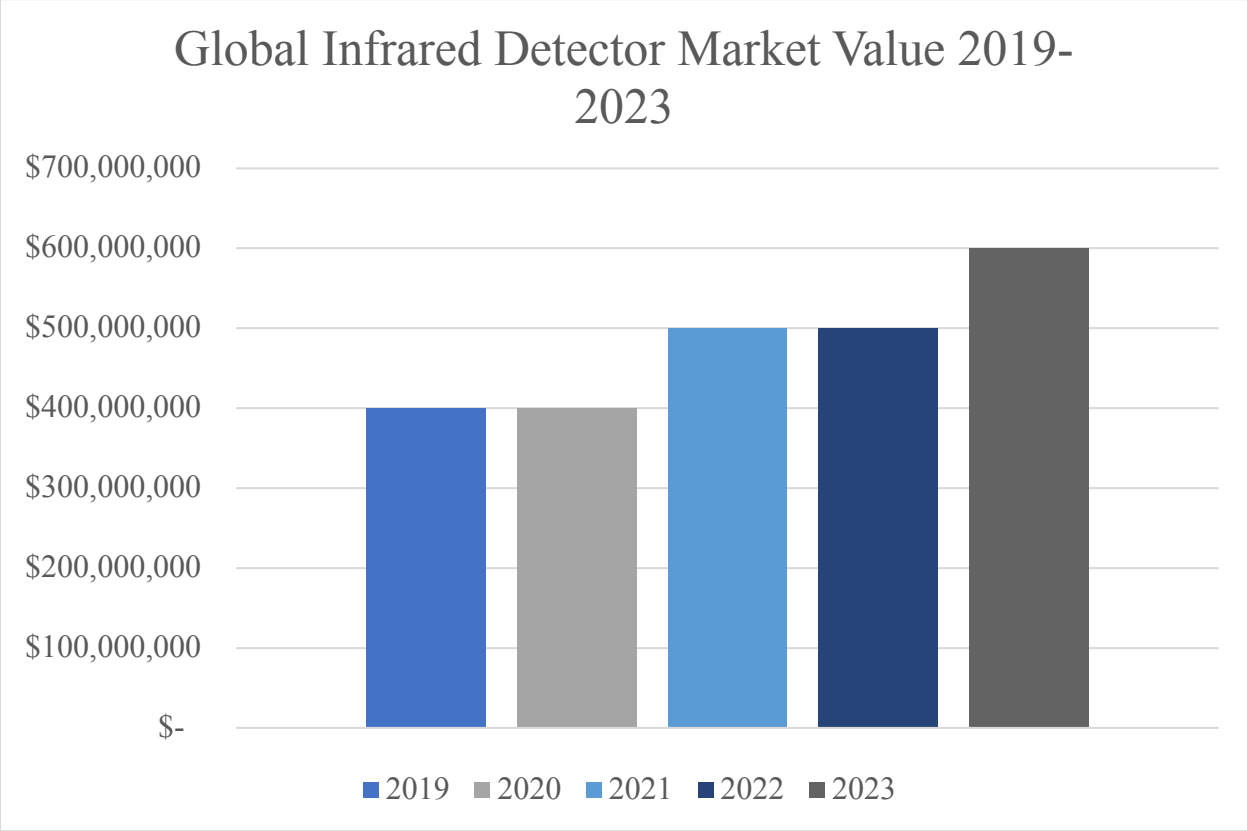
The U.S. Night Vision Device Market is used to define, quantify and assess the various types of solutions available. This market was worth $3.7 billion USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 2.0 percent through 2023. This equates to a market value of $4.2 billion USD in 2023.



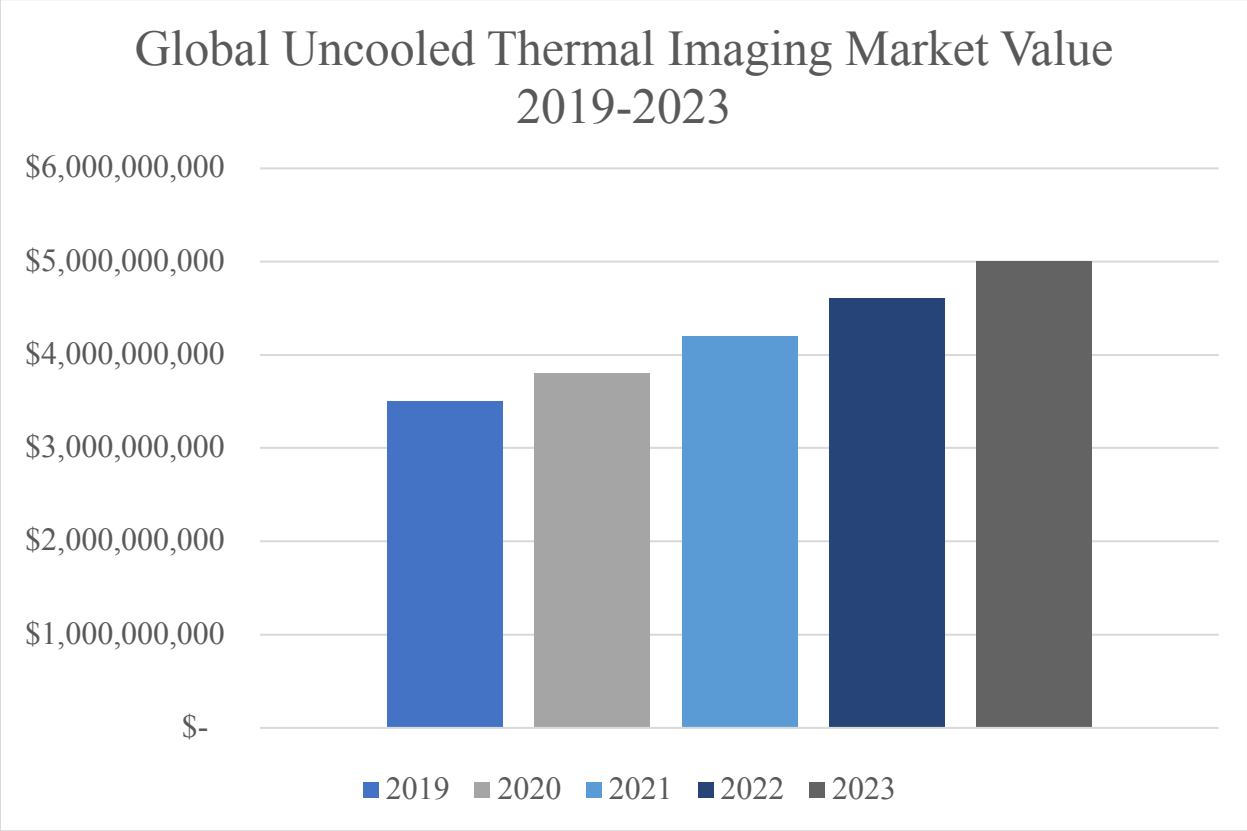
The Infrared Imaging Market is used to define, quantify and assess the various types of solutions available. This market was worth $5.2 billion USD in 2018 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 7.2 percent through 2023. This equates to a market value of $7.3 billion USD in 2023.



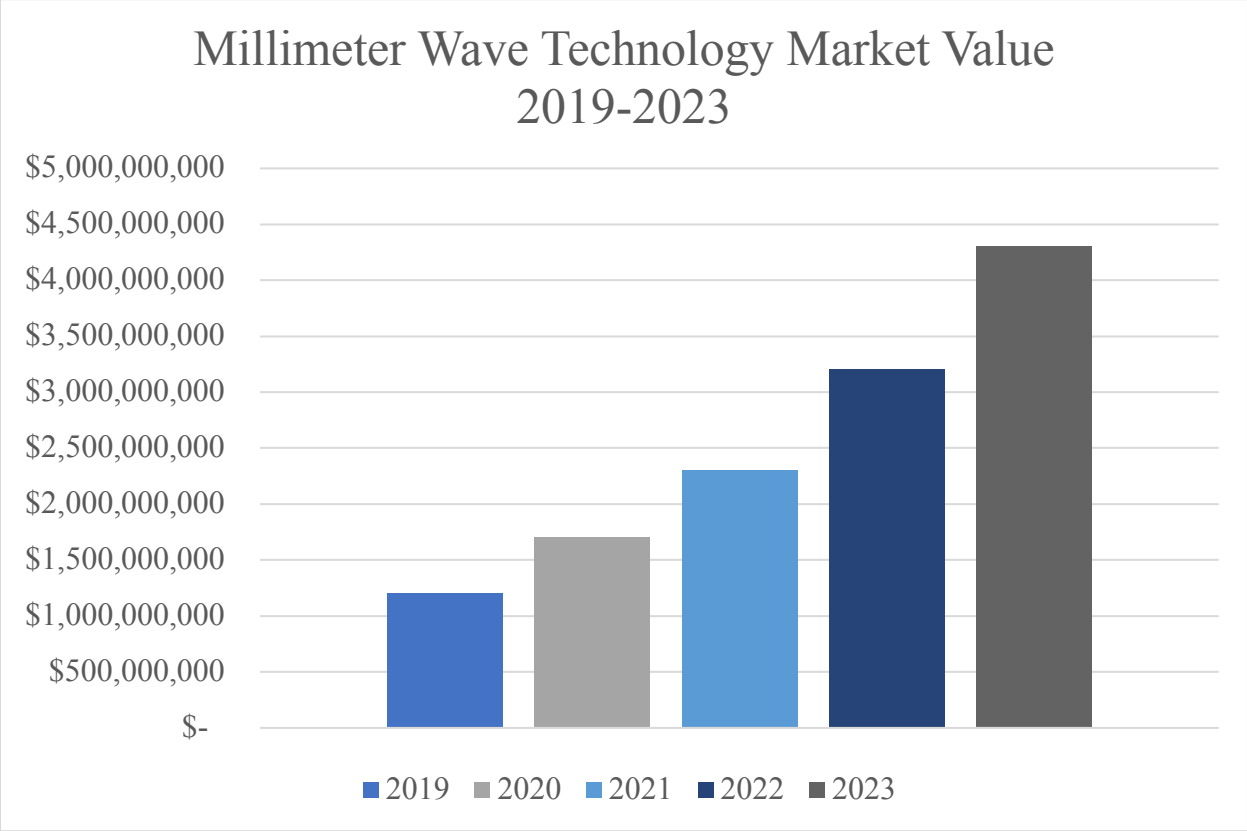
The Global Infrared Detector Market is used to define, quantify and assess the various types of solutions available. This market was worth $307.3 million USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 10.6 percent through 2023. This equates to a market value of $562.4 million USD in 2023.



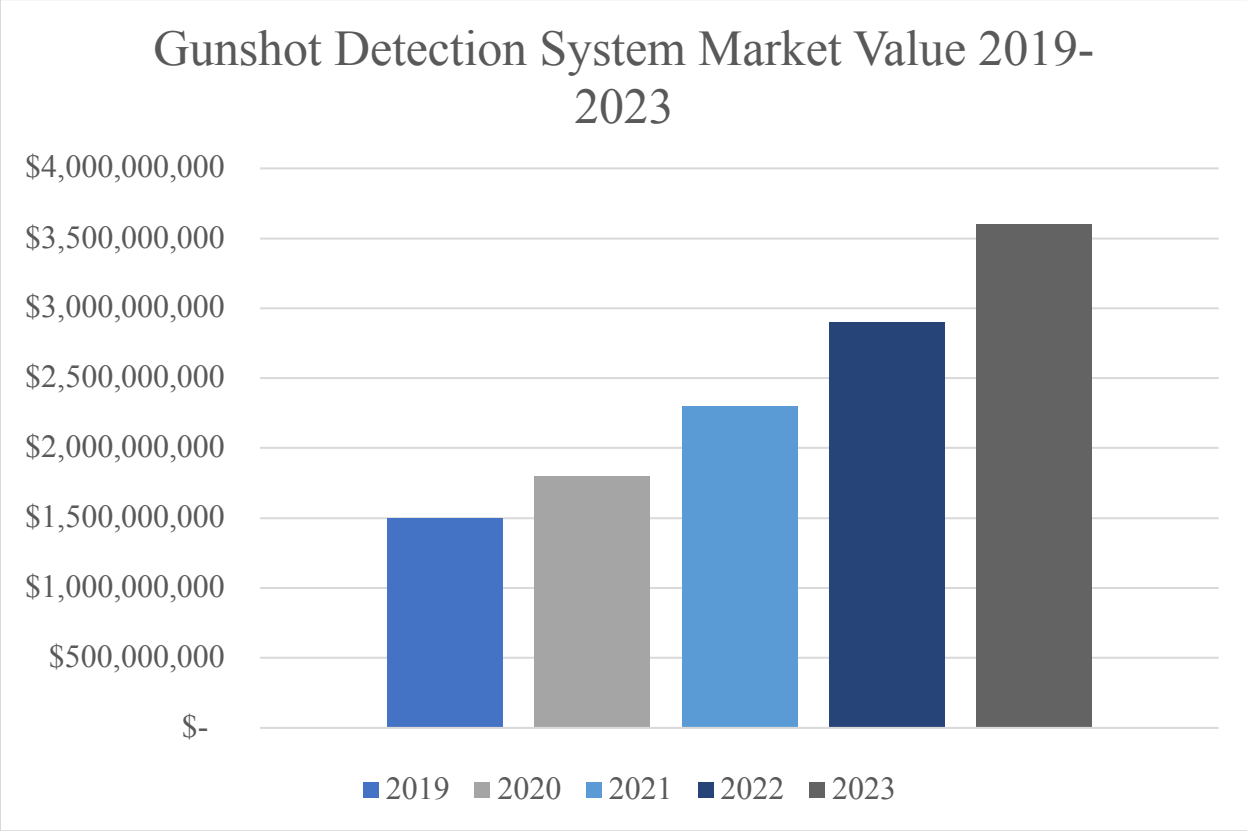
The Global Uncooled Thermal Imaging Market is used to define, quantify and assess the various types of solutions available. This market was worth $2.9 billion USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 9.6 percent through 2023. This equates to a market value of $5.0 billion USD in 2023.



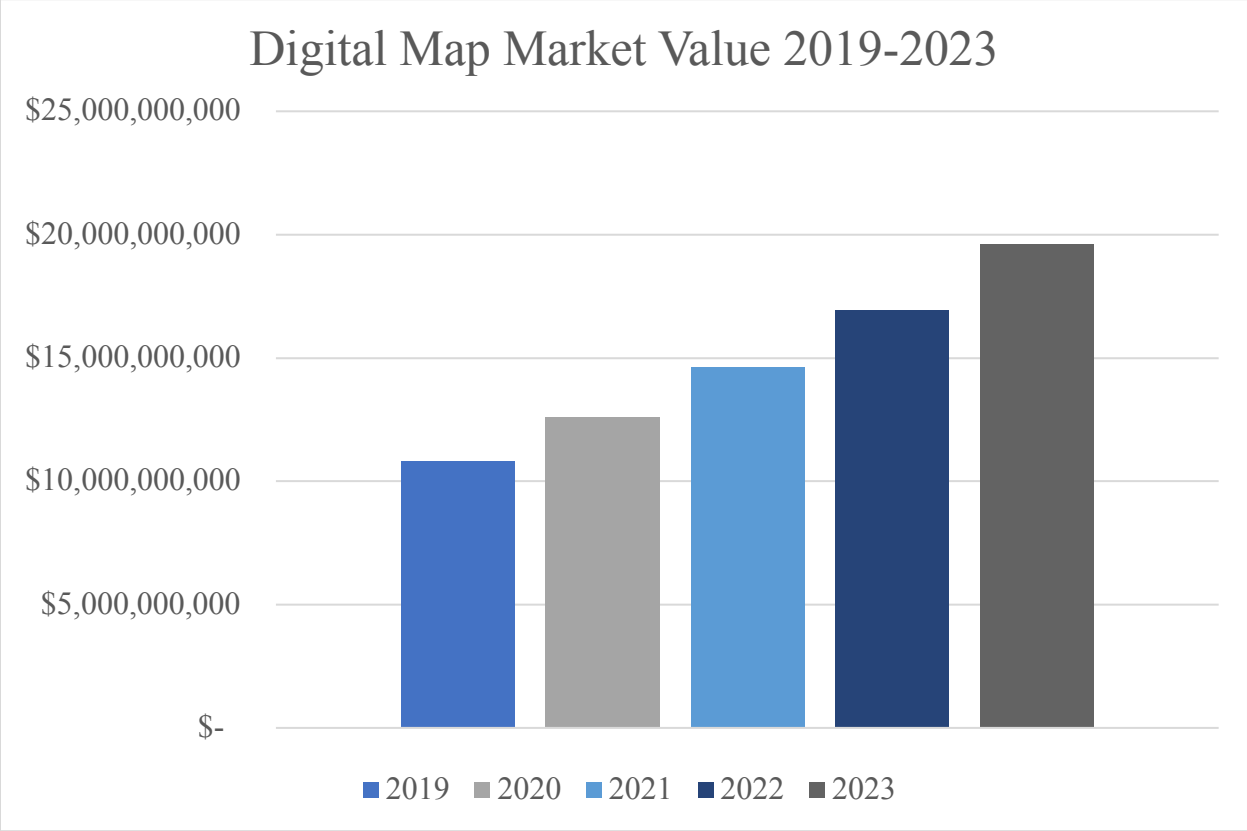
The Millimeter Wave Technology Market is used to define, quantify and assess the various types of solutions available. This market was worth $670 million USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 36.4 percent through 2023. This equates to a market value of $4.3 billion USD in 2023.



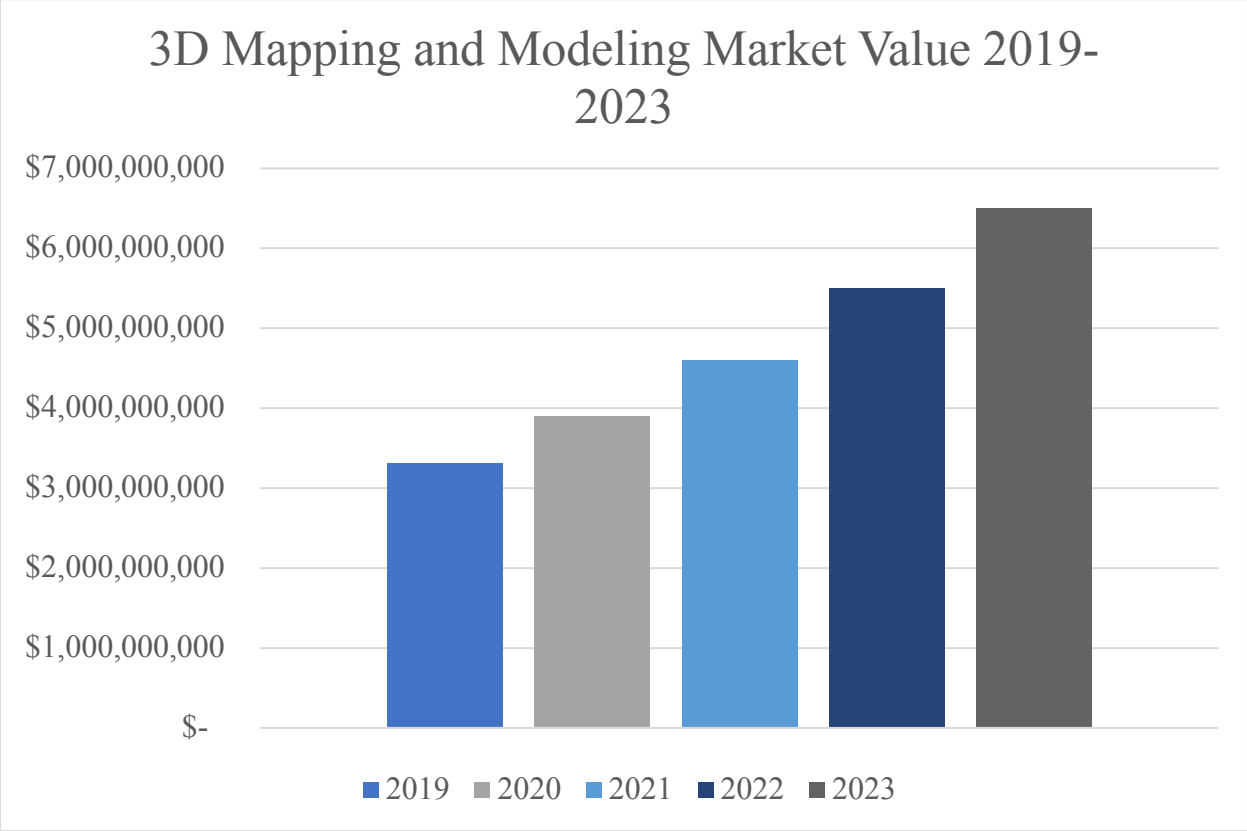
The Gunshot Detection System Market is used to define, quantify and assess the various types of solutions available. This market was worth $930 million USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 25.4 percent through 2023. This equates to a market value of $3.6 billion USD in 2023.



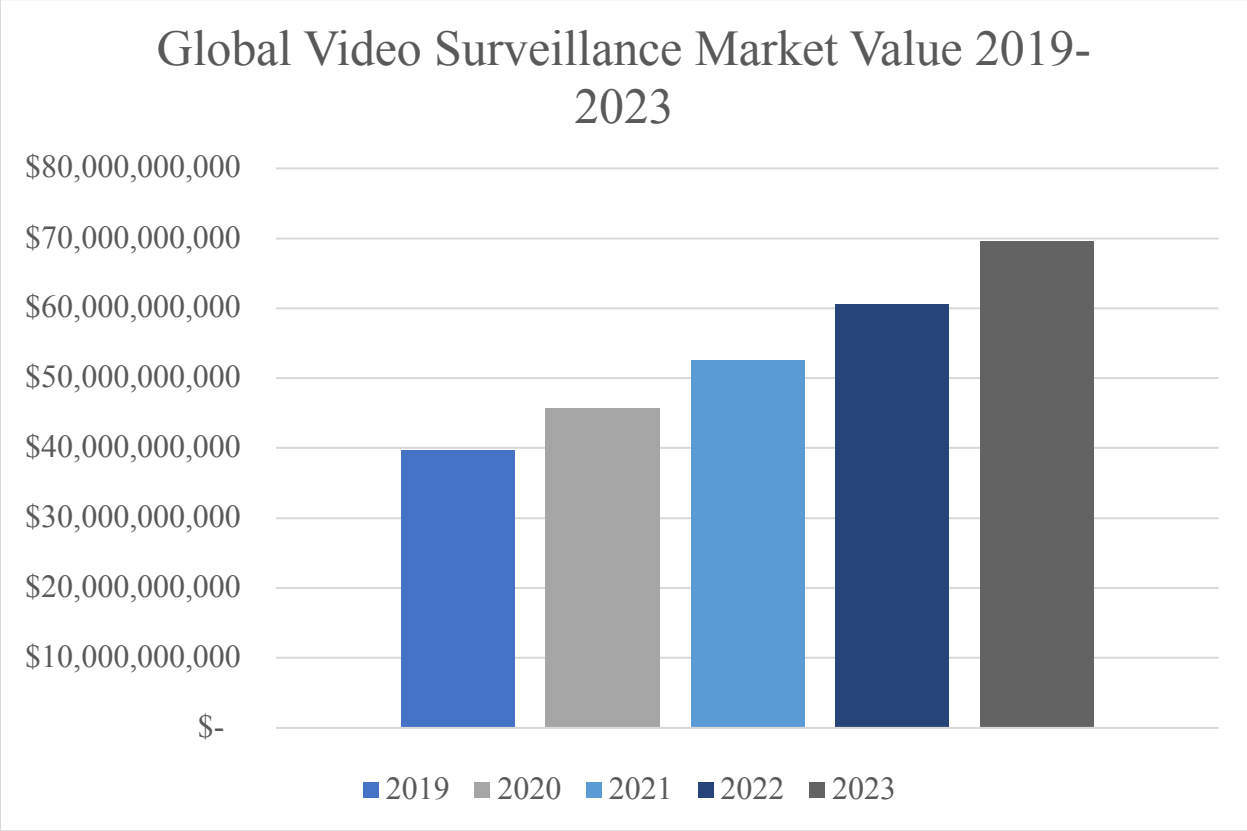
The Digital Map Market is used to define, quantify and assess the various types of solutions available. This market was worth $8.0 billion USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 16.0 percent through 2023. This equates to a market value of $19.6 billion USD in 2023.



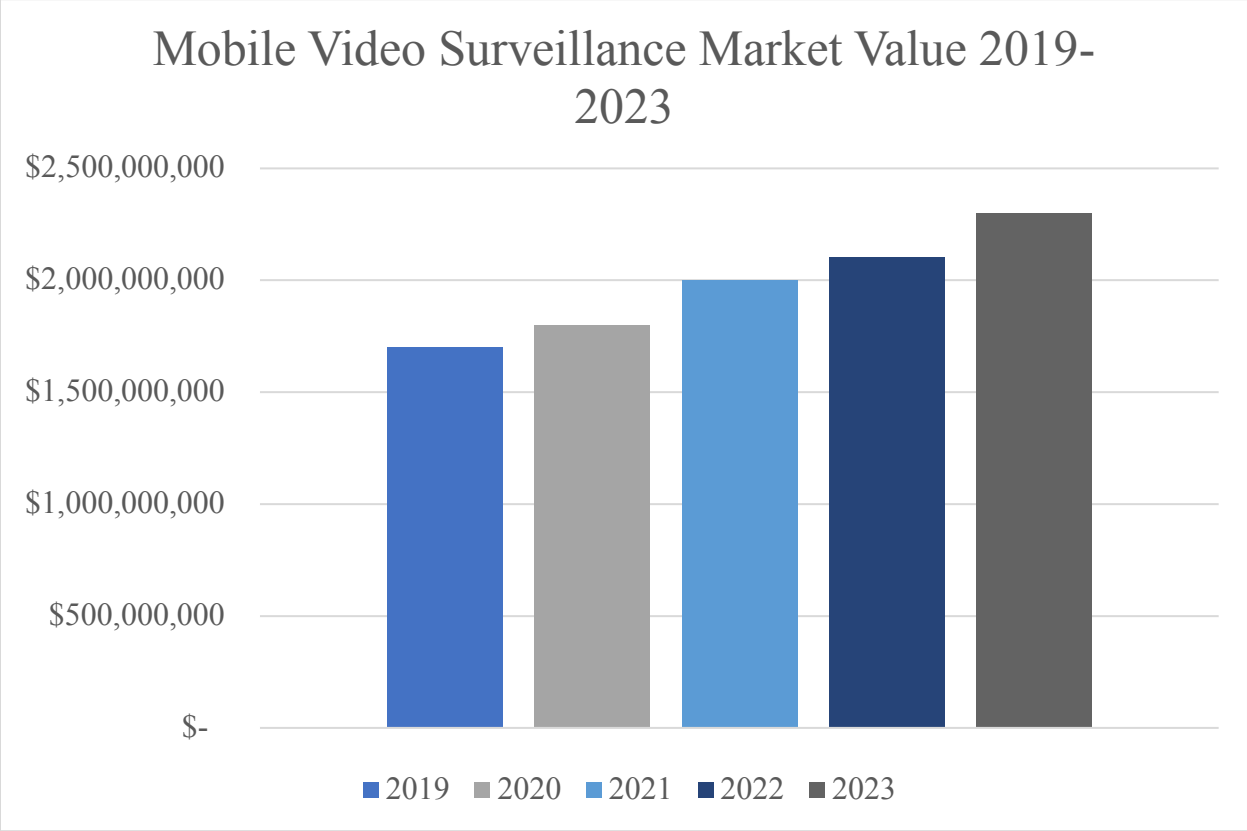
The 3D Mapping and Modeling Market is used to define, quantify and assess the various types of solutions available. This market was worth $2.8 billion USD in 2018 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 18.3 percent through 2023. This equates to a market value of $6.5 billion USD in 2023.



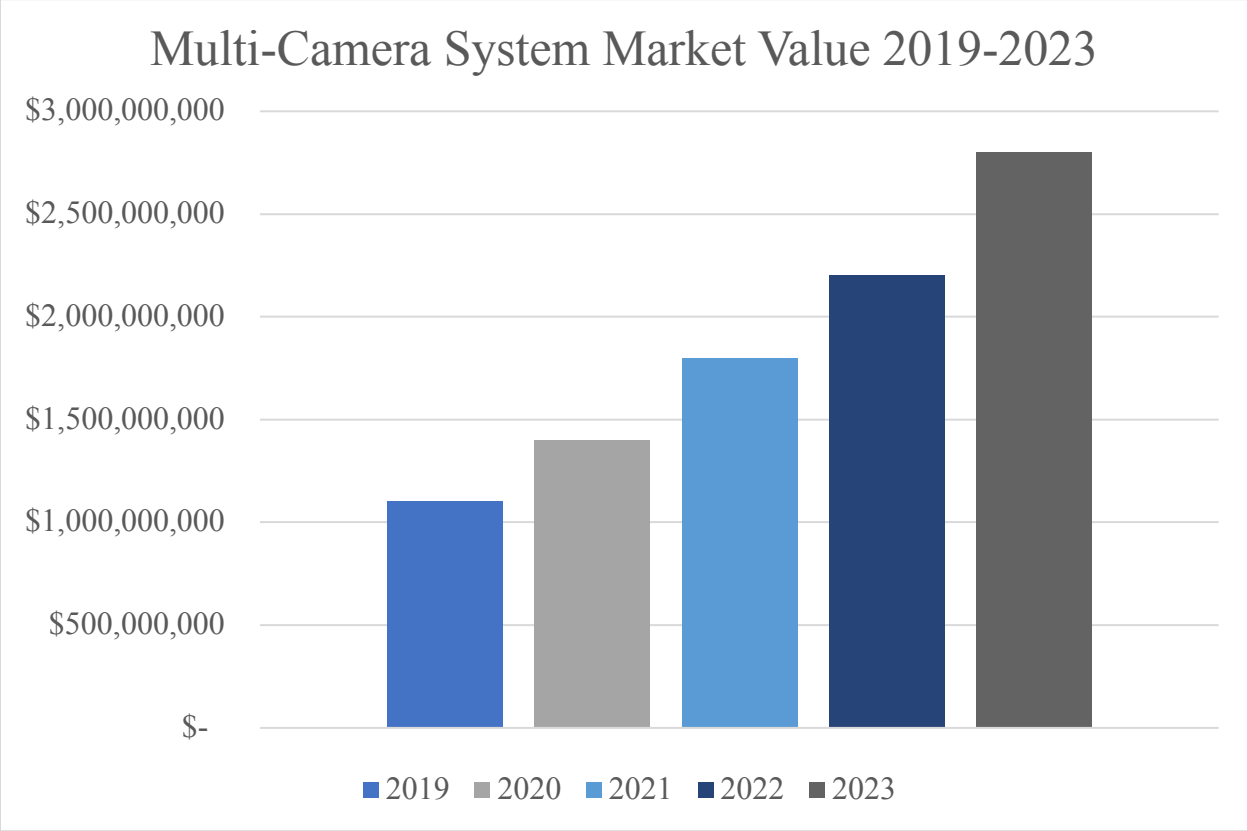
The Global Video Surveillance Market is used to define, quantify and assess the various types of solutions available. This market was worth $30.0 billion USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 15.1 percent through 2023. This equates to a market value of $69.6 billion USD in 2023.



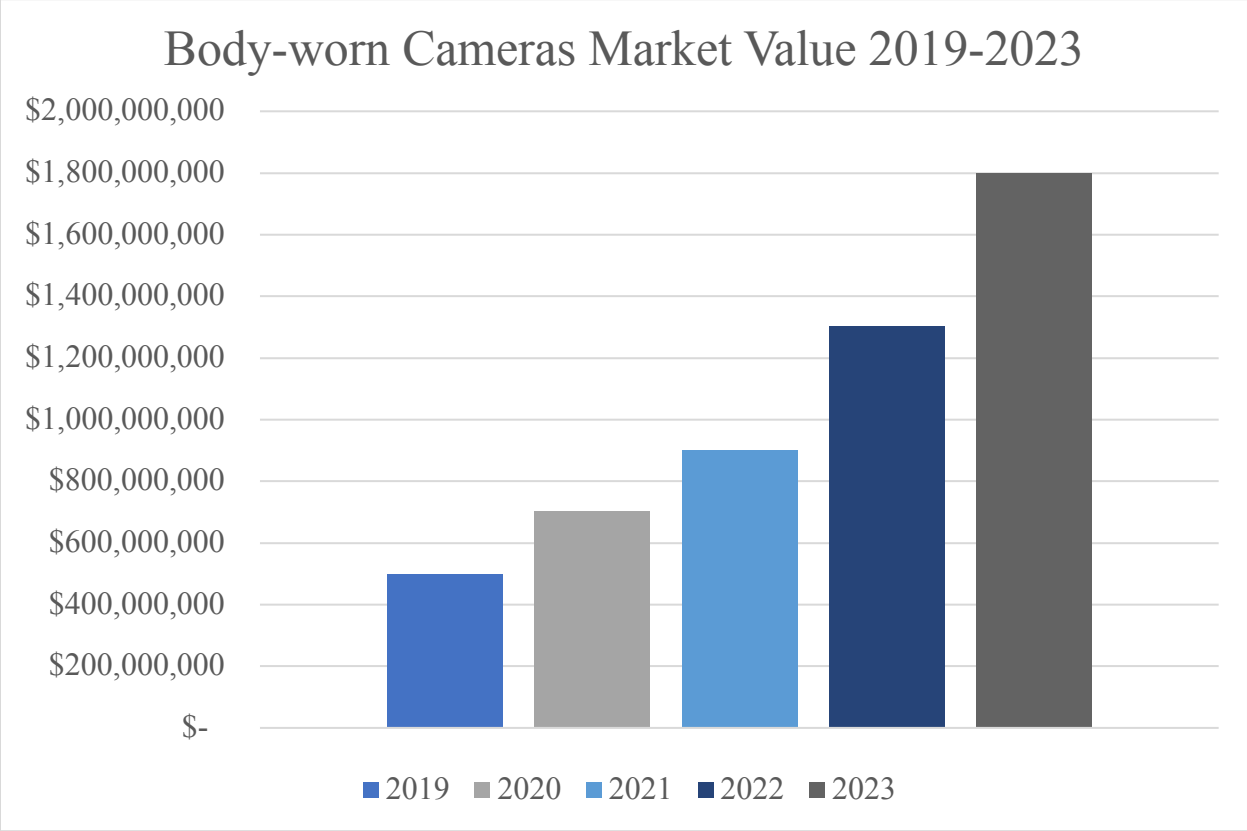
The Mobile Video Surveillance Market is used to define, quantify and assess the various types of solutions available. This market was worth $1.4 billion USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 8.8 percent through 2023. This equates to a market value of $2.3 billion USD in 2023.



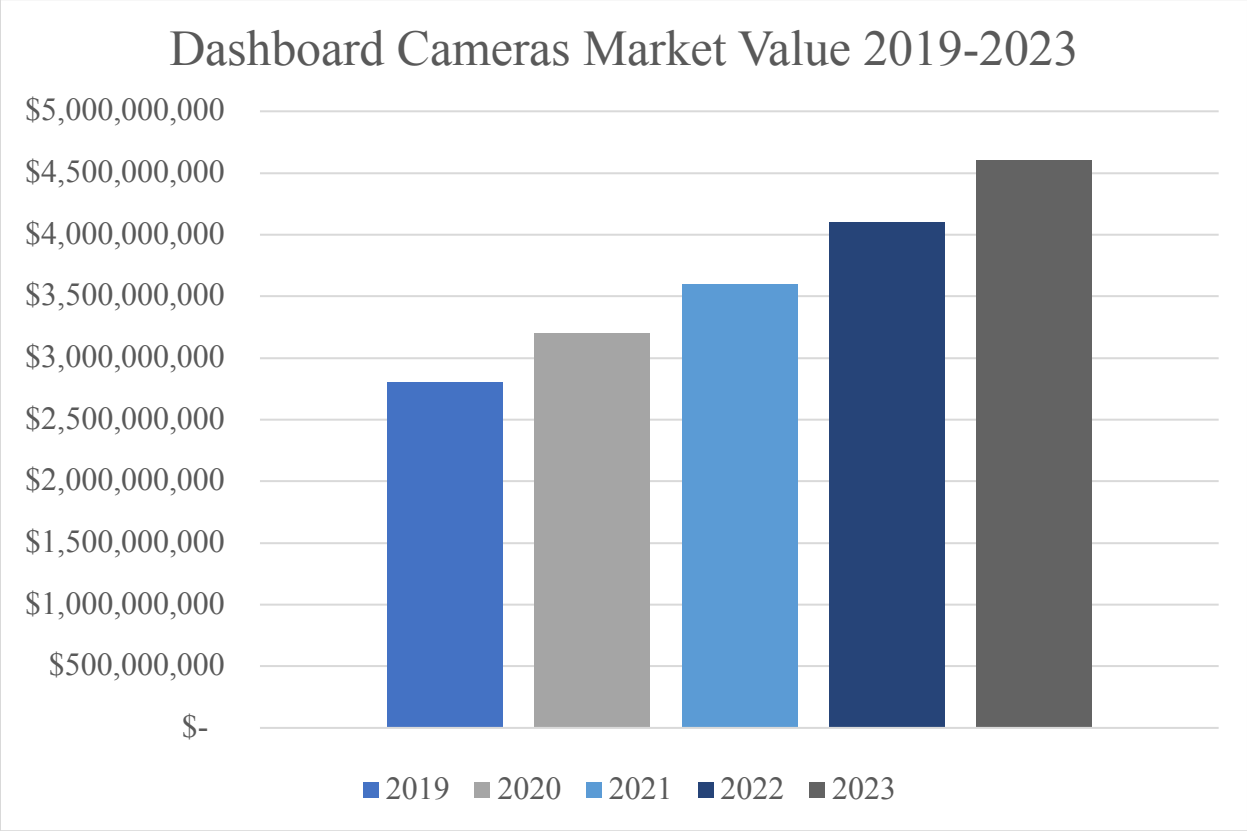
The Multi-Camera System Market is used to define, quantify and assess the various types of solutions available. This market was worth $700.5 million USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 26.2 percent through 2023. This equates to a market value of $2.8 billion USD in 2023.



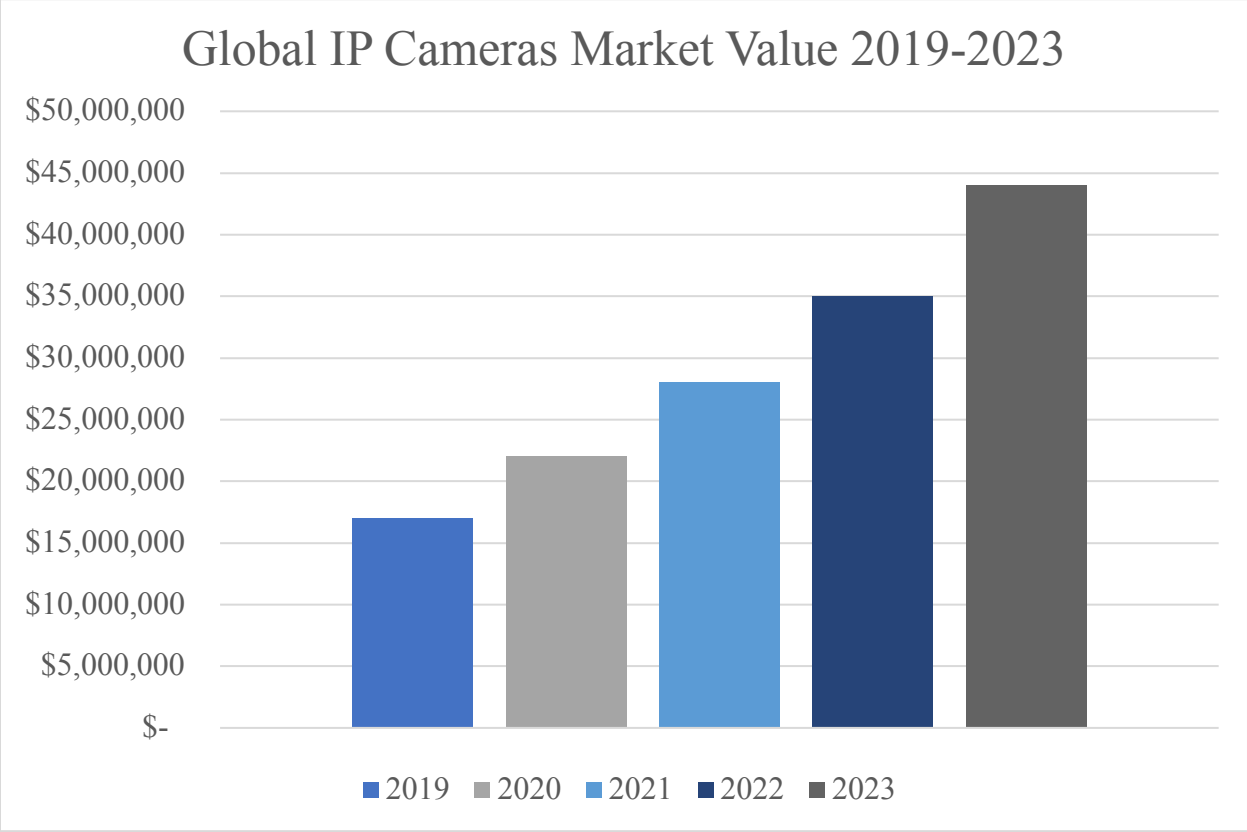
The Body-worn Cameras Market is used to define, quantify and assess the various types of solutions available. This market was worth $260.0 million USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 38.2 percent through 2023. This equates to a market value of $1.8 billion USD in 2023.



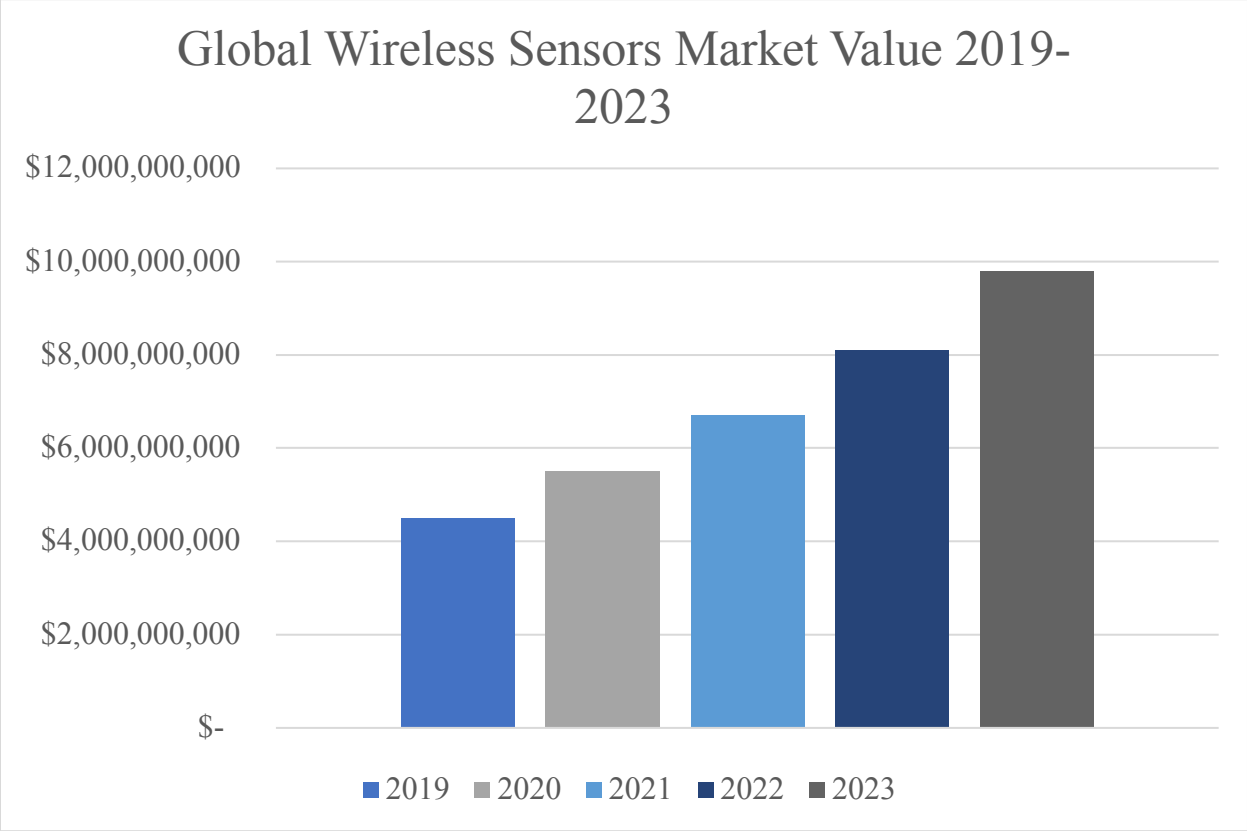
The Dashboard Cameras Market is used to define, quantify and assess the various types of solutions available. This market was worth $2.2 billion USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 13.3 percent through 2023. This equates to a market value of $4.6 billion USD in 2023.



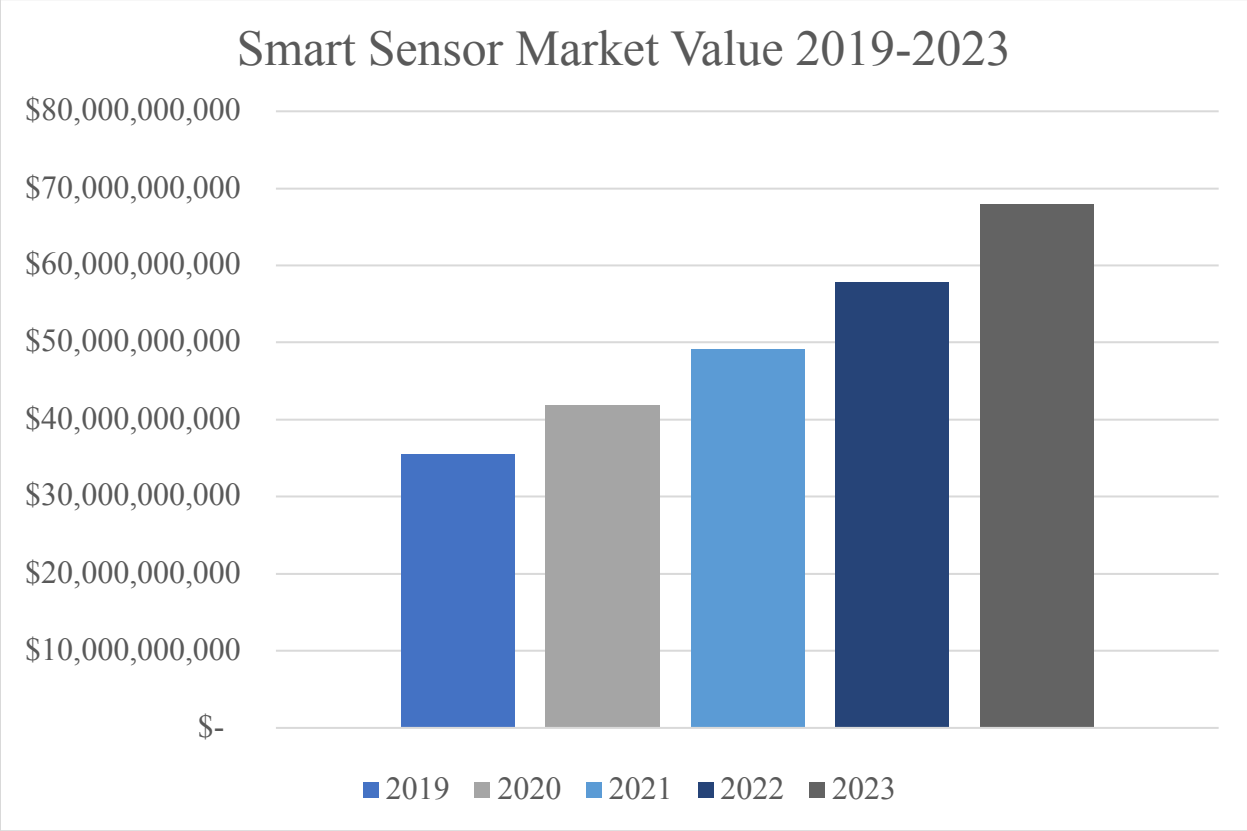
The Global IP Cameras Market is used to define, quantify and assess the various types of solutions available. This market was worth $11.0 million USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 25.8 percent through 2023. This equates to a market value of $43.6 million USD in 2023.



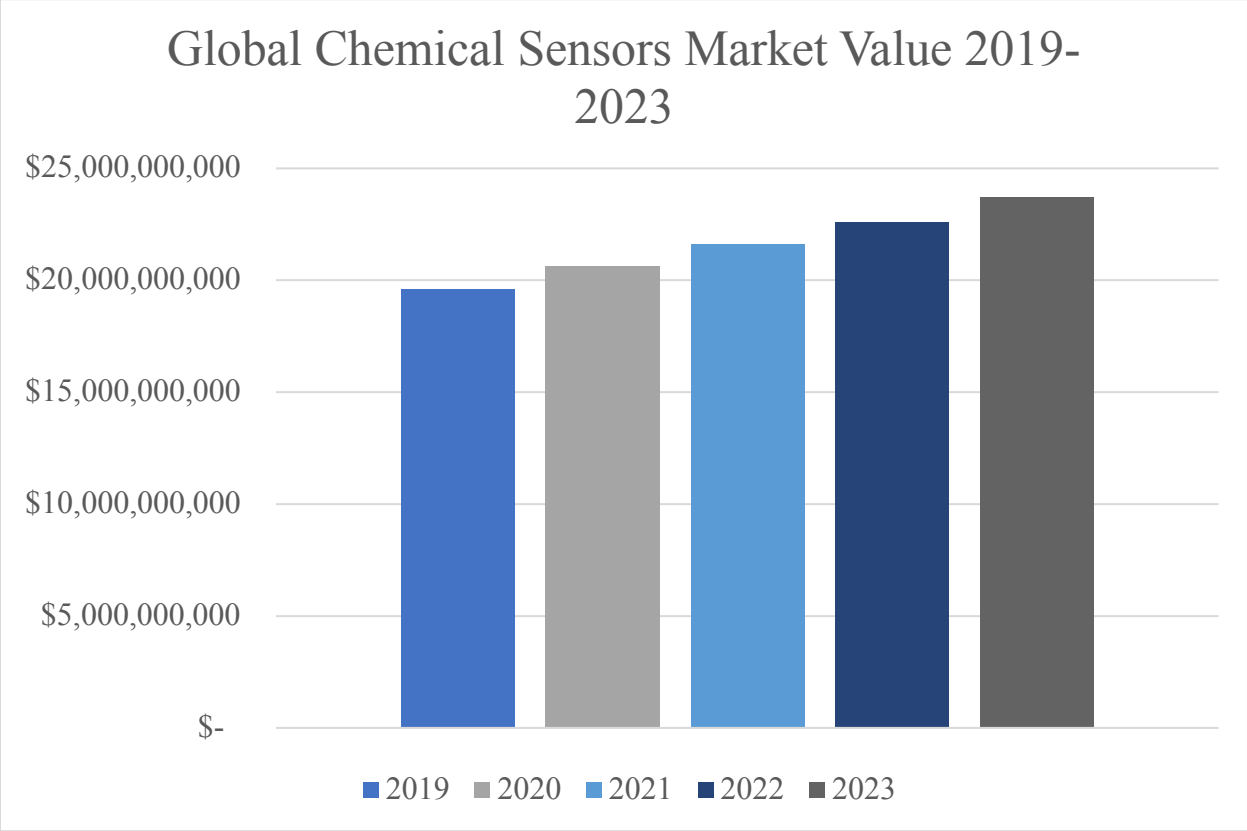
The Global Wireless Sensors Market is used to define, quantify and assess the various types of solutions available. This market was worth $3.1 billion USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 21.1 percent through 2023. This equates to a market value of $9.8 billion USD in 2023.



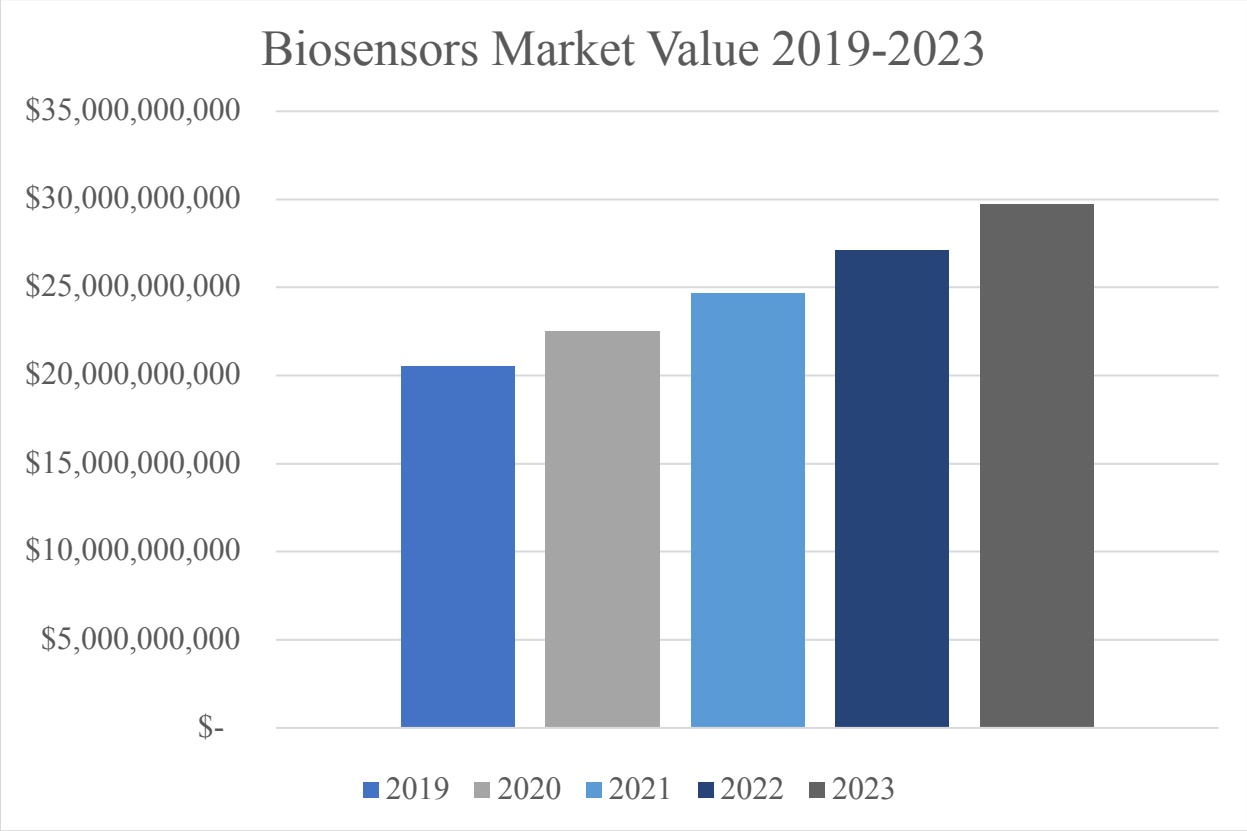
The Smart Sensor Market is used to define, quantify and assess the various types of solutions available. This market was worth $18.6 billion USD in 2015 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 17.6 percent through 2023. This equates to a market value of $67.9 billion USD in 2023.



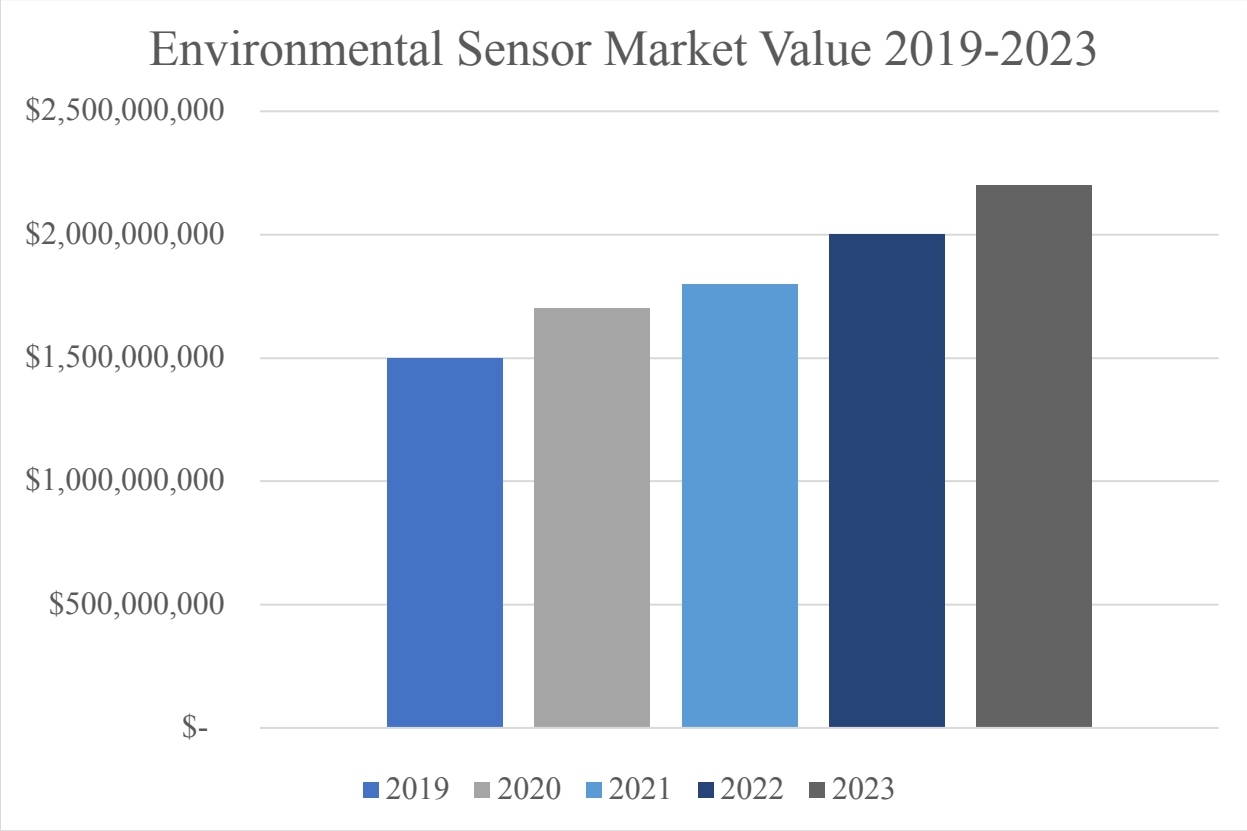
The Global Chemical Sensors Market is used to define, quantify and assess the various types of solutions available. This market was worth $16.3 billion USD in 2015 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 4.8 percent through 2023. This equates to a market value of $23.7 billion USD in 2023.



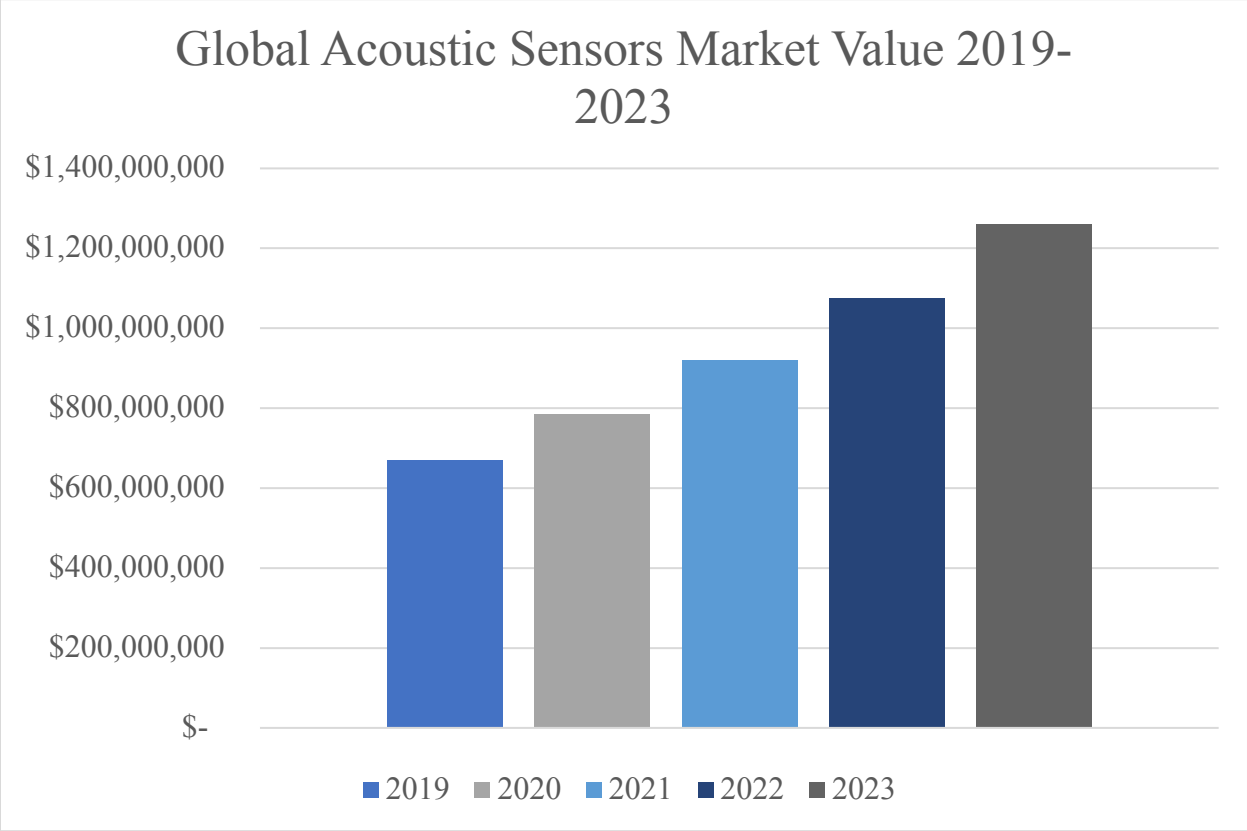
The Biosensors Market is used to define, quantify and assess the various types of solutions available. This market was worth $17.0 billion USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 9.7 percent through 2023. This equates to a market value of $29.7 billion USD in 2023.



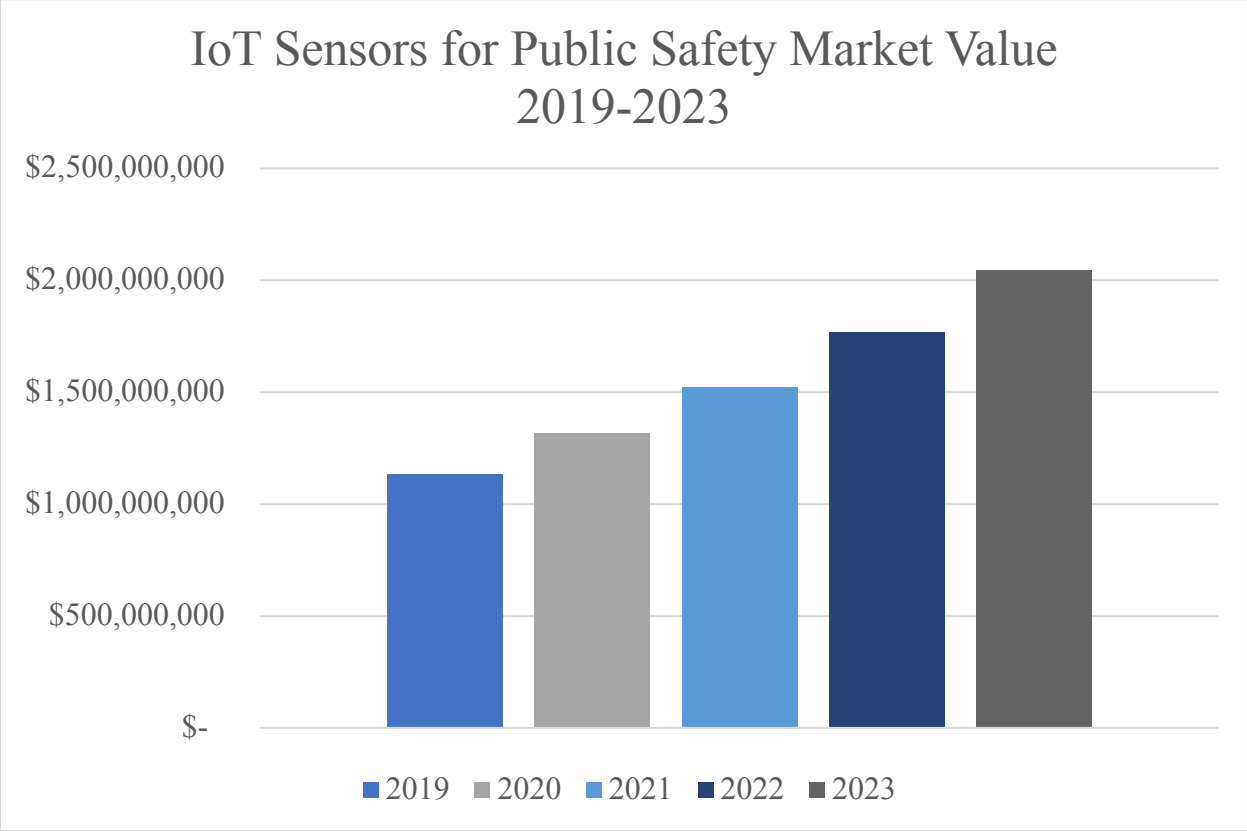
The Environmental Sensor Market is used to define, quantify and assess the various types of solutions available. This market was worth $1.4 billion USD in 2018 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 9.8 percent through 2023. This equates to a market value of $2.2 billion USD in 2023.



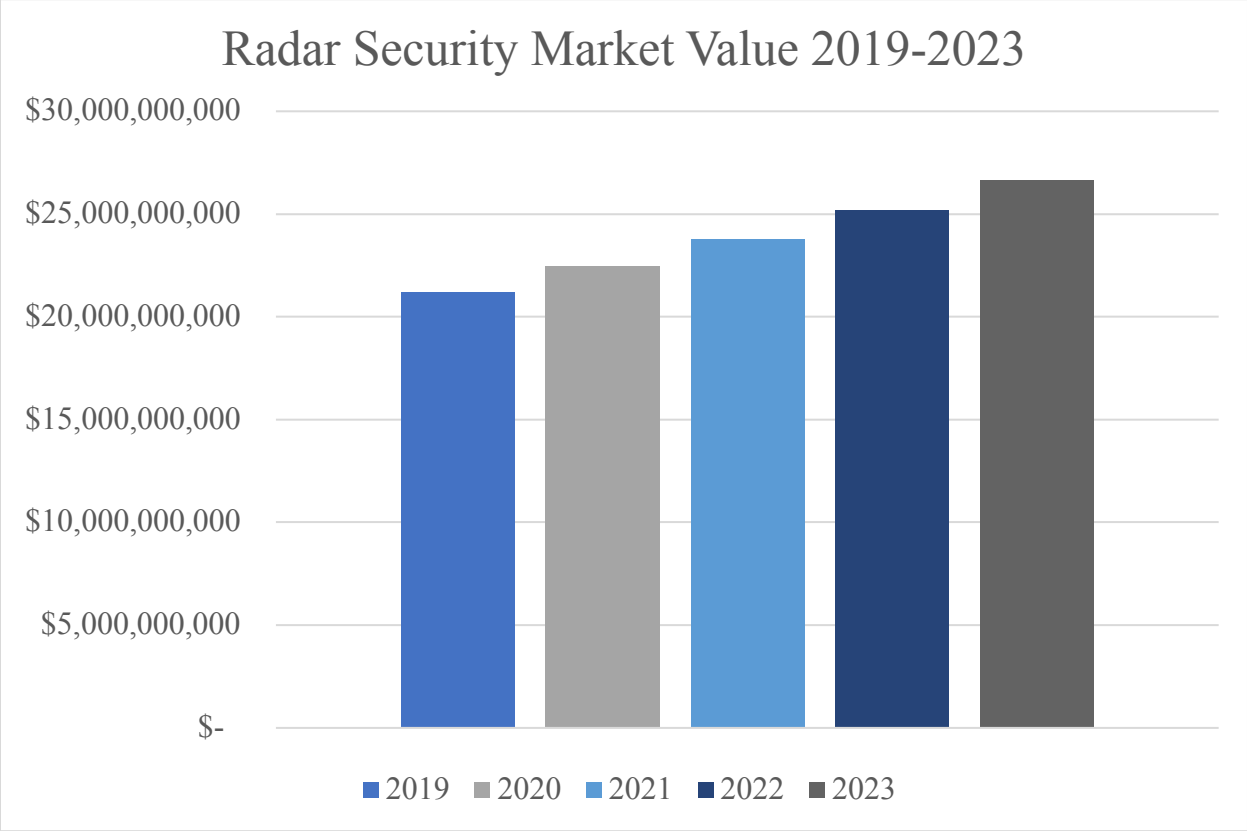
The Global Acoustic Sensors Market is used to define, quantify and assess the various types of solutions available. This market was worth $489.6 million USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 17.1 percent through 2023. This equates to a market value of $1.3 billion USD in 2023.



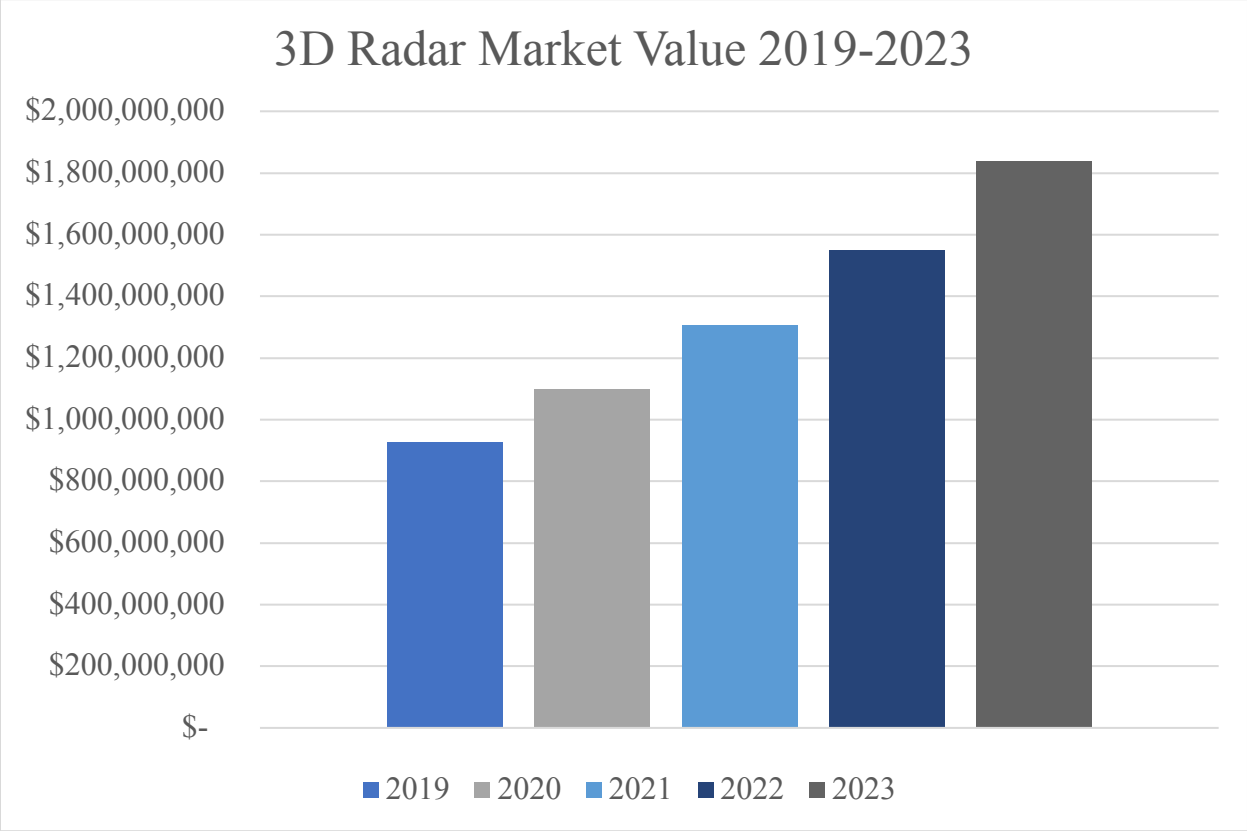
The IoT Sensors for Public Safety Market is used to define, quantify and assess the various types of solutions available. This market was worth $979.0 million USD in 2018 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 15.9 percent through 2023. This equates to a market value of $2.0 billion USD in 2023.



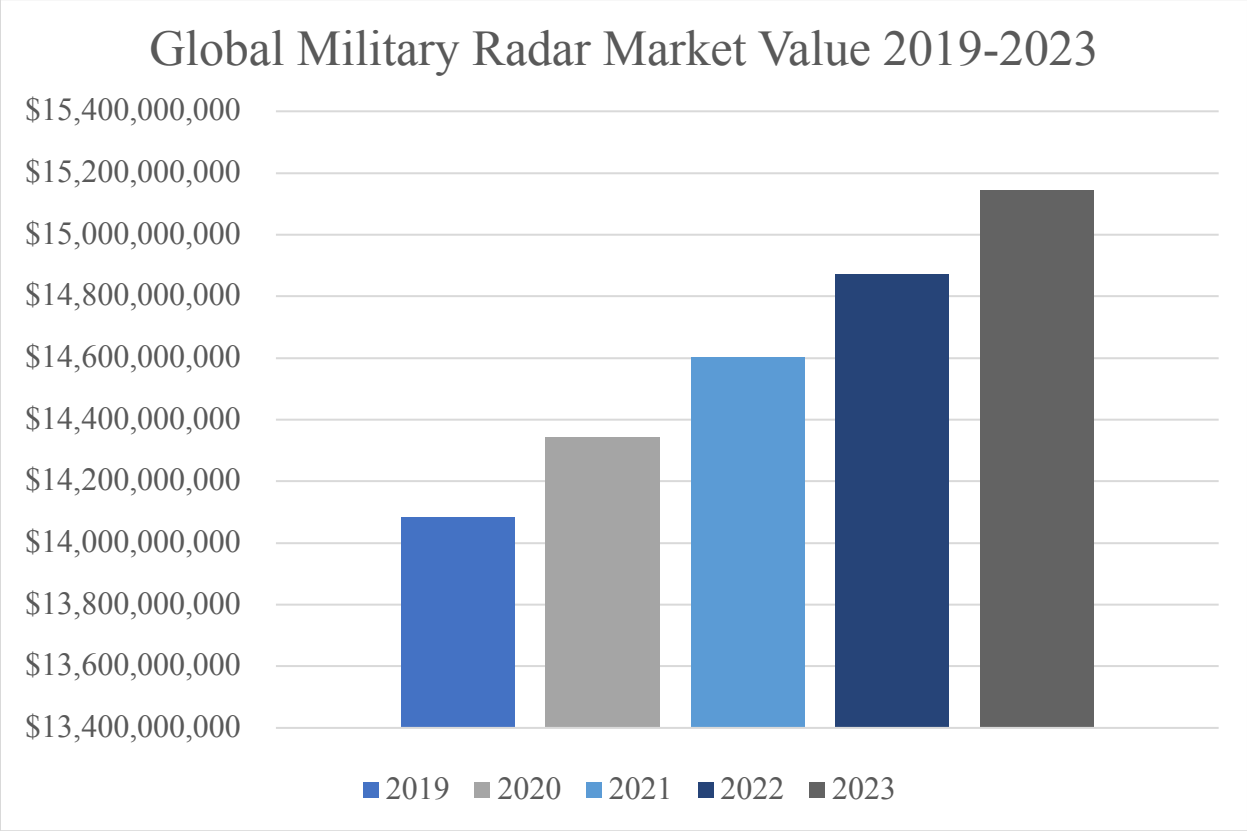
The Radar Security Market is used to define, quantify and assess the various types of solutions available. This market was worth $17.9 billion USD in 2016 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 5.9 percent through 2023. This equates to a market value of $26.7 billion USD in 2023.



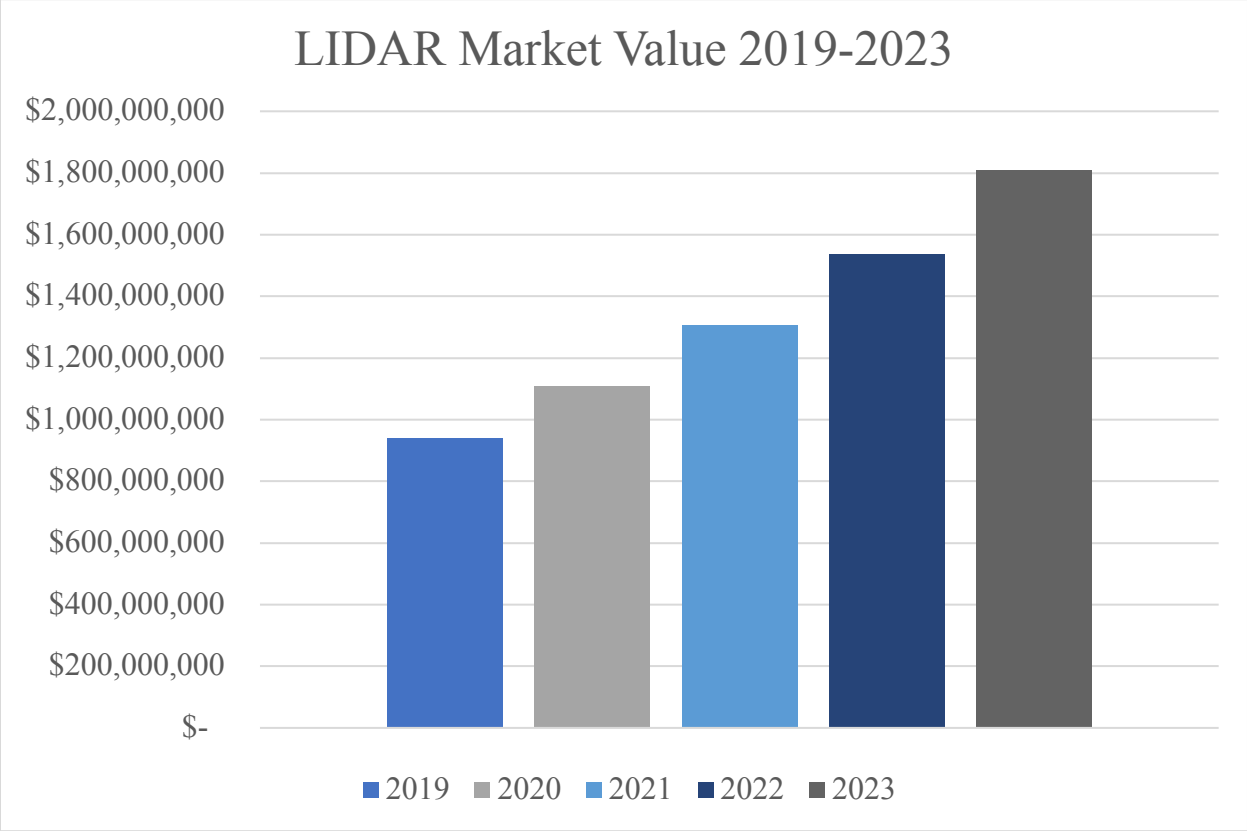
The 3D Radar Market is used to define, quantify and assess the various types of solutions available. This market was worth $657.6 million USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 18.7 percent through 2023. This equates to a market value of $1.8 billion USD in 2023.



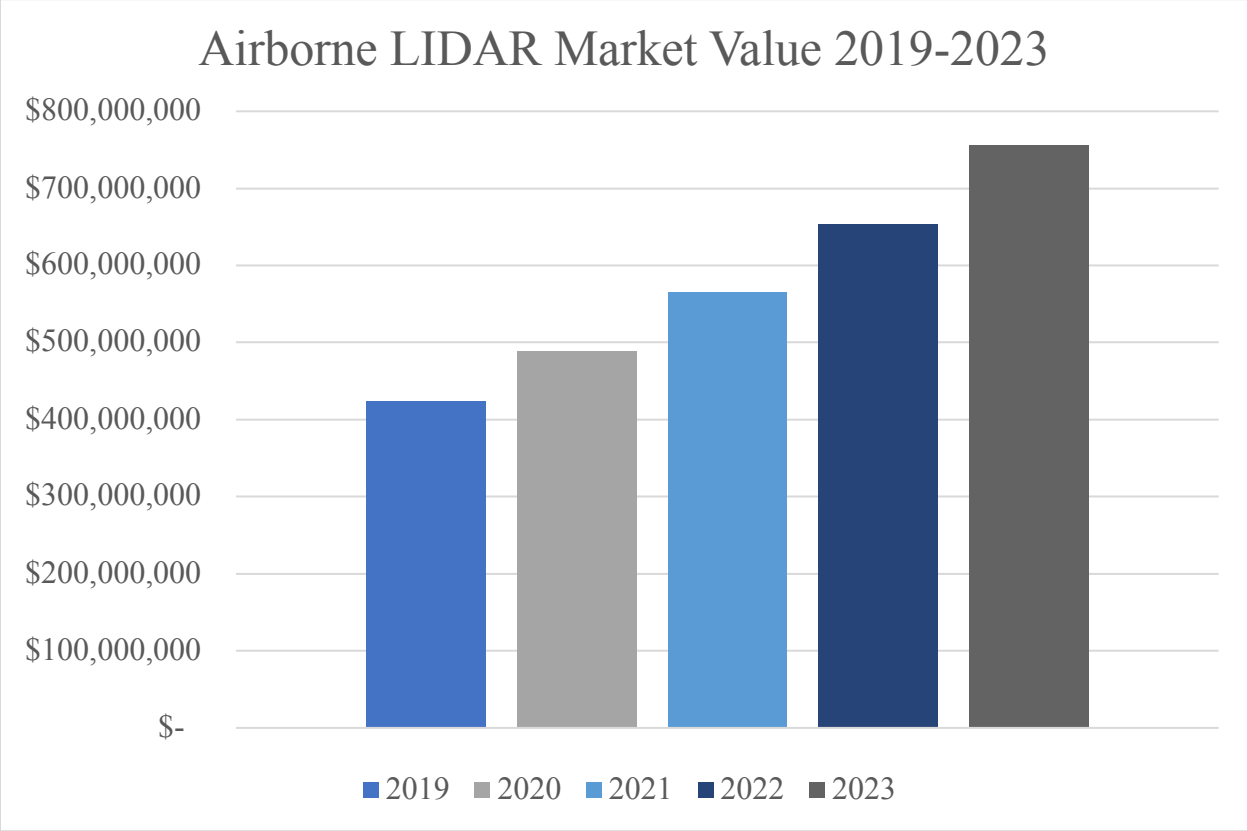
The Global Military Radar Market is used to define, quantify and assess the various types of solutions available. This market was worth $13.1 billion USD in 2015 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 1.8 percent through 2023. This equates to a market value of $15.1 billion USD in 2023.



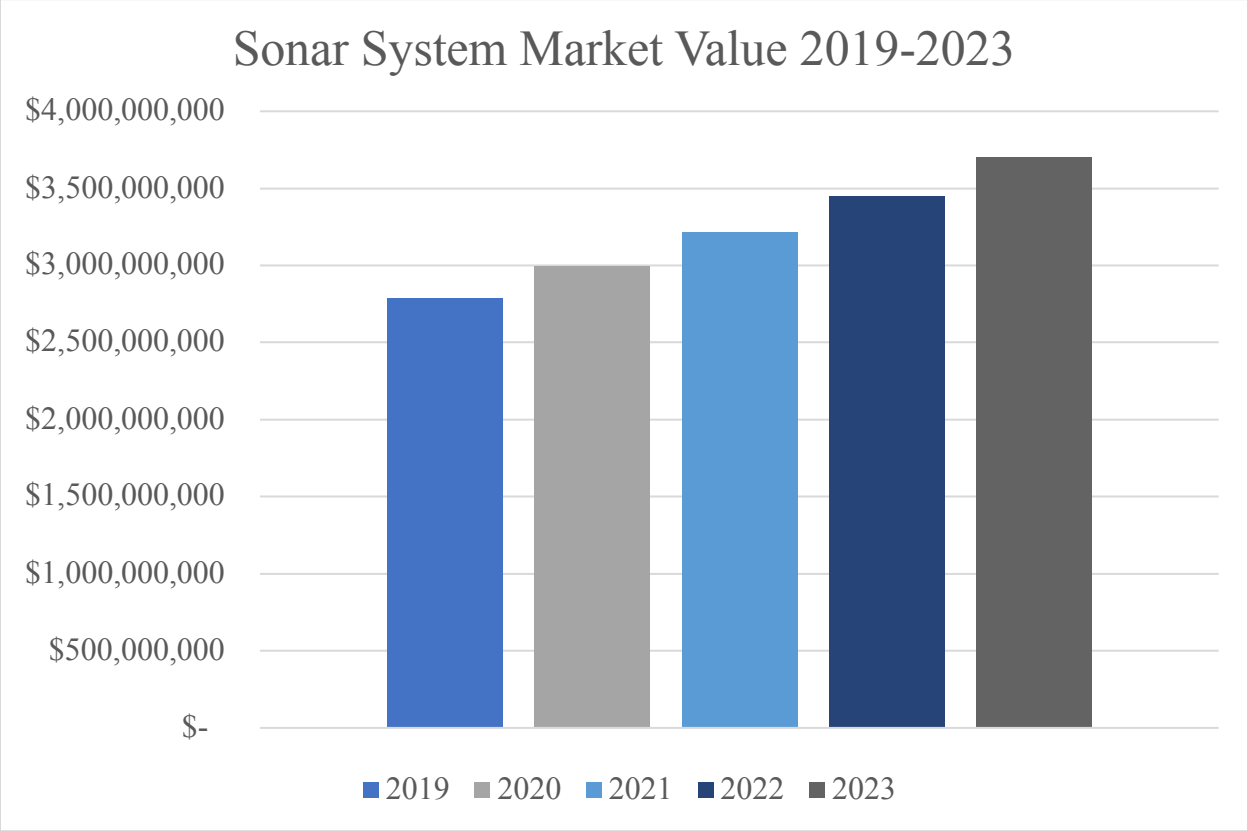
The LIDAR Market is used to define, quantify and assess the various types of solutions available. This market was worth $677.5 million USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 17.8 percent through 2023. This equates to a market value of $1.8 billion USD in 2023.



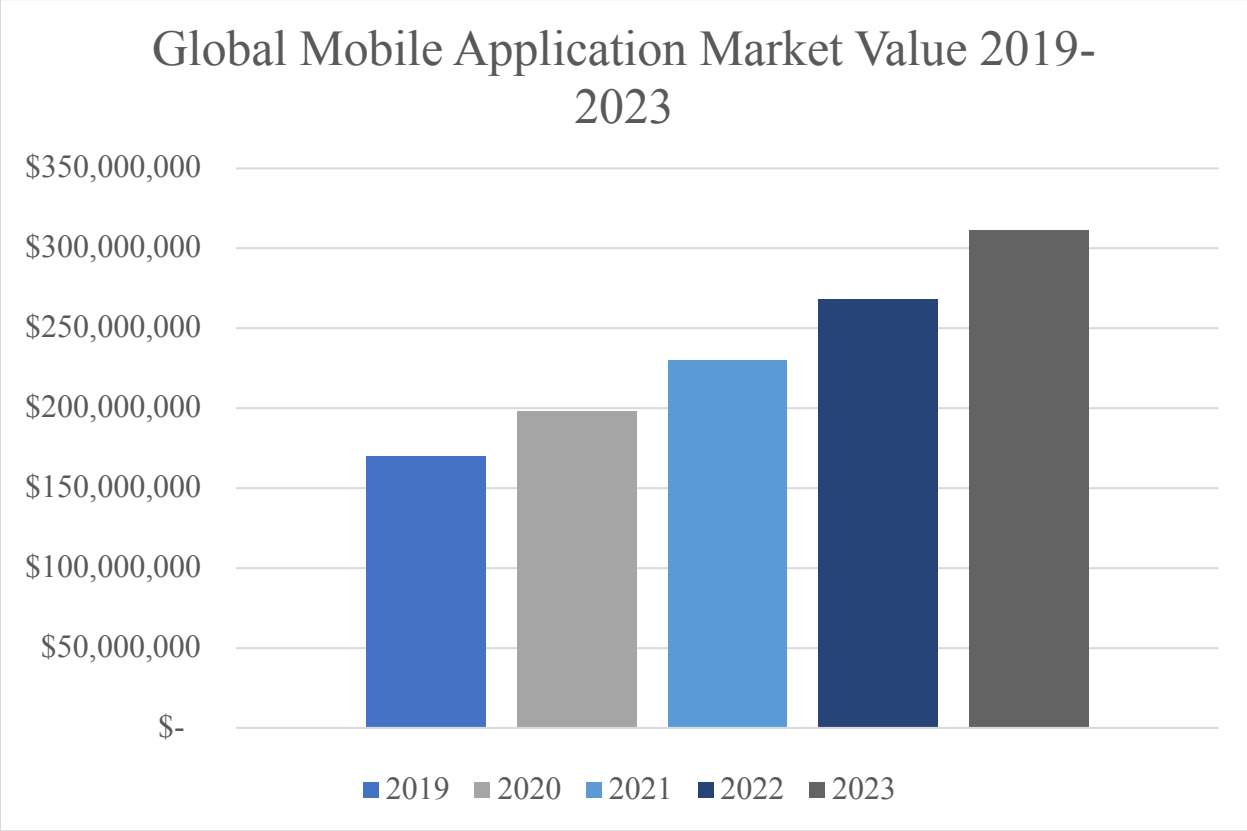
The Airborne LIDAR Market is used to define, quantify and assess the various types of solutions available. This market was worth $316.0 million USD in 2017 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 15.6 percent through 2023. This equates to a market value of $755.4 million USD in 2023.



The Sonar System Market is used to define, quantify and assess the various types of solutions available. This market was worth $2.6 billion USD in 2018 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 7.3 percent through 2023. This equates to a market value of $3.7 billion USD in 2023.



The Global Mobile Application Market is used to define, quantify and assess the various types of solutions available. This market was worth $108.4 million USD in 2016 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 16.3 percent through 2023. This equates to a market value of $311.2 million USD in 2023.



Market Figures

The following table presents the estimated revenue figures for the various sub-markets identified for the Capability Gap 6 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 B of this report.

Obtaining Critical Information Remotely

	Revenue by Year (in $1,000,000 USD)					CAGR
	2019	2020	2021	2022	2023	
*No primary market identified	N/A	N/A	N/A	N/A	N/A	N/A
Global Airborne Surveillance Market [4]	$4,841.8	$5,067.6	$5,303.9	$5,551.2	$5,810.0	4.7%
Unmanned Aircraft Systems (UAS) Market[5]	$17,337.9	$20,757.0	$24,850.5	$29,751.2	$35,618.4	19.7%
Unmanned Aerial Vehicle (UAV) Market[6]	$23,637.6	$26,982.8	$30,801.3	$35,160.3	$40,136.1	14.2%
Small Drones Market[7]	$15,683.2	$18,355.4	$21,483.0	$25,143.4	$29,427.5	17.0%
Military Drones Market[8]	$13,555.7	$15,186.5	$17,013.4	19,060.2	$21,353.2	12.0%
Unmanned Ground Vehicles (UGV) Market[9]	$3,093.6	$3,544.7	$4,061.4	$4,653.5	$5,332.0	14.3%
Unattended Ground Sensors (UGS) Market[10]	$370,328.3	$393,379.0	$417,864.2	$443,873.7	$471,502.0	6.2%

Unmanned Underwater Vehicle (UUV) Market[11]	$2,927.2	$3,082.2	$3,245.6	$3,417.5	$3,598.6	5.3%
Autonomous Underwater Vehicle Market[12]	$571,873.7	$699,687.3	$856,067.2	$1,047.4	$1,281.5	22.3%
Thermal Imaging Market[13]	$3,103.4	$3,314.9	$3,540.9	$3,782.2	$4,040.0	6.8%
U.S. Night Vision Market[14]	$3,892.9	$3,971.6	$4,052.0	$4,134.0	$4,217.6	2.0%
Infrared Imaging Market[15]	$5,530.8	$5,928.1	$6,354.1	$6,810.6	$7,300.0	7.2%
Global Infrared Detector Market[16]	$375,839.2	$415,678.1	$459,740.0	$508,472.3	$562,370.3	10.6%
Global Uncooled Thermal Imaging Market[17]	$3,483.3	$3,817.6	$4,183.9	$4,585.4	$5,025.4	9.6%
Millimeter Wave Technology Market[18]	$1,245.8	$1,698.7	$2,316.4	$3,158.6	$4,307.0	36.4%
Gunshot Detection System Market[19]	$1,462.4	$1,833.8	$2,299.6	$2,883.6	$3,616	25.4%
Digital Map Market[20]	$10,825.4	$12,558.7	$14,569.4	$16,902.2	$19,608.4	16.0%
3D Mapping and Modeling Market[21]	$3,313.7	$3,921.6	$4,641.0	$5,492.4	$6,500.0	18.3%
Global Video Surveillance Market[22]	$39,723.1	$45,701.7	$52,580.1	$60,493.7	$69,598.3	15.1%
Mobile Video Surveillance Market[23]	$1,656.7	$1,802.2	$1,960.5	$2,132.7	$2,320.0	8.8%
Multi-Camera System Market[24]	$1,116.2	$1,409.1	$1,778.7	$2,245.4	$2,834.4	26.2%
Body Worn Cameras System Market[25]	$496,449.5	$686,002.9	$947,931.2	$1,309.9	$1,810.0	38.2%

Dashboard Camera Market[26]	$2,810.5	$3,183.8	$3,606.7	$4,085.9	$4,628.6	13.3%
Global IP Camera Market[27]	$17,424.2	$21,917.6	$27,569.7	$34,679.3	$43,622.4	25.8%
Global Wireless Sensors Market[28]	$4,549.7	$5,511.8	$6,677.4	$8,089.4	$9,800.0	21.5%
Smart Sensor Market[29]	$35,527.4	$41,777.6	$49,127.3	$57,770.0	$67,933.2*	17.6%
Global Chemical Sensors Market[30]	$19,642.4	$20,580.0	$21,562.4	$22,591.7	$23,670.1	4.8%
Biosensors Market[31]	$20,473.9	$22,468.6	$24,657.7	$27,060.0	$29,696.4*	9.7%
Environmental Sensor Market[32]	$1,504.8	$1,656.8	$1,815.3	$1,993.9	$2,190.0	9.8%
Global Acoustic Sensors Market[33]	$670,000.0	$785,113.4	$918,990.0	$1,075.7	$1,259.1	17.1%
IoT Sensors for Public Safety Market[34]	$1,134.4	$1,314.5	$1,523.1	$1,764.9	$2,045.0	15.9%
Radar Security Market[35]	$21,196.3	$22,445.8	$23,768.9	$25,170.0	$26,653.7*	5.9%
3D Radar Market[36]	$926,021.7	$1,098.9	$1,304.0	$1,547.5	$1,836.3	18.7%
Global Military Radar Market[37]	$14,083.9	$14,341.2	$14,603.2	$14,870.0	$15,141.7	1.8%
LIDAR Market[38]	$939,995.4	$1,107.2	$1,304.2	$1,536.2	$1,809.5	17.8%
Airborne LIDAR Market[39]	$422,518.4	$488,567.9	$564,942.5	$653,256.2	$755,375.3	15.6%
Sonar System Market[40]	$2,790.1	$2,994.1	$3,213.0	$3,447.9	$3,700.0	7.3%

Global Mobile Application Market[41]	$170,388.5	$198,087.6	$230,289.5	$267,726.3	$311,249.0	16.3%

Market Highlights

The ability to obtain critical information remotely about the extent, perimeter, or interior of an incident describes the need for improved situational awareness that allows responders and command to identify potential hazards, prioritize incident operations, and improve the safety of responders and affected populations in and around the scene.

Obtaining Critical Information Remotely

Current Capability:
Current solutions related to the ability to obtain information remotely about the extent, perimeter or interior of an incident are focused on technologies that can capture data and images at a distance (primarily UAS, UAV, UGS and camera systems).

Market Quantification

Market Size (2019):	No primary market identified	**Compound Annual Growth Rate (2016-2023):**	No primary market identified

Competitive Landscape

Number of Firms:	301	**Number of Responder-Specific Solutions:**	114

Market Phase

No primary market identified

Market Factors

The figure below summarizes the market factors associated with the ability to obtain critical information remotely about the extent, perimeter, or interior of an incident:[42]

Opportunities

- ✓ Growing adoption of unmanned aerial systems (UAS) and unmanned aerial vehicles (UAV) in civil and commercial applications and military applications
- ✓ Growing adoption of thermal imaging cameras, infrared imaging cameras and Internet-Protocol (IP) cameras
- ✓ Increasing demand for unmanned underwater vehicles (UUVs)
- ✓ Growing adoption of radio detection and ranging (RADAR) systems
- ✓ Increasing use of sensor technology
- ✓ Changing nature of warfare, rising geopolitical issues, terrorism and increasing insurgencies in nations
- ✓ Amendments in laws and rapid technological advancements
- ✓ Increasing national security and public safety threats and growing number of smart city initiatives and health and safety concerns
- ✓ Rising mobile data traffic, growing demand for high speed data connectivity and increasing penetration of internet services and cloud computing
- ✓ Increasing use of smart phones and smart phone applications
- ✓ Ongoing technological advancements in big data, video analytics, Internet of Things (IoT) and Cloud-Based Services
- ✓ Increasing adoption of Machine Learning (ML) and Artificial Intelligence (AI)-based public safety solutions
- ✓ Increasing demand for early detection and situational awareness
- ✓ Growing concerns over protecting critical infrastructure and sensitive data

Barriers

- x Restrictions and regulations on drone usage/airborne surveillance (e.g., FAA regulations)
- x Lack of proper air traffic management for unmanned aerial vehicles (UAV) and issues with safety and security of UAVs
- x Privacy issues regarding data usage
- x High cost of technology
- x Size and weight of devices
- x Cyber security concerns
- x Environmental concerns
- x Limited internet ranges

Competitive Landscape

A total of 301 firms were identified as operating in the markets listed above, 22 of which are considered key global market players, including:

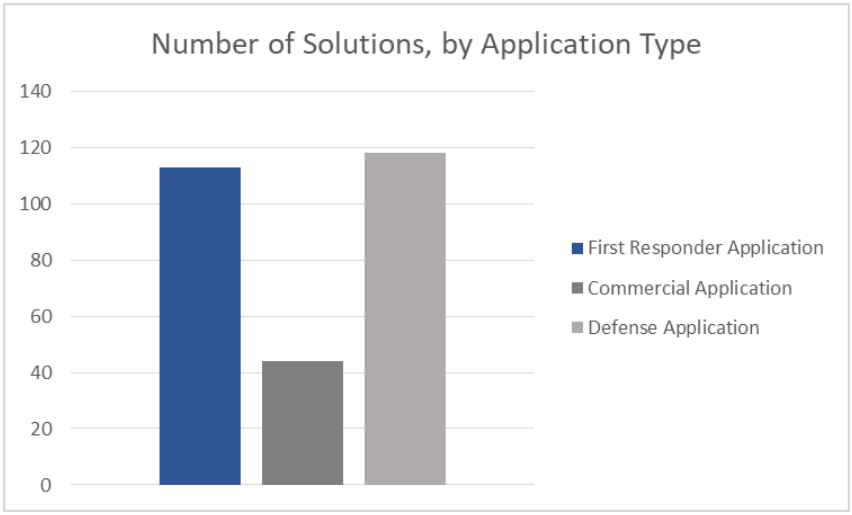
- Axis Communications (United States)
- BAE Systems (United Kingdom)
- Boeing (United States)
- Bosch Security Systems Incorporated (United States)
- Elbit Systems Ltd. (Israel)
- FLIR Systems, Inc. (United States)
- Harris Corporation (United States)
- Honeywell International Inc. (United States)
- Israel Aerospace Industries Ltd. (Israel)
- Kongsberg Gruppen (Norway)
- L3 Technologies (United States)
- Leonardo (Italy)
- Lockheed Martin Corporation (United States)
- Northrop Grumman Corporation (United States)
- Panasonic (United States)
- Raytheon (United States)
- Saab AB (Sweden)
- Siemens AG (Germany)
- Sofradir (France)
- Teledyne Technologies, Inc. (United States)
- Thales Group (France)
- Zhejiang Dahua Technology Company Limited (China)

Within this study there are a total of 189 existing solutions and 18 research and development (R&D) initiatives with relevance to Capability Gap 6 identified. This landscape is non-exhaustive, as the number of solutions is vast and ever-changing at a rapid pace.

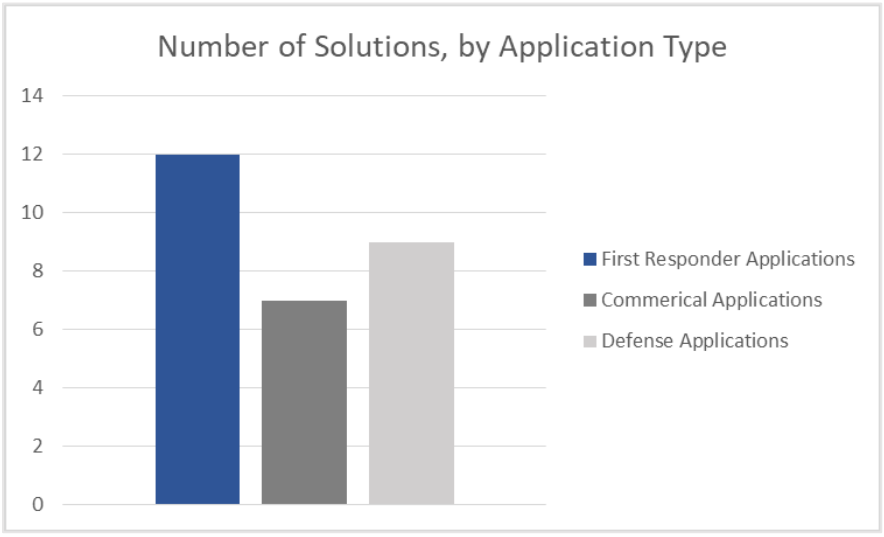
Among the existing and developing solutions identified, 114 solutions (60 percent) appear to have first responder applications and 12 solutions (67 percent) appear to be in development for first responder use. These numbers may indicate that industry is aware that a first responder need exists within 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. Remotely capture incident-related data in multiple topographies (e.g., inside buildings, at various depths and elevations, over rubble and across different terrains); and
2. Visualization of surveillance outputs to provide actionable information.

It appears that the greatest gap exists for systems capable of visualization of surveillance outputs to provide actionable information. Most of the existing solutions are have limitations with this aspect.



While the greatest number of existing solutions (118) identified in this assessment appear to have defense applications, 114 solutions have first responder applications and 44 have commercial applications.



There is also a total of 18 R&D initiatives related to Capability Gap 6 identified in this assessment. Among the developing solutions identified, industry is involved in the development of 13 solutions, academia is involved in the development of three solutions, and government is involved in the development of six solutions. Twelve developing solutions are focused on first responder applications, seven are focused on commercial applications and nine are focused on defense applications.

Based upon the data presented, more than half of all existing and developing solutions appear to be targeting first responder applications. Therefore, industry is likely 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 visualize surveillance outputs to provide actionable information is underserved. This presents an 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 6 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 A 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/Social Media Feeds/Analytics Software/Digital Maps

IncidentView

Alsea Geospatial, Inc. (AGI) is a mobile application, geographic information system (GIS) and database company. It is an ESRI® Business Partner and Authorized Developer and specializes in linking databases to GIS and developing tools that make GIS easy to use.[43]

AGI's IncidentView provides tactical information to first responders in augmented digital maps. It is a cross-platform application (app) for first responders created to decrease response times, provide fast access to critical tactical information, and improve response coordination. Data sources include automatic vehicle location (AVL), dispatch information and notifications, local infrastructure, address records, preplan displays, and routing and navigation. An editor feature allows users to control and edit fire infrastructure data such as hydrants, standpipes, and access panels. IncidentView can be accessed on Windows, iOS, and Android devices.[44]

Pricing for IncidentView depends on the particular device used.

Figure 1: IncidentView on desktop computer

Bryx, Inc.

Bryx is an employee-owned, public safety technology company that develops products for first responders. Specifically, it focuses on simplifying communications and delivering relevant and real-time information. The company has expertise in software engineering, mobile and station alerting, data analytics, app development, support and consulting and data mapping.[45] Bryx offers two first-responder specific solutions related to this Capability Gap:

The **Bryx 911 app** is a smartphone application that provides firefighters with real-time intelligence aimed to aid in incident response. New 911 job alerts are sent directly from the responding agency's computer-aided dispatch (CAD) and arrive 45 seconds before radio alerts. Responders are also able to receive information about the location of the incident including past 911 calls and site survey data. In addition, the app connects the responding agency's department with messaging groups and live location updates. Bryx states some additional key features which include:[46]

- Hydrant information;
- Routing and navigation;
- Flexible dispatch;
- Radio stream; and
- 24/7 support

The application is listed as free to first responders on the Bryx website.

The **Bryx Drone,** according to Bryx**,** is the first fully-integrated unmanned aerial system (UAS) that delivers autonomous, real-time information to public safety and emergency services. The drone is automatically integrated into the Bryx Platform and provides real-time data to first responders. The data that it captures is instantly distributed to responders through Bryx 911 and Bryx Station. Bryx states the key features of the drone include the following:[47]

- Live footage;
- Autonomous; and
- Easy deployment

Information regarding pricing does not appear to be publicly available.

Department of Homeland Security (DHS)

The U.S. Department of Homeland Security, established in 2002, is a cabinet department of the U.S. federal government with responsibilities in public security. Specifically, its mission is to "ensure a homeland that is safe, secure, and resilient against terrorism and other hazards."[48] Missions include: preventing terrorism and enhancing security, managing the nation's borders, administering immigration laws, securing cyberspace, and ensuring disaster resilience.[49] In addition, DHS focuses specifically on maturing and strengthening the homeland security enterprise itself. DHS offers a couple first-responder specific solutions related to this Capability Gap:

DHS developed the **FiRST (First Responder Support Tools) Application (App)**. FiRST provides responders and emergency managers with critical, map-based information to support improvised explosive device (IED) and HAZMAT incident response. The app allows users to post incident details, alert users when new information is posted, and retrieve incident details that remain fully interactive within the app. It is simple to use as it is available on mobile devices and is accessible anywhere. Some of the key features of the FiRST app include:[50,51]

- Place IED and HAZMAT incidents on map and view recommended standoff;
- View points of interest near an incident site;
- Create and save user defined IEDs and standoff;
- View an optimized set of roadblocks required to isolate the road network for user road data stored locally;
- Save/open incident data;
- Email incident details including GIS data (KML, Shapefiles);
- View IED and HAZMAT incidents on the same map;
- User define points of interest to display at incident locations;
- Annotate map with points;
- Annotate map with lines and polygons;
- Post and retrieve incidents from the FiRST sharing service with an associated organizational subscription;
- Access to 2012 Emergency Response Guidebook (ERG) chemical guides and contacts; and
- Display contours for six damage and injury categories resulting from an IED.

Figure 2: FiRST smartphone app for iOS and Android

FiRST is fully commercialized and available for purchase on iTunes and Google Play.

- iTunes: $4.99
- Google Play: $4.99

The **Next-Generation Incident Command System (NICS)** is a collaborative, online incident map with a virtual whiteboard that allows first responders to collaborate, pool resources, and plot strategies. The web-based software was developed by the Massachusetts Institute of Technology Lincoln Laboratory, in partnership with the California Department of Forestry and Fire Protection. NICS manages and distributes real-time feeds (e.g., vehicle locations, airborne images, video, weather, critical infrastructure, and terrain) to first responder decision makers during an incident. This information is then integrated into an online map using a geographic information system (GIS). Users can continue to enter information into the system even in disconnected environments. Once connection is regained, the data is updated. This system is available at no cost to first responders.[52]

Edgybees

Edgybees is a company that focuses on augmented reality and virtual environments. It originally started out developing video games for commercial users but soon realized that its technology could potentially provide life-saving benefits in the military and first responder realm. The company overlaid its game-like interfaces on to dynamic and complex real-world scenarios which proved to eliminate operational ambiguity with visual augmented intelligence and visually-enhanced real-time communication. Through this, Edgybees developed its primary technology, the Edgybees Visual Intelligence Technology™ Platform.[53]

The **Edgybees Visual Intelligence Technology™ Platform** fuses 3-dimensional (3D) video generation, computer vision and multi-sensor data analytics to create dynamic virtual worlds for

any complex environment. Specifically, it augments live video feeds with precise geo-information layers captured from any camera, human input or other data sources. It can be used in public safety to provide first responders with live-saving augmented reality visual intelligence software that can allow them to quickly understand any emergency operational scene with real-time collaborative visual intelligence technology. In the public safety case, the technology augments live drone feeds with geo-information layers including maps, building layouts, points of interest, user-generated markets and more data layers that provide visual context operational intelligence.[54,55] Information regarding pricing does not appear to be publicly available.

FLIR® Systems, Inc.

FLIR® Systems, Inc. designs, develops, manufactures, markets and distributes technologies that focus on enhancing perception and awareness. It offers thermal imaging, visible-light imaging, video analytics, measurement and diagnostic, and advanced threat detection systems solutions. FLIR® serves a number of applications in the government & defense, industrial, and commercial markets. It appears to offer several solutions related to this Capability Gap, some of which are listed and described below:

FLIR® TruWitness is a platform that combines smart mobile sensors and internet-of-things (IOT) capabilities with the FLIR® cloud. The tool allows responders to see and respond to complex threats as they occur in real-time. This is made possible through real-time video, audio and location data that is captured and displayed on FLIR®'s United Video Management System (VMS). TruWitness also enables enhanced collaboration between law officers, agents and control room operators. FLIR® states some of the key features of TruWitness include the following:[56]

Figure 3: FLIR TruWitness

- Offers superior image quality;
- Able to stream live video, audio and Global Navigation Satellite System (GNSS) data;
- Offers wearer-triggered alarms;
- Includes Neighbor Aware™[2];
- Includes Programmable CONOPS™[3];
- Offers cyber protection; and
- Creates event reports

Information regarding pricing does not appear to be publicly available.

[2] Interaction between different devices, creating an IoT network between the devices allowing to trigger nearby units, share location and metadata, auto-stream and record from nearby devices and auto-direct nearby PTZ cameras to the location of event.

[3] Allows user to set different business logic profiles such as recording profiles, pre-alarm recording buffer time, and audio.

Motorola Solutions, Inc.

Motorola Solutions, Inc. 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. It offers multiple first-responder specific technologies, some of which are listed and described below:[57]

The Motorola **Command Center Software Suite** is public safety's only command center software suite. It helps in increasing the situational awareness of responders in the field as it captures video and digital images of the incident and immediately sends it to first responders' devices. It was built for mission-critical environments. The suite integrates emergency call handling, command and control, records and evidence, and broadbands push-to-talk (PTT).[58] Information regarding pricing does not appear to be publicly available.

The **LEX L10 Mission Critical LTE Handheld** is a handheld communications device that was created specifically for police officers in the field. It ensures optimal coverage on both the Verizon 3G/4G Commercial and Public Safety LTE networks and allows officers more opportunities to quickly collaborate and share information across agencies either in daily or covert operations. Motorola states some of the key features of the LEX L10 include the following:[59]

Figure 4: LEX L10 Mission Critical LTE Handheld

- Google Mobility Services (Optional);
- Commercial LTE network (Band 13 & 4);
- Public safety LTE network (Band 14);
- FIPS 140-2 level 3 hardware encryption;
- IP67 and MIL-STD 810G rated durability;
- 4.7' touch display;
- Dedicated puch-to-talk button;
- APX audio quality at 100+ phon;
- Standard and high-capacity removable battery options;
- Covert operation mode;
- WiFi connectivity;
- Mission critical Bluetooth 4.0; and
- Public safety applications

Information regarding pricing does not appear to be publicly available.

The **PremierOne Handheld** is Motorola's smartphone application that keeps responders connected with mission-critical data on Android-powered smartphones or tablets. Officers are able to quickly look up critical details about people, property and vehicles while on the move, enhancing situational awareness. This solution does not require dispatch assistance and officers have the flexibility to control their access to critical data when and where they need it, which increases response time. Specifically, firefighters can use it to receive continuous access to dispatch and constantly changing situational data; police officers can use it to query suspects, attach photos to incidents, voice incident comments and collaborate with other officers responding to the scene; and command staff can use it to monitor department operations with visibility to active and pending incidents, and unit activities when away from the office.[60] The app appears to be free of charge; however further information regarding pricing does not appear to be publicly available.

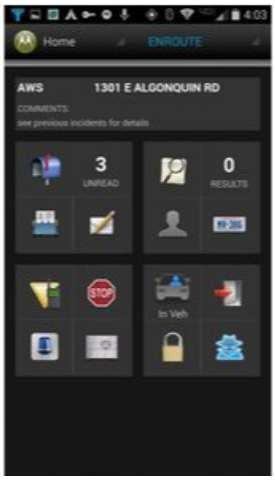


Figure 5: PremierOne Handheld

AXIS® Q6000-E Pan-Tilt-Zoom (PTZ) Network Camera

AXIS® Communications is a company that provides network solutions to improve security. The company operates in the information technology (IT) and security industries and has extended into the audio, voice over IP and building automation technologies. Video surveillance, access control and audio solutions are its primary offerings. It also provides training, service and support.[61]

The **AXIS® Q6000-E Pan-Tilt-Zoom (PTZ) Network Camera** is a surveillance camera that offers total situational awareness and is ideal for city surveillance applications such as monitoring of public squares and parking lots and other open areas. The camera features four 2-megapixel sensors to provide a complete 360-degree field of view over large areas. AXIS® states some of the key features of the AXIS® Q6000-E PTZ Network Camera include the following:[62]

Figure 6: AXIS Q6000-E Network Camera

- Full 360-degree overview with one-click PTZ control;
- Compatible with AXIS® Q60-E/Q61-E PTZ Network Cameras;
- Exchangeable M12 lenses;
- Flexible camera heads with tilt functionality; and
- AXIS® Zipstream technology

Information regarding pricing does not appear to be publicly available.

FLIR® Systems, Inc.

FLIR® Systems, Inc. designs, develops, manufactures, markets and distributes technologies that focus on enhancing perception and awareness. It offers thermal imaging, visible-light imaging, video analytics, measurement and diagnostic, and advanced threat detection systems solutions. FLIR® serves a number of applications in the government & defense, industrial, and commercial markets. It appears to offer several solutions related to this Capability Gap, some of which are listed and described below:

FLIR® states **FLIR Argus™** is a fixed, rugged, integrated wide-area surveillance system for perimeter security. It is designed to detect and track multiple threats and it works in harsh weather conditions. FLIR® claims some of the key features of Argus™ include the following:[63]

Figure 7: FLIR Argus

- Includes radar and thermal/visible cameras;
- Can be quickly installed (hours versus days);
- Can track more than 500 targets simultaneously;
- Offers multiple power options; and
- Provides continuous perimeter security

Information regarding pricing does not appear to be publicly available.

The **FLIR® UltraFORCE® 350-HD** is a compact multi-sensor gyro-stabilized surveillance system. This system was built to mount on to rotary-wing, fixed-wing, and unmanned airborne platforms. It offers high-quality, real-time full motion video (FMV) from both manned and unmanned airborne platforms. The camera can also identify targets from a long distance and has covert operations at high standoff ranges. The Global positioning system (GPS) provides accurate geo-referencing for peripheral moving maps. FLIR® states some of the key features of UltraFORCE® 350-HD include the following:[64]

Figure 8: FLIR UltraFORCE 350-HD

- Offers significant swap advantages;
- Has a flexible sensor payload;
- Includes multiple spotter and laser options;
- It is EASA Form 1 compliant; and
- Offers rich metadata output

Information regarding pricing does not appear to be publicly available.

The Boeing Company

The Boeing Company states it is the world's largest aerospace company and leading manufacturer of commercial jetliners, defense, space and security systems, and service provider of aftermarket support. The company supports airlines and U.S. and allied government customers in over 150 countries. Its solutions and services include commercial and military aircraft, satellites, weapons, electronic and defense systems, launch systems, advanced information and communication systems, and performance-based logistics and training.[65] Boeing offers a few solutions related to this Capability Gap, two of which are listed and described below:

The Boeing **High Altitude Long Endurance (HALE)** is an unmanned aerial system (UAS) that can fly at 65,000 feet for up to 10 days without having to refuel and with 270 nm sensing line-of-sight. It provides affordable, persistent intelligence, surveillance and reconnaissance, missile defense or other missions. Boeing states some of the key features of the HALE include the following:[66]

- Transformational range enables theater monitoring from afar;
- Twin engines, independent fuel supplies and redundant vehicle management systems;
- Up to 10 days endurance at 65,000 feet – 20 days endurance at 20,000-25,000 feet;
- Long mission duration, high system reliability, autonomy and fuel efficiency;
- Sensing light of sight (LOS) Horizon > 270 nm;
- Redundant systems for reliability;
- Low operating costs per hour; and
- Able to complete the mission with one engine inoperable

Figure 9: Boeing HALE

Information regarding pricing does not appear to be publicly available.

The Boeing **Integrator** is a UAS that is a modular, flexible and versatile solution for sustained operations and multiple missions on land or at sea. It has applications in search and rescue, disaster response, border security and firefighting, among others. The aircraft has six payload spaces that can be customized with cameras, communication capabilities and other advanced mission-specific technologies.[67] Information regarding pricing does not appear to be publicly available.

Figure 10: Boeing Integrator

DJI

DJI is a Chinese manufacturer of commercial unmanned aerial systems (UAS). Notably, it is the largest drone manufacturer in the world, comprising of two-thirds of the UAS global market.[68] Research findings indicate that responder communities across the world have leveraged many DJI technologies. However, it may also be important to note that various government agencies and oversight authorities have instituted restrictions due to the company's foreign ownership and related national security concerns. For instance, the U.S. Army banned DJI devices in the field. That said, since it is a prominent vendor in this space, it is important to highlight some of its solutions as they relate to this Capability Gap. A few of DJI's first-responder related solutions are listed and described below:

DJI states its **Inspire 1 v. 2.0.** is a drone that features an on-board camera that streams high definition (HD) video back to the police headquarters in real-time. It can also stream video to responders' cellphones. Inspire 1 v. 2.0 is controlled by a trained critical incident manager who communicates with officers in the field, giving them information about the incident. DJI states some of the key features of **Inspire 1 v. 2.0.** include the following:[69]

Figure 11: Inspire 1 v.2.0

- Upgraded image processing system;
- Goes from 0 to 50mph in five seconds;
- Has a dual battery system;
- FlightAutonomy allows it to have two directions of obstacle avoidance and sensor redundancy;
- Has multiple intelligent flight modes, including Spotlight Pro; and
- Upgraded video transmission system

Price: $2,999[70]

DJI offers its **Matrice 200 Series** drones which offer a thermal aerial solution for first responders. The drones are quadcopters that have motors paired with 17-inch propellers which help ensure stable flight in strong winds. The company has also developed an open API for their flight software. This enables the drones to have route automation and control. All of the Matrice 200 Series drones can be unfolded and folded quickly and may be applicable for power line inspection, search and rescue, wind turbine inspection, bridge inspection, and firefighting, among others.[71] Information regarding pricing does not appear to be publicly available.

Figure 12: DJI Matrice 200 Series Quadcopter

The **Mavic 2 Enterprise Dual** is DJI's first foldable enterprise thermal drone, ideal for thermal imaging pilots. It offers FLIR infrared and Red, Green, and Blue light (RGB) cameras which make situational awareness very easy. It has applications in firefighting, search and rescue and police activity. DJI states some of the key features of the Mavic 2 Enterprise Dual include the following:[72]

Figure 13: DJI Mavic 2 Enterprise Dual

- Powerful image transmission & timestamping;
- Long flight times;
- Safety awareness and data security; and
- Ready for attachments

Price: $2,949

FLIR® Systems, Inc.

FLIR® Systems, Inc. designs, develops, manufactures, markets and distributes technologies that focus on enhancing perception and awareness. It offers thermal imaging, visible-light imaging, video analytics, measurement and diagnostic, and advanced threat detection systems solutions. FLIR® serves a number of applications in the government & defense, industrial, and commercial markets. It appears to offer several solutions related to this Capability Gap, some of which are listed and described below:

FLIR® partnered up with DJI, a Chinese technology company, to provide the **FLIR® Aerial First Responder Kits** (i.e., basic and advanced). The Kits provide drone-based thermal imaging by equipping a DJI unmanned aerial system (UAS) with a FLIR® thermal imaging camera. They are particularly suited for firefighting support as they give incident commanders the ability to see through smoke and keep track of their firefighters in large fires. The Kits are also applicable for rapidly deployed search and rescue missions, day or night. FLIR® states some of the key features of the Aerial First Responder Kits include the following:[73]

Figure 14: FLIR Aerial First Responder Kits

- Offers airborne thermal imaging support;
- Ability to see through smoke and track personnel in complex fire scenes;
- Offers expanded search and rescue operations, day and night;
- Ability to monitor roof conditions to reduce risk to firefighters;
- Includes an integrated, easy-to-fly aircraft that provides an application for live video, camera control and digital recording; and
- Provides a complete package that includes everything needed to start flying within minutes

Information regarding pricing does not appear to be publicly available.

Insitu, Inc.

Insitu, Inc. is a wholly owned subsidiary of The Boeing Company that designs, develops, produces and operates unmanned aircraft systems (UAS). These UAS can be applied to intelligence, surveillance and reconnaissance efforts in defense as well as government and commercial industries (e.g., environmental monitoring, precision agriculture, search and rescue, disaster relief, and mining operations).[74]

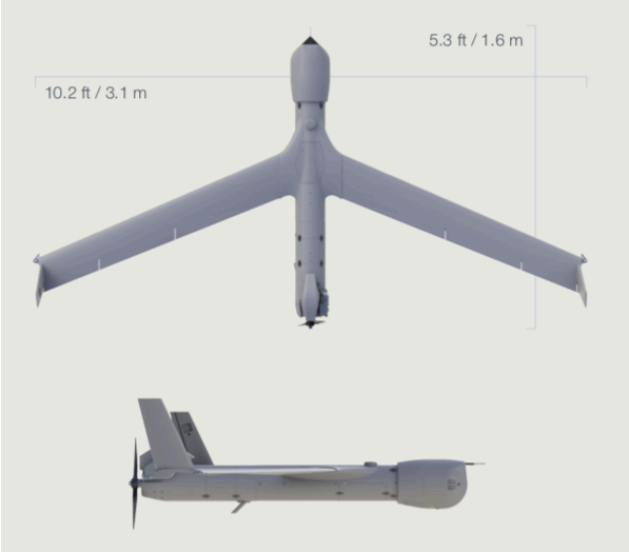


Figure 15: Insitu ScanEagle

Insitu's **ScanEagle®** and **ScanEagle® 2** are both UAS that deliver persistent imagery on land or at sea for intelligence, surveillance, and reconnaissance (ISR) missions. Insitu states ScanEagle® 2 offers extensive capabilities over ScanEagle® which include: more reliability and increased affordability, expanded payload options, rapid payload integration, and a purpose-built propulsion engine to optimize performance.[75] These solutions may be able to provide first responders with continuous surveillance of an incident scene, increasing response efficiency and responder safety.

Information regarding pricing does not appear to be publicly available.

Skyfront

Skyfront is a company that produces autonomous, hybrid-electric, aircraft vehicles.[76] The **Skyfront Perimeter™ Hybrid-Electric UAV** is a drone that is ideal for search and rescue missions as it allows responders to quickly search 1,000 acres. It can also be used for emergency communications relay, monitoring of wildfires, searches for lost hikers and swimmers, searches for fugitives, and damage surveys after disasters. Skyfront drones are able to carry many different payloads for long periods of time. Skyfront states some of the key features of the Skyfront Perimeter™ Hybrid-Electric UAV include the following:


Figure 16: SkyFront Perimeter Hybrid-Electic UAV

- Extremely long flight times (between 3-4 hours);
- Wide area coverage;
- Rapid deployment (less than five minutes);
- Easy to fly;
- Cold weather operation;
- Rain resistant; and
- Wide payload selection

Information regarding pricing does not appear to be publicly available.

Paladin Drone

Paladin Drone deploys drones to 911 calls for instant situational awareness. The company provides its **Paladin Drone Software** that automatically dispatches a drone to the scene of the emergency and streams a live video feedback to the Paladin Drone app. The software handles security, safety, weather, video, route planning, and more.[77] The goal is to do as much data gathering and analysis

as possible before any first responder gets on site. The software is currently only compatible with DJI drones, though the hope is that any drone can use the software to aid responders in the future.[78]

Phirst Technologies, LLC

Phirst Technologies, LLC has developed the **FIRST IZ™** commercial drone system. The product was co-conceived by technology company founder Phil Burks, CEO of The Genesis Group which is a global software solution provider for first responders.[79] FIRST IZ™ is programmed to autonomously fly to incidents at 60+ miles per hour (mph), send live video while in transit, sniff for hazardous gases, hover while still sending live video. This provides for enhanced situational awareness, allowing commanders to know what they are facing before they dispatch vehicles and people and allowing responders to know what they are facing before they arrive on scene. The FIRST IZ™ new class of drones is currently in the Beta Testing stage and a patent application was filed on May 11, 2018.[80]

Figure 17: FIRST IZ drone

Chemring Group PLC

Chemring Group PLC states it is a leading supplier of vehicle-mounted ground penetrating radar (GPR) detection systems, chemical, biological and explosive detection and identification systems. It has developed advanced sensors and detection systems for the U.S. military and its products are applicable to homeland security, law enforcement and international customers.[81] It appears to offer first-responder specific solutions related to this Capability Gap, two of which are listed and described below:

The Chemring **iCollector** is an advanced point and stand-off threat detection system and biological agent detector. Specifically, it enables fully autonomous networks of bio detectors that continuously monitor the air for biothreat agents for public health, law enforcement, emergency response and environmental protection organizations.[82] Information regarding pricing does not appear to be publicly available.

The Chemring **Visual Moving Target Indicator (VMTI) and Visual Target Analysis (VTA)** can automatically detect and track moving objects on the ground from aerial, full motion video (FMV), deployed on a UAV. It can track all moving objects, including people and cars, and it operates on both visible band and infrared (IR) imagery. Chemring states some of the key features of the VMTI and VTA include the following:[83]

- Increase situational awareness;
- Alert operators to moving objects;
- Reduce bandwidth;
- Allow for 24-hour surveillance;
- Provide zone surveillance; and
- Provide intrusion alerts.

Information regarding pricing does not appear to be publicly available.

Figure 18: VMTI and VTA screen shot

FLIR® Systems, Inc.

FLIR® Systems, Inc. designs, develops, manufactures, markets and distributes technologies that focus on enhancing perception and awareness. It offers thermal imaging, visible-light imaging, video analytics, measurement and diagnostic, and advanced threat detection systems solutions. FLIR® serves a number of applications in the government & defense, industrial, and commercial markets. It appears to offer several solutions related to this Capability Gap, some of which are listed and described below:

The **FLIR® K-Series** is a series of handheld thermal imaging cameras for firefighting. FLIR® states that the K-Series cameras offer bright images that help firefighters to see more clearly in dark and smoky environments. The Series offers a FLIR® In-Truck Charger that can be easily mounted inside of the firetruck. FLIR®'s Flexible Scene Enhancement (FSX) provides an ultra-sharp thermal image that shows more detail. These details are enhanced through digital image processing inside of the camera. FLIR® states some of the key features of the FLIR® K-Series thermal imaging cameras include the following:[84]

Figure 19: FLIR K53 (part of K-series

- Affordability;
- Rugged and Reliable;
- Provides clear and crisp thermal images;
- Produces simple reports;
- Easy to use, even with gloved-hands; and
- Offers in-camera video storage

Information regarding pricing does not appear to be publicly available.

FLIR® Systems, Inc.

Figure 20: FLIR LTV-X

FLIR® Systems, Inc. designs, develops, manufactures, markets and distributes technologies that focus on enhancing perception and awareness. It offers thermal imaging, visible-light imaging, video analytics, measurement and diagnostic, and advanced threat detection systems solutions. FLIR® serves a number of applications in the government & defense, industrial, and commercial markets. It appears to offer several solutions related to this Capability Gap, some of which are listed and described below:

FLIR®'s **LTV-X™** is a lightweight all terrain reconnaissance and surveillance system. It is quickly deployable, allowing operators to conduct fully self-contained surveillance missions using advanced radar, electro-optical and thermal imaging systems. FLIR® states some of the key features of LTV-X™ include the following:[85]

- Can be mission-ready in minutes;
- Offers "State-of-the-art" imaging & radar configurations;
- Able to take surveillance to the threat with off-road surveillance;
- Able to track 500 targets simultaneously; and
- Includes laser options

Information regarding pricing does not appear to be publicly available.

FLIR® Systems, Inc.

FLIR® Systems, Inc. designs, develops, manufactures, markets and distributes technologies that focus on enhancing perception and awareness. It offers thermal imaging, visible-light imaging, video analytics, measurement and diagnostic, and advanced threat detection systems solutions. FLIR® serves a number of applications in the government & defense, industrial, and commercial markets. It appears to offer several solutions related to this Capability Gap, some of which are listed and described below:

FLIR®'s **SkyWatch™** is a mobile surveillance platform that can withstand winds up to 60 miles per hour (mph). It is portable and rapidly deployable and can be manned or unmanned. The tower can support various payloads including fixed or pan tilt infrared, night vision, and visible-light cameras, ground radar, digital video recorder (DVR), and searchlights. It could be useful in controlling major venues, for high-crime area monitoring, and missing person command. FLIR® states some of the key features of SkyWatch™ include the following:[86]

Figure 21: FLIR SkyWatch

- PTZ camera options with eight channel DVR for documentation;
- Acts as a visible deterrent – manned or not;
- Has a 27' vantage point and 360-degree visibility;
- Offers an ergonomic command desk inside the tower plus air conditioning and heat for climate control;
- Can be rapidly deployed and is fully portable;
- Law enforcement or civilian single operator efficiency;
- Has a stronger upper lifting arm and a horizontal brace that prevents bending; and
- Can withstands 60 mph winds

Information regarding pricing does not appear to be publicly available.

FLIR® Systems, Inc.

FLIR® Systems, Inc. designs, develops, manufactures, markets and distributes technologies that focus on enhancing perception and awareness. It offers thermal imaging, visible-light imaging, video analytics, measurement and diagnostic, and advanced threat detection systems solutions. FLIR® serves a number of applications in the government & defense, industrial, and commercial markets. It appears to offer several solutions related to this Capability Gap, some of which are listed and described below:

FLIR®'s **TacFLIR® 280-HD** is a land-based imaging system designed to identify and track smugglers, terrorists, or any other threat, day or night and in tough terrain. FLIR® states that it is tailored for mobile deployment and provide long-range standoff to detect and identify targets due to its high-definition imaging and powerful optics. The system is intended to be mounted to a vehicle. Its internal navigation system and laser rangefinder allow it to provide accurate target location coordinates. FLIR® states some of the key features of the TacFLIR® 280-HD include the following:[87]

Figure 22: TacFLIR 280-HD

- Provides high-Definition (HD) extended range thermal imaging;
- Provides continuous zoom day/low-light camera;
- Includes an eye-safe laser rangefinder;
- Offers an internal navigation system; and
- Can be tailored for mobile applications

Information regarding pricing does not appear to be publicly available.

Social Media Feeds/Analytics Software

GEOS Safety Solutions

GEOS Safety Solutions is a leading global provider of safety and response solutions. Interestingly, it was the first and only International Emergency Response Coordination Center. GEOS solutions focus on alerting, communication and response systems for all hazards (including non-emergency incidents) and navigation and positioning.[88]

GEOS Safety and Response provides first responders with critical information about the situation they are responding to while on the way to the scene and upon arrival. GEOS is able to do this through the two-way communication it has with individuals and groups that are closest to the incident, in real-time, including video and audio monitoring. Along with the incident monitoring and situational awareness tools, the company also offers solutions that can help protect responders, like alerting and tracking technology. GEOS states some of the key features of GEOS Safety and Response include the following:[89]

- Incident Alerting – GEOs and the International Emergency Response Coordination Center (IERCC) provide around the clock incident monitoring and response globally.
- Two-Way Communication – as soon as GEOS receives an alert from a GEOS supported device; it will attempt to make contact with the user to let them know that help is coming. This can be through voice, text, or both.
- Incident Response Coordination – When GEOS receives an alert from a responder, it immediately communicates with the response department or agency to provide them with critical information about that responder (i.e., location, name). It also provides information regarding critical infrastructure, etc.
- Emergency Alternate Communications – GEOS provides a wide offering of alternate communication systems.
- Integration into Existing Systems and Protocols – GEOS can integrate with SCADA network devices, first response communications systems, CCTV and VMS solutions. It is also strongly engaged in safe city and smart city initiatives.

Information regarding pricing does not appear to be publicly available.

Parrot Business Solutions

Parrot is a wireless products manufacturer that is known for producing drone technologies. Parrot's **ANAFI Thermal** is a thermal imaging drone that is a quickly accessible and deployable solution for first responders and other commercial users. It is an ultra-compact solution that provides 4k and thermal imaging used in construction, fire mitigation, and environmental protection. Its software provides autonomous flight and customizable geofencing. The FreeFlight 6 app shows details of the scene with color to reveal the thermal differences and the areas of loss. This solution is compatible with iOS and Android.[90] Information regarding pricing does not appear to be publicly available.

Figure 23: ANAFI Thermal

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.

Obtaining Critical Information Remotely		
Existing Solutions		
Solution	**Solution Provider(s)**	**Country**
A12 - Police Wearable Reference Kit	Ambarella	United States
Agentase C2	FLIR Systems	United States
ANAFI Thermal	Parrot Business Solutions	United States
ANAFI Work	Parrot Business Solutions	United States
AN/PSS-14	L-3 Security & Detection Systems	United States
ArcGIS Online	ESRI	United States
Augmented Real-Time Intelligence	EdgyBees	United States
AXIS Perimeter Defender	AXIS Communications	Sweden
AXIS Q1941-E Thermal Network Camera	AXIS Communications	Sweden
AXIS Q6000-E PTZ Network Camera	AXIS Communications	Sweden
Biothreat Detection IMASS Device	BBI Detection	United Kingdom
BODYCAM	PRO-VISION Video Systems	United States
Boomerang III	Raytheon	United States
Bryx 9-11 App	BRYX Inc	United States
Cape Aerial Telepresence	Cape	United States
Chameleon Chemical Detection Armband	Morphix Technologies	United States
ChemKey TLD Toxic Gas Detector	Honeywell International	United States
Cisco Open Platform for Safety and Security	Cisco	United States
Collector App for ArcGIS	ESRI	United States
Colorimetric Gas Detection Tubes and Pump	RAE Systems	United States

Command Center Software Suite	Motorola Solutions	United States
Coriolis Recon	Berlin Instruments	France
Custom Engineered Sonar Products for Defense and Security	Edge Tech	United States
DINION IP Thermal 8000	Bosch Security and Safety Systems North America	United States
DJI Inspire 1 v2.0	DJI	China
DJI Matrice 100	DJI	China
DJI Matrice 600 Pro	DJI	China
DJI Mavic 2 Enterprise Drone	DJI	China
DJI Mavic 2 Enterprise Dual Thermal Drone	DJI	China
DJI Mavic Pro	DJI	China
DSLRPros Inspire 1 First Responder Thermal Kit	DJI	China
DSLRPros Matrice 200 First Responder Thermal Kit	DJI	China
DSLRPros Matrice 210 + XT2 First Responder Thermal Kit	DJI	China
DSLRPros Matrice 210 First Responder Thermal Kit	DJI	China
Explorer App for ArcGIS App	ESRI	United States
Fido X2	FLIR Systems	United States
Fido X3	FLIR Systems	United States
First Responder Support Tools (FiRST) and HazMat Evac	Applied Resource Associates	United States
FirstDefender RM Chemical Identification System	ThermoFisher	United States
FirstVu HD Body-Worn Camera	Digital Ally	United States
FLIR Aerial First Responder Advanced Kit	FLIR Systems/DJI	United States/China
FLIR Aerial First Responder Basic Kit	FLIR Systems/DJI	United States/China
FLIR BhS-X command	FLIR Systems	United States
FLIR BhS-Xr command	FLIR Systems	United States
FLIR HS-Series - HS 307	FLIR Systems	United States
FLIR HS-Series - HS 324	FLIR Systems	United States
FLIR K2	FLIR Systems	United States
FLIR K33	FLIR Systems	United States
FLIR K45	FLIR Systems	United States

FLIR K53	FLIR Systems	United States
FLIR K55	FLIR Systems	United States
FLIR K65	FLIR Systems	United States
FLIR KF6	FLIR Systems	United States
FLIR LSX/R	FLIR Systems	United States
GasID	Smith's Detection	United Kingdom
Gemini FTIR/Raman Handheld Analyzer	ThermoFisher	United States
GEOS Safety and Response	GEOS Safety Solutions	United States
GlobalFlyte	GlobalFlyte	United States
GOIR	Third Eye	Israel
Gyrocam 15DHD	Lockheed Martin	United States
Gyrocam 15TS	Lockheed Martin	United States
Gyrocam Portable Rapid Deployment Surveillance System (PRDS)	Lockheed Martin	United States
High Altitude Long Endurance (HALE)	Boeing	United States
i-Collector	Chemring Group PLC	United Kingdom
I-SCAD® Stand-off Chemical Detector	Chemring Group PLC	United Kingdom
IBM Intelligent Operations Center for Emergency Management	International Business Machines Corporation (IBM)	United States
identiFINDER R400	FLIR Systems	United States
Incident Management Preparedness and Coordination Toolkit (IMPACT)	Oak Ridge National Laboratory	United States
IncidentView	Incident View	United States
Integrator	Boeing	United States
Intergraph Mobile Responder	Hexagon AB	Sweden
LEX F10 LTE Device	Motorola Solutions	United States
LEX L10I Mission Critical LTE Handheld	Motorola Solutions	United States
LEX L11 Mission-Critical LTE Device	Motorola Solutions	United States
MCC 7500 Dispatch Console	Motorola Solutions	United States
Mission Optimized Situational Awareness Information and Collaboration (MOSAIC)	Airbox Systems	United Kingdom
MultiRAE	BAE Systems	United States

Multi Threat Locator DS (Dual Sensor)	L-3 Security &Detection Systems	United States
MX908	908 Devices	United States
Next-Generation Incident Command System	Department of Homeland Security	United States
NYPD Drone Fleet	DJI	United States
Object Video	Object Video Labs	United States
Parrot Behop-Pro Thermal Drone	Parrot Business Solutions	France
PATSCAN Cognitive Microwave Radar (CMR)	PatriotOne Technologies	Canada
PATSCAN Video Recognition System (VRS)	PatriotOne Technologies	Canada
PGR-1064	Chemring Group PLC	United Kingdom
Portable LTE Ecosystem	Motorola Solutions	United States
PremierOne CAD	Motorola Solutions	United States
PremierOne Handheld	Motorola Solutions	United States
QuikHelp	StreamQuik	United States
Ranger-R Link	L-3 Security &Detection Systems	United States
Recon M18	FLIR Systems	United States
Resolve	Agilent	United States
Salamander Live	Salamander	United States
Second Sight MS	Berlin Instruments	France
See Through Wall Human Detector	Acustek	United Kingdom
ShotSpotter Flex	ShotsSpotter	United States
SightLogix SightSensor	SightLogix	United States
SightSensor HD	SightLogix	United States
Sky Aerial Response Commands (ARC)	Singapore Police Force	Singapore
Skyfront Perimeter Hybrid-Electric UAV	Skyfront	United States
SkyWatch	FLIR Systems	United States
Star SAFIRE 380-HD	FLIR Systems	United States
TacFLIR 280-HD	FLIR Systems	United States
Titan	Teledyne Optech	Canada
ThermoSight T75	FLIR Systems	United States
TraceX Explosive Detection Kit	Morphix Technologies	United States

TruDefender FT and TruDefender Fti Handheld Chemical Identification	ThermoFisher	United States
Ultra High Resolution Lightweight, Portable Sonar	Edge Tech	United States
VeroVision Threat Detector	ChemImage Sensor Systems	United States
Virtual Social Media Working Group (VSMWG)	GH International	United States
Visual Moving Target Indicator (VMTI) and Visual Target Analysis (VTA)	Chemring Group PLC	United Kingdom
Yuneec 3DR H520-G	3D Robotics/Yuneec	United States/China
Yuneec H520 UAV System	Yuneec	China
Zeus	Raytheon	United States
Zoe	Acecore Technologies	The Netherlands

In-Development Solutions		
Solution	**Solution Developer(s)**	**Country**
Automated Driver and Responder Alert System	Department of Homeland Security	United States
Cells on Wings (COW)	US Government & AT&T	United States
Drone Swarm	Telstra	Australia
FirstIZ	Phirst Technologies LLC	United States
Flying Cell Site	Verizon	United States
Nuclear Waste Storage Tunnel Platform	University of Nevada	United States
Paladin Drone Software	Paladin Drone	United States
PHYLAX	German Aerospace Center	Germany
Prototype social media tool to improve emergency response outcomes	Phirst Technologies LLC	United States
Social Media Analytics and Reporting Toolkit (SMART)	Purdue University	United States
Stand-off Detection of Explosives and Hazardous Chemicals	US Naval Research Laboratory	United States
System and method of automated gunshot emergency response system	Onalert Guardian System	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.

- Smart Sensor Market
  Market figures and a CAGR were available for the time period 2015 through 2022. A CAGR of 17.6 percent was used to estimate the revenue values for 2023.
- Biosensors Market
  Market figures and a CAGR were available for the time period 2017 through 2022. A CAGR of 9.7 percent was used to estimate the revenue values for 2023.
- Radar Security Market

  Market figures and a CAGR were available for the time period 2016 through 2022. A CAGR of 5.9 percent was used to estimate the revenue values for 2023.

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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