Project Responder 6:
The Evolving Response Environment

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PROJECT RESPONDER 6

Final Report

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DISCLAIMERS:
This work was supported by the U.S. Department of Homeland Security (DHS), Science and Technology Directorate, (Contract # HSHQDC-17-C-00048). 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, of the DHS.

This study represents the best efforts of the study team to gather and assimilate data in order to describe emergency response capability needs and provide context on how the response environment is evolving. While several of the topics discussed within this report may have political connotations, the study team has approached these topics objectively and in the context of how they impact the response environment by using data from reputable, credible, and non-partisan sources. Subjective analysis and opinion have not been included in this report. It is also recognized that this study analyzes certain economic conditions. As these conditions are in constant flux, neither FirstLink nor its members can be responsible for these conditions. Any decisions, actions or investment made on the subject covered are solely those of the client.
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Executive Summary

This is the sixth iteration of a recurring effort — called Project Responder — designed to document emergency response capability needs across significant changes in the operating environment. The innovative Project Responder approach brings together responders from traditional (i.e., fire service, law enforcement, emergency medical services (EMS), emergency management (EM)) and non-traditional (e.g., public health, public works, medical examiner/coroner, search and rescue) response agencies to focus on identifying and prioritizing needs across disciplines. The Department of Homeland Security (DHS) Science and Technology Directorate (S&T) is the sponsor of Project Responder and uses the outcomes to guide research, development, and acquisition decisions for the response community. However, the results are also used by academia, private industry, and other domestic and international agencies and associations to guide the development of new capabilities.

Project Responder 6 Emergency Response Capability Needs

Over 60 responders from 23 states participated in Project Responder 6 (PR6). These participants identified 373 distinct capability needs during a series of meetings, interviews, and virtual workshops. Part 1 of the Outcomes and Findings section contains descriptions of the highest priority capability needs, with specific detail on the top 15 needs, as noted below.

Table 1. Highest Priority PR6 Capability Needs

<table>
<thead>
<tr>
<th>RANK</th>
<th>CAPABILITY NEED STATEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The ability to incorporate real-time incident data into decision-making</td>
</tr>
<tr>
<td>2</td>
<td>The ability to accurately geolocate responders (in three dimensions) inside of an enclosed/semi-enclosed structure (e.g., commercial facilities, public buildings)</td>
</tr>
<tr>
<td>3</td>
<td>The ability to maintain communications (voice and data) between units inside and outside of facilities (e.g., shopping malls, office/school buildings, subways)</td>
</tr>
<tr>
<td>4</td>
<td>The ability to maintain sufficient qualified staff for leadership roles during long-duration or simultaneous events</td>
</tr>
<tr>
<td>5</td>
<td>The ability to mitigate specific unmanned aircraft systems (UAS) in a set airspace</td>
</tr>
<tr>
<td>6</td>
<td>The ability to efficiently integrate the arrival of additional personnel (e.g., volunteers, mutual aid), including those from non-traditional response agencies</td>
</tr>
<tr>
<td>7</td>
<td>The ability to realistically exercise low-frequency, high-consequence incidents</td>
</tr>
<tr>
<td>8</td>
<td>The ability to increase cooperation and coordination between agencies and jurisdictions when they are competing for scarce resources</td>
</tr>
<tr>
<td>9</td>
<td>The ability to monitor the mental health of traditional and non-traditional responders (e.g., fire, law enforcement, EMS, public safety telecommunicators, front-line medical personnel) during routine and extreme/extended operations</td>
</tr>
</tbody>
</table>
The ability to maintain sufficient staffing levels during short-term surge or long-duration events

The ability to automatically and accurately geolocate (in three dimensions) the physical location of an emergency/situation

The ability to protect the private information of public safety and public health personnel (e.g., address, family information, schools)

The ability to safely enter areas of civil unrest to conduct traditional and non-traditional response operations (e.g., law enforcement, emergency medical, fire, public works)

The ability to view building information (e.g., blueprints, egress routes, known hazards, medical caches, communications centers, utility layouts) electronically in real time

The ability to maintain the security and integrity of the public safety answering points (PSAP) and the emergency communications center

The Evolving Response Environment

While it is not possible to foresee the incidents of the future, an examination of the current response environment, projection of data to identify possible trends, and assessment of technology advancements can give clues as to what the public safety community may expect to face. The project team identified a number of distinct factors that have and/or may impact emergency response operations. These factors are grouped into six areas — referred to as pillars throughout this document — as illustrated below:

![Figure 1. PR6 Operating Environment Pillars]

The output of the research and analysis related to these factors can be found in the Evolving Response Environment section of this report.
Background

Project Responder

Project Responder is a longitudinal and iterative study of the capability needs, shortfalls, and priorities of emergency responders. The initial Project Responder effort was funded in April of 2001 by the Memorial Institute for the Prevention of Terrorism (MIPT) subsequent to the bombing of the Alfred P. Murrah Federal Building in Oklahoma City, Oklahoma in 1995. At that time, much of the effort to identify capability gaps and potential solutions was done in a fragmented fashion. Associations related to the fire service would work on issues for their discipline; law enforcement associations would do the same for police officers, etc. There had not been a coordinated effort to identify common needs. The innovative Project Responder approach brought together responders from traditional (i.e., fire service, law enforcement, emergency medical services (EMS), emergency management (EM)) and non-traditional (e.g., public health, public works, medical examiner/coroner, search and rescue) response agencies to focus on identifying and prioritizing needs across disciplines. Over 500 emergency responders from federal, state, local, and tribal response agencies have participated in Project Responder since 2001.

Project Responder documents capability needs across significant changes in the operating environment — from the focus on weapons of mass destruction and terrorism response after 9/11 to an emphasis on an all-hazards approach after Hurricane Katrina, etc. Project Responder also examines the impact of current-day threats and hazards. This constantly evolving response environment supports the case for a recurring assessment of capability needs.

From its inception, the effort has relied on a responder-driven framework for categorizing capabilities. Capability domains, identified and defined by emergency responders, are broad operational categories in which similar needs are consistently identified. The domains serve as an organizational construct to allow research and discussion that spans across response disciplines.

Figure 2. Project Responder Capability Domains
Because they are responder-defined, these capability domains do not align with Federal Emergency Management Agency (FEMA) core capabilities defined in the National Preparedness Goal. As noted above, Project Responder is a longitudinal and iterative assessment of responder capability needs. A new iteration of Project Responder is completed approximately every three years. This approach is critical because the response environment and corresponding capability needs change over time. The Project Responder capability domain framework allows the project team to assess capability needs both in the context of current circumstances and across time using a common structure. This report presents the outcomes of the sixth iteration of Project Responder. A history of Project Responder can be found in Appendix A.

The intended purpose of the initial Project Responder effort was to “help planners formulate strategic choices and frame guidance for technology initiatives and planning to meet the needs of responders.”¹ That purpose remains today. The Department of Homeland Security (DHS) Science and Technology Directorate (S&T) is the sponsor of Project Responder and uses the outcomes to guide research, development, and acquisition decisions for the response community. However, the results are also used by academia, private industry, and other domestic and international agencies and associations to guide the development of new capabilities.

The United States (U.S.) does not have one common agency or organization responsible for developing and purchasing new solutions for responders as the Department of Defense (DoD) does for warfighters, for example. Private industry excels at the development of solutions when there is a clearly defined problem and marketable solution, but without a federal champion, there is no one available to do basic research and development or coordinate the integration of independent agencies and jurisdictions. Due to the fragmented nature of the local, regional, state, and federal public safety community, no one agency has the financial or organizational capacity to fund the development of new equipment or develop processes and procedures that are suitable across the diverse set of environments in the United States. That is why it is critical that DHS S&T is able to provide support to the development and transition of technology, systems, and standards for emergency responders.

DHS S&T’s mission is to enable effective, efficient, and secure operations across all homeland security areas by applying scientific, engineering, analytic, and innovative approaches to deliver timely solutions and support departmental acquisitions.² DHS S&T strives to identify emergency responder needs, identify existing technology, and work with the development community and industry to provide solutions that improve effectiveness, efficiency and safety.³ To do this effectively, DHS S&T must understand the capability needs of the response community that should be addressed to improve mission safety and effectiveness. The evolving response environment presents a challenge for federal planners because there must be a parallel evolution in new capabilities to meet current and emerging threats. Without an assessment of current and

anticipated needs, it is possible that DHS S&T may develop technologies and standards for outdated threats.

The Evolution of Project Responder 6

Less than six months after initiation of the original Project Responder effort, the attacks of September 11th expanded the scope of the study. It was immediately evident that the events of that day would have a lasting impact on emergency response operations. Although it originated from the terrorist attack in Oklahoma City, Project Responder became more focused on capability needs for response to catastrophic terrorism than previously envisioned. The outcome of the initial Project Responder study, the *National Technology Plan for Emergency Response to Catastrophic Terrorism* identified National Terrorism Response Objectives (NTRO) across several operational environments. Each NTRO assessed functional capabilities across chemical, biological, radiological, nuclear, and high explosive/incendiary environments. There have been five subsequent iterations of Project Responder since the initial report was published in 2004, each influenced by the response environment of the time.

The emergence of the novel coronavirus, SARS-CoV-2, impacted the scope, methodology, and schedule of the Project Responder 6 (PR6) effort. As the study plan was being developed, the PR6 project team intended to only include those facets of public health events that routinely impact response operations. Over the course of the 20-year Project Responder effort, public health personnel have participated in the discussion and identification of emergency response capability gaps. However, as the COVID-19 response demonstrated, the identification of public health capability gaps is a necessary study of its own. Although there is overlap in the capabilities needed for traditional response operations and public health events, a capabilities-based assessment for public health was, and remains, outside of the scope of Project Responder. The global COVID-19 pandemic provided a revealing illustration of the overlap that exists. For this reason, the project team, in coordination with DHS S&T, amended the scope of PR6 to include operational impacts of COVID-19 in the study.

Additionally, months of protests and civil unrest focused on public health restrictions, racial injustice, and national election results also mark the events of 2020 and early 2021. Changes to tactics, policies, and procedures will have far-reaching and enduring impacts on the response environment. While many of these activities were peaceful protests, a notable subset included violence against the public, responders, and property. As a result, the project team added an assessment of capability needs associated with *Protests/Civil Unrest* to the PR6 scope.

Objectives

There are four objectives associated with PR6 as illustrated in figure 3. Each objective is designed to contribute to the development of an integrated assessment of the responder operating environment and correlated capability needs.
SCOPE

For additional context, there are three components of this PR6 effort to highlight:

First, as noted above, Project Responder is focused on direct interaction and collaboration with emergency responders from across the United States. Over 60 responders from 23 states participated in PR6. These participants provided input into the characterization and wording of the capability need statements, description of current capability, identification of operational requirements, and reporting of potential barriers. Gap prioritization was completed by members of DHS S&T’s First Responder Resource Group (FRRG), and all participants were provided with the draft report to provide feedback. This level of interaction was done in order to ensure that the outcomes are based on an independent analysis of responder needs. See the Participants section for more information about the responders who participated in this effort.

Second, this iteration of Project Responder focuses on both strategic and tactical capability needs. The project team introduced the Operations domain into PR6 because some of the task-related needs did not align well with the existing domain categories. The highest-prioritized capability needs in the Operations domain can be found on page 134 and a list of all Operations capability needs can be found in Appendix P.

Third, this iteration of Project Responder includes an assessment of whether the needs are valid in the near-term (1-2 years), mid-term (3-5 years), and/or long-term (6-10 years). This was done to aid DHS S&T in its research and acquisition decisions and to determine where technology barriers may exist. The highest-rated capability needs in each domain include a depiction of the anticipated timeframes.

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4 The FRRG is a multi-disciplinary and all-volunteer group of approximately 120 emergency responders that helps DHS S&T maintain focus on the top-priority needs of responders in the field. The members are drawn from a broad range of disciplines, levels of government, and regions of the country. https://www.dhs.gov/publication/frrg
PR6 Methodology

The purpose of Project Responder 6 is to identify emergency response capability needs in the context of current and future threats and hazards. While it is not possible to foresee the incidents of the future, an examination of the current response environment, projection of data to identify possible trends, and assessment of technology advancements can give clues as to what the public safety community may expect to face. Inclusion of this examination of the evolving response environment can provide DHS S&T with a prioritized list of needs that — if addressed — could enable the responder of today and tomorrow. This section details the research and analysis methodology used during the Project Responder 6 effort.

Please use this link if you would like to skip the Methodology section and proceed to the Outcomes and Findings.

Research

Satisfying the first of the above-listed objectives requires an in-depth understanding of the roles and missions of the response community and an appreciation for barriers to safe, efficient, and effective operations. The PR6 project team conducted research on the current response environment to obtain a baseline for assessment of how it may change in the future.

The team reviewed publicly available after-action reports (AAR) and other documentation for many of the large-scale incidents that have occurred since a similar review was conducted for Project Responder 5. Post-incident analysis provides insight into the successes and failures that occurred during response operations and serves as a starting point for the identification of capability needs. A list of incidents reviewed can be found in Appendix B. The project team also reviewed shortfalls, capability gaps, and funding priorities identified by public safety associations and organizations. Many of these groups are focused on a particular discipline or mission, however, their targeted analysis provides information on gaps that may be common across disciplines. A list of all identified association gaps can be found in Appendix C. Finally, the team attended other public safety briefings and virtual meetings that provided information about the response environment and operations. The outputs of this research helped inform the project team regarding the current operating environment for emergency responders. A list of all documents and information sources used as research materials can be found in the Bibliography (Appendix S) at the conclusion of this report.

Throughout the research phase, the project team identified a number of distinct factors that can or may impact emergency response operations. These factors are grouped into six areas — referred to as pillars throughout this document — as illustrated below:
The project team conducted open-source research to identify, define, and assess the impacts of each factor on the current and future operating environments. The team also conducted interviews with subject matter experts to better understand particular factors. As noted above, the scope of PR6 expanded due to the emergence of COVID-19. The project team conducted research and interviews to understand the impacts of the pandemic on the response community. The output of the research and analysis related to these factors can be found in the Evolving Response Environment section of this report.

Focus Group Meetings
The Project Responder 6 methodology included focus group meetings to obtain input from the response community. During the research into the current and future operating environment, the team documented its initial findings. In January 2020 in Austin, Texas, the project team facilitated a focus group meeting with members of the FRRG to validate that the identified factors can or may impact operations and obtain further information via interactive discussions. During that focus group meeting, the responders provided feedback and identified additional topics for analysis.

The project team then facilitated two additional focus group meetings to explore the operating environment pillars. Participants at each meeting included emergency responders and subject matter experts to discuss the impact of each factor and related issues.

<table>
<thead>
<tr>
<th>FOCUS GROUP 1</th>
<th>FOCUS GROUP 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>February 2020</td>
<td>March 2020</td>
</tr>
<tr>
<td>Raleigh, North Carolina</td>
<td>Boulder, Colorado</td>
</tr>
<tr>
<td>Impacts of human behavior issues</td>
<td>Impacts of technology advancements</td>
</tr>
</tbody>
</table>

On March 11, 2020, the World Health Organization (WHO) announced the pandemic status of the novel coronavirus. After that date, DHS suspended travel and in-person group meetings that lasted through the duration of the PR6 effort. The project team amended the PR6 methodology
to mitigate the impacts of not being able to discuss operational issues and capability needs in person.

COVID-19 Surveys and Research
When COVID-19-related restrictions amended the approach to Project Responder, the opportunity to characterize the operational impacts of COVID-19 on the responder community emerged. Outside of the scope of Project Responder, FirstLink Research and Analytics (project team lead organization) built a survey using Qualtrics®, a commercial off the shelf (COTS) platform to build, distribute, and analyze survey responses. The distributed survey included more than 100 questions, both quantitative and qualitative, structured according to the Project Responder domains. The survey was distributed via email through the Qualtrics® platform to public safety personnel from across the United States and Canada. More than 150 responses were received and analyzed. The survey results demonstrated that COVID-19 produced impacts across all capability domains, with the most severe impacts on Logistics & Resource Management, Responder Health & Safety, and Operations. The survey results served as a basis for discussions with emergency responders regarding capability needs.

To augment these results, the study team reached out to a number of emergency response and public safety associations to share data related to COVID-19 impacts. The following organizations provided COVID-19 impact data that was incorporated into the Project Responder analysis:

- International Association of Firefighters (IAFF)
- International Association of Fire Chiefs (IAFC)
- National Association of Emergency Medical Technicians (NAEMT)
- International Association of Chiefs of Police (IACP)

Interviews
Given the inability to meet in person after mid-March 2020 due to COVID-19 restrictions, the project team developed a series of interview protocols to gather responder input on existing capability needs. The project team identified four primary objectives of these interviews as depicted in figure 5 below:

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5 FirstLink’s Operational Impacts of COVID-19 survey was not funded by the Department of Homeland Security or distributed through the Department. Results from the survey can be found here: [http://firstlinkanalytics.com/](http://firstlinkanalytics.com/)
One protocol was developed for each of the six response environment pillars described above. The team identified a cross-disciplinary group of responders for each set of interviews. A member of the project team conducted interviews using web-based video conferencing systems, each lasting approximately 90 minutes. Some participants requested to address questions on more than one topic. The interviews were semi-structured to allow the research team to explore those areas that were most salient during the interview but were also guided by specific protocols to assure thorough coverage of the topics.

Regardless of topic, interviewees were asked to assess the impact of each issue on their operations; whether related incidents had occurred in their jurisdiction/agency; whether their jurisdiction/agency changed tactics, policy, or procedures as a result; the impact of the issue on responder safety; and whether or not they had any related capability gaps. Interviews related to technology advancement also explored the interviewees familiarity with and operational usage of evolving technologies. At the conclusion of the interview, the respondent rated each issue as High, Medium, or Low priority.

The project team conducted a total of 34 interviews with responders from across the United States. The team then reviewed detailed notes from each of the interviews to identify potential capability needs.
The project team identified 373 distinct capability needs based on responder input from the focus group meetings, COVID-19 surveys, and interview input. Figure 8 illustrates the number of capability needs identified by domain. It was originally envisioned that all identified needs would be discussed during responder workshops. However, based on the high number of identified needs, the team developed a questionnaire to validate and prioritize the needs.

Prioritization
Using Qualtrics®, the team developed a survey asking participants if each capability need represented a valid gap for their community or discipline and, if so, what priority they placed on addressing the need (from 1—Very Low to 5—Very High). The prioritization scale is depicted in Figure 7 below:

![Figure 7. PR6 Capability Need Prioritization Scale](image)

The survey was distributed via email to 111 members of the FRRG. Nearly 70 people responded to the survey of almost 400 questions. The study team assessed results by examining the mean prioritization score for each capability need, as well as other statistical factors to identify trends over time.

Analysis of the prioritization results illustrates that domain with the highest average mean score was Command, Control, and Coordination. The team also examined the standard deviation of capability needs by domain to identify where there was most consistency in scoring. Again, capability needs within the Command, Control, and Coordination domain had the lowest average standard deviation scores, indicating higher levels of agreement in scoring. The figures below depict this analysis:
Five needs were ranked to be **Very High** priority based on mean score. Those needs include:

- **CCC.1** The ability to incorporate real-time incident data into decision-making
- **SA.48** The ability to accurately geolocate responders (in three dimensions) inside of an enclosed/semi-enclosed structure (e.g., commercial facilities, public buildings)
- **CIS.15** The ability to maintain communications (voice and data) between units inside and outside of facilities (e.g., shopping malls, office/school buildings, subways)
- **CCC.6** The ability to maintain sufficient qualified staff for leadership roles during long-duration or simultaneous events
- **SA.44** The ability to mitigate specific unmanned aircraft systems (UAS) in a set airspace

Also based on mean score, participants ranked 149 of the 373 (40 percent) capability needs to be **High** priority. This reveals that given the current and evolving response environment, emergency responders continue to experience many issues that inhibit their ability to carry out missions safely, effectively, and efficiently.

The team also identified which needs were deemed to be valid by all, meaning that every respondent agreed that the need was valid for their jurisdiction and provided a priority rating.
These needs are referred to as Universal Needs (UN) throughout this report. There are total of ten Universal Needs, with 40 percent derived from the Command, Control, & Coordination domain. Analysis of this data indicates that responders across disciplines and jurisdiction size experience many of the same issues. Five of the ten domains have Universal Needs. Figure 12 depicts the Universal Needs capability needs by domain. A complete list of those needs can be found in Appendix D. Universal needs are designated with this icon throughout the document.

Conversely, the project team examined whether there were capability needs where a significant percent of respondents did not find the need to be an issue for their discipline or jurisdiction. For 232 of the 373 (62 percent) capability needs, more than ten percent of the respondents said that the need was not an issue that impacts their operations. Notably, there were zero capability needs rated as “not valid for my discipline or jurisdiction” that did not at least get rated as “high priority” by another respondent. The Operations domain represents the largest number of these needs. This is not surprising given that, because they are tactically focused, some of these capability needs may not be widespread. Figure 13 depicts those capability needs assessed as “not valid for my discipline or jurisdiction” by domain. This is an interesting finding because it supports the idea that the existence of a solution (technology, policy, or otherwise) does not mean that it is available to public safety agencies or that has been adopted by all agencies.

![Universal Needs by Domain](image1.png)

**Figure 12. Universal Needs by Domain**

![More than 10% Not Valid by Domain](image2.png)

**Figure 13. More than 10% Not Valid by Domain**

Individual results by capability need are included in the Outcomes and Findings section of this report. A list of all capability needs by domain can be found in Appendices G-P of this document.

**Workshops**

In lieu of in-person gatherings, the project team facilitated two virtual workshops to review the highest priority capability needs in each domain. Participants included personnel from fire, law enforcement, emergency medical services, emergency management, and public safety communications agencies. Each of the workshops took place over a three-day period and each addressed five of the ten capability domains:
Through guided discussions, the facilitator asked participants to discuss five questions for the top capability needs in each domain as determined by the prioritization process. The discussion questions are depicted in figure 14 below:

<table>
<thead>
<tr>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
</tr>
</thead>
<tbody>
<tr>
<td>How does this capability need affect operations?</td>
<td>What is your current ability to do this?</td>
<td>How do you believe that you need to be able to do this?</td>
<td>What are the operational requirements for potential solutions?</td>
<td>What are the barriers to implementation?</td>
</tr>
</tbody>
</table>

The project team captured detailed notes during the workshop and noted all comments and suggested research materials/links that were provided by the participants in the “Chat” function of the online meeting platform.
Participation

As noted previously, responder participation is at the foundation of the Project Responder study. Approximately 500 responders have been involved in Project Responder activities since its inception. At the conclusion of the PR6 effort, over 60 emergency responders plus additional subject matter experts were involved. Participants were drawn from career and volunteer agencies that differ in size and area of the country. They include personnel from traditional and non-traditional response agencies. In addition, 68 members of the FRRG took the prioritization survey. Due to the anonymous nature of the survey, it is not possible to identify where there is overlap. Some of the responders participated in more than one PR6 activity. The participation graphic below illustrates how many participated by activity, by location, and by discipline.

![Participation Graphic]

A complete list of PR6 participants can be found in Appendix E.

The following section contains the Outcomes and Findings of the PR6 effort. Part 1 contains a description of each of the top five capability needs as discussed during the virtual workshops. Part 2 contains a description of the current and future operating environment as identified during the research, focus groups, and interview phases of this effort. Capability needs in Part 1 are correlated with operating environment issues and issues discussed in Part 2 are correlated with capability needs from the entire set of 373 to illustrate the impact of the response environment on capability needs.
Outcomes and Findings

This section of the report contains descriptions of the highest priority capability needs in each domain [Part 1] and a characterization of factors that impact the current and future response environment [Part 2]. The objective of this section is to describe the high priority needs so that potential solutions may be identified, developed or studies initiated. This may be done through the application of technology, knowledge products, social science, or policy changes. DHS S&T funds this effort for the purpose of identifying capability needs that may be addressed through the investment of federal funds, but welcomes its use by other federal agencies, associations, academia, and private industry to guide the development of solutions to these needs.

DHS S&T has contributed to the development of solutions to multiple needs identified through the past five iterations of Project Responder.

- The Enhanced Dynamic Geo-Social Environment (EDGE) is a free virtual training platform developed by DHS S&T after the need for “readily accessible, high-fidelity simulation tools to support training and exercises in incident management and response” was recognized as the highest priority capability need in Project Responder 3.

- DHS S&T is currently funding the development of the Precision Outdoor and Indoor Navigation and Tracking for First Responders (POINTER) technology to three-dimensionally locate responders. The need to geolocate responders has been a high priority need across all five previous iterations of Project Responder and remains an acknowledged Very High priority need in PR6.

- Through the Next Generation First Responder (NGFR) project, DHS S&T integrated DHS-developed technology with those that are commercially available for responders, creating a standards-based “plug-and-play” environment. Further, the development of an NGFR Integration Handbook provides recommendations on the design and development of interoperable emergency responder technologies.

DHS S&T investment in each of these programs is derived from the capability needs and requirements identified during the Project Responder effort. This investment is critical because of the distributed and fragmented nature of the response community in the United States. There are more than 70,000 response agencies in the United States, employing over 3.3 million
responders.\textsuperscript{6} Each jurisdiction is responsible for funding its public safety agencies, and no jurisdiction can afford to fund the development of new solutions unilaterally. This is exceptionally hard during a period of reduced civic budgets. Project Responder provides an independent assessment of emergency response capability needs and DHS S&T uses those outputs to fund the development of technology solutions, knowledge products, and standards to support the response community.

Part 1: PR6 Capability Needs

The first part of the Outcomes and Findings section contains descriptions of the highest priority capability needs in each of the ten Project Responder domains. The highest ranked PR6 needs are based on overall mean score and are agnostic of the domain. As illustrated previously, there is variability in the number of capability needs per domain, from 16 needs in the Command, Control, and Coordination domain to 64 needs in the Operations domain.

This section provides detailed analysis of the top 15 capability needs overall and discussion of the top needs in each domain. Table 2 below lists each of those needs by priority. The priority score and unique identifier is also listed for each need.

<table>
<thead>
<tr>
<th>RANK</th>
<th>DOMAIN</th>
<th>ID</th>
<th>SCORE</th>
<th>CAPABILITY NEED STATEMENT</th>
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<tbody>
<tr>
<td>1</td>
<td>CCC.1</td>
<td>4.13</td>
<td>The ability to incorporate real-time incident data into decision-making</td>
<td></td>
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<tr>
<td>2</td>
<td>SA.48</td>
<td>4.11</td>
<td>The ability to accurately geolocate responders (in three dimensions) inside of an enclosed/semi-enclosed structure (e.g., commercial facilities, public buildings)</td>
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<tr>
<td>3</td>
<td>CIS.15</td>
<td>4.06</td>
<td>The ability to maintain communications (voice and data) between units inside and outside of facilities (e.g., shopping malls, office/school buildings, subways)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CCC.6</td>
<td>4.00</td>
<td>The ability to maintain sufficient qualified staff for leadership roles during long-duration or simultaneous events</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>SA.44</td>
<td>4.00</td>
<td>The ability to mitigate specific unmanned aircraft systems (UAS) in a set airspace</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>CCC.12</td>
<td>3.97</td>
<td>The ability to efficiently integrate the arrival of additional personnel (e.g., volunteers, mutual aid), including those from non-traditional response agencies</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>TE.20</td>
<td>3.96</td>
<td>The ability to realistically exercise low-frequency, high-consequence incidents</td>
<td></td>
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<tr>
<td>8</td>
<td>CCC.8</td>
<td>3.93</td>
<td>The ability to increase cooperation and coordination between agencies and jurisdictions when they are competing for scarce resources</td>
<td></td>
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<tr>
<td>9</td>
<td>RHS.2</td>
<td>3.93</td>
<td>The ability to monitor the mental health of traditional and non-traditional responders (e.g., fire, law enforcement, EMS, public safety telecommunicators, front-line medical personnel) during routine and extreme/extended operations</td>
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<td>10</td>
<td>LRM.38</td>
<td>3.92</td>
<td>The ability to maintain sufficient staffing levels during short-term surge or long-duration events</td>
<td></td>
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<tr>
<td>11</td>
<td>SA.49</td>
<td>3.86</td>
<td>The ability to automatically and accurately geolocate (in three dimensions) the physical location of an emergency/situation</td>
<td></td>
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<tr>
<td>12</td>
<td>RHS.23</td>
<td>3.86</td>
<td>The ability to protect the private information of public safety and public health personnel (e.g., address, family information, schools)</td>
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<tr>
<td>13</td>
<td>OPS.5</td>
<td>3.86</td>
<td>The ability to safely enter areas of civil unrest to conduct traditional and non-traditional response operations (e.g., law enforcement, emergency medical, fire, public works)</td>
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<td>14</td>
<td>SA.2</td>
<td>3.85</td>
<td>The ability to view building information (e.g., blueprints, egress routes, known hazards, medical caches, communications centers, utility layouts) electronically in real time</td>
<td></td>
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<tr>
<td>15</td>
<td>OPS.29</td>
<td>3.79</td>
<td>The ability to maintain the security and integrity of the public safety answering points (PSAP) and the emergency communications center</td>
<td></td>
</tr>
</tbody>
</table>

The top 15 PR6 capability needs are drawn from seven capability domains, with four each from Command, Control, and Coordination (CCC) and Situational Awareness (SA). The allocation of the top 15 needs across domains is illustrated in Figure 17. The concentration of needs from CCC and SA is not surprising given the challenges of the recent past and the evolving changes to the responder operating environment. Responders need both an understanding of the scene and the threats that they face as well as the ability to make effective decisions based on that information. The highest rated capability need, the ability to incorporate real-time incident data into decision-making, advances the necessity for data integration to focus on transforming that data into actionable information that is

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**Figure 17. Map chart of PR6 highest-rated capability needs**
valuable for making strategic and tactical decisions. As more information is available, this transformation is critical to avoid information overload and ensure that responders are able to access the information and understand how it affects the incident. The need to geolocate responders has been among the highest rated capability needs across all six iterations of Project Responder. The second highest rated PR6 need, the ability to accurately geolocate responders (in three dimensions) inside of buildings (e.g., commercial facilities, public buildings) adds context to this need, focusing on indoor geolocation which has been hampered by technological barriers. The third highest-rated PR6 capability need is the ability to maintain communications between units inside and outside of facilities (e.g., shopping malls, office/school buildings). Like responder geolocation, the need for interoperable communications is often among the highest priority Project Responder needs and is frequently cited as an issue in after action reports. The fact that neither of these needs is new reflects the fact that they are all difficult problems to solve. However, the impact of technology advancement is apparent as some facets of these problems are being solved. If the goal of Project Responder is to identify capability needs so that government, academia, and private industry can find solutions for those needs, addressing individual operational requirements is one measure of achievement. Therefore, three domains — Casualty Management, Risk Assessment & Planning, and Intelligence & Investigation — are not represented within the top 15 capability needs. However, each has needs that were ranked as High priority.

Discussion of each of these capability needs can be found within the domain chapters. Each chapter is prefaced with a definition, a count of needs identified, the average priority score of needs, the distribution of priority scores, and the list of the top capability needs within that domain. Figure 18 below serves as a legend for the information at the beginning of each chapter.
Within each chapter, the highest priority individual needs are presented with the unique need identifier, need statement, priority score, and a designation whether the need is assessed to be a near-term (1-2 years), mid-term (3-5 years), and/or long-term (6-10 years) issue. If the need is among the top 15 overall the rank is designated and if it is a “universal need” a small star icon designates it. Figure 19 below serves as a legend for this information.

Each capability need includes a description of the gap between existing capability and what is needed to respond safely and effectively; operational requirements for potential solutions; potential barriers; and a correlation between the need and the operating environment. For those needs among the top 15, there is also an assessment of the current state of technology (based on open-source research of ongoing efforts in domestic and international agencies, academia, and private industry) and a description of potential barriers to solution adoption, including the existence of standards, cultural factors, etc.

Operational requirements within each capability need are grouped by topic (e.g., transmission requirements, compatibility requirements). Responders would prefer incremental, continuous advancement of solutions instead of waiting for equipment that meets all the requirements at once. As such, these requirements do not represent a minimum set of requirements that must be met before new tools, devices, platforms or systems can be released. There is no assessment of price parameters; however, potential solutions should be designed to minimize the costs of the system, consumables, training, upgrades, integrations, and maintenance. Potential solutions should be priced to be affordable to all response agencies and should be designed for daily use.

At the conclusion of each capability description, correlation to issues within the evolving response environment pillars is provided. There are links to the sections of the report that discuss those specific issues as depicted below.
The capability gap statements, descriptions of need, and operational requirements originate with the emergency responders that participated in the Project Responder 6 effort. The capability need prioritization was done by members of the FRRG as an assessment of priority for their area. This is a product of responder participation in the PR6 methodology, from project development through technical review of this report. The results below reflect an independent assessment of needs and do not reflect any pressure by DHS based on political or agency agendas. Finally, it is important to note that these capability needs reflect only a picture in time. The year 2020 demonstrated how quickly the response environment can change and that both capability needs, and their relative priority, will be impacted.

Appendix F includes a list of the top 50 needs in priority order.
SITUATIONAL AWARENESS (SA)

Defined as the capability to provide and distill specific knowledge concerning emerging threats, hazards, and conditions in a timely fashion to support incident management decisions across all phases of incident response.

NEEDS IDENTIFIED 52

AVG. PRIORITY SCORE 3.05

HIGHEST PRIORITY SA CAPABILITY NEEDS:

- **SA.48** The ability to accurately geolocate responders (in three dimensions) inside of an enclosed/semi-enclosed structure (e.g., commercial facilities, public buildings)
- **SA.44** The ability to mitigate specific unmanned aircraft systems (UAS) in a set airspace
- **SA.49** The ability to automatically and accurately geolocate (in three dimensions) the physical location of an emergency/situation
- **SA.2** The ability to view building information (e.g., blueprints, egress routes, known hazards, medical caches, communications centers, utility layouts) electronically in real time

There are four Situational Awareness needs presented below because they are all among the top 15 overall needs.

- **Average Need Score:** Situational Awareness was the fourth-highest rated domain for Project Responder 6, with an average priority score of 3.05.
- **Very High Priority Needs:** Two of the five capability needs rated as Very High priority are in the SA domain (SA.48 and SA.44).
- **Scoring Consensus:** The domain also had the second-lowest average deviation from the mean (1.41), meaning that there was the more agreement among participants about the priority ratings for the capability needs in this domain.
- **Need Status:** Situational Awareness had one Universal Need and 33 percent (17 of 52) for which more than 10 percent of participants did not find the need to be an issue for their discipline or jurisdiction.

A complete list of all SA needs can be found in Appendix G.
SA.48 The ability to accurately geolocate responders (in three dimensions) inside of an enclosed/semi-enclosed structure (e.g., commercial facilities, public buildings)

DESCRIPTION: There is one capability need that has consistently been rated as one of the highest priorities across all iterations of Project Responder. That is the ability to geolocate responders on the incident scene. (See Appendix Q: Project Responder Priorities Across Time.) For PR6, participants refined the capability need to focus on indoor or partially indoor geolocation of emergency responders. The refinement addresses the existing challenges with identifying the location of responders in large commercial facilities (e.g., shopping malls), segmented buildings (e.g., classrooms, apartments, offices), sites that have indoor and outdoor components (e.g., airports, transit stations), and structures that are partially or fully below grade (e.g., subway tunnels). Participants described multiple incidents where the inability to locate responders within a structure led to significant injury or loss of life.

Current capabilities are limited to land-mobile radio (LMR) integrated with global positioning system (GPS) location features. However, infrastructure and network requirements constrain the use of this feature. Commercially available GPS signals cannot penetrate building walls and are not ruggedized for the hazards on an incident scene. Cellular phone pings can also be used, but this technology is also hindered by construction materials and power supply. In the absence of a technology solution, agencies use paper tag and tally systems, string guidelines, and voice relay of location (over LMR).

As noted above, DHS S&T has partnered with the National Aeronautics and Space Administration (NASA) to develop the POINTER responder tracking technology. The system uses magnetoquasistatic fields to pinpoint the location of responders within one meter. DHS S&T has identified a partner to commercialize this technology, but it is not yet available to public safety agencies.

Responders would like to know the location of all personnel on the incident scene and maintain a visualization of all responder locations.

Participants rated SA.44 as a Very High priority capability need.

DESIRED CAPABILITY: Potential solutions should:

Accuracy Requirements

- Geolocate responders to within three feet for x, y and z coordinates
- Determine the location of responders on the incident scene at least every five seconds
- Provide accurate responder geolocation across all operational environments:
  - Inside building structures of varying sizes and composition
PROJECT RESPONDER 6
SITUATIONAL AWARENESS

- In partially indoor environments (e.g., airports, transit stations)
- Below ground and in confined areas (e.g., basements, tunnels)

- Scale up or down to agency-configurable distance
- Geolocate responders that are up to 15 meters below ground
- Incorporate a confidence level to indicate accuracy of location
- Function in the absence of digital information about the incident scene (e.g., building data)
- Function without the need for pre-placement of technology (e.g., sensors, repeaters)

Data Integration Requirements

- Integrate with digital blueprints, floorplans, terrain maps
- Highlight the location of standpipes, exits, stairwells, exhaust systems, vents
- Allow user to update floor plans in real time
- Accommodate sub-division of building spaces (e.g., apartments, cubicles)

Transmission Requirements

- Not be reliant on long-term evolution (LTE) or cellular networks for transmission
- Encrypt responder geolocation data prior to transmission
- Be able to authenticate users and/or devices transmitting data
- Transmit responder geolocation data to intended destination
- Transmit responder location using geographic information system (GIS) coordinates
- Transmit responder location data in real time
- Function in a communications-degraded environment
  - Securely cache data intended for recipients when connection to a communication network cannot be made
  - Securely transmit cached data to recipients when connection to a communications network is restored without affecting live data streaming
- Store responder geolocation data for post-incident analysis
- Prioritize transmission of responder safety-related geolocation data (e.g., distress, hazard proximity) to agency-configured destination

Visualization Requirements

- Display data using GIS-enabled incident-specific maps
- Display the location of all or selected responders on three-dimensional incident-specific maps
- Differentiate between responder types and roles
- Display the proximity of all or selected responders when integrated with display of incident threats and hazards
PROJECT RESPONDER 6
SITUATIONAL AWARENESS

- Identify closest responders to an endangered responder
- Allow user- or agency-configuration of display features
- Allow user to turn off layers when integrated with other data sets
- Display direction to exit or egress path
- Allow user to individually select and cluster responders (i.e., assign groups) for display purposes
- Use standard icons to illustrate geolocation and building components (e.g., windows, exits, disciplines)

Compatibility Requirements:
- Integrate with responder life safety alarms
- Comply with exchange standards for data transmission (e.g., National Information Exchange Model (NIEM))
- Comply with Next Generation First Responder (NGFR) open architecture
- Bi-directionally communicate with existing response-related software and systems (e.g., electronic situational awareness, dispatch, physiological monitoring, threat sensors)

Form Requirements
- Be operable by users wearing personal protective equipment (PPE)
- Be designed to prevent deactivation by responder during an incident
- Be minimal size and weight
- Be camouflageable and concealable

Alarm Requirements
- Integrate aural, visual and/or haptic alerts
- Provide option for tactical mode/covert alerts
- Require a positive action to acknowledge receipt of the alert
- Be discriminable and recognizable in environments that are excessively noisy and/or have reduced visibility
- Generate an alert to notify a user when connection to the communications network is lost
- Emit a low power source warning signal

Power Source Requirements
- Operate for a minimum of 24 operational hours and 48 stand-by hours
- Be able to replenish power supply using non-proprietary technology
- Utilize an easy-to-replenish power source

7 The requirements contained in the NGFR Integration Handbook can be found at https://www.dhs.gov/science-and-technology/ngfr/handbook
PROJECT RESPONDER 6
SITUATIONAL AWARENESS

- Power source should be replaceable with gloved hands and wearing protective clothing
- Be available with non-intrinsically safe or intrinsically safe power source options

**Maintenance Requirements**
- Be easy to decontaminate
- Provide live notification of a fault
- Maintain a fault log

**Robustness Requirements**
- Operate at temperature ranges typical of climates in the United States
- Operate at temperature ranges typical of response activities
- Function through traditional construction materials
- Function after immersion in water
- Function under water
- Function at humidity of 100 percent
- Resist air pollutants, dust, smoke, ash and sand
- Match the laundry life of garment or textile if components are integrated into garments or textiles

**STATE of TECHNOLOGY:** Two-dimensional tracking of personnel has been available within the private sector for some time. Most of these systems employ radio-frequency identification (RFID) tags to track movement of personnel through facilities and boast the ability to accurately locate specific individuals in near real-time. However, the ability to locate personnel in a three-dimensional setting is a more complex issue. The private sector offers a variety of products developed specifically for the military and public safety communities that deal with tracking personnel in real-time. These products employ a variety of components including small, wearable sensors, handheld transmitters, integrated (CAD) units, and smart device applications that integrate into cloud-based display platforms. Each of these products is designed to track assets in real-time and provide the x,y,z coordinates for each signal to within several meters of the individual. Additionally, some versions of these products are able to function within GPS-denied...

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8 Personnel Tracking, Northern Apex, 2020, [https://northernapex.com/personnel-tracking.php?gclid=Cj0KCQiAv6yCBhCLARIsABqJTjYRO3RrqNade6_zGsiP5ehKFj0P5NV4QbnENwiuP080Do37F4HveeQaAuZkEALw_wcB](https://northernapex.com/personnel-tracking.php?gclid=Cj0KCQiAv6yCBhCLARIsABqJTjYRO3RrqNade6_zGsiP5ehKFj0P5NV4QbnENwiuP080Do37F4HveeQaAuZkEALw_wcB).
locations. Many of these products have been evaluated in field training and exercises by both the military and various response agencies.\(^\text{11}\)

As noted above, DHS S&T is currently funding the development of the Precision Outdoor and Indoor Navigation and Tracking for Emergency Responders (POINTER) technology to three-dimensionally locate responders. The system uses magneto-quasistatic fields to locate responders during emergencies — especially when visibility is low due to heavy smoke or debris. Figure 20 illustrates the features of the POINTER system.

The U.S. Army has initiated an upgrade of its Blue Force Tracking situational awareness network. The new platform, called BFT 3, will have increased network capacity for data transfer, advanced resilience to cyber-attacks, and improved methods to move data from the source to its destination in different operating environments. At this time, the initial studies have been completed and the Army expects to field BFT 3 by 2025.\(^\text{12}\)

**BARRIERS:**

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<thead>
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<th>Policy</th>
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<tr>
<td>Construction material interference</td>
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<td>Cybersecurity concerns</td>
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<table>
<thead>
<tr>
<th>Culture</th>
<th>Other</th>
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</thead>
<tbody>
<tr>
<td>Responder resistance to tracking</td>
<td>Perceived cost to outfit entire department</td>
</tr>
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</table>


SA.48 ISSUE CORRELATION:

- **Attack Behavior**
- **5G IoT Wearables**
- **Weather Hazards**
- **Commercial Facilities**
- **Protests/Civil Unrest**

- **Climate Hazards**
- **Government Facilities**

- **Geologic Hazards**
DESCRIPTION: Unmanned aircraft systems (UAS), sometimes referred to as ‘drones’, are used by civilians and commercial entities for a multitude of purposes. It is not uncommon to see these robotic devices flying through neighborhoods or hovering over sports games. The payload of most civilian systems is a camera used to capture or transmit video back to the controller. However, other functions are rapidly becoming more prevalent. In 2020, the Federal Aviation Administration (FAA) approved a major retailer to operate a fleet of drones designed to deliver orders. UAS can be used to collect data on unreachable disaster sites or identify the presence of casualties in search and rescue operations. There are many potential uses in support of response operations.

However, there are circumstances where UAS present a potential danger to personnel or response efforts. Unknown UAS could deliver explosive, chemical, or biological payloads; they could be used to conduct unauthorized surveillance on operations; or they could pose a hazard to manned and unmanned public safety vehicles. The first issue is identifying the presence of these systems (some can be quite small); second is querying the system to identify ownership; and third is disrupting or mitigating the UAS without endangering responders or civilians.

Public safety agencies have virtually no capability currently to address any of these issues. Awareness of UAS generally comes from seeing them in flight over the incident scene. If identified, there are no approved options for state or local agencies to remove the UAS from flight. The U.S. Department of Defense (DoD) maintains a sizable budget for counter-UAS (C-UAS) activities ($404 million on research and development and $83 million on procurement in FY2021), although its focus is on small and large UAS. The DoD also drafted a Counter-Small Unmanned Aircraft Systems Strategy that was released in January 2021. DoD capabilities include small missiles and guns, high-powered microwaves and lasers, directed energy weapons, and electrical jamming technology. These capabilities are not approved for use by public safety agencies, primarily because of civilian safety concerns and the potential to interfere with federal laws and regulations. In August 2020, four federal agencies published an interagency legal advisory to provide an overview of potentially applicable federal laws and regulations related to C-UAS actions or systems.

14 Advisory on the Application of Federal Laws to the Acquisition and Use of Technology to Detect and Mitigate Unmanned Aircraft Systems, Federal Aviation Administration (FAA), Department of Justice (DOJ), Federal Communications Commission (FCC), and Department of Homeland Security (DHS); August 2020. https://www.faa.gov/ucas/resources/c_uas/media/Interagency_Legal_Advisory_on_UAS_Detection_and_Mitigation_Technologies.pdf
PROJECT RESPONDER 6
SITUATIONAL AWARENESS

Responders would like the ability to safely remove unknown UAS that may pose a danger to the public or to those on the incident scene. Participants rated SA.44 as a Very High priority capability need.

DESIRED CAPABILITY: Potential solutions should:

Detection Requirements

- Detect the presence of all UAS in a set airspace
- Track the path of selected UAS
- Identify the manufacturer of selected UAS
- Determine friend-or-foe status of selected UAS
- Identify the potential location of UAS pilot

Platform Requirements

- Pose low risk for operators, responders, and civilians
- Deploy within 20 minutes
- Be able to neutralize selected UAS
- Operate in covert or overt/highly visible mode
- If solution is airborne:
  - Navigate without becoming a hazard to others (e.g., deconflicting air space)
  - Allow remote release of payload
  - Allow manual or autonomous navigation
  - Be able to maintain an operationally appropriate altitude
- Be resistant to interference with functionality
- Be able to operate in hazardous (e.g., chemical, radiological) environments

User Interface Requirements

- Be able to be controlled remotely
- Be controlled intuitively (e.g., hand-held operator control unit, heads up display)
- Provide optional secondary monitors for viewing by others beyond controller

Compatibility Requirements

- Comply with existing federal and/or international standards and guidelines

STATE of TECHNOLOGY: The private sector has developed several products for the military and various national security agencies that work for mitigation and interdiction of UAS in restricted airspace. However, these technologies are lawful for use by only a few federal entities such as the U.S. Departments of Transportation, Defense, Justice, Homeland Security, and Energy only in certain circumstances as defined by the Federal Aviation Agency (FAA) Reauthorization Act of 2018 (P.L. 115-254) and the National Defense Authorization Act for Fiscal Year 2017 (P.L. 114-
328). As such, airports and state and local agencies in the United States do not have the legal authority to deploy C-UAS technologies due to a number of potential risks and legal barriers.  

Interdiction technologies unavailable to responders include jamming devices that disrupt flight control signals between the drone and the controller; systems that transmit signals to spoof drone guidance systems or take over control of the drone; capturing drones in nets; and disabling or destroying drones with lasers. However, there are other strategies that the responder community can lawfully employ against unauthorized UAS. The most commonly used techniques include low altitude authorization and geofencing. The Low Altitude Authorization and Notification Capability (LAANC) is a collaboration between the FAA and Industry that supports UAS integration into the airspace. The LAANC provides drone pilots access to airspace at or below 400 feet and knowledge of restricted and unrestricted airspace. It also provides air traffic control personnel with visibility into when and where drones are in operation. Geofencing, which uses GPS to create virtual geographic boundaries can be used to restrict UAS operations in critical areas (e.g., some UAS models will not operate if the GPS coordinates indicate the aircraft is in restricted airspace). Geofencing can severely limit the capabilities of a UAS for legitimate uses. However, since geofencing has no set standards or requirements, its efficacy depends on the individual UAS manufacturer. Finally, the Cybersecurity and Infrastructure Security Agency (CISA) has detailed three additional options for prevention of UAS in restricted airspace. These options include the use of signage detailing the locations of “No Drone Zones”, initiating temporary flight restrictions and special security instructions restricting flight operations which are communicated via the LAANC, and requesting a C-UAS interagency request for assistance from authorized federal resources.

The DoD, DARPA, and DHS have been working on developing strategies for countering small UAS threats. These technologies often employ the use of lasers to damage or destroy drones; high power microwave (HPM) systems to detect, track and disrupt drone guidance systems; electromagnetic weapons that provide non-kinetic defeat of drone swarms; and using AI and deep learning identify and classify an approaching UAS and applying countermeasures to force the device to land or return to its home base. While these, and other technologies still in the

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developmental stages and show promise, none have been proven to meet all current and potential C-UAS needs.22

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Related Standards and Guidelines

- FAA Reauthorization Act of 2018- P.L. 115-25423
- Small Unmanned Aircraft Systems (UAS) Regulations 14 CFR Part 10725

**SA.44 ISSUE CORRELATION:**

- **Attack Behavior**
- **UAS/C-UAS Robotics**
- **Protests/Civil Unrest**

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SA.49 The ability to automatically and accurately geolocate (in three dimensions) the physical location of an emergency/situation

DESCRIPTION: Many calls for emergency service are placed from known locations such as homes and office buildings. Callers are usually able to accurately report their address or precise position (including floor, room location, etc.) in a building. However, some calls are from people who do not know their exact whereabouts or are not in the same place as the emergency situation. Indoor locations where people may not know their precise location include shopping malls, hotels, convention centers, sports arenas, etc. Problematic outdoor locations include large parks, hiking trails, and interstate highways. It is difficult for the public safety telecommunicator to dispatch units to the incident scene when there is uncertainty as to where that is.

This capability need is similar to SA.44 that focuses on indoor geolocation of responders. The key difference is that to support tracking, responders will wear or carry a beacon or device that can be tracked. Members of the public generally do not have pre-furnished geolocation components. In addition, members of the public can move and the location that a call for service originated may not be the same as where it concludes. Eighty (80) percent of 9-1-1 calls originate from cellular telephones according to recent estimates. Units are currently dispatched to the caller’s location (if unknown) based on the cellular tower that handles the call, although this may not be the closest tower. If indoors, construction materials may block any ability to determine location or actively ping the phone.

Time spent searching for the location of a call for service can significantly impact medical outcomes and potential damage. Responders would like to precisely geolocate a call for service, whether indoor or outdoor, mobile, or stationary. Participants stated a preference for utilizing devices commonly carried by the public (e.g., cellular or broadband telephones).

This need is related to CIS.15, the ability to maintain communications (voice and data) between units inside and outside of facilities (e.g., shopping malls, office/school buildings).

Participants rated SA.49 as a High priority capability need.

DESIRED CAPABILITY: Potential solutions should:

Accuracy Requirements

- Geolocate callers to within three feet for x, y and z coordinates
- Provide accurate geolocation across all operational environments:
  - Inside building structures of varying sizes and composition
  - In outdoor environments and remote areas

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PROJECT RESPONDER 6

SITUATIONAL AWARENESS

- In partially indoor environments (e.g., airports, transit stations)
- Below ground and in confined areas (e.g., basements, tunnels)
- Scale up or down to agency-configurable distance
- Geolocate callers that are up to 15 meters below ground
- Incorporate a confidence level to indicate accuracy of location
- Function in the absence of digital information about the incident scene (e.g., building data)
- Function without the need for pre-placement of technology (e.g., sensors, repeaters)

Data Integration Requirements

- Integrate with digital blueprints, floorplans, terrain maps
- Highlight the location of standpipes, exits, stairwells, exhaust systems, vents
- Allow user to update floor plans in real time
- Accommodate sub-division of building spaces (e.g., apartments, cubicles)

Data Integrity Requirements:

- Correlate reported location with known geolocation data
- Correlate geolocation with other available sources (e.g., repeaters, beacons, towers)

Transmission Requirements

- Allow caller to opt in/out of geolocation solutions
- Not be reliant on LTE or cellular networks for transmission
- Transmit caller geolocation data to intended destination
  - PSAP/CAD system
  - Responding units
- Transmit caller location using GIS coordinates
- Transmit caller location data in real time
- Function in a communications-degraded environment
  - Securely cache data intended for recipients when connection to a communication network cannot be made
  - Securely transmit cached data to recipients when connection to a communications network is restored without affecting live data streaming
- Store caller geolocation data for post-incident analysis

Visualization Requirements

- Display data using GIS-enabled incident-specific maps
- Display the location of caller on three-dimensional incident-specific maps
- Display track of mobile callers
- Allow user- or agency-configuration of display features
PROJECT RESPONDER 6
SITUATIONAL AWARENESS

- Allow user to turn off layers when integrated with other data sets
- Display direction to exit or egress path
- Use standard icons to illustrate geolocation and building components (e.g., windows, exits, disciplines)

Compatibility Requirements:
- Comply with exchange standards for data transmission (e.g., NIEM)
- Comply with NGFR open architecture
- Bi-directionally communicate with existing response-related software and systems (e.g., electronic situational awareness, dispatch, threat sensors)

STATE of TECHNOLOGY: There are some solutions available from the private sector that help with identifying locations of emergency calls even inside of buildings. One solution has many features that would be useful for responders, but it requires building owners to implement by employing an array of sensors in conjunction with a data collection platform. The sensors aid with knowledge of building population in real time, locations of emergency calls, and contact tracing needs primarily by measuring the presence of smart devices including phones, watches, laptops and tablets, and tags using including light detection and ranging (LiDAR), Bluetooth, and Wi-Fi. Other platforms allow responding units to turn device-based location data from connected devices into visualizations which are accurate to a radius as low as 4 meters from the call for help. Additionally, some platforms allow the responder to send a text message to the caller to help with any additional location needs.

BARRIERS:

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<tbody>
<tr>
<td>Privacy concerns of the public</td>
<td>Potential resistance by carriers or phone manufacturers to incorporate tracking technology</td>
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</tbody>
</table>

Related Standards and Guidelines

27 The requirements contained in the NGFR Integration Handbook can be found at https://www.dhs.gov/science-and-technology/ngfr/handbook
29 The Most Scalable Indoor Location Platform, InnerSpace, https://innerspace.io/platform
SA.49 ISSUE CORRELATION:

- Citizen Journalism
- Inability/Refusal to Evacuate
- Substances of Abuse
- Attack Behavior
- Human Settlement Trends
- Crowd Behavior
- Rise in Homelessness
- Reliance on Technology

- 5G
- IoT
- Social Media (Investigation)
- UAS/C-UAS

- Weather Hazards
- Climate Hazards
- Geologic Hazards

- Commercial Facilities
- Government Facilities

- Protests/Civil Unrest
SA.2 The ability to view building information (e.g., blueprints, egress routes, known hazards, medical caches, communications centers, utility layouts) electronically in real time

DESCRIPTION: Both on scene personnel and incident command would like the ability to visualize information about buildings that are the site of current or impending response operations. This information can include accurate and current floor plans, the location of emergency response equipment (e.g., standpipes, sprinkler controls, communications centers), the location of known threats and hazards (e.g., oxygen tanks, electric/gas lines), and designated exits. This information can enhance responder safety and allow them to move through a building more efficiently.

Many agencies are reliant on paper maps and blueprints for decision-making, if those are even available. Some jurisdictions have begun collecting digital blueprints or making them a condition for permitting. However, there are limited platforms that allow responders to view these files from the scene. In addition, many paper maps or devices (e.g., phones, tablets) are not ruggedized for the incident scene and remain in vehicles instead of with the responders in the building.

Emerging solutions allow responders and inspectors to document building information in three dimensions. Unfortunately, the file types most commonly used with building information are not easily read by or integrated with common situational awareness or incident command systems. The data is therefore not available in the field or to support real-time operations or decision-making. Further, building information files can be large and difficult to access or store for many agencies.

DESIRED CAPABILITY: Potential solutions should:

Data Integration Requirements
- Integrate with satellite images, terrain maps
- Highlight the location of standpipes, exits, stairwells, exhaust systems, vents
- Allow user to update floor plans in real time

Data Access Requirements
- Allow user to access large data files from incident scene in the absence download capability
- Allow user to access necessary components of protected data (e.g., critical infrastructure floorplans)
- Allow user to access data outside of response vehicles

Visualization Requirements
- Display data using GIS-enabled incident-specific maps
- Display data to reflect three dimensions
PROJECT RESPONDER 6
SITUATIONAL AWARENESS

- Display sub-division of building spaces (e.g., apartments, cubicles)
- Allow user- or agency-configuration of display features
- Allow user to turn off layers when integrated with other data sets
- Display responder-critical data elements (e.g., caches, exits)
- Use standard icons to illustrate geolocation and building components (e.g., windows, exits, disciplines)

Compatibility Requirements:
- Integrate with responder life safety alarms
- Comply with exchange standards for data transmission (e.g., NIEM)
- Comply with NGFR open architecture
- Bi-directionally communicate with existing response-related software and systems (e.g., electronic situational awareness, dispatch, responder geolocation, threat sensors)

STATE of TECHNOLOGY: Detailed facility profiles can be shared with public safety entities to protect the property and its occupants. Facility profiles may include:

- Points of contact and owner information
- Best access gates for all buildings in an emergency
- Fire and security alarm locations and contacts
- Boundaries including parking lots and other outdoor areas
- Floor plans and key building information
- Utility information and shutoff locations

Building information modeling (BIM) is increasingly used in building development because it generates three-dimensional models of the entire project. Using BIM technology software, it is possible to obtain the virtual equivalent of a facility’s actual components including walls, columns, slabs, roofs, windows, doors, mechanical systems, ducts, plumbing, electrical, etc. Access to such plans would allow responders to have critical information on hand during an emergency. Additionally, recent technological developments have produced BIM-to-augmented reality (AR) models. These new models allow full-resolution three-dimensional data of any size to be optimized and then delivered and rendered to untethered mobile devices (i.e., iPads and

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32 The requirements contained in the NGFR Integration Handbook can be found at https://www.dhs.gov/science-and-technology/ngfr/handbook
smartphones). This capability would allow almost any entity to have access to such data via a mobile connection.\textsuperscript{35,36}

Digital twins are another technology experiencing increased use in building development. A digital twin is a virtual replica of a physical product, process, or system. It can grow in complexity from representing single items to a model of systems of interconnected things.\textsuperscript{37} A digital twin can also provide information about the current state of building subsystems.\textsuperscript{38}

**BARRIERS:**

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<tr>
<th>Technology</th>
<th>Policy</th>
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</thead>
<tbody>
<tr>
<td>File formats incompatible with existing software</td>
<td>Data security restrictions, especially for critical infrastructure</td>
</tr>
<tr>
<td><strong>Culture</strong></td>
<td><strong>Other</strong></td>
</tr>
<tr>
<td>Lack of information sharing among levels of government</td>
<td>Inability to capture interior building modifications (e.g., apartment subdivisions)</td>
</tr>
</tbody>
</table>

**SA.2 ISSUE CORRELATION:**

- **Inability/Refusal to Evacuate**
- **5G**
- **Augmented/Virtual Reality (AR/VR)**
- **Artificial Intelligence (AI)**
- **Data Analytics**
- **Internet of Things (IoT)**
- **Robotics**
- **Chemical Commercial Facilities**
- **Defense Industrial Base**
- **Energy**
- **Government Facilities**


\textsuperscript{37} What is a Digital Twin?, IoT For All, 2019, https://www.iotforall.com/what-is-digital-twin-technology.

COMMUNICATIONS & INFORMATION SHARING (CIS)

Defined as the capability to seamlessly and dynamically connect multiple persons/entities and convey meaningful and actionable information to all relevant parties.

NEEDS IDENTIFIED 37

AVERAGE PRIORITY SCORE 3.12

HIGHEST PRIORITY CIS CAPABILITY NEEDS:

- **CIS.15**: The ability to maintain communications (voice and data) between units inside and outside of facilities (e.g., shopping malls, office/school buildings, subways)

- **CIS.20**: The ability for on-scene responders to receive updated information and data in real time (e.g., optimal navigation routes, situational awareness data) without relying on push-to-talk communications

- **CIS.33**: The ability to provide responders with sufficient technology/connectivity to work remotely as needed

The top three Communication & Information Sharing needs are described in the section below; one is among the top 15 needs.

- **Average Need Score**: Communications & Information Sharing was the second highest rated domain for Project Responder 6 (tied with RHS), with an average priority score of 3.12.

- **Need Status**: For 38 percent (14 of 37) of the CIS needs, more than 10 percent of participants did not find the need to be an issue for their discipline or jurisdiction. However, at least one respondent identified these as high or very high priority needs.

A complete list of all CIS needs can be found in Appendix H.
CIS.15 The ability to maintain communications (voice and data) between units inside and outside of facilities (e.g., shopping malls, office/school buildings, subways)

**DESCRIPTION:** Commercial cellular networks are able to provide relatively stable voice and data connectivity because the user is able to connect to and choose among available LTE and Wi-Fi networks. The devices can switch automatically to ensure that calls are not dropped and so that consumers are able to continuously access data feeds. With the correct password, users are able to pick from among many local networks. Customers express significant frustration when they are not able to access data and rarely have problems connecting via voice or text.

This is not the case for the public safety community. Participants described many incidents where units deployed inside of a building or below ground lost connectivity with those outside. Given that many response operations occur inside of large buildings or in underground parking garages or subway tunnels, this can be a significant problem that impacts responder safety and mission efficiency. If the area of operations has limited lighting, responders may not know that their radio has lost connectivity.

While some facilities have mounted communications repeaters (especially during construction), this is generally not mandatory and many buildings balk at the cost of installing this technology retroactively. For example, bi-directional antennas can significantly improve connectivity, but they are relatively expensive, and communities have no way to enforce their use unless it is part of a construction requirement. Portable repeater systems allow responders to add temporary communications infrastructure during operations, but placement may not be optimal without advanced knowledge of the building or space. Many responders use personal cell phones in order to maintain communications with their unit and command.

The focus of this capability need is on developing solutions for new construction and existing facilities that will allow responders to maintain voice and data connectivity for the duration of response operations.

Participants rated CIS.15 as a **Very High** priority capability need.

**DESIRED CAPABILITY:** Potential solutions should:

**Network Requirements**

- Support all required devices for communication of:
  - Voice
  - Audio
  - Video
  - Images
  - Text
  - CAD data
PROJECT RESPONDER 6
COMMUNICATIONS & INFORMATION SHARING

- Sensor (e.g., chemical, radiological) data
- GIS data
- Application data
- Other incident-related data (e.g., building blueprints, model outputs)
- Provide continuous connectivity to all devices on the incident scene
- Integrate with existing LMR systems that may be using multiple frequency bands
- Allow multiple independent networks to interoperate without impact on user
- Share location and RF transmission parameters to avoid or minimize interference
- Allow devices to function across many networks and platforms
- Allow device-to-device (D2D) communications when user equipment is in proximity without reliance on network connectivity
- Allow D2D links, forming a chain of nodes to create or extend a network
- Allow authorized users to elevate or reduce the priority of operations or user transmissions
- Allow preemption for emergency message traffic and critical alerts (e.g., Personal Alert Safety System (PASS))
- Allow user-configurable prioritization of users or devices
- Automate data routing, storage, and processing
- Deployable systems should be ad-hoc, reliable, self-forming, and self-healing
- Self-organize to maximize coverage area and resource distribution
- Continuously assess network health and reliability
- Report on network health and availability

Infrastructure Requirements

- Utilize the existing infrastructure to enhance or amplify signals or clarity of communications
- Be scalable based on incident size and scope
- Be rapidly deployable to meet mission requirements

Robustness Requirements

- Operate at temperature ranges typical of climates in the United States
- Operate at temperature ranges typical of response activities
- Function through traditional construction materials
- Function up to 15 meters below ground
- Function after immersion in water
- Function at humidity of 100 percent
- Resist air pollutants, dust, smoke, ash and sand
STATE of TECHNOLOGY: Public safety in-building wireless communication capabilities are governed by codes and standards. This ensures that responders can communicate in every building area, including critical coverage areas (e.g., stairwells, basements, elevators, and shielded areas). Any new construction must pass inspection on in-building wireless communications by the regional authority having jurisdiction (AHJ) before receiving an occupancy permit. These in-building public safety communication systems are comprised of components that allow for the sending and receiving of various public safety radio bands, bi-directional repeaters, and strategically allocated antennas throughout a building to pass the transmit and receive radio communications.

There are several products available from the private sector to assist with maintaining communications inside and outside of large facilities. The most common components used in constructing in-building wireless communications coverage capabilities include Bi-Directional Amplifiers (BDA) and Distributed Antenna Systems (DAS). These two pieces of technology work together to rebroadcast communications signals. BDAs amplify low radio signal levels to a standardized level. These amplified signals are transmitted by the DAS, a network of antennas, cables, splitters that cover a large area. This rebroadcasted signal allows responders to use radios in locations within a building that were previously dead zones.

BARRIERS:

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<td>Political resistance to installation of 5G</td>
<td>Cost of infrastructure</td>
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<tr>
<td></td>
<td>Time delays to change building codes</td>
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<tr>
<td></td>
<td>Resistance to changing building codes</td>
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</table>

Related Standards and Guidelines

- National Fire Protection Association (NFPA) 72- National Fire Alarm and Signaling Code®
- National Fire Protection Association (NFPA) 1225- Standards for Emergency Services Communications
- National Fire Protection Association (NFPA) 70- National Electrical Code® (NEC®)
- International Fire Code (IFC) 510.4.2.1- Amplification Systems and Components

PROJECT RESPONDER 6
COMMUNICATIONS & INFORMATION SHARING

- Federal Communications Commission (FCC) Part 90- Rules and certification testing for radio products that are used in defined bands for public safety services
- Underwriter Laboratories UL2524- Standard for Safety for In-building 2-way Emergency Communication Enhancement Systems

CIS.15 ISSUE CORRELATION:

- Attack Behavior
- 5G Wearables
- Chemical Communications
  - Critical Manufacturing
  - Dams
  - Defense
  - Industrial Base
- Energy
- Financial Services
- Food & Agriculture
- Government Facilities
- Healthcare & Public Health
- IT
- Nuclear
- Transportation
- Water & Wastewater
- Protests/Civil Unrest
**DESCRIPTION:** The majority of public safety agencies in the United States use LMR systems for communications between personnel. These radios have a push-to-talk functionality that literally allows responders to communicate only after they have pushed a button that initiates a communications link with whoever is listening on the set channel. Most systems in use today have no data screens and all communication takes place via voice relay. The access to data enjoyed by consumers that use current smart phones is unavailable to most responders — unless they are using personal or agency-issued cellular phones.

Two hands are often needed to complete response tasks (e.g., pulling hose, performing chest compressions). However, push-to-talk functionality generally requires that responders have one hand free to enable the connection. Some microphones exist that allow activation through other means (e.g., bone conduction), but these may not be well-suited for all missions.

The cost of replacing LMR devices for an entire department makes it extremely difficult for an agency to switch manufacturers or systems. As a result, most responders in the United States have no access to data while in the field unless it is audibly relayed to them over their radio. Given the previous capability need discussion on issues with connectivity, responders can be left with no means to communicate or receive critical information.

Responders need to be able to receive information that is critical to their safety and to the response operations without having an additional device to carry.

Participants rated CIS.20 as a **High** priority capability need.

**DESIRED CAPABILITY:** Potential solutions should:

**Device Requirements**

- Transmit and receive regardless of physical environment:
  - Voice communications
  - Data communications (e.g., text, documents, sensor data, images, video)
- Record and transmit:
  - Streaming audio
  - Streaming video
- Allow proximity-based communications
- Allow D2D synchronization of data
- Minimize mouth-to-ear (M2E) latency
- Enhance fidelity of voice communication and incorporate mechanisms to ensure that spoken communication is intelligible
• Selectively neutralize the effects of ambient sound, regardless of proximity, decibel, or frequency
• Provide multi-sensory (e.g., visual, haptic) communications
• Integrate or be compatible with PPE, wearable devices, and/or provide hands free functionality
• Convert voice to text
• Convert text to voice
• Communicate with other public safety devices, regardless of frequency or waveform

Network Requirements
• Provide continuous connectivity to all devices on the incident scene
• Integrate with existing LMR systems that may be using multiple frequency bands
• Allow multiple independent networks to interoperate without impact on user
• Share location and RF transmission parameters to avoid or minimize interference
• Allow devices to function across many networks and platforms

Display Requirements
• Provide a usable display under operating and environmental lighting conditions
• Maintain luminescence/contrast sufficient to prevent confusion
• Be designed to minimize distraction and cognitive failure (i.e., the failure of the user to switch attention from the display to/from the outside visual scene when necessary)
• Be designed to minimize user memory load (e.g., key data should be on the display at the same time)

Transmission Requirements:
• Transmit data to intended destination
• Transmit data in real time
• Transmit data using geographic information system (GIS) coordinates

Compatibility Requirements:
• Comply with exchange standards for data transmission (e.g., NIEM)
• Comply with NGFR open architecture

Robustness Requirements
• Operate at temperature ranges typical of climates in the United States
• Operate at temperature ranges typical of response activities
• Function after immersion in water

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42 The requirements contained in the NGFR Integration Handbook can be found at [https://www.dhs.gov/science-and-technology/ngfr/handbook](https://www.dhs.gov/science-and-technology/ngfr/handbook)
PROJECT RESPONDER 6
COMMUNICATIONS & INFORMATION SHARING

- Function at humidity of 100 percent
- Resist air pollutants, dust, smoke, ash and sand

BARRIERS:

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<td>- Construction and terrain barriers</td>
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CIS.20 ISSUE CORRELATION:

- Attack Behavior
- Reliance on Technology
- 5G
- AR/VR
- IoT
- Wearables
- Weather Hazards
- Climate Hazards
- Geologic Hazards
- Chemical
- Commercial Facilities
- Communications
- Dams
- Energy
- IT
- Nuclear
- Protests/Civil Unrest
### CIS.33 The ability to provide responders with sufficient technology/connectivity to work remotely as needed

**DESCRIPTION:** Employees across the United States were required to work remotely during the COVID-19 pandemic. Although not all emergency response tasks can be done remotely (e.g., fire suppression, emergency medical response), many in the public safety community were asked to work from home. This created a number of difficulties for those asked to do so.

First, many jurisdictions did not maintain sufficient stockpiles of telecommunications equipment such as laptops, tablets, etc. that could be distributed to personnel for home use. Many responders reported having to go out and purchase their own laptop so that they were able to work from home. Agencies maintaining limited stockpiles of devices is primarily the result of cost and lack of previous need.

The second issue is lack of connectivity. The network speeds and data allowances required for video teleconferencing (as well as sharing that connectivity with children doing remote schoolwork) come at a cost that was again often borne by the responder. Some agencies did offer mobile Wi-Fi hotspots or reimbursements for network costs, but many agency budgets did not support this. There also remain areas throughout the country (e.g., rural areas with reduced populations) that do not have access to the internet, requiring people in those areas to drive long distances for network access. A number of organizations are developing networks that will deliver satellite-based broadband internet access to rural or remote areas, but the service is not yet available.

The third issue is the limited availability of collaboration platforms that are designed for use by public safety agencies. While some applications exist, they are not yet widely known or adopted by many agencies. As an alternative, many chose to use no-cost video teleconferencing platforms that did not provide the security or other features necessary for the public safety community (e.g., encryption, access restrictions, data sharing, messaging).

Responders would like to be able to seamlessly work from home (or other remote locations) without bearing personal upfront and recurring costs. Seamlessly working from home includes reliable connectivity with sufficient network speeds and platforms designed for public safety requirements.

Participants rated CIS.33 as a **High** priority capability need.

**DESIRED CAPABILITY:** Potential solutions should:

**Device Requirements**

- Develop standard guidance for public safety devices (e.g., processor speed, graphics speed, microphone/camera specifications)
PROJECT RESPONDER 6
COMMUNICATIONS & INFORMATION SHARING

Network Requirements
- Develop standard guidance for public safety network access (e.g., upload/download speeds, throttling restrictions)

Platform Requirements
- Allow text, voice, and video communications/collaboration
- Allow upload of documents
- Allow file sharing of documents
- Provide access controls
- Provide encryption of communications

BARRIERS:

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<td>Limited collaboration platforms focused on public safety needs</td>
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<td>Cost to jurisdiction/agency</td>
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<td></td>
<td>Personal cost to responder</td>
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CIS.33 ISSUE CORRELATION:

- Human Settlement Trends
- Reliance on Technology
- 5G
- Communications
- IT
- COVID-19
- Settlement
- Trends
- Reliance on Technology
- 5G
- Communications
- IT
- COVID-19
COMMAND, CONTROL, & COORDINATION (CCC)

Defined as the capability to identify incident priorities, allocate scarce resources, and exchange relevant information to make decisions in a stressful environment.

There are four Command, Control, and Coordination needs presented below because they are all among the top 15 overall needs.

- **Average Need Score:** Command, Control, and Coordination was the highest rated domain for Project Responder 6, with an average priority score of 3.20.
- **Very High Priority Needs:** Two of the five capability needs rated as Very High Priority are in the CCC domain (CCC.1 and CCC.6).
- **Scoring Consensus:** The domain also had the lowest average deviation from the mean (1.29), meaning that there was the more agreement among participants about the priority ratings for the capability needs in this domain.
- **Need Status:** Command, Control, and Coordination had the highest number of Universal Needs and the lowest number of needs in which more than 10 percent of participants did not find the need to be an issue for their discipline or jurisdiction.

A complete list of all CCC needs can be found in Appendix I.
DESCRIPTION: A significant number of the PR6 capability needs focus on the need to integrate data and information into command and operations. However, responders noted that it is easy for them to “drown in data”. The amount of data available to responders continues to increase, while the ability to process, validate, and analyze that data has not improved at the same pace. It is difficult for responders to access reliable data — much less actionable information — that can inform decision-making. Participants stated that they need actionable information derived from up-to-date, valid, and reliable data that is drawn from multiple sources.

There are a number of factors that impede the ability to incorporate real-time incident data into decision-making. Currently, there is both a lack of data standards and the common use of proprietary data formats among solution providers. This makes it difficult for existing systems to share data. Because data elements may be designated or named differently, it is difficult for a system to integrate what might be the same type of data. This is exacerbated by the fact that individual solutions may integrate dissimilar types of data as well. Further, by using proprietary formats, some data sets may be difficult to access or integrate. Data sets may also include out-of-date, redundant, or incorrect information. Another issue is that some available data has not been validated. While there are some data sources deemed more trustworthy than others, it is difficult to make decisions when the validity of the data is in question. Finally, systems that are able to integrate data sets are often deemed too expensive for many jurisdictions or agencies. The result is that strategic and tactical decisions are often made using inaccurate and/or incomplete data. This can have significant repercussions on responders and on incident outcomes.

Once the issues of data integration and validation have been addressed, there are further problems with providing the same data to all authorized personnel. Not all agencies or jurisdictions use the same system, so personnel responding to the same incident may see different information or may have no capability to access data or information at all. In addition, the ability to convert data to actionable information is a critical gap. Actionable information requires both analysis of the data and adaptation into usable formats (e.g., guides, templates, prompts). Data and information overload can be as much, or more, of a problem than not having the data in the first place.

Participants rated CCC.1 as a Very High priority capability need.

DESIRED CAPABILITY: Proposed solutions should:

Data Source Requirements:

- Integrate data from open source, proprietary, and protected data sources
- Ingest data in multiple file formats (e.g., .txt, .xls, .jpeg, .mpeg, .avi, .json)
• Integrate real-time data from responders on scene
• Rapidly integrate new validated data into system
• Allow users to remove data sources or records from system

Data Integrity Requirements:
• Be able to validate data based on consensus criteria
  o Label source of data
  o Designate that data is derived from a validated source
• Provide a confidence level
  o Define confidence in source
  o Designate confidence in data integrity

Data Visualization Requirements:
• Provide visualization of incident data/information
• Display data in multiple formats (e.g., text, images, audio, graphs, charts, maps)
• Allow display on common communications and computing devices (e.g., smartphones, tablets, laptops)
• Provide an intuitive graphical user interface (GUI)
• Allow user and/or agency to customize the interface
• Utilize a standard set of incident-related icons
• Include system of data layers
• Allow user to turn individual data layers on and off
• Provide visual notification when accessed data feeds have been updated

Data Analysis Requirements:
• Indicate whether new data changes response or priority of actions
• Provide a data filter feature
• Use a classification schema to organize data
• Incorporate metadata into classification schema

Potential Data Sources:
• Video feeds
• Still images
• Social media data
• Hazard sensor data
• Model predictions and forecasts
• Digital building blueprints (e.g., building information modeling (BIM))
• Data from Internet of Things (IoT)-connected devices
• Public safety data sources (e.g., law enforcement record systems, license plate readers, computer-aided dispatch (CAD) data)
• Public data feeds (e.g., traffic, school, municipal video feeds, property tax records)
• Available private data feeds (e.g., cell phone records and triangulation, bank records)
• Data from response-related repositories (e.g., Emergency Response Guidebook)
• Satellite imagery
PROJECT RESPONDER 6
COMMAND, CONTROL & COORDINATION

- Allow users to compare data across time (historical and incident-specific)
- Provide user-defined triggers, warnings, and alerts
- Allow user to create customized reports
- Convert incident-specific data into common file formats
- Alert user to anomalies or results that require further attention

Decision-Support Requirements:
- Integrate a standardized system for building data collection requirements
- Provide actionable information based on discipline, role, and type of incident
- Provide analysis, templates, prompts, etc.

Transmission Requirements:
- Transmit data to intended destination
- Transmit data in real time
- Transmit location of video and images using geographic information system (GIS) coordinates

Data Storage Requirements:
- Store incident-related data for post-incident analysis
- Encrypt or protect incident data
- Provide options for local or cloud-based storage

Compatibility Requirements:
- Comply with exchange standards for data transmission (e.g., National Information Exchange Model (NIEM))
- Comply with Next Generation First Responder (NGFR) open architecture
- Bi-directionally communicate with existing response-related software and systems (e.g., electronic situational awareness, dispatch, model prediction and forecasts)

Maintenance Requirements:
- Maintain backwards compatibility after upgrade
- Perform automated periodic virus detection and cybersecurity screening of software components

STATE of TECHNOLOGY: Currently, there are many platforms available from the private sector that assist organizations with collection and analysis of data. The data sources integrated into the system vary between the different platforms as well as the information needs of the end user. This gives each organization looking for such systems a wide array of options from which to choose.

43 The requirements contained in the NGFR Integration Handbook can be found at https://www.dhs.gov/science-and-technology/ngfr/handbook
The great value of this data collection and analysis is the ability to incorporate the outcomes into actionable information in a timely manner (i.e., received in time to make a meaningful decision that delivers a positive impact to strategic planning and operational decisions). While many platforms offer analytical outcomes that can be put into action, not all platforms on the market offer a real-time data analysis capability. This is an important requirement as it is critical during ongoing and fast-paced situations, such as emergency events, that decision-makers receive information that is both accurate, up-to-date, and keeps pace with informational needs.

Platforms that offer real-time data collection and analysis do so by integrating feeds from disparate sources. There are common sources used by responders (e.g., cameras, phones, robots) that are readily integrated into these platforms. Newer platforms are integrating both human and passive technological inputs into the analytical stream in order provide a more complete common operating picture. By incorporating IoT technology such as sensors, wearables, and smart devices, along with traditional data sources, into these platforms, the responder community has been able to develop a more robust picture of operational events. Plans for future platforms include integrating data feeds from intelligent infrastructure (i.e., part of the Smart City initiative).

These data analysis platforms are becoming increasingly common within responder agencies that are integrating data analytic tools into their preparedness, response, and recovery/mitigation operations. For example, the Arizona Department of Emergency and Military Affairs launched an “Operations Dashboard.” The dashboard is a situational awareness mapping tool that helps the state coordinate emergency support functions in real time. In another instance, the New York State Division of Homeland Security and Emergency Services uses data visualization dashboards for preparedness planning through County Emergency Preparedness Assessments (CEPA). Finally, in response to the COVID-19 pandemic, the New York City Emergency Management Agency employed new data analytics platforms to develop interactive dashboards used to track and analyze COVID-19 case counts, hospitalizations, fatalities, and resource allocation efforts.

The United States national labs have been involved in research projects focused on developing and testing situational awareness and decision algorithms for emergency responder use during the COVID-19 pandemic. For example, Sandia National Laboratories led eight projects related to

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pandemic situational awareness to inform decisions within the responder community. These projects included aspects such as disease transmission estimates, forecasting resource requirements, determination of resource allocations, quantifying decision-making, modeling return-to-work decisions, and detecting and addressing misinformation campaigns. Brookhaven National Laboratory and Oak Ridge National Laboratory have large computer science, visualization and data facilities with several programs that are applicable to the responder community. Argonne National Laboratory conducts research in data visualization, analysis, and management for the capture, transport, reduction, transformation, storage, and understanding of data. The lab also has several programs focused on decision science and analysis. The U.S. Department of Energy, U.S. Department of Defense, and several academic institutions are partnering to create a consortium of subject matter experts focused on incorporating aspects such as machine learning, cybersecurity, distributed systems, and communications into these analytical platforms as a way to increase the real-time situational awareness and decision-making capabilities of the responder community.

The Defense Advanced Research Projects Agency (DARPA) has the Collection and Monitoring via Planning for Active Situational Scenarios (COMPASS) program. The objective of the program is to develop software that is able to clarify intent by assessing an adversary’s responses to various stimuli. COMPASS leverages artificial intelligence (AI) technology, game theory, modeling, and estimation to identify information about enemy intentions and provides decision makers with reliable intelligence on both positive and negative tradeoffs of potential actions. The goal of the program is to provide operations and planning personnel with robust analytics and decision-support tools that reduce the uncertainty about events they may encounter.

**BARRIERS:**

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<tr>
<td>Proprietary data sources</td>
<td>Lack of common NIMS-typed nomenclature and symbology</td>
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<tr>
<td>Transmission speed issues</td>
<td>Lack of data standards and system silos</td>
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<tr>
<td></td>
<td>Time requirements for scrubbing data for release</td>
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</table>

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### PROJECT RESPONDER 6
**COMMAND, CONTROL & COORDINATION**

| Culture                          | Other                                                           |
|----------------------------------|                                                                |
| • Acceptance of change           | • Data storage limitations                                      |
|                                  | • Concerns about information overload                          |

**Related Standards and Guidelines**

- Emergency Data Exchange Language (EDXL) Distribution Element, v. 2.0 - EDXL-DE-V2.0

**CCC.1 ISSUE CORRELATION:**

- **Attack Behavior**
  - Crowd Behavior

- **5G Data Analytics**
  - IoT
  - Social Media (Investigation)
  - UAS/C-UAS

- **Weather Hazards**
  - Climate Hazards
  - Geologic Hazards

- **Chemical Communications**
  - Critical Manufacturing
  - Dams
  - Defense Industrial Base
  - Energy
  - Financial Services
  - Food & Agriculture
  - Government Facilities
  - Healthcare & Public Health
  - IT
  - Nuclear
  - Transportation
  - Water & Wastewater

- **COVID-19**
- **Protests/Civil Unrest**
DESCRIPTION: During the interview phase of Project Responder 6, the participants were asked to describe the biggest challenges facing their agency. A majority of respondents cited a lack of staff to carry out their mission as their biggest challenge. Across disciplines, participants attributed municipal funding shortages for this deficiency.

In addition to the lack of operational staff, participants reported that there is often a lack of qualified personnel for command and leadership positions. Not only are there an insufficient group of trained personnel available, but the issue also becomes further strained during prolonged events when leadership training is unavailable or not a priority or when all available resources are assigned to operational tasks. Examples include prolonged wildfire seasons where teams are needed at subsequent fires, COVID-19 response, and communities with multiple protest/civil unrest events. This lack of staff availability for leadership roles exists because of insufficient training, skills, experience, or qualifications. In some jurisdictions, promotional systems are also governed by labor contracts and state laws which impact who is eligible for advancement.

Responders would like systems for pre-vetting existing staff for leadership qualities, specific training options, and opportunities for individuals to demonstrate leadership skills in simulated environments. Other career fields use a system of metrics to assess the strengths and weaknesses of prospective employees. These metrics are profession or position-specific and are able to evaluate leadership or management potential. These metrics or assessment criteria have not been developed for public safety recruits. The ability to identify whether current staff or recruits have leadership qualities could help to address this capability need.

In addition, there is a lack of training opportunities focused on developing leadership skills. FEMA’s Emergency Management Institute (EMI) offers a select number of courses on leadership and the NIMS/Incident Command System (ICS). Some of these courses are available for independent study and others are only taught in-person. Public safety associations and other organizations offer leadership assessment programs and courses. One issue is that these programs are not designed to assess leadership potential but are largely focused on helping individuals with promotion exams. Another issue is that the availability of on-site or in-person training has been hindered by COVID-19 restrictions. However, participants stated that some courses were difficult to access or too costly for their jurisdiction, even prior to the pandemic. Limited virtual training opportunities exist and often do not focus on command or incident management functions or skills.

Participants rated CCC.6 as a Very High priority capability need.
PROJECT RESPONDER 6
COMMAND, CONTROL & COORDINATION

DESIRED CAPABILITY: Proposed solutions should:

Qualification Assessment Requirements:
- Develop standardized, discipline-specific metrics to assess leadership potential
- Develop standardized role-specific assessment metrics

Qualification Reporting Requirements:
- Allow personnel to track qualifications against discipline-specific and role-specific assessment criteria:
  - Training courses
  - Experience in role (real-life and exercises)
  - Skills
  - Degrees/credentials/certifications
- Allow management to query tracking system

Simulated Training Requirements:
- Allow users to train in specific roles
- Allow users to train solo or with real or virtual team members
- Assess leadership and command knowledge
- Assess leadership and command skills
- Assess decision-making skills
- Identify skills requiring improvement
- Identify alternate outcomes based on specific decisions
- Incorporate evolving challenges and scenarios
- Integrate agency-specific policies and protocols
- Allow customization based on jurisdiction-, incident-, and role-based variables

Simulated Exercise Requirements:
- Provide multiple scenarios to assess decision-making skills
- Accurately reflect consequences of decisions
- Allow customization based on jurisdiction-, incident-, and role-based variables

STATE of TECHNOLOGY: Since this is not predominantly a technology issue, the key to achieving this capability will be creating a culture shift within agencies that changes the focus to creating a leadership pipeline to ensure that staff is properly trained and ready to lead when required. Such a pipeline is useful for bolstering an agency’s depth of leadership by fostering such skills in select personnel while enhancing its organizational capability. Developing this pipeline begins with the process of identifying and then nurturing leadership skills by exposing prospective individuals to
a variety of developmental opportunities and experiences. The leadership pathway should be a simple and transparent process to ensure buy-in from all levels of the agency. When personnel are aware of the process and how to go about gaining the knowledge they need to ascend to the next level, they are more likely to want to participate. There are many white papers and business journal articles that discuss how large companies and organizations have successfully created thriving leadership pipeline processes. A leadership pipeline creates a systematic process that incorporates personnel development, evaluation, training, and promotion.

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<td>• Simulated training not available for referenced topics</td>
<td>• Lack of standardized advancement processes</td>
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<table>
<thead>
<tr>
<th>Culture</th>
<th>Other</th>
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</thead>
<tbody>
<tr>
<td>• Resistance to technological advancements</td>
<td>• Political favor of candidates</td>
</tr>
<tr>
<td>• Resistance to cultural change of leadership advancement</td>
<td>• Ego of leadership</td>
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<td></td>
<td>• Cost</td>
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CCC.6 ISSUE CORRELATION:

- 5G
- AR/VR
- Weather Hazards
- Climate Hazards
- Geologic Hazards
- COVID-19
- Protests/Civil Unrest

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59 Developing Your Leadership Pipeline, Sigma Assessment Systems Inc., [https://www.sigmaassessmentsystems.com/developing-your-leadership-pipeline/](https://www.sigmaassessmentsystems.com/developing-your-leadership-pipeline/).
DESCRIPTION: As incident size or complexity grows, response agencies may need to incorporate additional personnel. This is often done through mutual aid agreements, many of which are exercised on a routine basis. Mutual aid agreements provide personnel and equipment when requested to support routine or incident-specific needs. When done frequently, agencies have knowledge of and confidence in the qualifications of the resources being provided. However, if an incident is large, unprecedented, or requires uncommon skills, the agency must be able to seamlessly integrate potentially unknown personnel into operations. Incident command needs to be able to account for the presence of these personnel on scene and effectively assign them to tasks that support the response.

This is difficult for several reasons. First, not all agencies use the same or interoperable personnel accountability systems. These systems may use proprietary data formats, incompatible fields, or exist in non-digital formats. Second, there is a lack of standardization of abilities and knowledge among positions across jurisdictions. Workshop participants noted, for example, that there are no common training requirements to become a firefighter. While many of the skills are the same across the United States, there is no certainty that additional personnel will use the same tactics, be familiar with tools or technology, or have knowledge of the jurisdiction. These issues are further exacerbated when non-traditional response assets or volunteers are needed. Members of the National Guard, medical staff, and canine search assets, for example, are not often called upon for traditional response operations. When needed, however, they may require additional training, escort, or other accommodations. All these factors combine to complicate the process of integrating additional personnel into operations. Often, arriving assets feel under-utilized because there is insufficient time to adequately familiarize or train them to work independently.

Participants rated CCC.12 as a High priority capability need.

DESIRED CAPABILITY: Proposed solutions should:

Qualification Requirements

- Enable correlation of staff with standard skills and knowledge for emergency response positions (as defined in the Resource Typing Library Tool)\(^6\)
- Develop standard equipment packages for response teams or apparatus
- Develop standard data form to characterize incoming personnel assets (e.g., numbers at each position, resource type, unique skills, brand of personnel safety equipment)

Planning Requirements

- Develop planning templates for the integration of asset types
- Develop knowledge packages for arriving units (e.g., annotated jurisdiction maps, known hazards, points of contact, just-in-time (JIT) training videos)

Data Integration Requirements

- Develop standard accountability system fields or format
- Allow user to query for specific skills/credentials/certifications

Compatibility Requirements:

- Comply with exchange standards for data transmission (e.g., NIEM)
- Comply with NGFR open architecture
- Bi-directionally communicate with existing response-related software and systems (e.g., electronic situational awareness, dispatch, model prediction and forecasts)

STATE of TECHNOLOGY: Several federal entities have released guidelines for dealing with the arrival of volunteers and additional personnel to the emergency site. These documents provide the responder community, especially emergency managers, with a framework for planning, managing, tracking, legal issues, task assignments, and training of affiliated and unaffiliated volunteers. Most of the framework describes how to employ the ICS and NIMS to account for these extra personnel and civilians onsite. Additionally, academic institutions, such as Mississippi State University, have developed planning “pathways” for use in volunteer coordination in times of emergency. This pathway outlines each step in the process the volunteer coordinator should take throughout the response phase. Finally, the Western Massachusetts Medical Reserve Corps has published guidance for a scalable volunteer management plan. The plan includes integration with ICS, communications, screening and training, deployment, and retention sections.

61 The requirements contained in the NGFR Integration Handbook can be found at https://www.dhs.gov/science-and-technology/ngfr/handbook
PROJECT RESPONDER 6
COMMAND, CONTROL & COORDINATION

There are several products available from the private sector that can assist responders with integrating and tracking personnel and volunteers onsite. These products aid in providing risk management, more accountability, and more insight into the skills and certifications of those present on the incident scene. A few products allow for the creation of a database of local and national volunteer organizations and certified individuals that make it easier for emergency managers to identify and call-in additional aid when needed. Additionally, some products allow for issuance of onsite identification badges or QR codes which can be scanned when each individual onsite enters and leaves the area. Many features of these products were designed to provide Incident Command with insight into the resources available to them in real-time.67,68

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<td>• N/A</td>
<td>• Lack of position standards (other than EMS)</td>
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<table>
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<td>• Standards</td>
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<tr>
<td></td>
<td>• Lack of knowledge of other agency resources</td>
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<td>• Lack of knowledge of non-dispatched resources and volunteers</td>
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Related Standards and Guidelines

- Personal Identity Verification (PIV) of Federal Employees and Contractors- FIPS 20169
- Volunteer Protection Act of 1997- P.L. 105-1971

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68 Incorporating Emergency and Disaster Response Volunteers into your All-Hazards Plan, Galaxy Digital, https://www.galaxydigital.com/blog/disaster-response-volunteers/.
PROJECT RESPONDER 6
COMMAND, CONTROL & COORDINATION

CCC.12 ISSUE CORRELATION:

- Attack Behavior
- Mental Health Crises
- Volunteerism

- Weather Hazards
- Climate Hazards
- Geologic Hazards

- Chemical Commercial Facilities
- Dams
- Energy
- Healthcare & Public Health
- Transportation
- Water & Wastewater

- COVID-19

- Protests/Civil Unrest
DESCRIPTION: Agencies and jurisdictions across the United States experienced shortages of key supplies in dealing with COVID-19. Responders reported difficulties in obtaining masks, gowns, gloves, face shields, decontamination supplies, swabs, and other PPE.\(^{72}\) While there have been many examples from the COVID-19 pandemic, the need for cooperation and collaboration exists across many incident types. This capability need is focused on the coordination among agencies and jurisdictions when supplies are scarce, not on the procurement of resources.

The dissemination of supplies among entities that need them can be based on objective or subjective criteria. While relationships and politics should be minimized to ensure the most effective allocation, these factors often play a significant role. Elected officials – whom may or may not have in-depth subject-based knowledge – often make decisions about resource allocation that preclude equitable allocation and hinder cooperation among jurisdictions.

Further, many jurisdictions have outdated information about what is in their stockpiles, difficulties with locating existing supplies that they are assumed to have on hand, expired supplies, and lack of awareness about what is available to them through local, state, or federal stockpiles.\(^{73}\) It is difficult for an organization to make logical decisions about resource allocation when its stakeholders have conflicting or outdated information. In addition, participants reported that many agencies will not divulge an accurate accounting of supplies and equipment because of concerns that they may not receive scarce resources or that some may be taken from them. Another impediment to optimal allocation is evident in smaller jurisdictions. Often the same person will perform the same role for multiple municipalities or multiple roles within a jurisdiction. It is challenging to rationalize allocation decisions without relying on objective criteria.

Workshop participants stated that the ability to improve local resilience and stockpiles are optimal solutions but may not always be possible given municipal budgets and existing culture.

Participants rated CCC.8 as a **High** priority capability need.

**DESIRABLE CAPABILITY:** Proposed solutions should:

**Planning Requirements**

- Develop criteria and metrics for allocation of scarce resources within jurisdiction/agency
- Develop rationale for allocation criteria and metrics
- Identify potential barriers to distribution

\(^{72}\) Operational Impacts of COVID-19 Survey Results, FirstLink Research & Analytics, completed April 2020.

\(^{73}\) Ibid
Identify critical supplies for potential high-impact or resource-intensive events
Develop stockpile guidance and packages for potential high-impact or resource-intensive events
Assess lessons learned and best practices from COVID-19 resource shortages
Identify and assess redundant supply chain options (including manufacturing, distribution, and delivery options)
Identify non-traditional alternatives (e.g., 3D printing of face shields) to obtain supplies

Resource Management Requirements

Integrate accurate inventory of supplies within jurisdiction/agency
Integrate accurate location of supplies within jurisdiction/agency
Track expiration and maintenance dates for supplies (as warranted)

STATE of TECHNOLOGY: There are no technology components to this capability need that do not already exist in another field. Modern logistics management systems are able to integrate inventory levels, identify the precise location of supplies, and track expiration and maintenance dates.

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<td>Ability to maintain an accurate count of resources</td>
<td>Lack of transparent resource allocation policies</td>
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<tr>
<td>Culture</td>
<td>Other</td>
</tr>
<tr>
<td>Unwillingness to disclose accurate count of resources</td>
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CCC.8 ISSUE CORRELATION:

- Weather Hazards
- Climate Hazards
- Geologic Hazards
- Healthcare & Public Health
- COVID-19
Responder Health & Safety

The top three Responder Health & Safety needs are described in the section below; two are among the top 15 needs.

- **Average Need Score**: Responder Health & Safety was the second highest rated domain for Project Responder 6 (tied with CIS), with an average priority score of 3.12.

- **Need Status**: RHS had one Universal Need and 63 percent (17 of 27) in which more than 10 percent of participants did not find the need to be an issue for their discipline or jurisdiction.

A complete list of all RHS needs can be found in Appendix J.
The ability to monitor the mental health of traditional and non-traditional responders (e.g., fire, law enforcement, EMS, public safety telecommunicators, front-line medical personnel) during routine and extreme/extended operations.

**DESCRIPTION:** The ability to monitor the mental health of responders has been a long-standing Project Responder need. The essence of emergency response is dealing with stressful situations. Many responders routinely deal with the worst that humanity and mother nature have to offer. The number of violent, deadly, catastrophic, complex, and/or extreme incidents that the project team reviewed during the research phase of PR6 numbered in the hundreds (see Appendix B). The pressure of dealing with these incidents, the consequences of failure, and the seemingly unending nature of the mission have physical, psychological, and cognitive effects. This is compounded by daily assignments involving shootings, domestic abuse, child abuse, traffic collisions, overdoses, medical emergencies, suicides, work accidents, etc. On a daily basis, emergency responders — traditional and non-traditional — try to assist people through these personal tragedies. The effects of dealing with both the daily and exceptional incidents can be cumulative and produce physical and psychological symptoms including anxiety, avoidance, hyper-awareness, changes in behavior or beliefs, eating and sleeping disorders, apathy, mood swings, changes in or lack of interests, and substance abuse.

Suicide rates of emergency responders continue to be a significant issue. Data indicates that more firefighters and police officers died from suicide in 2017 than from line of duty deaths. The number of official responder suicides is likely under-reported. Post-traumatic stress disorder (PTSD) and depression affect responders at significantly higher rates than the national average, which has cascading impacts on physical health and decision-making.

Many of these issues have been exacerbated by the activities and restrictions associated with COVID-19. A longer discussion of the impacts of the virus on the response environment can be found in the COVID-19 section of Part 2. In brief, a significant increase in anxiety, PTSD, and suicide by emergency responders and medical personnel are being revealed anecdotally and through clinical studies. Similarly, the increase in sustained or sequential extreme weather events and natural disasters (e.g., wildfires) have caused similar issues. The inability of

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76 Ibid, Ruderman.

responders to separate themselves from an unceasing threat, separation from their families, and an increase in exposure to perpetually dangerous situations gives responders little to no ability to decompress and maintain physical and psychological health. These factors also make it difficult for those in leadership to monitor their staff. All of this is further aggravated if a segment of the public verbally and/or physically attacks responders based on their duties, as occurred during and after some of the racial injustice protests in the summer of 2020 and during the U.S. Capitol riot in January 2021.

Most responders are largely asked to self-monitor their mental health. There are a number of limitations related to methodologies that ask people to self-monitor and self-report their symptoms. Some larger (and primarily career) agencies offer annual physical examinations, but do not provide ongoing psychological assessments. Many agencies provide an initial psychological test but do little after the baseline evaluation to compare data against initial findings. Supervisors or chaplains may check in on staff, especially following a traumatic incident, but this is also harder during social distancing. Further, a distinctive cultural bias against seeking help hinders responders from pursuing support if they do self-identify issues. Surveys of responders indicate that while awareness of mental health issues continues to grow within the community, a common sentiment is that mental health issues are not something people want to talk about because they do not want to be seen as weak or unfit to do their job.78 Participants report some degree of progress addressing this cultural bias but admit that it is far from resolved.

Like physical injuries, psychological wounds can impact a responder’s ability to do their job safely, effectively, and objectively. Responders would like short-duration and long-term monitoring of the symptoms of stress, anxiety, depression, and other mental health issues.

Participants rated RHS.2 as a High priority capability need.

**DESIRED CAPABILITY:** Potential solutions should:

**Monitoring Requirements**

- Allow for monitoring of psychological data:79
  - Social activity
  - Physical activity
  - Mood changes
  - Irritability
  - Sleep duration and health
  - Medication usage
  - Stress level
  - Cognitive signs

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Alcohol intake
Voice patterns

• Allow user to self-report some data variables (e.g., social activity)
• Integrate with user interface that allows user to input data in a minimally intrusive manner (i.e., from device/component used or worn daily)
• Allow user to provide data in a surreptitious manner to protect health information
• Use standard mental health inventories, scales, etc.
• Integrate relevant data (e.g., incident anniversaries, notable personal dates, changes in marital status, financial issues, legal issues, recurrence of incident type)
• Integrate physiological data (e.g., heart rate, blood pressure)
• Integrate with hardware or software technology to collect data in minimally invasive manner
• Integrate images or video of signs or symptoms

Data Analysis Requirements

• Compare physiological data against responder-specific patterns over time
• Identify user-specific or incident type-specific patterns or signals for concern

Transmission Requirements:

• Transmit data to intended destination (e.g., mental health professional)
• Transmit data in real time

Data Storage Requirements:

• Store incident-related data for post-incident analysis in accordance with local, state, federal policies
• Encrypt or protect incident data

STATE of TECHNOLOGY: It is technologically possible to track the physiological and psychological status of a group of individuals. The World Trade Center (WTC) Health Program is a federal health program that provides no-cost medical monitoring and treatment for certified health conditions to those directly affected by the 9/11 attacks in New York, the Pentagon, and Shanksville, Pennsylvania. The program also funds medical research into physical and mental health conditions related to 9/11 exposures. However, an academic study of the WTC Health Program participant data indicates that little research has been done to examine any factors associated with the perceived need for mental health care. This type of investigation is critical to promoting open and frequent engagement in the mental health treatment in this population. The study

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80 World Trade Center Health Program: About the Program, Centers for Disease Control and Prevention, https://www.cdc.gov/wtc/about.html.
notes that non-traditional responders are far more likely than traditional responders to perceive a need for mental health treatment.\textsuperscript{81}

Platforms exist to technologically monitor mental health symptoms. Using wearables and smart devices, individuals can self-report and automatically disclose subjective and objective data related to their psychological health. Some systems include visualization components, allowing practitioners to view data and assess trends over time. Other platforms offer screening tests and can help to get responders in touch with resources that are available in their area.

The U.S. Department of Justice (DOJ), DHS, and U.S. Department of Health and Human Safety (HHS) offer several mental health programs for responders. The programs range from offering general help to focusing on specific disciplines (e.g., law enforcement) or circumstances (e.g., disaster response). Specifically, the DOJ offers such programs as the Edward Byrne Memorial Justice Assistance Grant (JAG), the VALOR Officer Safety and Wellness Program, and the National Officer Safety Initiative.\textsuperscript{82} The DOJ’s COPS Office awards grant funding to state, local, and tribal law enforcement agencies to establish peer mentoring mental health and wellness programs.\textsuperscript{83} The National Park Service, U.S. Forest Service, and U.S. Fire Administration provide programs that address mental health and wellness for firefighters. Additionally, the National Interagency Fire Center offers Critical Incident Stress Management services to fire departments focused on suicide prevention, intervention and post-intervention management. Finally, the Federal Interagency Committee on EMS and the National EMS Advisory Council focus on mental health and wellness strategies for the EMS community. The HHS’s Substance Abuse and Mental Health Services Administration (SAMHSA) supports a number of programs ranging from suicide prevention and community mental health to the Disaster Technical Assistance Center (DTAC). The DTAC funds programs that support survivors of disasters as well as organizations and agencies administering aid.\textsuperscript{84}

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<td>No national mental health assessment standard related to public safety</td>
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<tr>
<td></td>
<td>Legal barriers impacting the eligibility of responders to be employed if seeking mental health treatment</td>
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## PROJECT RESPONDER 6
### RESPONDER HEALTH & SAFETY

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<tr>
<td>• Resistance from labor organizations</td>
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</tr>
<tr>
<td>• Resistance from those in organization that do not recognize priority of mental health issues</td>
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### Related Standards and Guidelines

- Health Insurance Portability and Accountability Act (HIPAA) - P.L. 104-191[^85]
- Law Enforcement Mental Health and Wellness Act (LEMHWA) - P.L. 115-113[^86]

### RHS.2 ISSUE CORRELATION:

- **Attack**
  - Behavior
  - Mental Health Crises

- **AI**
  - Data Analytics
  - Wearables

- **Weather**
  - Hazards
  - Climate Hazards
  - Geologic Hazards

- **COVID-19**

- **Protests/Civil Unrest**


RHS.23 The ability to protect the private information of public safety and public health personnel (e.g., address, family information, schools)

DESCRIPTION: This capability need is focused on preventing the unauthorized or inappropriate release of information, often called doxxing, about emergency responders or their families. Doxxing refers to gathering an individual’s personally identifiable information (PII) and disclosing or posting it publicly, usually with malicious intent such as public humiliation, stalking, identity theft, or targeting an individual for harassment.\(^\text{87}\) In some cases, this information can include spouse or children’s names, location of a spouse’s workplace, or children’s schools. Many public safety and public health officials experienced doxxing amid the protests related to racial injustice, coronavirus restrictions, and election disputes of 2020. It is not illegal to release this information, but there are concerns that the release of this information could lead to violent actions against emergency responders or public health officials by violent extremists or those with a past grudge against specific individuals (e.g., history of past arrests).

Referred to as the BlueLeaks hack, a June 2020 release included over twenty years of data from over 200 police departments, fusion centers, and training centers. Among the documentation were the names, email addresses, phone numbers, and other data of an estimated 700,000 police officers. Data from the BlueLeaks hack also included one state’s repository of personal information about COVID-19 positive residents that was created in order to protect responders from exposure or infection.\(^\text{88}\)

Data releases from hacked accounts explain the source of some of this personal information, but other information can be found in publicly available data repositories or through records requests. Because they are municipal, state, or federal employees, most public safety or public health personnel do not have the ability to restrict the disclosure of their personal information. Several states allow law enforcement officers, public officials, and their families to qualify for legal, opt-out services permitting them to be deleted from public information databases. These states include Idaho, Nevada, California, Texas, Utah, Colorado, Florida, and New Jersey.\(^\text{89}\)

However, this only applies to specific data sets.

Many responders refrain from social media accounts, but this is not mandated or universal. Organizations exist that will identify and scrub personal information posted on the internet

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\(^\text{89}\) Privacy for Cops, [https://privacyforcops.org/privacy](https://privacyforcops.org/privacy)
PROJECT RESPONDER 6
RESPONDER HEALTH & SAFETY

(including the “dark web,”) but those services come at a cost and are not often reimbursed by an employer. This becomes a personal cost burden of serving the community.

In essence, public safety and public health personnel want to safeguard their PII, financial information, and health data to protect themselves and their families from cyber and physical attacks.

Participants rated RHS.23 as a High priority capability need.

**DESIRED CAPABILITY:** References to personal information in this section should include PII, financial data, health information, and any other data that may cause a vulnerability based on legal or authorized activities. Potential solutions should:

**Data Security Requirements**

- Allow public safety and public health officials (and their families) to mask personal information in publicly available databases and records
- Allow public safety and public health officials (and their families) to mask personal information in private databases and records for the duration of their employment
- Notify public safety and public health officials (and their families) when information requests are made that would include release of information (whether masked or not)
- Allow public safety and public health officials to block the release of information related to minor children
- Notify public safety and public health officials (and their families) that use social media accounts when there are searches for their private information

**STATE of TECHNOLOGY:** The protection of information is not a technology issue. Intelligence agencies are currently able to do this, although they have also been victim to cyber-attacks and unauthorized data releases. Cyber security remains an ongoing battle between those trying to illegally obtain, release, or withhold data, and those trying to protect it. Although cyber-related capability needs are not within the purview of this iteration of Project Responder, future iterations of this study may consider how they may be included. See the [Conclusions](#) section for further analysis of this issue.

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<td>Insufficient cyber security or statutory regulations regarding the cyber security of federal, state, and local data</td>
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<tr>
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<tbody>
<tr>
<td>Trend towards greater transparency into public safety operations</td>
<td>Private companies owning financial and health data</td>
</tr>
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</table>
Related Standards and Guidelines


**RHS.23 ISSUE CORRELATION:**

- Citizen Journalism
- Biometrics & DNA
- Financial Services
- Protests/Civil Unrest
- Reduced Respect for Authority
- Dark Web
- Wearables
- IT
- Social Media (Investigation)

---

DESCRIPTION: Of the 373 capability needs identified during Project Responder 6, 189 focus on or have requirements related to the integration or visualization of data. Like mental health monitoring, data integration has been a high-priority need — especially in recent years. There are other capability needs in this report that address the technical integration of ever-increasing amounts and types of data. This need focuses on the impact of that data on the responder. There are two facets to this capability need — the first is minimizing the disruption caused by the introduction of information without restricting the delivery of needed data. The requirements listed below pertain to this element.

The second is monitoring signs that indicate cognitive overload is occurring to decrease or mitigate effects on performance. Signs of cognitive overload include perception of fatigue, mood or energy level, and deficits in sensory discrimination, reaction time, vision, and memory. The ability to monitor the mental health of responders is described above in RHS.2.

As noted in the previous iteration of this report, being able to access the right data, in the right format and at the right time, could provide significant advancements in situational awareness and responder safety. However, too much information could overwhelm a responder while in the field, potentially causing them to block out all incoming information (and possibly missing critical data) or hinder decision-making because of concerns that all variables have not been assessed.

Preventing information overload involves identifying information critical to the task at hand, delivering it in the most beneficial and appropriate format, and removing (temporarily or permanently) when it is no longer necessary. Monitoring information, or cognitive, overload is critical to ensure that personnel are able to safely and efficiently complete their tasks.

Participants rated RHS.6 as a High priority capability need. It is also a Universal Need, meaning that all of the participants in the prioritization process stated that this capability need was valid for their jurisdiction and discipline.

DESIRED CAPABILITY: Potential solutions should:

User Interface Requirements

- Allow user to prioritize information type in advance of incident
- Allow user to customize user interface
- Allow user to cache or hide information when not currently necessary

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PROJECT RESPONDER 6
RESPONDER HEALTH & SAFETY

- Respond to user commands (e.g., audible, tactile)
- Provide data in format most appropriate (e.g., audible, visual, tactile)
- Use standard naming conventions for layers or data elements

Data Analysis Requirements

- Automatically remove redundant information
- Compare signs of cognitive overload against responder-specific patterns over time
- Identify user-specific or incident type-specific patterns or signals for concern

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<td>State of technology insufficient for ruggedized solution to deliver information in visual format</td>
<td>Lack of common NIMS-typed symbology</td>
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<td>Legal liability if solution fails to provide critical information or provides poor data</td>
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RHS.6 ISSUE CORRELATION:

- Attack Behavior
- 5G
- AR/VR
- AI
- Data Analytics
- IoT
- Social Media (Investigation)
- Wearables
- Weather Hazards
- Climate Hazards
- Geologic Hazards
- Communications
- COVID-19
- Protests/Civil Unrest
LOGISTICS & RESOURCE MANAGEMENT (LRM)

Defined as the capability to identify, acquire, track, and distribute available equipment, supplies, and personnel in support of incident response.

**NEEDS IDENTIFIED** 53

**AVERAGE PRIORITY SCORE** 2.80

**HIGHEST PRIORITY LRM CAPABILITY NEEDS:**

- **LRM.38** The ability to maintain sufficient staffing levels during short-term surge or long-duration events
- **LRM.39** The ability to accurately determine available staffing levels during times of emergency
- **LRM.51** The ability to identify who is authorized to be within the scene perimeter during incident response operations

The top three Logistics & Resource Management needs are described in the section below; two are among the top 15 needs.

- **Average Need Score:** Logistics & Resource Management was the sixth highest rated domain for Project Responder 6, with an average priority score of 2.80.
- **Need Status:** Two of the ten Universal Needs are from the LRM domain and 49 percent (26 of 53) in which more than 10 percent of participants did not find the need to be an issue for their discipline or jurisdiction.

A complete list of all LRM needs can be found in **Appendix K**.
DESCRIPTION: As mentioned previously, staffing challenges are one of the most significant concerns for response agencies. Participants stated that maintaining daily staffing is always an issue. Many routine matters impact the availability of staff, including authorized time off and injuries. During large or extended incidents, additional factors exacerbate this issue. Responders with COVID-19 or who had been exposed to SARS-CoV-2 caused significant challenges for many agencies. By the end of January 2021, the Los Angeles Police Department (LAPD), for example, lost eight sworn officers to COVID-19, had more than 2,500 who had tested positive for the virus, and an additional 600 officers in isolation because of exposure. Natural disasters can also place additional burdens on available staff if families must evacuate or lose housing.

This issue is further exacerbated because multiple agencies may rely on the same staff. Often, especially in small communities, personnel work for more than one department. This practice is common in some areas and is predominant with some volunteer agencies. During a geographically widespread event like flooding, agencies will call in staff to support response and rescue operations. However, the same person may be paged to support different agencies.

Further, many police agencies are running below proper staffing levels because of some public perceptions about law enforcement, communities that have defunded police departments, or limited municipal budgets resulting from the pandemic.

Participants rated LRM.38 as a High priority capability need. It is also a Universal Need, meaning that all of the participants in the prioritization process stated that this capability need was valid for their jurisdiction and discipline.

DESIRED CAPABILITY: This capability need may be addressed through the development of additional mutual aid networks and the increase in public safety budgets instead of through any technology applications. Although response agencies rely on mutual aid for many incidents, participants stated that this option was not available when dealing with surges during the pandemic; there simply were no resources available to lend to another agency.

FEMA and the U.S. Fire Administration have published guidance on maintaining operational capabilities during the SARS-CoV-2 pandemic that will also translate well into other emergency situations. The document provides direction on topics such as staffing, training, sustainability,

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and resource sharing. Additionally, there are quick reference sheets for each discipline and a staff planning tool worksheet included.\(^{93}\)

Participants noted that development of standard guidance on personnel resource requirements would be helpful. Based on this input, potential solutions should:

**Data Analysis Requirements**

- Develop standardized templates that calculate appropriate staffing levels
- Allow the user to enter parameters for surge staffing needs (e.g., anticipated duration, known constraints)
- Allow the user to tailor templates to include jurisdiction-specific information (e.g., population, known hazards, regional capabilities, action plans)
- Account for fluctuations in population (e.g., day/night, seasonal)
- Integrate ICS staffing positions

**STATE of TECHNOLOGY:** Workforce management staffing solutions are available on the market, with some focused on public safety agencies. Functionality of these systems allows users to set standard and ad hoc staffing levels, notify staff, calculate associated financial data, and allow analysis of staffing data. These systems are not used extensively, often due to cost and technological capacity within the agency. However, these solutions do not address the issue of helping an agency or jurisdiction calculate optimal staff levels.

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<td>Limited municipal budgets for public safety</td>
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<td></td>
<td>Insufficient applicants</td>
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**Related Standards and Guidelines:**

- International Information Security Standard- ISO/IEC 27001:2013\(^{94}\)

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LRM.38 ISSUE CORRELATION:

- **Weather Hazards**
- **Climate Hazards**
- **Geologic Hazards**
- **COVID-19**
- **Protests/Civil Unrest**
DESCRIPTION: This need is focused on the ability of response agencies to have awareness of the availability of their staff in real time. While this can be an issue for regular shift staffing as well, a difficulty arises when staff need to be called in to deal with an incident or event. A description of factors that impact the availability can be found in the description of LRM.38 below.

Many public safety agencies today rely on telephone calls, pages, texts, and email to assess availability. Often staffing status is maintained in spreadsheets, but participants cited the time-consuming aspect of the outreach, difficulties maintaining current data, and lack of functionality with documents as inhibiting their ability to understand who is available during times of emergency. Some mobile and computer-based applications (apps) are available (see State of Technology section below) that offer advanced functions, but their use is not yet widespread.

This capability largely exists in other fields. Responders would like the capability to quickly ascertain the availability of staff members, estimated time of arrival, and maintain understanding of conflicts and commitments (e.g., court dates, quarantine/isolation, authorized leave, medical restrictions).

Participants rated LRM.39 as a High priority capability need.

DESIRED CAPABILITY: Proposed solutions should:

Contact Requirements

- Electronically communicate with staff to query availability status
- Transmit availability request in real time
- Allow user to selectively transmit request based on specific criteria (e.g., role, shift, certification)
- Selectively transmit availability request based on known conflicts (e.g., no transmission to staff in quarantine or on authorized leave)
- Annotate when personnel have seen or reviewed status request
- Allow staff to electronically select availability status
- Allow staff to note time period of known unavailability (e.g., court session schedule)
- Provide estimated time of arrival from current location
- Allow personnel to edit estimated time of arrival to account for other factors (e.g., not in agency vehicle)
Data Visualization Requirements

- Allow staff to view navigation directions based on current location
- Display status of each staff member (e.g., red/yellow/green)
- Allow users to view location of en route personnel on jurisdiction or incident map
- Display location of known issues or hazards that may impact availability (e.g., traffic backups, high water levels)

Data Storage Requirements:

- Store availability data for post-incident analysis
- Encrypt or protect incident availability data
- Provide options for local or cloud-based storage

Compatibility Requirements:

- Comply with exchange standards for data transmission (e.g., NIEM)
- Comply with NGFR open architecture
- Bi-directionally communicate with existing response-related software and systems (e.g., electronic situational awareness, dispatch, staffing, responder geolocation)

Maintenance Requirements:

- Maintain backwards compatibility after upgrade
- Perform automated periodic virus detection and cybersecurity screening of software components

STATE of TECHNOLOGY: Workforce management staffing solutions are available on the market, with some focused on public safety agencies. Functionality of these systems allows users to set standard and ad hoc staffing levels, notify staff, calculate associated financial data, and allow analysis of staffing data. These systems are not used extensively, often due to cost and technological capacity within the agency.

There are several products available through the private sector that assist with tracking staffing availability. Many of these products are not specifically designed for use by emergency responders but have features that can be adapted to such applications. Sports teams, clubs and volunteer organizations use applications and platforms that allow for scheduling participants, communications via email and text, assigning tasks and trainings, and cataloguing skills and certifications. There are also some applications that provide an option for on-call planning/availability that can be accessed by administrators and all team members. These products are scalable, cloud-based, can integrate incident management data, and allow for the mapping and notification of partners.

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95 The requirements contained in the NGFR Integration Handbook can be found at https://www.dhs.gov/science-and-technology/ngfr/handbook
PROJECT RESPONDER 6
LOGISTICS & RESOURCE MANAGEMENT

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</thead>
<tbody>
<tr>
<td>• Potential labor issue related to having to report location</td>
<td>None</td>
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</table>

Related Standards and Guidelines:
• International Information Security Standard- ISO/IEC 27001:2013\(^97\)

LRM.39 ISSUE CORRELATION:

[Images of hexagons with icons and text]

**Human Settlement Trends**
**Data Analytics**
**Weather Hazards**
**COVID-19**
**Protests/Civil Unrest**

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LRM.51 The ability to identify who is authorized to be within the scene perimeter during incident response operations

PRIORITY: 3.42

DESCRIPTION: There are two dimensions to this capability need. The first is determining who is authorized to be within the scene based on permissions. The second is determining who is authorized based on ability. Incident command must - for the safety of responders and the public – know who is on the incident scene and their qualifications. It is also essential that they are able to establish and maintain the integrity of the scene by removing those that may hinder response operations.

An incident scene is often chaotic; there may be people injured and calling for help; bystanders; incident command staff; responders who have been called to the scene; citizen journalists and traditional media. Some responders self-dispatch to the scene, meaning that they hear about the incident and show up in an effort to support the operations. They may not be in uniform, have appropriate PPE, or in an agency vehicle. During past incidents, self-dispatched personnel have arrived from different jurisdictions and even across multiple state lines. Sometimes self-dispatching law enforcement officers are visibly armed. This makes it difficult to differentiate these people from perpetrators, bystanders, volunteers, or members of the media.

Responders that arrive through dispatch or through mutual aid are assumed to have a certain level of qualifications. For example, responders with a paramedic certification have the same standard level of skills. They must pass an accredited paramedic education program and pass a National Registry exam that covers both knowledge and skills. The same is not true for the fire service, law enforcement, and emergency management, much less for some specialized teams such as special weapons and tactics, (non-federal) search and rescue, swiftwater rescue, etc. This means that when an agency requests mutual aid, they often do not know the personnel qualifications or equipment resources arriving with that aid. If dispatched personnel arrive on scene without the requisite skills, resources to care for themselves, or equipment to safely carry out the tasks assigned, then they become a greater burden on response operations.

Multiple past iterations of Project Responder have discussed the need for identity, credential, and access management (ICAM). Project participants again stated the need for an accountability system that is able to positively identify the person and carry information about qualifications and certifications.

DESIRED CAPABILITY: Accountability systems exist in multiple other fields. The Department of Defense’s Common Access Card (CAC) provides identification, biometrics, and authentication of healthcare and benefits. The International Atomic Energy Agency (IAEA) uses smart cards to track radiation exposure history. Private industry uses smart identification cards to track time and attendance, location, training or certifications, etc. and some use the same cards as a form of cashless payment systems. The public safety community, however, is made up of tens of
thousands of jurisdictions, each with its own priorities and budgets. If a national ICAM system for emergency responders is developed, potential solutions should:

Qualification Requirements

- Integrate discipline-specific national standards for emergency responders
- Integrate qualification and training standards for specialized response teams

Qualification Reporting Requirements

- Provide multiple options to ascertain identity of personnel (e.g., photograph, biometrics)
- Provide agency affiliation
- Provide credential expiration date
- Provide training courses and certificates
- Provide expiration dates for certifications
- Provide differentiation for nationally recognized training/certifications

Site Access Requirements:

- Function with entry and alarm systems
- Provide multiple form factors for carrying authorization credentials (e.g., badges, devices, wearables)

Data Storage Requirements:

- Store authorization data for post-incident analysis
- Encrypt or protect data

Compatibility Requirements:

- Comply with exchange standards for data transmission (e.g., NIEM)
- Comply with NGFR open architecture
- Bi-directionally communicate with existing response-related software and systems (e.g., electronic situational awareness, dispatch, staffing, responder geolocation)
- Function with standard and non-proprietary readers or scanners

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<td>Data currency and validation</td>
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<td></td>
<td>Lack of agencies to regulate or monitor position qualifications in some states</td>
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</table>

98 The requirements contained in the NGFR Integration Handbook can be found at [https://www.dhs.gov/science-and-technology/ngfr/handbook](https://www.dhs.gov/science-and-technology/ngfr/handbook)
## PROJECT RESPONDER 6
### LOGISTICS & RESOURCE MANAGEMENT

<table>
<thead>
<tr>
<th>Culture</th>
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<tbody>
<tr>
<td>• Self-dispatching response personnel</td>
<td>• Lack of standards for position qualifications</td>
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<tr>
<td>• Buy-in by the responder community</td>
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### LRM.51 ISSUE CORRELATION:

- **Citizen Journalism**
- **Blockchain**
- **Chemical**
- **Protests/Civil Unrest**
- **Journalism**
- **Biometrics & DNA**
- **Commercial Facilities**
- **Attack Behavior**
- **Communications**
- **Critical Manufacturing**
- **Volunteerism**
- **Dams**
- **Vigilantism**
- **Defense**
- **Industrial Base**
- **Energy**
- **Government Facilities**
- **Financial Services**
- **Food & Agriculture**
- **Healthcare & Public Health**
- **IT**
- **Nuclear**
- **Transportation**
- **Water & Wastewater**
Casualty Management

CASUALTY MANAGEMENT (CM)

Defined as the capability to provide rapid and effective search and rescue, medical response, prophylaxis, and decontamination for incident casualties and identify appropriate sheltering and transportation options.

NEEDS IDENTIFIED: **31**

AVERAGE PRIORITY SCORE: **2.16**

HIGHEST PRIORITY CM CAPABILITY NEEDS:

- **CM.1** The ability to conduct search operations remote from response personnel
- **CM.2** The ability to conduct rescue operations remote from response personnel
- **CM.3** The ability to identify the substances causing overdose in real time

The top three Casualty Management needs are described in the section below.

- **Average Need Score:** Casualty Management was the lowest rated domain for Project Responder 6, with an average priority score of 2.16.
- **Need Status:** For 93 percent (29 of 31) of the CM needs, more than 10 percent of participants did not find the need to be an issue for their discipline or jurisdiction. However, at least one respondent identified these as high or very high priority needs.

A complete list of all CM needs can be found in Appendix L.
DESCRIPTION: The task of searching for casualties involves careful examination of the incident scene to look for signs of life or decomposition. The objective is to find and mark the location of casualties and is distinct from the rescue mission, although the two are often discussed together and may happen consecutively. However, in the case of large or complex incidents, a team may be tasked to identify the location of living or deceased victims and note the location. This can be a difficult task and can put responders in harm’s way. In some cases, search teams may not be allowed into hazardous areas to look for victims if potential danger is too high (e.g., unstable rubble, active shooter, the presence of ionizing radiation or chemical toxins). Responders must wait until the hazard has passed or find another way to mitigate the issue.

Current capability to search for casualties includes the use of canines, reports from bystanders or other victims, and technology solutions. Cell phone pings or triangulation can be used but may not have the accuracy desired. Radar technology can be used to detect the heartbeats of victims trapped in wreckage, and thermal imaging can be used to detect the heat signature of human bodies. However, most of these capabilities require that the responder be immediately in the vicinity of the victim.

Responders would like the ability to precisely identify the location of casualties and obtain information about the physical and medical status of that person. This should be done at a safe distance from threats and hazards on the scene. This ability to remotely search the scene for casualties could improve both victim and responder safety.

Participants rated CM.1 as a High priority capability need.

DESIRED CAPABILITY: Proposed solutions should:

**Geolocation Requirements**
- Search the incident scene vertically and horizontally
- Operate in open and closed areas (e.g., confined spaces)
- Provide location within three feet for x, y, and z coordinates
- Locate casualties at a distance of at least 50 feet standoff distance
- Locate casualties that are up to 30 feet below ground
- Provide a confidence level to indicate accuracy of location
- Scale up or down to agency-configurable distance

**Data Visualization Requirements**
- Provide a graphic display of casualty location on the incident scene
• Provide a graphic display of casualty physiological data when integrated with such systems
• Display search-relevant information when available (e.g., voids in rubble, on-scene hazards)
• Augment visualization with data elements
• Display data using GIS-enabled incident-specific maps
• Allow user- or agency-configuration of display features

Compatibility Requirements
• Integrate digital information about the incident scene (e.g., terrain maps, building data)
• Comply with exchange standards for data transmission (e.g., NIEM)
• Bi-directionally communicate with existing response-related software and systems (e.g., electronic situational awareness, patient tracking, patient physiological monitoring, responder geolocation)
• Comply with appropriate regulations and guidelines

Transmission Requirements
• Encrypt data prior to transmission
• Transmit data to intended destination
• Transmit data using GIS coordinates
• Transmit data in real time
• Transmit casualty data at agency configurable rate
• Store casualty geolocation data for post-incident analysis

Power Source Requirements
• Operate for a minimum of 24 operational hours and 48 stand-by hours
• Be able to replenish power supply using non-proprietary technology
• Utilize an easy-to-replenish power source
• Be available with non-intrinsically safe or intrinsically safe power source options

Maintenance Requirements
• Be modular to allow for upgrade and replacement of components
• Maintain backwards compatibility after upgrade
• Be rated for a service life of no less than five years
• Perform automated periodic virus detection and cybersecurity screening of software components

99 It may not be possible to encrypt solutions that rely on analog technologies.
Robustness Requirements

- Operate in hazardous conditions
- Operate in all weather conditions
- Have recyclable components
- Be easy to decontaminate

BARRIERS:

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<td>- Lack of line-of-sight capability</td>
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<tr>
<td>- Building materials inhibit signals</td>
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<table>
<thead>
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<tr>
<td>- Responder confidence in data and results</td>
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<tr>
<td>- Maintenance of training</td>
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<td>Liability issues if error</td>
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CM.1 ISSUE CORRELATION:

- Refusal/Inability to Evacuate
- Attack Behavior
- Human Settlement Trends
- Volunteerism
- AI Data Analytics
- Robotics
- Digital Forensics
- Biometrics & DNA
- Social Media (Investigation)
- UAS/CUAS Autonomous Vehicles
- Weather Hazards
- Climate Hazards
- Geologic Hazards
- Chemical Nuclear
CM.2 The ability to conduct rescue operations remote from response personnel

PRIORITY: 2.83

DESCRIPTION: This capability need is similar to that described above (CM.1) but focuses on the ability to convey casualties back to a designated triage point or other designated area. If the incident scene is too hazardous for responders to conduct search operations, it is likely not possible for them to reach, stabilize and transport victims. Rescue operations can involve significant effort to release or free victims that are trapped (e.g., unstable rubble, damaged vehicles), distantly located, or in the vicinity of other hazards (e.g., downed electrical wires). It is a difficult task that requires attention to ensure that any injuries are not aggravated.

Typical rescue operations involve responders that are able to extract injured persons (conscious or unconscious), conduct triage activities to ascertain their medical state, perform necessary medical interventions, and transport them back to a designated site. The need for this capability is most evident at any time where responders are placed in danger while attempting to rescue victims. This capability will require solutions that are able to perform gross and fine motor tasks.

Other than directing victims to self-rescue (if they are able), there are limited capabilities to do this currently. Some unmanned marine systems are available to conduct remote water rescue.

Participants rated CM.2 as a Medium priority capability need.

DESIRED CAPABILITY: Potential solutions should:

Platform Requirements

- Carry mission-appropriate payloads (e.g., an arm with hose attachments):
  - Fine motor manipulator
  - Gross motor tools
  - Camera/surveillance systems (e.g., electro-optical, infrared, thermal imaging)
  - Threat, hazard, and biometric sensors
  - Lighting
  - Communications equipment (e.g., microphones, repeaters)
  - Medical transport and/or treatment equipment
  - Tools for neutralizing threats/targets
- Be able to transport associated equipment and supplies
- Pose low risk for operators, responders, and civilians
- Deploy within 20 minutes
- Be able to be deployed and operated by two or less persons
- Be able to move payload in excess of 150 kilograms (e.g., person, equipment)
- Be able to accommodate variations in weight of person
• Be able to be controlled remotely
• Be controlled intuitively (e.g., hand-held operator control unit, heads up display)
• Provide optional secondary monitors for viewing by others beyond controller
• Provide depth perception to operator
• Be able to navigate around threats, hazards, and obstacles
• Navigate without becoming a hazard to others (e.g., deconflicting air space)
• Operate in covert or overt/highly visible mode
• Be able to operate multiple systems in a networked configuration
• Provide one- or two-way audio and/or video systems (dependent on mission)
• Ground systems:
  o Be able to right itself after tip over
  o Be able to climb stairs and obstacles
  o Be able to manipulate surroundings (e.g., open/close doors)
  o Provide an operational range of at least two kilometers
  o Be able to cut away debris
  o Be able to traverse various terrains
• Maritime systems: operate on the surface and/or underwater
• Aerial systems: provide minimum and maximum altitude parameters
• Allow remote release of payload
• Be resistant to interference with functionality
• Allow manual or autonomous navigation
• Detect targets or threats
• Locate targets or threats
• Identify targets or threats
• Prevent actions that will damage or destroy the system (e.g., driving off a cliff) without authorization
• Be able to record audio, video, sensor data
• Provide real time GIS waypoints
• Automatically return to base at low power

**Power Source Requirements**

• Provide one-to-four-hour operational endurance (dependent on mission)
• Incorporate interchangeable battery systems
• Incorporate power systems that can be safely and compliantly carried on commercial aircraft
• Be able to replenish power supply using non-proprietary technology
• Be available with non-intrinsically safe or intrinsically safe power source options
Compatibility Requirements
- Integrate digital information about the incident scene (e.g., terrain maps, building data)
- Comply with exchange standards for data transmission (e.g., NIEM)
- Bi-directionally communicate with existing response-related software and systems (e.g., electronic situational awareness, patient tracking, patient physiological monitoring, responder geolocation)
- Comply with appropriate regulations and guidelines

Maintenance Requirements
- Be modular to allow for upgrade and replacement of components
- Maintain backwards compatibility after upgrade
- Be rated for a service life of no less than five years
- Perform automated periodic virus detection and cybersecurity screening of software components

Robustness Requirements
- Operate in hazardous conditions
- Operate in all weather conditions
- Have recyclable components
- Be easy to decontaminate

BARRIERS:

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<td>Responder confidence in technology</td>
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</table>
ISSUE CORRELATION:

- Refusal/Inability to Evacuate
- Attack Behavior
- Human Settlement Trends
- Crowd Behavior
- Volunteerism
- Robotics
- IoT
- Wearables
- UAS/CUAS
- Autonomous Vehicles
- Weather Hazards
- Climate Hazards
- Geologic Hazards
- Chemical Nuclear
- Weather Hazards
- Climate Hazards
- Geologic Hazards
DESCRIPTION: Nearly one million Americans have died in the past 20 years due to drug overdose. Per the CDC, many states are showing significant increases in fatal and non-fatal overdoses. Please see the Substances of Abuse section in Part 2 for a more detailed discussion of this issue. The consequence of this escalation in substance abuse and overdose behavior is an increase in calls for service to provide emergency medical services to unresponsive individuals. Often patients with suspected overdose are treated with a generalized cocktail of medications designed to mitigate the effects. However, there are a number of concerns with this treatment. First among these is that the unresponsive patient may not be experiencing a drug overdose. A person experiencing a diabetic emergency, for example, may present with symptoms similar to alcohol or narcotic intoxication. Making the assumption that a patient is suffering from an overdose may hamper the ability to provide the correct life-saving treatments. Second, not all overdose incidents are the same and some substances do not react to the generalized cocktail. Xylazine, for example, is a sedative and analgesic that is often mixed with fentanyl. Because it suppresses the respiratory system, patients can be mistaken for being deceased. Arriving units may administer naloxone, a common medication for the treatment of suspected opioid overdose cases. However, Xylazine is not an opioid and does not react to naloxone. Third, some medical treatments interfere with epidemiological tracing efforts. This makes it difficult to determine if there is an epidemic caused by a “bad batch” or new variant.

For these reasons, and with the intention of improving patient outcomes, responders would like the ability to test the patient to determine which substance(s) are causing the overdose signs and symptoms. While friends or family may be able to provide some indication about the substance, many are cut with other materials. In addition, some overdose patients are found alone, with no one available to provide information. The solution must be very fast-acting, allowing the responding units to quickly provide the appropriate medical interventions.

Participants rated CM.2 as a Medium priority capability need.

DESIRED CAPABILITY: Potential solutions should:

Detection Requirements

- Detect substances of abuse
  - Detect substances of abuse that endanger responder (e.g., fentanyl)
  - Detect substances of abuse that cause rapid death of patient
- Provide positive/negative assessment or quantitative results (preferred)
- Conduct detection within 30 seconds (less preferable)
- Conduct detection without interfering with crime scene
Detect substances without relying on bodily fluids
- Minimize false positives and false negatives
- Maintain log of testing completed that would follow chain of evidence and be admissible in court

**Form Requirements**
- Be handheld or easily portable
- Incorporate hardware components that are to be used on more than one patient without decontamination
- Use non-proprietary disposable parts
- Be operable by users wearing PPE
- Be minimum weight
- Be minimum size

**Training Requirements**
- Incorporate training mode that does not require substances be present

**Maintenance Requirements**
- Allow for auto-calibration
- Self-initialize, self-calibrate and execute self-diagnostics in less than 1 minute
- Be modular to allow for upgrade and replacement of components
- Be rated for a service life of no less than five years
- Perform automated periodic virus detection and cybersecurity screening of software components

**BARRIERS:**

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</thead>
<tbody>
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<td>Confidence in test results – positive and negative</td>
<td>Safety of sample preservation</td>
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</table>
CM.3 ISSUE CORRELATION:

- Substances of Abuse
- Illegal Drug Production
- Mental Health Crises
- Rise in Homelessness
Training & Exercise

TRAINING & EXERCISE (TE)

Defined as the capability to provide instruction on necessary skills for incident response and coordinate and practice implementation of plans and potential response prior to an incident.

NEEDS IDENTIFIED 27

AVERAGE PRIORITY SCORE 3.01

HIGHEST PRIORITY TE CAPABILITY NEEDS:

- **TE.20** The ability to realistically exercise low-frequency, high-consequence incidents
- **TE.23** The ability to provide leadership training to staff during extended response operations
- **TE.5** The ability to exercise operational plans in advance of pre-planned events using immersive capabilities

The top three Training & Exercise needs are described in the section below.

- **Average Need Score**: Training & Exercise was the fifth highest-rated domain for Project Responder 6, with an average priority score of 3.01.
- **Need Status**: For 50 percent (13 of 26) of the CM needs, more than 10 percent of participants did not find the need to be an issue for their discipline or jurisdiction. However, at least one respondent identified these as high or very high priority needs.
- **Universal Needs**: There are two Universal Needs within the Training & Exercise domain, but only one is among the top 15 overall or top three within the domain.

A complete list of all TE needs can be found in Appendix X.
The ability to realistically exercise low-frequency, high-consequence incidents

**DESCRIPTION:** This capability need is focused on the ability to conduct operation-based exercises for those incidents that do not happen on regular basis yet have the potential to cause a significant number of casualties or amount of damage. In today’s budget-constrained environment, public safety agencies must trade-off among many obligations: staff salaries, sufficient PPE to protect personnel, aging apparatus and facilities, etc. This is in addition to training and exercise requirements mandated by federal and state governments in order to receive funding and be eligible for grants. Furthermore, reduced staff counts do not make it easy to free up personnel to plan or attend additional exercises. Functional exercises and full-scale exercises have both financial and personnel costs, both of which are constrained for most jurisdictions. Given this context, it is difficult for jurisdictions to be able to afford to conduct non-mandated exercises.

However, this is not to say that these exercises are not exceedingly important. Many jurisdictions in the United States had not conducted pandemic exercises prior to 2020. Those that did found the development of relationships and identification of potential issues to be helpful in negotiating the response to the SARS-CoV-2 pandemic. Exercises of this type often include the involvement of many response agencies and disciplines. An incident scenario focused on a dam collapse or failure of a wastewater system, for example, will involve many agencies beyond those that typically participate in local public safety exercises.

Responders would like the ability to exercise these incidents while minimizing the associated financial, time, and personnel costs. Participants stressed that conducting these exercises realistically is very difficult; many times, the artificialities introduced into the exercise (because of time, logistics, etc.) cause the outcomes to be a less-than accurate representation of the incident response. Also, the level of control over the script and outcomes makes it difficult to assess where failures may happen in the real world. Workshop discussions centered around the need for immersive exercise capabilities that allow responders to assess their skills, policies, and procedures.

Participants rated TE.23 as a **High** priority capability need. Similar versions of this capability need have also been identified as high priority in several past iterations of Project Responder.

**DESIRED CAPABILITY:** The requirements listed below reflect different potential solutions (i.e., immersive versus in-person exercise options). They should not be assumed to apply to all possible opportunities. Potential solutions should:

**User Interface Requirements**

- Allow user to participate in exercise in different roles
- Allow user to participate solo or with a selected group
PROJECT RESPONDER 6
TRAINING & EXERCISE

- Allow customization based on jurisdiction-, incident-, and role-based variables
- Function on multiple operating systems (e.g., iOS, Android and Windows)
- Allow user to access system from mobile devices and computers
- Integrate realistic audio and visual components (e.g., fire alarms, scene video)

Simulated Exercise Requirements

- Provide multiple scenarios to assess decision-making
- Accurately reflect consequences of decisions
- Accurately reflect circumstances or injects (e.g., arrival of self-dispatching responders)
- Accurately reflect stress and chaos
- Provide data for after-action reporting at individual or team level
- Ensure scenarios and roles are inclusive of traditional and non-traditional response agencies
- Integrate jurisdiction-specific tools and equipment (virtual and real)
- Integrate realistic incident conditions (e.g., crowd noise, weather)

Facility/Site Requirements

- Be able to accommodate multiple agencies and disciplines
- Travel to jurisdictions (versus personnel traveling to central location)

Compatibility Requirements

- Integrate with jurisdiction-specific maps
- Comply with exchange standards for data transmission (e.g., NIEM)
- Bi-directionally communicate with existing response-related software and systems (e.g., electronic situational awareness, responder geolocation)
- Comply with appropriate regulations and guidelines

Maintenance Requirements

- Be modular to allow for upgrade and replacement of components
- Maintain backwards compatibility after upgrade
- Regularly introduce new scenarios
- Perform automated periodic virus detection and cybersecurity screening of software

STATE of TECHNOLOGY: High-consequence low-frequency events are becoming more common.\(^{100}\) Therefore, being able to plan and exercise for these types of “once in a lifetime”

PROJECT RESPONDER 6
TRAINING & EXERCISE

Events is becoming more critical. Some sectors have begun planning for and exercising for the unknown events in different ways.

- “Horizon-scanning” exercises test current operations against what could possibly occur in the future. These types of exercise allow the sector to assess the impact of such risks and identify any potential weak links or stop-gaps in the process.\(^{101}\)
- The development of comprehensive high-impact, low frequency plans that address a multi-hazard risk environment assists in preparing for potential unforeseen events.\(^{102}\)
- Scenario-based planning and exercises often establish a “base case” and then identify “best case” and “worst case” scenarios. Scenario-based exercises aid in developing plans that are based on the assumptions that several different futures could occur as a result of decisions made and focuses attention on the underlying drivers that can shape future outcomes. This allows organizations not only to plan for the here and now but also to look towards the future so that when disaster strikes, they are not left unprepared.\(^{103,104}\)

FEMA’s EMI provides the opportunity for a number of jurisdictional representatives to gather and conduct strategic-level exercises which could be used for low-frequency, high-consequence events. While this opportunity is valuable, it does not allow for the assessment of operational policies and procedures.

Immersive training and exercises, including the integration of augmented and virtual reality into public safety training, has been a desired capability for many years. In fact, readily accessible, high-fidelity simulation tools to support training and exercises in incident management and response was the highest rated capability need in Project Responder 3: Toward the First Responder of the Future (2012).\(^{105}\) While there are limited AR/VR offerings currently, the EDGE system (discussed previously) developed by DHS S&T allows responders to practice response to events in a virtual environment.

**BARRIERS:**

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<tbody>
<tr>
<td>Difficult to emulate emotional response</td>
<td>Backfill costs of personnel participating in live full-scale exercises</td>
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### PROJECT RESPONDER 6
**TRAINING & EXERCISE**

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<tbody>
<tr>
<td>• Reluctance to plan exercises that may show weaknesses</td>
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<tr>
<td>• Lack of relationships with agencies that should participate in exercises</td>
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<tr>
<td>• Leadership buy-in</td>
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<tr>
<td>• High anticipated costs to jurisdiction</td>
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<tr>
<td>• Hesitancy to use equipment during exercises because agency cannot afford to replace or repair</td>
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<tr>
<td>• Space/site requirements</td>
<td></td>
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<tr>
<td>• Limited time and personnel budgets</td>
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#### TE.20 ISSUE CORRELATION:

- **Attack Behavior**
- **AR/VR**
- **Climate Hazards**
- **Geologic Hazards**
- **Chemical**
- **Commercial Facilities**
- **Communications**
- **COVID-19**
- **Protests/Civil Unrest**
- **Critical Manufacturing**
- **Dams**
- **Defense Industrial Base**
- **Energy**
- **Financial Services**
- **Food & Agriculture**
- **Government Facilities**
- **Healthcare & Public Health**
- **IT**
- **Nuclear**
- **Transportation**
- **Water & Wastewater**
The ability to provide leadership training to staff during extended response operations

DESCRIPTION: As noted in the discussion of CCC.6 (the ability to maintain sufficient qualified staff for leadership roles during long-duration or simultaneous events), TE.23 is one facet of that problem. It can be difficult for response agencies to provide all required training during a normal operational tempo, much less during protracted periods of high volume. The difficulties of 2020, from the toll taken by response to SARS-CoV-2, the extended wildfire response, on-going protests/civil unrest, to the record number of billion-dollar weather and climate disasters, were felt by jurisdictions across the United States. These unrelenting crises made it difficult to provide leadership training, or most any training, to personnel.

While most years may not mirror 2020, the circumstances outlined in the Evolving Response Environment section of this report (Part 2) do not indicate that operations will be slowing down significantly. Further, the increasing prevalence of low-frequency, high-consequence events makes the need to train leadership staff on a spectrum of existing or potential incidents essential. Periods of extended response operations do not afford agencies the luxury of taking those in current or potential leadership positions off the line or off shift in order to participate in training courses. These periods are generally an “all hands on deck” situation and many agencies cannot afford to lose staff to training that is not absolutely critical to the current mission. Although fire service agencies generally build training into existing shift assignments, law enforcement and EMS do not. Workshop participants noted that it is not possible to pull resources from the field to conduct training when demand is high.

For this reason, responders would like solutions that can provide training in multiple formats, allowing personnel to train in the time and place most convenient to them. Leadership training should focus on the standardized discipline-specific and role-specific metrics described in CCC.6.

Participants rated TE.23 as a High priority capability need. It is also a Universal Need, meaning that all of the participants in the prioritization process stated that this capability need was valid for their jurisdiction and discipline.

DESIRED CAPABILITY: Potential solutions should:

User Interface Requirements

- Allow user to participate in training for specific roles
- Allow user to participate solo or with a selected group
- Allow customization based on jurisdiction-, incident-, and role-based variables
- Function on multiple operating systems (e.g., iOS, Android and Windows)
- Allow user to access system from mobile devices and computers
- Integrate realistic audio and visual components (e.g., fire alarms, scene video)
Simulated Training Requirements:
- Assess leadership and command knowledge
- Assess leadership and command skills
- Assess decision-making
- Identify skills requiring improvement
- Identify alternate outcomes based on specific decisions
- Incorporate evolving challenges and scenarios
- Integrate agency-specific policies and protocols
- Allow customization based on jurisdiction-, incident-, and role-based variables
- Integrate realistic incident conditions (e.g., crowd noise, weather)

Compatibility Requirements
- Integrate with jurisdiction-specific maps
- Comply with exchange standards for data transmission (e.g., NIEM)
- Bi-directionally communicate with existing response-related software and systems (e.g., electronic situational awareness, responder geolocation)
- Comply with appropriate regulations and guidelines

Maintenance Requirements
- Be modular to allow for upgrade and replacement of components
- Maintain backwards compatibility after upgrade
- Regularly introduce new scenarios
- Perform automated periodic virus detection and cybersecurity screening of software

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TE.23 ISSUE CORRELATION:

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<td>Climate Hazards</td>
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<td></td>
<td>Geologic Hazards</td>
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</table>
**DESCRIPTION:** This capability need is focused on the need for response agencies to test plans and procedures in advance of a known event. Much of the rationale presented in the above discussions of TE.20 and TE.23 likewise applies to this capability need. There are limited resources available to conduct assessments for pre-planned events. There are many events that occur annually (e.g., marathon races) or that have a set schedule (e.g., professional sports games). In addition, communities often host large gatherings or events with extended planning cycles (e.g., music festivals). These events bring together tens of thousands of participants, fans, and bystanders. As such, they pose a number of risks for the community. The high-visibility and attendance level may make the event attractive for an attack or put many people in harm’s way if there is an accident or natural disaster.

There are many factors that make pre-planned events complex: additional security concerns, the introduction and integration of mutual aid assets to support the event, budget impacts, the effects of large crowds on operations, etc. Because of these factors, the need to plan and exercise for a large event is critical.

However, response agencies often do not have sufficient resources to update plans or exercise tactics and procedures. Participants noted that often the same plan is used from year-to-year for annual events without taking the time to review or revise when needed. In addition, the same plan may be used for different events by just changing the name on the binder. Responders would like the ability to assess, train, and exercise operational plans in advance of these events. When possible, responders would also like the ability to individually rehearse such plans in small or large groups. If the potential solution is technology-based, responders would like an immersive experience, allowing them to exercise their plans without the cost and time burdens of a traditional exercise.

Participants rated TE.23 as a **High** priority capability need.

Many of the requirements for TE.5 mirror those in TE.20 and TE.23 above.

**DESIRED CAPABILITY:** Potential solutions should:

**User Interface Requirements**

- Allow user to participate in exercise in different roles
- Allow user to participate solo or with a selected group
- Allow customization based on jurisdiction-, incident-, and role-based variables
- Function on multiple operating systems (e.g., iOS, Android and Windows)
- Allow user to access system from mobile devices and computers
- Integrate realistic audio and visual components (e.g., fire alarms, scene video)
**Simulated Exercise Requirements**
- Allow users to exercise joint command and the Incident Command System
- Provide multiple scenarios to assess decision-making
- Accurately reflect consequences of decisions
- Accurately reflect circumstances or injects (e.g., crowd behavior)
- Accurately reflect stress and chaos
- Provide data for after-action reporting at individual or team level
- Ensure scenarios and roles are inclusive of traditional and non-traditional response agencies
- Integrate jurisdiction-specific tools and equipment (virtual and real)
- Integrate realistic incident conditions (e.g., crowd noise, weather)

**Compatibility Requirements**
- Integrate with jurisdiction-specific maps
- Comply with exchange standards for data transmission (e.g., NIEM)
- Bi-directionally communicate with existing response-related software and systems (e.g., electronic situational awareness, responder geolocation)

**Maintenance Requirements**
- Be modular to allow for upgrade and replacement of components
- Maintain backwards compatibility after upgrade
- Perform automated periodic virus detection and cybersecurity screening of software

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<td>Limited time and personnel budgets for planning and exercises</td>
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<tr>
<td></td>
<td>High anticipated costs to jurisdiction</td>
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TE.5 ISSUE CORRELATION:

- Attack Behavior
- AR/VR
- Commercial Facilities
- Government Facilities
- Protests/Civil Unrest
Risk Assessment & Planning

RISK ASSESSMENT & PLANNING (RAP)

Defined as the capability to identify and manage likely vulnerabilities and threats, and to develop appropriate responses to potential incidents based on identified risks.

NEEDS IDENTIFIED 28

AVERAGE PRIORITY SCORE 2.67

HIGHEST PRIORITY RAP CAPABILITY NEEDS:

- **RAP.14** The ability to capture and assess impacts, smart practices, and lessons learned to inform planning for future pandemic response
- **RAP.2** The ability to identify and track who (specific persons) within a jurisdiction does not have the ability to evacuate
- **RAP.3** The ability to map the location and status of persons that cannot or have not evacuated during a specific incident

The top three Risk Assessment & Planning needs are described in the section below.

- **Average Need Score**: RAP was the sixth highest-rated domain for Project Responder 6, with an average priority score of 3.67.
- **Need Status**: For 79 percent (22 of 28) of the RAP needs, more than 10 percent of participants did not find the need to be an issue for their discipline or jurisdiction. However, at least one respondent identified these as high or very high priority needs.

A complete list of all RAP needs can be found in Appendix N.
DESCRIPTION: The CDC confirmed the first case of COVID-19, caused by the SARS-CoV-2 virus, in the United States on January 21, 2020. The fifteen months since that date (as of the time of writing) have witnessed shortages of PPE, high rates of illness and death among response personnel, staff shortages due to quarantine, overwhelmed medical and response systems, confusing or conflicting guidance, and political hostility over effective courses of action. When combined with the increase in operational tempo from other incidents, there has been limited time to capture impacts, smart practices, and lessons learned. This capability need focuses specifically on COVID-19 because of the unprecedented, overwhelming, and extended nature of the pandemic. Responders stated that they felt particularly unprepared to assess pandemic operations. However, many of the requirements listed below apply to after action and lessons learned assessments for all incident types.

Further, the ability to get accurate and consistent data has been constrained. Data has been classified in different ways, concealed, and altered. Health Insurance Portability and Accountability Act (HIPAA) and other regulations inhibit the release of some data. The operational tempo has resulted in responders that are fatigued and have difficulty recalling the decisions or choices made from earlier waves of the pandemic, because the situation continues to evolve — bringing with it ever-changing issues. Participants stated that it may be difficult to capture much of this information because of the time that has elapsed. Further, trust issues in the data are a problem because of the politicized nature of the pandemic itself.

Conversely, an unprecedented amount of unrestricted data is available to any interested stakeholder. Public-facing dashboards provide geolocated daily case and fatality rates to whomever is interested in viewing them. A number of public safety associations have collected data about the physical and logistical impacts of COVID-19 related to their associated discipline and many communities have captured data for their jurisdiction. In addition, hundreds of communities shared descriptions of policy actions related to COVID-19 response on the National League of Cities Local Action Tracker.¹⁰⁶

Responders are looking for a repository to bring all of this data together to assess the response to COVID-19 in a manner that will allow responders across the country to identify smart practices and lessons learned in advance of the next pandemic.

See the COVID-19 discussion in the Evolving Response Environment section of this report for a lengthier discussion of the impacts of the pandemic on the public safety community.

Participants rated RAP.14 as a High priority capability need.

**DESIRED CAPABILITY:** Potential solutions should:

**Data Source Requirements**
- Integrate data from open source, proprietary, and protected data sources
- Ingest data in multiple file formats (e.g., .txt, .xls, .jpeg, .mpeg, .avi, .json)
- Integrate data from initial COVID-19 awareness through recovery
- Integrate subjective information as well as data (e.g., responder recollections)

**Data Repository Requirements**
- Integrate standard schema for lessons learned and smart practices
- Integrate jurisdiction-specific characteristics (e.g., population size, medical infrastructure, manufacturing capability)
- Allow user to download policies, templates, guidance

**Data Integrity Requirements:**
- Designate source of data
- Provide a confidence level
  - Designate confidence in source
  - Designate confidence in data integrity

**Data Visualization Requirements:**
- Display data in multiple formats (e.g., text, images, audio, graphs, charts, maps)
- Provide an intuitive graphical user interface (GUI)
- Utilize a standard set of incident-related icons
- Include system of data layers
- Allow user to turn individual data layers on and off

**Data Analysis Requirements:**
- Provide a data filter feature
- Use a standardized classification schema to organize data
- Allow users to compare data across time (historical and incident-specific)
- Integrate analytics allowing user to compare their jurisdiction or circumstance with lesson learned or smart practice (e.g., correlation score, list of similarities/differences)
- Allow user to create customized reports

**Decision-Support Requirements:**
- Provide analysis, templates, prompts, etc.
- Identify jurisdictions with similar characteristics based on filter criteria
## BARRIERS:

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<tr>
<td>• Lack of infrastructure to share best practices</td>
<td>• Concerns about legal liability for acknowledging issues or missteps</td>
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<table>
<thead>
<tr>
<th>Culture</th>
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<tr>
<td>• Politicized pandemic response</td>
<td>• Distrust in data available</td>
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<td>• Conflicting data</td>
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<td>• Unwillingness to share data</td>
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<td></td>
<td>• Inconsistent data characteristics</td>
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<td>• Lack of standardized assessment tool to determine what is a “best practice”</td>
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### RAP.14 ISSUE CORRELATION:

- **Refusal to Comply with COVID Restrictions**
- **Data Analytics Blockchain**
- **Healthcare & Public Health**
- **COVID-19**
RAP.2 The ability to identify and track who (specific persons) within a jurisdiction does not have the ability to evacuate

DESCRIPTION: There are many reasons that a person does not evacuate after receiving orders to do so. Some people do not evacuate because they or family members are non-ambulatory, dependent on medical devices (e.g., left ventricular assisting devices (LVAD)), without transportation, or financially dependent on employment that does not allow or provide paid time off during emergency situations. See the Inability/Refusal to Evacuate discussion in the Evolving Response Environment section of this report for a lengthier discussion of why people do not evacuate and how this impacts the response community. The focus of this capability need is identifying, in advance, those people in the community that are not able to or do not believe that they are able to move out of harm’s way. While inability/refusal to evacuate is often thought of in relation to hurricane or flooding events, this is also an issue for wildfires, chemical releases, and other industrial incidents.

There are a number of strategies that a community can use to help people evacuate or mitigate the problems if they stay. Doing so, however, requires knowing who they are, where they are located, and the issues that they are facing. Technology exists to mark and update the location of individuals on jurisdiction-specific maps. Computer-aided dispatch software includes the ability to incorporate notes for specific addresses. Some jurisdictions maintain applications or databases that allow people to provide information for emergency management purposes. Ventura County, California developed Fire Evacuation Survey, an application that allows law enforcement to enter data in real time about notifications, refusals, and whether special assistance is needed for evacuation.\textsuperscript{107} The County developed the app after issues with evacuations during wildfires. Non-governmental organizations (NGOs) and social media platforms also allow individuals to update their location during incidents and natural disasters.

However, a primary issue is the ability for a jurisdiction to collect and integrate this data. Some of the required data is readily available. For example, HHS provides an interactive map that illustrates the number of electricity-dependent Medicare recipients by zip code.\textsuperscript{108} However, for the purposes of this capability need, the repository only provides raw totals and only includes those receiving one specific government benefit. Some communities collect data on individuals with access and functional needs but find that it is very difficult to keep this data set updated. Much of the data, however, is not available for a variety of reasons. For instance, there are many populations that are not covered in existing data sets (e.g., caregivers, those without


\textsuperscript{108} U.S. Department of Health and Human Services; HHS empower Map. Viewed 8 April 2021. empowermap.hhs.gov
Therefore, the data that is available does not provide a comprehensive understanding of the population that is unable to evacuate.

Responders would like the ability to identify those people who are unable to evacuate and visualize their location.

Participants rated RAP.2 as a High priority capability need.

**DESIRED CAPABILITY:**

**Data Source Requirements**
- Integrate data from open source, proprietary, and protected data sources
- Allow users to self-report data
- Ingest data in multiple file formats

**Data Repository Requirements**
- Integrate standard schema for individual populations
- Integrate jurisdiction-specific characteristics (e.g., ingress/egress routes, vulnerable bridges or access barriers)

**Data Integrity Requirements:**
- Designate source of data
- Provide a confidence level
  - Designate confidence in source
  - Designate confidence in currency of data

**Data Visualization Requirements:**
- Display data in multiple formats (e.g., text, images, audio, graphs, charts, maps)
- Provide an intuitive graphical user interface (GUI)
- Utilize a standard set of incident-related icons
- Include system of data layers
- Allow user to turn individual data layers on and off

**Data Analysis Requirements:**
- Provide a data filter feature
- Use a standardized classification schema to organize data
- Allow users to compare data across time (historical and incident-specific)
- Allow user to create customized reports

---

**Potential Populations:**
- Electricity-dependent individuals
- Individuals with access and functional needs
- Individuals with recurring medical treatment needs (e.g., dialysis)
- Individuals in homecare or hospice
- Caregivers
- Individuals who cannot drive
- Self-reported Individuals with no transportation
- Self-reported individuals that are tied to site-specific employment
- Minor children or dependent adults of above listed populations
### BARRIERS:

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<tr>
<td>• Concerns about sharing private information</td>
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### RAP.2 ISSUE CORRELATION:

- Inability/Refusal to Evacuate
- Human Settlement Trends
- Rise in Homelessness
- Social Media (Communication)

- AI Data Analytics
- Weather Hazards
- Climate Hazards
- Geologic Hazards
RAP.3 The ability to map the location and status of persons that cannot or have not evacuated during a specific incident

**DESCRIPTION:** RAP.3 is very closely related to the above-described RAP.2. Please see the description of RAP.2 above and the [Inability/Refusal to Evacuate](#) discussion in the Evolving Response Environment section of this report (Part 2) for a lengthier explanation of why people do not evacuate and how this impacts the response community. There are two distinctions to RAP.3. First, it is focused on using data during a specific incident. The second is that it is inclusive of people who refuse to evacuate for reasons other than those stated in RAP.2. Ideally, maintaining the data set (RAP.2) when possible, serves as a precursor to RAP.3.

Incident response that involves evacuation of the population (in part or in whole) can be a chaotic endeavor. Those persons that remain within the jurisdiction are often personally at risk and can endanger responders who attempt to support or rescue them. Responders would like to see the location of those who have not evacuated on a jurisdiction or incident-specific map. They would also like to query the system to identify factors that may aid in the response. For example, those who cannot evacuate because of lack of transportation may be aided by the provision of buses to remove them from the scene. This requires a different level of effort than moving individuals that are tied to electricity-dependent medical devices.

An additional component of RAP.3 is the ability to obtain up-to-date information about the status of those who have not evacuated. Obtaining current information may include directly contacting those individuals or soliciting the self-reporting of information. Responders also believe that integrating evacuation status information with other data sets can provide a more comprehensive picture of incident status. For example, visualizing evacuation data integrated with flood inundation models may provide decision-support on those individuals most in need of help.

Participants rated RAP.3 as a **High** priority capability need.

**DESIRED CAPABILITY:**

**Data Integration Requirements**

- Integrate database of those unable to evacuate with knowledge of individuals who refuse to evacuate
- Integrate with other relevant data sets (e.g., current power status, weather forecasts)
- Develop standard evacuation status fields or format

**Data Visualization Requirements:**

- Display data in multiple formats (e.g., text, images, audio, graphs, charts, maps)
- Provide an intuitive graphical user interface (GUI)
• Utilize a standard set of evacuation-related icons
• Include system of data layers
• Allow user to turn individual data layers on and off

**Data Analysis Requirements:**
• Provide a data filter feature
• Use a standardized classification schema to organize data
• Allow users to compare data across time (historical and incident-specific)
• Allow user to create customized reports

**Contact Requirements**
• Electronically communicate with designated individuals
• Allow individual to report current status and location
• Allow individual to report current issues/problems
• Transmit information request in real time
• Allow user to selectively transmit request based on specific criteria (e.g., zip code)
• Annotate when individuals have seen or reviewed status request

**Compatibility Requirements:**
• Comply with exchange standards for data transmission (e.g., NIEM)
• Comply with NGFR open architecture
• Bi-directionally communicate with existing response-related software and systems (e.g., electronic situational awareness, dispatch, model prediction and forecasts)

**BARRIERS:**

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<th>Culture</th>
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<tbody>
<tr>
<td>• Concerns about sharing information</td>
<td>• N/A</td>
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109 The requirements contained in the NGFR Integration Handbook can be found at [https://www.dhs.gov/science-and-technology/ngfr/handbook](https://www.dhs.gov/science-and-technology/ngfr/handbook)
RAP.3 ISSUE CORRELATION:

Inability/ Refusal to Evacuate
Human Settlement Trends
Social Media (Communication)

AI
Data Analytics
IoT
Social Media (Investigation)

Weather Hazards
Climate Hazards
Geologic Hazards

Chemical
Dams
Nuclear
INTELLIGENCE & INVESTIGATION (II)

Defined as the capability to collect, integrate, and assess information to develop conclusions or courses of action prior to an incident or identify the cause or responsible persons following an event.

- **Needs Identified**: 39
- **Average Priority Score**: 2.58

**Highest Priority II Capability Needs:**

- **II.31**: The ability to identify specific strategic and operational needs that can benefit from advanced analytics
- **II.25**: The ability to integrate data from multiple sources for analysis
- **II.32**: The ability to develop a common organization or tagging structure for emergency response data elements

The top three Intelligence and Investigation needs are described in the section below.

- **Average Need Score**: II was the seventh highest-rated domain for Project Responder 6, with an average priority score of 2.58.
- **Need Status**: For 90 percent (35 of 39) of the II needs, more than 10 percent of participants did not find the need to be an issue for their discipline or jurisdiction. However, at least one respondent identified these as high or very high priority needs.

A complete list of all II needs can be found in Appendix O.
II.31 The ability to identify specific strategic and operational needs that can benefit from advanced analytics

**DESCRIPTION:** A recurring theme throughout this iteration of Project Responder is the need to integrate data, with the expectation that response agencies or personnel will be able to obtain actionable information. One component of developing actionable information is analysis of the data. There are numerous analytical methods that can be employed to support public safety operations, but current capabilities are insufficient. Participants noted that many available solutions are developed individually within a jurisdiction, tied to proprietary systems, or do not produce the outputs needed.

Too often agencies or associations develop their own solutions to operational problems, doing so in a silo or without collaboration with others that may need similar analysis capabilities. Although some common public safety software packages include analytical capability, many agencies do not have staff trained to conduct data analysis. Participants stated that most data is captured in spreadsheets that limited people have access to and fewer have the skills to assess. When commercial systems are available, responders report that they are often expensive to use and customize.

The primary emphasis of this capability need is not that public safety agencies have limited capability to access the limited analytical tools available, but that there is no overarching identification of analysis that can support strategic or operational decision-making. What are the key problems in emergency response that can be solved with the application of analysis? This capability need suggests an assessment of needs from the top down instead of performing analysis on only the data is available.

There are numerous emerging technologies (e.g., artificial intelligence) that provide advanced analytics; however, it is critical for responders to identify the problems that must be fixed before applying these methodologies. The process involved in mitigating this capability need is to:

1. Identify the outputs that would be helpful (strategic and operational);
2. Identify what data is necessary to collect; and
3. Integrate the data so that analysis can be performed.

This capability need is focused on the ability to identify the problems that need to be solved, not on the development of data analysis solutions.

Participants rated II.31 as a **High** priority capability need.
DESIRED CAPABILITY: Potential solutions should:

**Planning Requirements**
- Identify high priority public safety issues where actionable information can support decision-making
  - Within disciplines
  - Across disciplines
- Identify data requirements related to specific public safety issues
- Identify sources of needed data
- Identify barriers to collection of data (e.g., legal, technological)
- Develop data customized data visualizations based on analytical outputs
- Develop analytical outputs that can be shared across agencies or jurisdiction
- Identify standards that impact analytical outputs
- Identify user skills requirements

**Decision-Support Requirements:**
- Integrate a standardized system for building data collection requirements
- Provide actionable information based on discipline, role, and type of incident
- Provide analysis, templates, prompts, etc.

**Compatibility Requirements:**
- Comply with exchange standards for data transmission (e.g., NIEM)
- Comply with NGFR open architecture¹¹⁰
- Bi-directionally communicate with existing response-related software and systems (e.g., electronic situational awareness, dispatch, model prediction and forecasts)

**BARRIERS:**

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<tr>
<th>Technology</th>
<th>Policy</th>
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<tbody>
<tr>
<td>Limited availability of public safety data sets</td>
<td>Proprietary systems and outputs costly and complicate collaboration across jurisdictions</td>
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<tr>
<td>Limited cross-jurisdictional data sets</td>
<td>Restricted data (e.g., FOUO, LES)</td>
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<td>Issues related to data sharing</td>
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<th>Culture</th>
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<tr>
<td>Unwillingness to share data</td>
<td>Cost</td>
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<tr>
<td>Lack of analytical staff in public safety agencies</td>
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¹¹⁰ The requirements contained in the NGFR Integration Handbook can be found at [https://www.dhs.gov/science-and-technology/ngfr/handbook](https://www.dhs.gov/science-and-technology/ngfr/handbook)
II.31 ISSUE CORRELATION:

<table>
<thead>
<tr>
<th>Social Media (Communication)</th>
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<tr>
<td>5G</td>
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<td>AI</td>
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<tr>
<td>Data Analytics</td>
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<tr>
<td>Quantum Computing</td>
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<td>Digital Forensics</td>
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<tr>
<td>IoT</td>
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<tr>
<td>Biometrics &amp; DNA</td>
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<tr>
<td>Malicious Misinformation</td>
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<tr>
<td>Dark Web</td>
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<tr>
<td>Social Media (Investigation)</td>
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<tr>
<th>Weather Hazards</th>
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<td>Climate Hazards</td>
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<td>Geologic Hazards</td>
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<tr>
<td>Protests/Civil Unrest</td>
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The ability to capture, process, integrate and manage raw and digital information related to incident response, operations or an investigation was the highest prioritized capability need from PR5. Integrating the data from multiple sources continues to be a significant issue. There are many barriers that make it difficult for agencies or jurisdictions to integrate available data sets.

- Legal barriers (e.g., HIPAA) prevent sharing data related to health information (e.g., awareness of contagious disease at call for service, identification of health outcomes of medical interventions)
- Lack of automated mechanisms to de-identify or sanitize data
- Lack of automated mechanisms to aggregate data
- Lack of large cross-jurisdictional data sets
- Lack of confidence in data quality, currency, or source
- Limited awareness of available data sets
- Limited ability to access private or proprietary data sets
- Unwillingness of some persons, agencies, or jurisdictions to share data
- Proprietary data formats and schema prevent integration
- Common occurrence for public safety data sets to be out of date
- Lack of staff with data science/management skills
- Lack of common schema or organizational structure

Some states and cities have created data catalogues that assemble data published by municipal departments. The city of Seattle, for example, published an Open Data Portal that provides access to data that can be downloaded from the site. As of the date of writing (April 2021), there are 88 public safety-related data sets on the Portal. For each data set, the site provides a description, API endpoints, field names, the date that the data set was last updated, tags, and the ability to link to or download the data. Currently less than 50 cities or counties within the United States have developed these data portals, but the collection of data sets is an important step in addressing this capability need.

The capability need is focused on the prerequisite to integrate data from many different sources so that analysis can be performed, and actionable information can be developed.

Participants rated II.25 as a High priority capability need.
DESIRED CAPABILITY: Potential solutions should:

Data Source Requirements:
- Integrate data from open source, proprietary, and protected data sources
- Ingest data in multiple file formats (e.g., .txt, .xls, .jpeg, .mpeg, .avi, .json)
- Provide information about data set (e.g., description, API endpoints, field names, revision date, tags)

Data Integration Requirements
- Develop standard schema or organizational structure
- Develop cross-discipline or cross-jurisdictional public safety data sets
- Allow user to automatically integrate chosen data sets
- Rapidly integrate new validated data into system
- Allow users to remove data sources or records from system

Data Integrity Requirements:
- Be able to validate data based on consensus criteria
  - Designate source of data
  - Designate that data is derived from a validated source
- Provide a confidence level
  - Designate confidence in source
  - Designate confidence in data integrity
- Provide automated mechanism to sanitize or de-identify data based on user criteria, policies, or standards

Data Storage Requirements:
- Store data for post-incident analysis
- Encrypt or protect incident data
- Provide options for local or cloud-based storage

Compatibility Requirements:
- Comply with exchange standards for data transmission (e.g., NIEM)
- Comply with NGFR open architecture\textsuperscript{111}
- Bi-directionally communicate with existing response-related software and systems (e.g., electronic situational awareness, dispatch, model prediction and forecasts)
- Comply with local, state, federal policies and restrictions for data sharing

\textsuperscript{111} The requirements contained in the NGFR Integration Handbook can be found at https://www.dhs.gov/science-and-technology/ngfr/handbook
Maintenance Requirements:
- Maintain backwards compatibility after upgrade
- Perform automated periodic virus detection and cybersecurity screening of software components

BARRIERS:

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<td>Unwillingness to share data</td>
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</tr>
<tr>
<td>Lack of public safety staff with data management skillsets</td>
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II.25 ISSUE CORRELATION:

- Attack Behavior
  - Social Media (Communication)
  - 5G
  - AI
  - Data Analytics
  - Digital Forensics
  - IoT
  - Biometrics & DNA
  - Dark Web
  - Social Media (Investigation)

- Weather Hazards
  - Climate Hazards
  - Geologic Hazards

- Chemical
  - Commercial Facilities
  - Communications
  - Critical Manufacturing

- COVID-19
  - Dams
  - Defense
  - Industrial Base
  - Energy
  - Financial Services
  - Food & Agriculture

- Protests/Civil Unrest
PROJECT RESPONDER 6
INTELLIGENCE & INVESTIGATION

- Government Facilities
- Healthcare & Public Health
- IT
- Nuclear
- Transportation
- Water & Wastewater
II.32 The ability to develop a common organization or tagging structure for emergency response data elements

DESCRIPTION: A recurring element in many of the requirements listed in this document is the need for a common structure for data set development and integration. Currently, proprietary or organic data sets are developed that use independent categories and schema to organize data. When this data needs to be integrated, whether across platforms or across jurisdictions, the files or data sets are incompatible. This capability need is focused on the ability of the public safety community to create and integrate data sets in a manner that the structure and visualization are consistent despite the platform.

The inclusion of metadata and tags are another component of this capability need. Metadata is data that describes information about the data elements. An image captured on a smart phone, for example, may include the time and location that the picture was taken. This information provides additional context and allows additional analytics to be performed on the data. However, like data fields, this data is inconsistent. If all data items that require or imply geolocation were to use a GIS-enabled designation, then any system or application that provides location visualization would be able to access this data. Similarly, a common date/time format would allow for easier integration of data. In terms of visualization, a set of common icons would allow users across platforms to recognize like data element. Finally, tags are often applied to data elements to facilitate filtering and analysis. The study team used tags for articles and information on the Evolving Response Environment section of this report, allowing for easier sorting and filtering of data and information (e.g., #evacuation, #COVID, #socialmedia). Multiple tags can be assigned to the same data element, allowing the user to customize analysis and reporting. While many tags would be specific to the individual data, a common set of public safety data tags would improve the ability of agencies to develop actionable information from the data.

Through NIMS, a resource typing schema was developed to define and categorize specific equipment, tools, apparatus, and teams commonly used on an incident scene. This is a very useful first step, but participants stated that it needs to be significantly expanded to include data elements that are not related to resources. The U.S. Geological Survey (USGS) developed a comprehensive set of geological map symbolization, but a similar standard symbology is needed for other public safety data elements.

Responders would like a standard data classification, visualization, and tagging schema to support integration of data sets across platforms and jurisdictions. It is critical that the public safety community is included in all phases of this effort to ensure acceptance and use.

Participants rated II.32 as a High priority capability need.
DESIRED CAPABILITY: Potential solutions should:

Data Organization Requirements

- Develop a standardized non-proprietary system for organization of public safety data
  - Data fields
  - Data structure
  - Symbology (e.g., icons)
  - Color scheme (as needed) (e.g., hexcode)
  - Metadata elements
  - Metadata structure
  - Data tags
- Develop generalized and topic-specific data schema
- Provide graphics in multiple formats (e.g., PDF, JPG, vector)
- Allow standardized data schema to be imported across multiple platforms (e.g., spreadsheet software, data visualization applications)

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<tbody>
<tr>
<td>Distributed nature of public safety decision-making</td>
<td>Proprietary schema in commercially available platforms</td>
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II.32 ISSUE CORRELATION:
OPERATIONS (OPS)

Defined as the capability to carry out tactics, techniques, and procedures in support of response tasks and missions.

**NEEDS IDENTIFIED** 52

**AVERAGE PRIORITY SCORE** 3.05

**HIGHEST PRIORITY OPS CAPABILITY NEEDS:**

- **OPS.5** The ability to safely enter areas of civil unrest to conduct traditional and non-traditional response operations (e.g., law enforcement, emergency medical, fire, public works)
- **OPS.29** The ability to maintain the security and integrity of the public safety answering points (PSAP) and the emergency communications center
- **OPS.6** The ability to extract critically-injured persons from a crowd

As previously noted, the Operations Domain was added to the Project Responder organizational structure for PR6. It contains more tactical and mission-specific capability needs than identified in previous iterations of Project Responder. The top three Operations needs are described in the section below.

- **Average Need Score:** It was the ninth highest-rated domain for Project Responder 6, with an average priority score of 2.54.
- **Need Status:** For 86 percent (55 of 64) of the OPS needs, more than 10 percent of participants did not find the need to be an issue for their discipline or jurisdiction. However, at least one respondent identified these as high or very high priority needs. This percentage is not surprising given that some of the OPS capability needs may be more discipline-specific given their tactical nature.

A complete list of all OPS needs can be found in Appendix P.
DESCRIPTION: As discussed in the Protests/Civil Unrest section, there has been a significant increase in the number of protests and incidents of civil unrest in the United States in recent years. The Armed Conflict Location & Event Data Project (ACLED) recorded more than ten thousand individual demonstrations and protests in a six-month period of 2020 alone. The majority of those were related to racial injustice and COVID-19 restrictions. While nearly 95% of those protests were peaceful and did not include destructive activities, many communities experienced extreme and/or persistent violent incidents.112

This capability need is focused on those protests that evolve into battles with authorities, violence against citizens, and destruction of property. Incidents of civil unrest can significantly hinder the ability for responders to carry out operational tasks and place them in danger. During the protests of 2020 and 2021, rioters vandalized private and public businesses, set fire to buildings and vehicles, committed acts of violence against citizens and responders, and seized state or local government property. While this was occurring, public safety personnel were still responsible for controlling the violence, treating medical emergencies, fighting fires, and restoring power. This can be extremely hard to do when people are throwing incendiary devices and projectiles, setting fires, and exhibiting other violent behavior. Much of the violent behavior in 2020 and 2021 was directed at law enforcement officers, but other responders were targeted as well.

Responders currently have limited ability to understand what is going on within a violent crowd, how to communicate among units or agencies, and how to maintain physical and mental health while dealing with violent individuals. National Guard units have been called in to assist during some incidents of civil unrest, but the lack of prior training for these types of events and differences in rules of engagement, resulted in some additional challenges to response operations. In the absence of crowd control, responders still need to be able to carry out their mission in impacted areas. In addition to the potential violence and destruction caused by the rioters, those uninvolved continue to experience a normal volume of medical distress, house fires, etc. Being able to safely conduct operations includes body protection for responders and safeguarding of apparatus and equipment.

Participants rated OPS.5 as a High priority capability need.

DESIZED CAPABILITY: Potential solutions should:

**Body Protection Requirements**
- Provide basic protection from:
  - Cuts or tears
  - Punctures (e.g., needle-stick)
  - Extreme heat
  - Blood-borne pathogens
  - Weather extremes
  - Impact energy (e.g., blunt trauma)
  - Hazardous substances (e.g., corrosives)
- Provide increased localized protection as needed (e.g., knees, forearms)
- Enhance comfort (e.g., body temperature regulation, moisture wicking)
- Enhance responder performance
- Not hinder responder dexterity or range of movement
- Accommodate differences in gender and body size
- Include options for multiple climates
- Include range of styles and colors
- Ensure visual appearance is still in line with discipline and public image
- Be compatible with mission-specific gear (e.g., turnout gear)
- Be easily able to be decontaminated in station

**Compatibility Requirements**
- Comply with international standards for responder garments and equipment\(^{113}\);
- Integrate with:
  - Hazard sensors
  - Responder geolocation systems
  - Responder physiological monitoring systems

**Communications Requirements**
- Ensure interoperable communications in the presence of loud ambient noise (see CIS.20 – *the ability for on-scene responders to receive updated information and data in real time without relying on push-to-talk communications*):
  - Neutralize the effects of sound, regardless of proximity, decibel, or frequency
  - Provide multi-sensory (e.g., visual, haptic) communications
  - Integrate with existing or future communications devices and/or PPE

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\(^{113}\) Example: National Fire Protection Association [NFPA] 1971 *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*
Planning Requirements

- Develop training and exercise events focused on response operations during incidents of civil unrest (see TE.20 – the ability to realistically exercise low-frequency, high-consequence events)

Policy Requirements

- Develop guidance on standard tactics and protocols for response to civil unrest
- Develop standardized rules of engagement for traditional and non-traditional response operations within an area of civil unrest at the state level

STATE of TECHNOLOGY: Most large agencies, the National Guard, and the military already have written plans, checklists, and standard operating procedures (SOPs) for addressing civil unrest. However, most of these plans have not been updated to reflect the changes in today’s societal norms and issues related to social media.

In addition to plans and SOPs, some new technologies were used by private industry during the recent civil unrest that may have some application for the emergency responder community. For example, a smartphone application was used to track the movement and safety of employees during protests in Portland, Oregon. The platform allows the user to hit a “panic button” when they feel threatened. The alert is pushed to security teams via text, email, and automated phone call. This allows the security teams to help the user identify a nearby safe place. Additionally, the application can put up a geofence around areas of high risk that can track when users enter and exit the area.\[114\]

BARRIERS:

<table>
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<tbody>
<tr>
<td>N/A</td>
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<td>• Topic of protests may impact mentality of some responders</td>
<td>• Potential for quick change from peaceful protest to civil unrest</td>
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<td>• Differing perception of protests across jurisdictions</td>
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Related Standards and Guidelines

- Fire and EMS Civil Unrest Response- U.S. Fire Administration
- Standard for an Active Shooter/Hostile Event Response (ASHER) Program- NFPA 3000

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OPS.5 ISSUE CORRELATION:

Crowd Behavior
Attack Behavior
Reduced Respect for Authority
Vigilantism

Robotics
Smart Textiles
UAS/C-UAS
Autonomous Vehicles

Government Facilities

Protests/ Civil Unrest
**DESCRIPTION:** A PSAP is a call center where public safety telecommunicators take calls from persons requesting emergency assistance. Other telecommunicators communicate the details of that call for assistance to the responding agencies. The link between the call-taking system and the dispatch system is the CAD platform. The CAD is a software program that requires network connectivity and a stable power system. Like other software programs, it is vulnerable to natural and man-made threats.

As is common with many things public safety-related, different communities have diverse systems for taking calls and dispatching personnel to respond. Some jurisdictions separate calls by discipline, others by function. Some smaller communities use the same personnel for communications with both the public and the responding units. Regardless of the system used, it is imperative that the emergency communications center and system remain up and running despite call volume and other threats and hazards.

Failure of the system can be caused by provider network outages, call volume, or cyber threats. High call volume, whether actual (e.g., COVID-19 calls for service) or simulated (telephony denial of service (TDoS) attacks) can significantly hamper operations. These calls can overwhelm the system leading to a delay or drop of calls or be maliciously routed to other locations. It does not help the person needing immediate assistance if their call is answered several states away. An increase in PSAP ransomware attacks is also affecting many jurisdictions. Perpetrators have been able to infect CAD systems, reroute calls, or take the system hostage in expectation of ransom payments. Participants noted that while some communities do not make these payments, the insurance carriers of other systems have forced them to do so. This spurs the threat for additional ransom attacks. Due to COVID-19 and recent natural threats (e.g., flooding), some communities have developed the ability to shift operations to remote locations without disrupting the call-taking or dispatch functions.

Participants rated OPS.29 as a **High** priority capability need.

**DESired CAPABILITY:** Potential solutions should:

**Planning Requirements**

- Develop training and exercise events focused on operations during a network outage or TDoS event
- Develop standard continuity of operations templates and guidance
- Develop standard PSAP vulnerability assessment tools
- Develop standard mitigation strategies for common vulnerabilities
- Develop PSAP cybersecurity standards
PROJECT RESPONDER 6

OPERATIONS

- Identify PSAP cyber capability needs
- Develop standard investigative guidance to capture evidence of criminal activity

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<td>• Intergovernmental politics and conflicts</td>
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OPS.29 ISSUE CORRELATION:

- Attack Behavior
- 5G IoT
- Weather Hazards
- Climate Hazards
- Geologic Hazards
- Communications Energy Information Technology
- COVID-19
**DESCRIPTION:** As described in OPS.5 above, crowd behavior can make it difficult for emergency responders to carry out operational missions. In cases of medical distress, EMS personnel need to reach, triage, treat, and extract affected individuals from the crowd. During the Capitol Hill Occupied Protest (CHOP) in Seattle, Washington, emergency medical personnel were unable to enter the zone without a police escort for safety. This resulted in the death of at least one person inside the zone.

Even if an event remains peaceful, it can be difficult to remove injured people from within a crowd. Conferences, festivals, parades, and community celebrations can result in the closure of streets for many blocks. Being able to get an ambulance (or smaller medical vehicle) into these areas is problematic. Temporary infrastructure placed in streets (e.g., tents, stages) obstruct evacuation routes. Street curbs hinder the ability to for vehicles with low clearance to use sidewalks.

Some communities have adopted smaller vehicles to allow emergency medical personnel to move through a crowd. The city of San Diego uses enhanced scooters to reach individuals with medical needs. Other communities use small motorbikes or all-terrain vehicles. Workshop participants reported the development of an all-terrain rescue vehicle with the ability to grab a victim through the floor of the vehicle, providing them with some level of protection from a crowd. While these solutions allow responders greater flexibility in reaching a victim, it can still be difficult to remove them from the crowd without causing further injury. While some all-terrain vehicle configurations carry a stretcher or basket to extract the patient, it is reported to be a rough ride and not optimal for some injuries. In the absence of one of these vehicles, responders may need to carry or wheel patients out on a backboard or stretcher. In the case of a serious medical condition, however, carrying a patient out is time-consuming.

Responders would like to efficiently extract individuals from crowds (both peaceful and hostile) without injuring themselves or causing harm to the patient.

Participants rated OPS.6 as a **High** priority capability need.

**DESIRED CAPABILITY:** Potential solutions should:

**Platform Requirements**

- Carry mission-appropriate payloads (e.g., medical cache):
  - Camera/surveillance systems (e.g., electro-optical, infrared, thermal imaging)
  - Threat, hazard, and biometric sensors
  - Lighting
  - Communications equipment (e.g., microphones, repeaters)
PROJECT RESPONDER 6

OPERATIONS

- Medical transport and/or treatment equipment
  - Be able to transport associated equipment and supplies
  - Pose low risk for operators, responders, and civilians
  - Deploy within 20 minutes
  - Be able to be deployed and operated by 2 or less persons
  - Be able to move patients in excess of 150 kilograms (e.g., person, equipment)
  - Be able to accommodate variations in weight of person
  - Be able to navigate around threats, hazards, and obstacles
  - Be able to neutralize threats to the platform (e.g., water disruptor)
  - Be able to be easily decontaminated

Patient Safety Requirements

- Allow EMS personnel to provide advanced life support operations during transport
- Provide suspension capable of transporting patients over diverse terrain without causing further injury
- Provide shield over patient and person providing care (e.g., protection from water and other weather, projectiles, etc.)
- Calculate quickest route through crowd given current size, location, and scope

Investigation Requirements

- Able to document operations and/or surroundings if patient is at the scene of a crime

BARRIERS:

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<th>Other</th>
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</thead>
</table>
| • N/A | • Locating patient within crowd
• Limited storage space for medical equipment limits treatment options |
OPS.6 ISSUE CORRELATION:

- Crowd Behavior
- Attack Behavior
- Reduced Respect for Authority
- Vigilantism

- Robotics
- Autonomous Vehicles

- Protests/ Civil Unrest
Part 2: Evolving Response Environment

The capability needs of today and tomorrow are impacted by many factors. An examination of these factors provides context to the capability needs, rationale for why they exist and priority among responders, and an understanding of how needs may change in the future. At the outset of the Project Responder 6 effort, the study team conducted research to identify possible impacts on the response environment. As mentioned in the Research and Evolution of Project Responder 6 discussions earlier in this report, the team originally identified four areas – or pillars – where changing conditions were significantly impacting how responders carry out their mission. These pillars included: Human Behavior, Technology Advancements, the Environment, and Infrastructure. The team added COVID-19 and Protests/Civil Unrest as a result of the historic events of 2020 on the response community.

Figure 21. PR6 Operating Environment Pillars

In total, the team examined 56 issues within these six pillars. Research, focus group meetings, and interviews focused on the following questions:

- What issues are responders currently facing?
- How does the issue impact response operations?
- What are the root causes of the issue?
- Does the issue impact responder safety? If yes, how so?
- Does the issue impact the safety of the public? If yes, how so?
- Are there specific barriers related to addressing the issue?

The following sections provide an overview of the issues, a discussion of the impacts on the responder operating environment, and correlation to associated PR6 capability needs. As is evidenced in each successive iteration of Project Responder, the situation in which responders must do their job is constantly changing. Identifying needs without an examination of this situation can neglect critical factors that an agency, organization, or company should consider when making research and development decisions.

Figure 22 on the following page depicts all of the issues assessed as part of the PR6 effort.
Figure 22. PR6 Evolving Response Environment Issues
HUMAN BEHAVIOR

There are 16 Human Behavior issues that are currently impacting response operations. Click on the boxes below to link to a description of each issue:

<table>
<thead>
<tr>
<th>CITIZEN JOURNALISM</th>
<th>CROWD BEHAVIOR</th>
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<td>MENTAL HEALTH CRISIS</td>
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<td>SUBSTANCES OF ABUSE</td>
<td>RISE IN HOMELESSNESS</td>
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<td>SOCIAL MEDIA (AS A COMMUNICATIONS TOOL)</td>
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<td>RELIANCE ON TECHNOLOGY</td>
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<td>REFUSAL TO COMPLY WITH COVID-19 RESTRICTIONS</td>
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<td>HUMAN SETTLEMENT TRENDS</td>
<td>VIGILANTISM</td>
</tr>
</tbody>
</table>

For this report, human behavior is defined as the response of individuals or groups to internal and external conditions. This response revolves around three facets (cognition, physical action, and emotional reaction) and how they interplay with each other. Actions are defined as things that can either be observed or physiologically measured. Feelings are described as brief conscious occurrences of intense mental activity but is not a result of reasoning or knowledge. Feelings are categorized along a scale from positive (pleasurable) to negative (unpleasant). Thoughts are defined as both verbal and nonverbal images and are comprised of skills and knowledge.115

While the specific traits of one’s personality and disposition are considered to be consistent, other behaviors may change depending on the situation encountered. New experiences are adapted, merged and integrated into a human’s outlook. This allows the flexibly to adapt to and predict how current events may be influenced by actions.116

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116 Ibid.
Each of the *Human Behavior* issues reflect how people react to situations. Those reactions may be the result of — or the cause of — natural and man-made emergency response incidents. Through research, interviews, and focus group meetings, these are the issues that responders believe currently have or will continue to have the most impact on their operations.

It is critical to acknowledge that not only does human behavior vary dependent on the situation, but also that perceptions of what constitutes rational behavior in the face of an emergency may diverge as well. Refusal to evacuate in the face of an incoming hurricane, for example, may be irrational to some. To a person with limited means to stay elsewhere, the need to care for a dependent, or concerns about losing a job that requires attendance, the calculation is different.

There are 16 issues addressed below in which human behavior causes or impacts an incident that requires emergency response operations. Note that many of these issues are very political and divisive in nature. The intent of this section is to address impacts on the response environment. Every effort has been made to present an impartial accounting of the topic without adding subjective analysis or opinion.
CITIZEN JOURNALISM

Overview: Citizen journalism involves members of the public remaining at (or traveling to) the scene of an incident in order to document what is occurring. Mobile devices with high quality photo and video cameras, combined with the availability of broadband and cellular networks, and the ubiquity of social media feeds have provided a platform in which bystanders are often the first to report on breaking news stories even as they are occurring. This user-generated content can include images, video, audio, and text media. When this content is uploaded to a social media platform or livestreamed from the scene, viewers can experience what is happening, regardless of their physical location.

Because bystanders are generating the content, multiple viewpoints can be presented from the same incident. Perceived biases of media are minimized when viewers can see and/or hear the action for themselves. This behavior not only applies to bystanders, those directly involved in the incident have also posted images or video.

Because citizen journalists can disseminate content before the traditional media or official sources, the content, editing, and analysis accompanying their content can have multiple impacts. Traditional media outlets must comply with 18 U.S. § 1464, which provides standards for broadcast television. Delays in broadcast of live video allow the media to blur faces, trademarks, etc. Citizen journalists and bystanders may be less aware of existing laws and regulations that govern reporting and may not comply with the same standards. Information and images that traditional media sources have been unwilling to provide (because it may divulge an individual’s health information, images of juveniles, home addresses or phone numbers) are often fair game for some citizens.

This is a further problem when the image or video is intentionally or unintentionally edited to inaccurately portray what is happening. In addition, citizen journalists or bystanders may not verify their sources before reporting. Occurrences of vigilantism or violence have occurred because the information surrounding an incident, as reported, was not accurate or complete. Conversely, video from the public has been used to exonerate responders or members of the public who have been falsely accused of violent actions.

Bystanders or citizen journalists can potentially impede the ability of responders during their operations. In the aftermath of the deadly shooting at the Tree of Life Synagogue in Pittsburgh, for example, responders reported that many onlookers crowded the perimeter to get pictures and video. This made it difficult for law enforcement and EMS personnel to move freely around the scene as necessary. In some cases, capturing images or video can pose an immediate danger to life or health. Internet-based videos showing individuals filming approaching tornadoes or vehicles driving into floodwaters are abundant. Filming can also occur during violent attacks. Several attendees at the Route 91 Harvest music festival in Las Vegas captured video while pinned down as gunfire erupted around them. There are legitimate concerns that focusing on capturing what is happening makes an individual less attentive to their own safety.
or that of others. In fact, bystanders have been criticized for watching as events unfold so that they can capture the activity on video instead of stepping in to provide aid or activating the 9-1-1 system.

Citizen journalism and the posting of information to social media feeds is not limited to members of the public. A number of emergency responders have lost their jobs because they have posted data from an incident scene to social media sites. In response, several states have enacted laws prohibiting emergency responders from sharing graphic images or information for personal purposes, even if the posts are to private groups.

Finally, incorporation of media from the public can prove to be traumatic for citizens and for responders. Call-takers in the public safety answering point (PSAP), for example, regularly talk with people who are suicidal. They are not always able to provide the help needed and sometimes hear the audio of suicide attempts over the 911 call. If these conversations were to take place over video instead of audio, the call takers would now see as well as hear an individual’s self-harm activities. In addition, livestreamed or posted content can contain graphic images. For example, in March 2019, an extreme-right terrorist entered two mosques in Christchurch, New Zealand and used a social media app to livestream himself killing 42 people. The footage was violent and explicit and none of the viewers of the original live broadcast reported it to Facebook. Despite Facebook’s removal of 1.5 million videos of the attack within 24 hours, other users re-cut the video to upload it onto YouTube. Tens of thousands of videos of the attack were uploaded to YouTube within hours of the incident. Livestream apps have also been used to distribute other graphic content, including rape, suicide, assault, and murder. There is no warning label to prevent a viewer from seeing disturbing content and no means to prevent sharing of images and video unless the company actively removes it from the site.

This issue was more consequential given the events of January 6, 2021 during the attack on the U.S. Capitol Building. A significant number of those that attacked the building used social media platforms to document their activities. Although one of those platforms was temporarily shut down due to its policies for regarding violent content, a group was able to scrape the majority of content from the site before it was closed. The significant number of videos, images, and messages proved of notable value to law enforcement in identifying and charging those who participated in the attack.

117 The Christchurch shooter eventually killed 51 people. However, the livestream cut out while he was driving between the site of the first mosque shooting and the second mosque.
119 Ibid.
120 Ibid.
Impact on Responder Environment:

There are a number of ways in which citizen journalists or bystanders photographing or filming an incident can impact the response environment.

1. Responders may have greater degrees of situational awareness by being able to view incident scene activities prior to arrival.

2. Bystanders that do not leave the incident scene create more potential victims. Those who film an oncoming tornado, for example, may not be able to move out of the path of the fast-moving winds.

3. Bystanders that do not leave the incident scene place additional burdens on law enforcement officers that are trying to establish a perimeter and remove people from harm’s way.

4. Members of the public can be falsely implicated by citizen journalists, potentially leading to violent behavior and other adverse consequences (e.g., loss of employment, incarceration) against those accused.

5. Responders may change their actions or perceptions based on knowledge that they are being filmed, with both potentially positive and negative consequences. Responders may not be as proactive if they know that there will be a digital record of their operations. Conversely, unwillingness to divulge tactics or activities (e.g., SWAT movements, informants) may put responders at greater risk.

6. Responders experience greater levels of stress because they know that they are being filmed regularly.

7. There is limited ability to ingest, analyze, or store citizen-generated media as part of investigations or incident record.

8. There are policy issues to be resolved including collection, storage, retention duration, access privileges, and chain of custody.

9. The graphic nature of citizen-generated media may cause physical or mental stress for some public safety personnel.

10. Responders are concerned about the potential for nefarious information-gathering or scouting by bad actors. The use of multi-media data could give a tactical advantage to those looking to cause harm.
Citizen Journalism Associated Capability Needs:
INABILITY / REFUSAL TO EVACUATE

Overview: There are many reasons that people cannot or will not evacuate in the face of impending danger. The calculation is very easy for many people. Some evacuate on the first order to do so, with cars packed and an easy or obvious destination in mind (e.g., hotel, relatives). Others believe that they have withstood previous incidents and, therefore, have the ability to do so again. For many, however, the evaluation of options is not as clear cut. Decisions on whether to evacuate are generally rational, made after considerations of cost and benefit. There are many people for whom the known costs outweigh the potential benefits.

It can be expensive to evacuate. A one-week evacuation for a family of four can cost more than $2000, including fuel, meals, and a hotel. Many people do not have sufficient savings to afford this. Further, people fear that they will lose their jobs if they do not show up for work. Even when evacuation is mandatory, employers can insist that their staff is still available for work and can terminate employees who do not report for duty. Other employers do not pay staff for time off in conjunction with a mandatory evacuation. When forced to choose between evacuation and losing current and future income, many choose to remain with their job. Further, the evacuation of others presents opportunities to make additional money because services may be in high demand.

Dependency is another reason that people do not evacuate. Caregivers are responsible for dependent adults and children. An adult taking care of a parent with physical or cognitive issues, a daycare provider watching multiple children, the owner of house pets or livestock that cannot be evacuated; all of these are examples of people who are constrained in their evacuation decisions. A related issue is those that are tied to powered medical devices or a medical regimen, where evacuation is a complex process.

Regardless of reason, many people cannot or will not evacuate. A study from Hurricane Sandy showed that less than 50 percent of residents in shore communities in New Jersey evacuated because of the storm. This resulted in thousands of residents who did not evacuate. It is not just impending hurricanes; people do not evacuate in the face of catastrophic flooding, wildfires, etc. These people remain in the community and there is often limited awareness of who has not evacuated or where they are located.

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If they become stranded or need support, some will call 9-1-1 for rescue. Although some communities tell residents that responders will not be dispatched to help them (or make them sign a release), responders can be dispatched to provide aid or rescue. This not only pulls resources away from other response operations but can endanger responders that go out in hazardous conditions to answer the call for service.

Impact on Responder Environment:

There are a number of ways in which citizens who do not evacuate during an incident can impact the response environment.

1. Responders are often placed in danger helping to support people who have not evacuated.
2. Some members of the public need support to evacuate, from access to continuous power for those on powered medical devices, to those without transportation or a place to go.
3. Responders are publicly rewarded for heroic behavior (e.g., saving a person who is stranded by flood waters), but this impacts the perceptions of the public that someone will be there to help them if they do not evacuate.
4. Currently, there is difficulty in effectively communicating the threat to the public that includes all of the information they would need to make a decision about evacuation.
5. Many people may trust social media or alternative sources more than what is being issued via official government sources about the nature of the threat.
6. Specialized teams and resources may be required for specialty transport situations (e.g., non-ambulatory, children).

Inability/Refusal to Evacuate Associated Capability Needs:
Overview: Substances of abuse include legal and illegal drugs and alcohol taken by people that can affect their behavior and cause bodily harm to themselves and others. There are upward trends in the use of both alcohol and drugs that are impacting emergency responders.

Over 100,000 people died from overdose in the 12-month period ending in April 2021. This is the largest number of overdose deaths ever recorded in a 12-month period. The COVID-19 pandemic accelerated the rate of these deaths. Synthetic opioids were the primary cause of the increase in deaths. During this time period:

- 37 of the 38 jurisdictions with available synthetic opioid data reported increases in synthetic opioid-involved overdose deaths.
- 18 of these jurisdictions reported increases greater than 50 percent.
- 10 western states reported more than a 98 percent increase in synthetic opioid-involved deaths.

Overdose deaths involving cocaine increased by 26.5 percent and those involving psychostimulants (including methamphetamines) by 34.8 percent. However, most illicit substances available are a combination of ingredients. Fentanyl is often used as a cutting agent because of the ease and low cost of production. Unfortunately, fentanyl is 50 to 100 times more potent than morphine which makes it a dangerous additive to many illicit drugs. Many die from a fentanyl overdose without knowing that it was present. Drug overdose incidents and deaths are causing a significant strain on the emergency medical services of many communities and are especially hard-hitting in rural areas. Some communities have initiated leave-behind naloxone programs that allow those closest to drug users to inject naloxone, which rapidly reverses the effects of opioids. This practice improves patient outcomes and reduces the high demand on response agencies.

Not only are patients endangered by the existence of fentanyl and other compounds, but responders may also be harmed as well. There are numerous reports of responders experiencing illness after being in proximity to fentanyl. In addition to the strain on response agency resources, patients suffering from the effects of drugs can become violent. Responders from all disciplines routinely experience physical aggression from people having bad reactions.

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126 Ibid.
Alcohol consumption is likewise on the rise. Recent studies have shown that harmful drinking patterns increased as COVID-19 lockdowns extended. While social distancing guidance and occupancy restrictions contributed to initial reductions in drunk driving, fatalities increased when restrictions were relaxed according to the National Highway Traffic Safety Association. Further, 65 percent of drivers treated for injuries after serious crashes had drugs and/or alcohol in their systems. This is compared with 50.6 percent before the pandemic.

**Impact on Responder Environment:**

There are several ways in which substances of abuse can impact the response environment.

1. Family, friends, and bystanders are rarely prepared to help in the administration of narcotic countermeasures (e.g., naloxone).
2. Responders are often unable to identify the substance ingested during calls related to overdose calls for service, leading to the administration of generalized cocktails for treatment.
3. There are insufficient facilities available to treat those with substance abuse issues.
4. It is often difficult for responders to find open facilities for patients experiencing substance abuse emergencies.
5. Responders are endangered by drug paraphernalia.
6. Responder resources are allocated to overdose calls at an increasing rate.
7. Responders and the public are endangered by drivers under the influence of alcohol and/or drugs.

**Substances of Abuse Associated Capability Needs:**

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Overview: The previous iteration of Project Responder examined multiple mass shootings as part of the identification of capability needs. While mass shootings continue to occur in the United States, there have been adaptations in attack behavior that have significant impacts on the response community. Note: this section does not include violent criminal activities committed as part of the protests and civil unrest of 2020 and 2021 unless the behavior was linked to violent extremist groups.

The biggest evolution has been in home grown extremism. Domestic violent extremists (DVEs) include groups on both the far-left and the far-right. The Office of the Director of National Intelligence (ODNI), the Department of Justice (DOJ), and DHS recently released an unclassified summary of the joint comprehensive threat assessment on domestic violent extremism. The assessment is that DVEs pose a heightened threat in 2021 and beyond. This may include organized group behavior or lone wolf actors. Racially or ethnically motivated extremists and violent militia extremists pose the greatest threat per this assessment. These groups are also the most well-armed. In 2020 and 2021, these groups were responsible for attempted kidnapping of a state governor, the execution of federal officers, and the siege on the United States Capitol building. Left-wing extremists participated in the formation of the autonomous zone and civil unrest incidents across the United States. The violence associated with DVEs has posed an immediate and physical threat to emergency responders and will continue to do so.

Targets of violence continue to be specific populations as well as soft and symbolic locations. Attacks in Pittsburgh, Pennsylvania (Tree of Life Synagogue mass shooting) and the El Paso, Texas (Walmart mass shooting) illustrate the racially motivated and public targets of recent violent incidents. There nearly 700 mass shootings in the United States in 2021, with targets including night clubs, work locations, shopping malls, and other soft locations.

Methods also continue to evolve. Multi-location terrorist attacks have recently turned to low-skill, hard-to-predict attack methods. Arson (structures and wildland), stabbing sprees, vehicle ramming attacks, and lone offender assaults have become predominant. These attacks are extremely hard to predict, prevent, or mitigate.

The internet provides an increasingly available platform for recruitment and exploitation of vulnerable people. Not only do many of the DVEs communicate and share propaganda via the internet.

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129 Ibid.
130 Mass shootings in this case are defined as attacks in which four or more people are injured or killed and are perpetrated in public. It excludes domestic shootings and those attributable to underlying criminal activity. Gun Violence Archive, Mass Shootings. [https://www.gunviolencearchive.org/mass-shooting](https://www.gunviolencearchive.org/mass-shooting)
internet, but they also post manifestos and livestream attacks which further inspire others. In addition, the internet offers videos and how-to guides that allow interested persons to learn attack behaviors and tactics.

**Impact on Responder Environment:**

There are a number of ways in which changing attack behavior can impact the response environment.

1. Responders are put in harm’s way during attack incidents.
2. The number of attacks is increasing, further straining available staffing and resources.
3. Attacks can cause significant loss of life and injury to targeted populations.
4. Many attacks are difficult to prevent or mitigate.
5. Many anti-government militia groups actively target law enforcement officers. The attacks on the U.S. Capitol demonstrate that groups are willing to attack police officers in the pursuit of their goals.

**Attack Behavior Associated Capability Needs:**

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### PROJECT RESPONDER 6

**Evolving Response Environment: Human Behavior**

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GANG ACTIVITY

Overview: Organized street gangs can be defined as a group of people whose primary activities include the commission of criminal acts and who have a common, identifying sign or symbol. Transnational criminal organizations (TCO) are groups engaged in illegal behavior to generate profit and power — irrespective of geography. The distinction between these two groups is increasingly blurred as many street gangs operate as TCOs. La Mara Salvatrucha (MS-13), for example, operates in the United States, Central America, and Europe. These gangs are responsible for violent crimes across the country including murder, narcotics and human trafficking, and conspiracy to finance or commit acts of terrorism.

Federal, state, and local law enforcement officers have targeted these organizations because of threats to public safety. Official relationships between the United States and other countries, especially Mexico, can significantly impact the ability for law enforcement to mitigate or eliminate gangs and their associated violence. Many of those relationships have been strained in recent years, hindering response operations.

Impact on Responder Environment:

There are a number of ways in which gang activity can impact the response environment.

1. Gun-related violence is commonly associated with street gangs and TCOs.
2. The gun-related violence is further taxing available staffing and resources.
3. Gang and TCO members have a history of targeting public safety personnel. The Federal Bureau of Investigation recently warned law enforcement that local gangs in Chicago targeted police that draw their weapon.

Figure 23. MS-13 presence in the United States in 2020.

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133 “FBI-Chicago warns that gang cabal may be targeting CPD officers,” abc7chicago.com, https://abc7chicago.com/chicago-police-department-gangs-fbi-shootings/6397730/
4. Law enforcement officers at federal, state, and local levels face legal and cultural barriers to working with foreign counterparts to address gang threats.

5. Gangs and TCOs use social media platforms to recruit new members and conduct intimidation operations. Lack of access or ability to analyze posts on social media platforms makes it difficult to investigate these activities.

Gang Activity Associated Capability Needs:
**ILLEGAL DRUG PRODUCTION**

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**Overview:** There are multiple types of illegal or clandestine drug production facilities and farms. Methamphetamine, fentanyl, the hallucinogen N,N-Dimethyltryptamine (DMT), and butane honey/hash oil production facilities, for example, are found across the United States. Illegal marijuana farms are also common. Not only do these facilities produce substances that are harmful when ingested, inhaled, or injected, but the manufacturing process is associated with additional hazards. Explosions, fires, the generation of toxic gasses and caustic chemicals, and the contamination of buildings, soil, and water supplies are all hazards common to illegal drug production. These can be large facilities associated with organized crime or small operations for personal use and limited distribution. Across the United States, clandestine drug production facilities and farms can be located in suburban neighborhoods, homeless encampments, multi-residential buildings, abandoned structures, and remote/rural properties. In essence, these facilities present a hazard to all members of the public. Many facilities go undetected until they cause an incident.

Regulation, taxation, and high demand for legal marijuana have resulted in the expansion of illegal grow farms. In many legalized states, unlicensed businesses outnumber legal sites.\(^{134}\) Growers on these farms often alter the terrain (e.g., divert waterways), tap into public utility systems, and use hazardous chemicals that contaminate the soil, waterways and harm wildlife.\(^{135}\)

Many criminal drug manufacturers and growers use extensive security systems to protect their investments. Armed guards and booby-traps are commonly used. Not only do these pose hazards to members of the public that accidentally find these locations, but also to responders that must investigate and clear these sites. There are significant additional health hazards to responders when responding to incidents at production facilities and farms. Contact with

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clandestine methamphetamine labs, for example, can cause eye and respiratory irritation, lung damage, and burns.\textsuperscript{136}

**Impact on Responder Environment:**
There are a number of ways in which illegal drug production facilities can impact the response environment.

1. Illegal drug production facilities produce hazards (e.g., explosive, flammable, caustic, toxic) that responders are exposed to during investigation and mitigation operations.
2. Violent security measures (e.g., booby-traps) pose additional threats to responder health and safety.
3. Manufacturers and growers can develop relationships with gangs and cartels for distribution, increasing the potential for violence and complicating investigations.
4. The clandestine nature of these sites makes it possible or likely that responders will discover them during the course of other activities and while they are not wearing the appropriate PPE to protect themselves.

**Illegal Drug Production Associated Capability Needs:**

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https://www.researchgate.net/publication/232035721_Occupational_Health_Hazards_to_First_Responders_from_Clandestine_Methamphetamine_Labs
Overview: The dangers of spreading the SARS-CoV-2 virus led to federal, state, and local restrictions related to occupancy rates and gathering size, as well as required use of facial coverings. The type and duration of these restrictions varied across the country. The evolving nature of COVID-19 guidance, disagreement about the scientific findings, and politicization of the restrictions led to a notable portion of the population that did not comply with government restrictions. This manifested itself in several distinct actions:

- People that refused to wear masks or face coverings while in public
- People that verbally assaulted others related to enforcement of COVID-19 restrictions
- People that spit, coughed on, or physically attacked others in protest of COVID-19 restrictions
- People that refused to provide information to inform contact tracing efforts
- People that refused to quarantine after known exposure or infection
- People that planned and/or held large gatherings in defiance of restrictions
- People that attended gatherings after known COVID-19 exposure or infection

The unique nature of the virus and the contentious views on appropriate response activities led to behaviors that would not be allowed in other circumstances. State and local governments have developed extensive communicable disease control laws. Every state possesses general public health legal authority that may be invoked to control communicable diseases. For diseases like tuberculosis, municipalities can authorize syndromic surveillance to collect disease data, require reporting of infection, authorize mandated screening and vaccination, compel examination and treatment, quarantine infected persons, and enforce isolation. There were impediments to each of these authorities for the COVID-19 pandemic.

Emergency responders and public health personnel were largely over-taxed with other responsibilities to enforce many restrictions. It was often left up to business employees to try to enforce mask mandates and social distancing guidelines. This led to a number of verbal and physical attacks on these workers. Conflicting guidelines among levels of government, executive orders that countermanded restrictions, and changes to government authorities further exacerbated these problems. The divisions associated with the COVID-19 response may not be addressed or healed before another pandemic or National-level incident.

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Impact on Responder Environment:

There are a number of ways in which refusal to comply with COVID-19 restrictions can impact the response environment.

1. Infected persons in public interact with emergency responders, putting them at risk for exposure.
2. COVID-19 outbreaks resulted from people refusing to comply with COVID-19 restrictions, endangering responders and members of the public.
3. COVID-19 outbreaks resulted from people refusing to comply with COVID-19 restrictions, thereby stressing public safety and healthcare resources.

Refusal to Comply with COVID-19 Restrictions Associated Capability Gaps:
Overview: The movement of Americans – to and from rural and urban areas – changes over time. In the past years, there have been two primary trends that have a significant impact on the response environment: movement into wildland areas and into coastal areas.

Regional shifts in population, amenity migration (i.e., moving to areas with attractive scenery and cultural features/activities), urban land use, and greater opportunities to work remotely due to COVID-19 are among the reasons that more people are moving to remote areas.\textsuperscript{140} What this means is that more people are in the path of wildland fires – often called the Wildland Urban Interface (WUI). This in turn causes two issues – first, there will be more fires caused by human actions. Second, wildfires – whether of natural or human ignition – will endanger more people and property.\textsuperscript{141} This is further exacerbated because the public safety infrastructure in these areas is often not sufficient to deliver fire suppression, emergency medical, and law enforcement services as needed or expected. Water sources and infrastructure are often lacking in the community, especially as many experience drought conditions. Also insufficient is the transportation infrastructure. Many mountainous communities have limited ingress and egress routes, which can be blocked by fire. This prevents people from evacuating to other areas and impedes the inflow of resources to contain and control the fire. Across multiple fires people have died in their vehicles while trying to evacuate an area.

Not only are there wildfire issues with movement into the wildland areas, but the concentration of humans changes the risks and vulnerabilities of the area. Increased human habitation leads to deforestation, blocking of natural drainage, changes in foliage due to the introduction of invasive plant species, and soil erosion.


Continuing movement to coastal areas presents separate issues. As the Nation experiences more frequent and more extreme storms (see the discussion of Weather Hazards in the Environment section), more people are moving into areas prone to flooding and destructive storms. As in wildland areas, the transportation infrastructure is often insufficient to accommodate evacuation traffic. For example, coastal/island communities who rely on bridge access may have limited ability to utilize high volume evacuation routes. The construction of additional buildings in coastal ecosystems can damage or destroy natural storm barriers and change drainage patterns. This in turn leaves the shore – and anything constructed on it – more susceptible to waves and storm surge. In addition, rising sea levels endanger areas of habitation. Figure 26 below, from the 2018 National Climate Assessment, illustrates the potential impacts to the coasts from climate change.

Figure 25. Coastal population in the United States. Image from the 2014 National Climate Assessment.

Figure 26. Coastal Impacts of Climate Change. Image from the 2018 National Climate Assessment.


Despite the increase in people moving to these high-risk areas, inhabitants often expect response times to match urban areas, transportation and resources to support movement in an emergency, and public safety operations to save them or their property. They expect a comprehensive and well-supplied response despite variable weather conditions and seasonal population surges.

**Impact on Responder Environment:**
There are a number of ways in which changing human settlement patterns can impact the response environment.

1. The encroachment of urban areas into wildland areas opens population up to wildland fire, disease, human-wildlife interactions, etc.
2. There is increased settlement along coastal regions prone to flooding and increasingly destructive storms.
3. Many are reluctant to or unable to leave disaster prone areas in favor of living in safer places.
4. Responders are endangered by people who are unable or unwilling to evacuate. (See the discussion of Inability/Refusal to Evacuate for more information on this issue.)
5. Transportation routes and evacuation plans often hinder the ability to move response assets into remote areas.
6. Small or more isolated communities can be at a greater risk than larger areas because of the lack of ingress and egress routes.
7. Many of these areas may have connectivity issues due to the remote nature of the region or the susceptibility of network infrastructure to storm effects. This can make it difficult for responders to communicate among themselves or with the public.

**Human Settlement Trends Associated Capability Gaps:**
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Overview: The PR6 assessment of crowd dynamics originally focused on primarily on protest behavior. However, given the unique characteristics in terms of number, location, and type of crowd activity in 2020-2021, the study team conducted a separate assessment of these issues. There is further discussion of this topic in the Protests/Civil Unrest section. Based on changes to the methodology for PR6, this section concentrates on crowd behavior outside of protests or civil unrest. This can include incidents and events at locations where people have congregated in a set location (e.g., stadiums) or converged due to normal activities (e.g., airport).

Human behavior can change dramatically when we are taken out of our comfort zone or familiar surroundings. The outcome of an emergency is largely determined by the behavior of the people involved. Studies have shown that in an emergency situation those affected take on a similar attitude, motivation, and behavior to those around them. Therefore, for emergency plans to be robust, planners must profile the crowd in advance and predict human behavior in emergency situations.¹⁴⁴

People involved in emergency situations will be physically and mentally stressed — which is not always a bad thing because people tend to act quicker under pressure. The way a person deals with stressful situations depends on many factors including experience, environmental conditions and task demands. The longer someone is exposed to the danger, the more stressed they become.

Group dynamic influences interaction and cooperation to help get injured and helpless to safety and escape harm. In incidents like human stampedes and crushes, these influences can lead to both positive and negative outcomes. Examples such the Route 91 Harvest festival shooting in Las Vegas illustrate the support that members of the crowd can provide. Concertgoers helped to carry injured victims away from the venue, provide critical first aid, and transported people to medical facilities.¹⁴⁵ Conversely, law enforcement and fire service personnel stated that they were unable to reach injured persons inside of the Capitol Hill protest zone in Seattle because the crowd hindered entry into the area.

Impact on Responder Environment:
There are several ways in which crowd behavior can impact the response environment.

1. There is a lack of individual resilience and understanding of appropriate emergency behavior and actions.
2. Responders often find it difficult to effectively communicate with large groups of people in real time.
3. It is often difficult to decelerate violence and panic in crowds.
4. While some national programs exist to train civilians in first aid, many members of a crowd are not able to provide life-saving medical treatment or offer other help to responders.

Crowd Behavior Associated Capability Needs:
MENTAL HEALTH CRISSES

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**Overview:** Beginning in the 1970s, the United States began deinstitutionalizing of the nation’s mentally ill. This effectively removed thousands of patients from long-term, in-patient psychiatric care without having adequate alternatives in place. As a result, jails and prisons around the United States are full of mentally ill individuals who have been “re-institutionalized” as the result of their lack of treatment.\(^\text{146}\)

There are not enough psychiatric hospital beds of last resort. This leads to a cycle of mental health crises and emergency short-term care that persistently burdens community health, hospitals, and emergency responders without solving the underlying problem. The longer individuals with mental health problems wait for treatment, the more likely it is that a mental health crisis will develop. This often results in the need for more intensive treatment for a longer period of time. Thus, this creates a lose-lose situation for both the mentally ill individual and the community.\(^\text{147}\)

Those in mental crisis often need the help of intervention by emergency responders. This intervention comes in a variety of ways. First, concerned family or friends call on law enforcement or emergency medical services to come assess the patient. Second, the mentally ill are taken into custody when they are having violent episodes, this requires law enforcement resources. Third, lone wolf actors are often proven to be suffering from various forms of untreated mental illness leading to acts of violence. Finally, often when dealing with the homeless, mental illness is part of the equation.\(^\text{148}\)

Unfortunately, responders do not have sufficient training in dealing with mental health crises. They also may struggle to recognize the difference between mental health emergencies and the effects of drugs. Some communities have introduced crisis intervention teams that involve emergency medical, law enforcement, and mental health professionals to address emergencies in the field. However, this practice is not widespread and law enforcement is often the first and only interaction with those experiencing a mental health crisis. Finally, many communities do not have sufficient resources to deal with the extent of mental health issues in the community. Often there is not a facility or resources available to assist the individual in crisis.

**Impact on Responder Environment:**

There are a number of ways in which mental health crises can impact the response environment.

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\(^{147}\) Ibid.

\(^{148}\) Ibid.
1. Law enforcement is often the first intervention for those experiencing an acute mental health crisis.
2. It may be difficult for responders to distinguish between a mental health crisis and other conditions, especially if aggression is displayed or there is a perceived potential for violence.
3. The lack of dedicated mental health facilities across the United States often results in the incarceration of those experiencing a mental health crisis.

**Mental Health Crises Associated Capability Needs:**

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- CIS.25
- CCC.12
- CCC.16
- RHS.2
- LRM.2
- CM.3
- CM.5
- TE.8
- TE.25
- RAP.2
- RAP.9
- II.7
- CM.6
- CM.11
- CM.12
- CM.13
- CM.20
- CM.24
RISE IN HOMELESSNESS

Overview: The U.S. Department of Housing and Urban Development (HUD) defines homelessness as “lacking a fixed, regular, and adequate nighttime residence.” Over 550,000 Americans experience unsheltered homelessness each night. Additionally, about 1.4 million will enter a homeless shelter at some point this year. Figure 27 shows the 2019 Point-in-Time Count, meaning the number of people experiencing homelessness on a given night. According to HUD, homelessness fell progressively after 2010, but increased annually from 2016 to 2019.¹⁴⁹,¹⁵⁰,¹⁵¹

Historical data shows that men, Native Americans, Black Americans, Hispanics, the mentally ill, domestic-violence survivors, substance abusers, and veterans all experience homelessness at higher rates. However, new data indicates a growing trend indicating more families with children are experiencing homelessness. More families experience homelessness in the United States than in any other industrialized nation. More children under the age of five are experiencing homelessness now than ever before.¹⁵²,¹⁵³

Cities and states with large homeless populations must allocate significant resources to address multiple issues such as health care, law enforcement, and social services. The largest

percentage, more than half, of resources go to health care. Almost a third is applied to law enforcement, particularly jails. About 10 percent is spent on social services.\(^\text{154}\) Emergency calls for service (i.e., 9-1-1 calls) make up a disproportionate percentage of incidents, especially for law enforcement and EMS personnel. A study from the city of Los Angeles, for example, examined the frequency of 9-1-1 calls for homeless patients attended by the Los Angeles Fire Department. Homeless patients were involved in 10.2 percent of incidents in 2018, although they represent only 0.8 percent of the population. Of the calls resulting in transport to the emergency department, 13.3 percent involved a homeless patient (19 times higher than housed patients).\(^\text{155}\)

![Figure 28: Many response agencies have established homeless community liaisons. Image from Portland.gov.](image)

Homeless encampments are another issue of concern for emergency responders. People experiencing homelessness may choose to group together to increase their safety. These encampments can take many forms, including tents, shacks, occupation of abandoned buildings or other physical structures (e.g., tunnels, overpasses), groups of vehicles, etc.\(^\text{156}\) Data indicates that the number of documented homeless encampments have noticeably increased across the country. Many of these encampments are hidden to avoid legal problems or eviction. Some last for many years but others are designed to move frequently.\(^\text{157}\) There are multiple threats and hazards associated with these camps. In some communities, law enforcement officers are tasked with clearing, or “sweeping” these encampments. They may encounter opposition or aggression from the inhabitants; biological hazards from human waste and contagious diseases; chemical hazards from narcotics labs; and explosive or incendiary hazards from propane tanks, cooking fires etc. Further, some encampments place home-made security measures or booby-traps in or near the camp. Multiple respondents stated that they do not have sufficient PPE for operations


involving homeless encampments. Emergency medical personnel face many of these same hazards when entering to provide aid as do fire service personnel.

**Impact on Responder Environment:**

There are a number of ways in the rise in homelessness can impact the response environment.

1. The increase in homelessness in both traditional and non-traditional areas of the United States is causing a strain on public safety resources.
2. Responders feel that they have limited options on what to do with, or where to place, homeless persons.
3. Homeless encampments create hazardous conditions.
4. There is limited ability to catalogue, store, or dispose of the possessions of homeless persons.
5. Calls for service related to homeless persons are difficult to coordinate across agencies, making it difficult for responders to have awareness of past interactions or potential issues.
6. The large volume of calls for service related to the homeless means that responders are unavailable for response to other incidents.

**Rise in Homelessness Associated Capability Gaps:**
Volunteerism

Overview: Volunteers can offer much-needed support to emergency response operations by providing additional skills or resources that are in short supply or absent from public safety agencies. For example, amateur radio operators have a long history of supplementing communications when other systems fail. Likewise, medical volunteers provide substantial surge capacity during mass casualty events. There are two types of volunteers — those that are associated with existing groups or organizations (i.e., affiliated) and those that are not (i.e., unaffiliated).

Affiliated volunteers arrive using a planned structure and processes. They are usually vetted in advance and credentials/qualifications verified. These groups provide recognized skills and often require the least management. Many agencies routinely train and exercise with volunteer organizations and their personnel.

Self-dispatching public safety personnel are another form of affiliated volunteers. In many incidents, responders that are not on shift or are from neighboring jurisdictions arrive on scene to join in response operations. Generally, the larger the disaster, the more self-dispatching personnel arrive — and from a farther distance. This can lead to command-and-control challenges if these people (or units) do not coordinate with the incident command structure for accountability or tasking. In some instances, self-dispatching personnel can unknowingly obstruct ongoing operations or put themselves in danger, especially when they show up in civilian clothing and without proper PPE.

The first people on the scene of an incident are often not responders. They are the attendees, bystanders, patrons, etc. that are already at the incident when it occurs. Those that are not injured or do not evacuate often stay on scene to provide help. They can deliver cardiopulmonary resuscitation (CPR), administer initial first aid and medical treatment, help move others to safety, and provide critical situational awareness information to arriving responders. However, these people may balk at leaving the scene or hinder response operations. Reports of intoxicated bystanders providing first aid and people providing misinformation can impede the ability of responders to establish scene safety and mitigate threats. Further, these people can become additional casualties from ongoing or secondary threats.

Unaffiliated volunteers can provide considerable assistance, especially during disaster response. These individuals arrive on scene to offer support and can act as a force multiplier during some tasks. However, not all volunteers have the skills that they profess to have or are suitable to help and it is time-consuming for responders on scene to manage these potential resources. Past incidents have seen volunteers claim military and medical qualifications that were fabricated, for example. Some may attempt to coordinate with responders while others act at their own discretion. For some incidents, volunteers may become frustrated that they are not able to participate in the tasks that they want to support. Others have defied public safety direction and guidance to conduct the operations that they believe are necessary (e.g.,...
rescuing people trapped by flood waters). Volunteers that act on their own discretion can place more people in harm’s way or obstruct response operations. In addition, they may not arrive with sufficient supplies (e.g., food, water, shelter) and expect that to be provided for them. Participants reported that it would be helpful to coordinate all volunteers with emergency or disaster management organizations to reduce the burden of trying to verify, task and manage unaffiliated volunteers.

An emerging capability is the growth of virtual or online volunteers. Many people possess the technical skills that can support or enhance response operations. Volunteers in areas such as genealogy, data archiving and exchange, mapping and visualization, and language translation support incident operations. These people can provide skills on a volunteer basis that many public safety agencies are unable to afford.

Donations are an additional component of volunteerism. While many donations are helpful, the amount and kind of donations can encumber the response as well. Being able to receive, account for, store, and dispose of donations is difficult. Participants reported receiving many donations for COVID-19 response, but given the tempo of operations, many were misplaced or set aside for later management. One PR6 participant reported receiving items like wedding dresses from those donating to hurricane response efforts. In many cases, these donated items are passed from one disaster site to another. However, this can also lead to frustration by whomever donated the items that they are not being used as envisioned.

**Impact on Responder Environment:**

There are several ways in which volunteerism can impact the response environment.

1. Managing unaffiliated volunteers can require significant public safety resources.
2. Volunteers can interfere with response operations or exacerbate a situation if they are not familiar with established processes.
3. It may be difficult to effectively use volunteers because of the demands of tasking and management.
4. It is difficult to ascertain the credentials or qualifications of volunteers, especially those not affiliated with established voluntary organizations.
5. Volunteer groups may not listen to public safety direction (e.g., entering exclusion zones), creating more potential casualties or obstructing response operations.
6. Volunteers may not arrive with sufficient supplies, thereby placing a burden on the existing response infrastructure.
7. Donations management systems are insufficient to deal with the quantity and type of items contributed.
Volunteerism Associated Capability Gaps:

SA.8  SA.43  CIS.7  CCC.11  CCC.12  LRM.8  LRM.45
SA.45  LRM.46  LRM.47  LRM.48  LRM.49  LRM.50  LRM.51
LRM.52  LRM.53  CM.1  CM.2  OPS.9  OPS.23
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<th>NEAR</th>
<th>MID</th>
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**Overview:** This issue is focused on the use of social media as a communications tool. See the discussion of [social media as an investigative tool](#). Approximately 70 percent of Americans connect with each other via social media sites, many using these sites daily. These sites are increasingly being used as a source — in some cases the only source — for information. Figure 29 below shows the growth in social media over the past 15 years.

![Figure 29. Increases in social media usage over time. Graphic from Pew Research Center.](#)

While overall usage, and specific use of some sites, is higher among younger generations, 45 percent of Americans over 65 use these sites. There are also age disparities in the use of social media sites to access news and information. Of those who use social media sites, 53 percent use them **often** to get news; with a higher proportion by younger generations.

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159 Ibid.

In this way, the public has changed its expectations of how emergency response agencies will communicate. Most agencies maintain accounts on the primary social media sites, but their ability and willingness to provide information varies. There are three primary sites in which agencies maintain social media accounts (e.g., Twitter, Facebook, Instagram), but the number and type of commonly used sites continues to grow and adapt. It is important that public safety agencies provide information on the forums that are most in use. However, responders report that their agencies often struggle to keep up with one or two sites, much less to devise appropriate communications on new platforms. Figure 30 above illustrates the prevalence and use of specific social media sites over time.

Social media sites also provide a forum for the public to communicate with emergency response agencies. Critical situational awareness information can be provided from casualties and bystanders on the scene. However, the sheer amount of information being posted is hard to access, validate, and analyze for many agencies. Many agencies do not have staff or training to monitor these sites in real time.

Some people use social media sites to request help during an emergency, either in addition to or instead of traditional 9-1-1 calls. They are able to post their location, mark whether they are safe or need assistance, and/or post specific needs (e.g., food, water, rescue). Unfortunately, these requests are not often sent to public safety organizations but merely posted online with the hopes that the “right” person will see and respond.

**Impact on Responder Environment:**

There are a number of ways in which social media as a communications tool during an incident can impact the response environment.

1. There are citizen expectations that information and guidance will be provided via social media.
2. There is a reliance on information from social networks before, during and after an incident.
3. Misinformation can be spread via social media.
4. There are concerns about vigilantism from misinformation.
5. Responders feel that they are often unable to harness the value of information on social media sites during an emergency.

6. There is a changing prevalence of popular social media platforms.

7. There are cybersecurity concerns regarding some platforms.

Social Media (as a Communications Tool) Associated Capability Needs:
RELIANCE ON TECHNOLOGY

Overview: Technology has become an integral and indispensable part of our everyday lives. Unfortunately, the ubiquitous nature of technology has led to an overdependence on its presence. This reliance can lead to a loss of decision-making abilities and other critical and analytical skillsets. Over-reliance on technology can result in serious consequences.\(^\text{161,162}\)

Concerns about reliance on technology are related to the ability to convey information, whether via social media as described above or through text-based emergency alerts. According to a recent study, more than 86 percent of Americans get at least some news or information from digital devices.\(^\text{163}\) The problem is that these devices require power and network connectivity. During periods of sustained power outage, members of the public can lose access to the information that these devices provide when batteries and backup power sources fail. For the large portion of people that rely on digital devices for information – like navigation or emergency alerts – this loss could have significant impacts on their ability to make decisions and act in ways to protect themselves.

In addition to the public reliance on technology, many responders use technology on a daily basis (e.g., computer-aided dispatch, cardiac monitors). When these devices fail, responders can struggle with basic operations.

Another issue is that people have become dependent on these devices for basic functions. The loss of map reading skills, loss of knowledge of contact information, and inability to find information can be attributed to having this information constantly at one’s fingertips. Again, this can lead to issues during disaster response if someone has limited ability to follow evacuation orders, for example.

Finally, technology can malfunction or provide misleading information. This could lead a person to change course and turn a correct decision into an error. For example, if navigation information does not show where roads are closed or a bridge is out, large groups of people can be guided in the wrong direction. In 2018, the State of Hawaii accidentally issued a ballistic missile launch emergency alert that proved to be a mistake. For nearly 10 minutes, residents scrambled to take cover until a correction was issued. A second alert was not sent out to smartphones until nearly 40 minutes after the first alert.

Impact on Responder Environment:

There are a number of ways in which citizen reliance on technology can impact the response environment.

1. The public may not receive or properly be able to follow guidance during an emergency.
2. Members of the public may not be able to perform specific tasks (e.g., read a paper map) or know critical information (e.g., family phone numbers) in the absence of technological devices.
3. Technology devices are vulnerable to cyberattacks.

Reliance on Technology Associated Capability Needs:
REDUCED RESPECT FOR AUTHORITY

| NEAR | MID | LONG |

**Overview:** Participants in Project Responder 6 reported a notable decrease in respect for authoritative direction and/or guidance. While substantially directed at law enforcement personnel, fire service and EMS staff have also experienced hostility and disregard during routine activities. The section on Protests/Civil Unrest provides a description of violence and aggression towards responders; this discussion is focused on the impacts of a reduced willingness to listen to or comply with emergency response personnel. This discussion is primarily based on accounts from PR6 participants across disciplines and is included in this analysis because of the impacts on both daily operations and in emergency situations. There are as of yet no identified independent studies of this phenomenon or its effects. However, in both interviews and focus group meetings, participants stated that respect for authority has notably decreased.

Law enforcement officers have seen the brunt of the change in attitude. A survey from August 2020 found that confidence in police officers has dropped to a record low among Americans to only 48 percent of the population. This manifests itself in an increased willingness of the public to show disrespect or be critical during routine encounters. One outcome of the events of 2020 is the “Defund the Police” movement, which advocates for reallocating resources to non-law enforcement public safety services such as social work, mental health programs, etc. Several large cities, including Austin, Texas, New York, New York, Minneapolis, Minnesota, and Seattle, Washington have cut more than ten percent of their police department budgets.

There have also been threats and expressions of violence against responders. An NFPA assessment noted that responders are enduring historically high levels of violence during routine operations. The impacts of this are both physical and mental. In addition to bodily harm and subsequent unavailability while recovering, there are significant mental health ramifications. Multiple PR6 participants (across fire service, EMS, and law enforcement) reported that repeated verbal and physical abuse takes a toll. In addition to other manifestations (e.g., higher rates of substance abuse, relationship issues), responders are at an increased risk for depression and suicide. Studies have shown that law enforcement officers and firefighters are more likely to die by suicide than the public.

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Impact on Responder Environment:

There are a number of ways in which reduced respect for authority can impact the response environment.

1. People may be less likely to comply with responder direction or guidance during an emergency.
2. Fire service and EMS are now being issued ballistic protection in some agencies, adding additional weight to existing equipment load.
3. There is a mental impact when responders are consistently insulted and/or violently attacked.
4. Retention rates are falling across disciplines, complicating already problematic staffing levels.

Reduced Respect for Authority Associated Capability Needs:
VIGILANTISM

Overview: Vigilantism occurs when citizens take actions to enforce laws as they perceive them. An increase in vigilante events occurred throughout 2020 and early 2021. PR6 participants included this as a current and future issue because of the potential for serious injury that may occur in the community and to those responding to these incidents.

- In February 2020, two men in Glynn County, Georgia tried to execute a “citizen’s arrest” against Ahmaud Arbery based on claims that he had possibly stolen something from a house under construction. The men followed, shot, and killed Arbery during their encounter.
- In June 2020, a family from Spokane, Washington was detained in their camper bus by multiple carloads of people. The nearby residents followed the bus and prevented it from leaving a camping site because of concerns that the family were left-wing extremists.
- In January 2021, protesters at the U.S. Capitol Building tried to interrupt proceedings to count the electoral college votes from presidential election because of their perceptions about the legality of the Congressional activities. Large groups stormed the Capitol Building to attempt to overturn the election results. Five people died during or soon after because of the events of that day.

Vigilantism can occur at the individual, neighborhood, or group level. While there are a number of instances where an individual has taken law enforcement matters into their own hands, there have also been cases of a neighborhood taking action against a perceived wrong. Many of these incidents of vigilantism are related to the perception of disparity in the political system, or governmental over/under reach as perceived by the individual.

Recent efforts to equate vigilantism with patriotism have motivated individuals and groups (often armed) to enforce laws or protect property. Misinformation and inaccurate reporting have contributed to these actions, often leading groups to believe that impending violence was soon to occur.

Activities where members of the public try to enforce the law are often tense situations. Responders may encounter these activities in response to a routine call for service or during an incident or event. Law enforcement officers are often called by multiple parties and must try to figure out what has happened, halt illegal activities, and diffuse the situation. EMS personnel are called to provide medical support to those injured during these incidents. These responders can be significantly endangered during the incidents, as evidenced by the many Capitol Police officers attacked during the January 6, 2020 events, or the assaults committed during otherwise peaceful social change protests where officers were shot or directly assaulted. Conflicts with potential or in progress vigilantes is a serious concern for response personnel. Many of the people who profess to be protecting their rights or the community are
heavily armed. As such, they may pose a significant danger to the responders tasked with preventing the person or groups desired behavior.

This issue is also related to the notable growth of anti-government militia groups. Although many profess commitment to defending the Constitution of the United States, some are focused on disrupting government activities at the local or national level. This often puts group activities in confrontation with federal, state, and local public safety personnel. Many of these groups offer “perimeter security” or similar services during protests or potential confrontations.

**Impact on Responder Environment:**

There are a number of ways in which vigilantism can impact the response environment.

1. There is a potential for serious harm to citizens or to the public safety personnel that respond to these incidents.
2. Responders who interfere with or try to stop vigilante behavior can become targets of aggression.
3. The appearance of armed subjects can heighten tensions at protest events.
4. The appearance of armed subjects in a crowd can reduce overall resources when some staff are assigned to monitor the armed individual(s).
5. An increase in staffing for may be necessary for events where armed subjects are going to protest or counter protest, in order to maintain overall security or to keep the different groups apart to avoid direct conflict.
6. The development of standard operating procedures (SOPs) for acts of vigilantism – based on jurisdiction-specific laws — may be necessary.

**Vigilantism Associated Capability Needs:**

- SA.10
- CIS.8
- CIS.21
- CCC.4
- LRM.51
- LRM.52
- II.23
- OPS.5
- OPS.6
This section contains descriptions of 20 current and emerging technologies that may impact the response environment. Some, like robotics, are used on a daily basis by public safety agencies. However, the potential applications may expand in the coming years. Other technologies, like quantum computing, offer long-term potential. Every effort has been made to present an impartial discussion of the topic without adding subjective analysis or opinion.
Overview: 5G is the fifth generation of mobile network technology that serves as a follow on to the current 4G long-term evolution (LTE) mobile network. All four previous generations of mobile networks have used macro cell towers, hundreds of feet tall, that required vast power outlays to transmit data over long distances. 5G maximizes throughput by using a combination of frequencies from multiple bands. The network also uses smaller micro cells for new millimeter wave spectrum bands to create a blanket of ultrahigh-speed network coverage. The arrival of 5G provides significantly faster network speeds, up to 100x faster than its predecessors. That said, the speed of 5G will enable emergency responders to access and share critical information during emergencies and have better situational awareness. In addition, “the greater bandwidth provided by 5G can allow response organizations to run predictive analytics, artificial intelligence, and machine learning applications on-site while their emergency efforts are ongoing.” This new communications infrastructure can also further enhance network slicing so that public cellular usage does not overwhelm public safety communications. It also allows for ad-hoc networks to be set up on scene where commercial networks are weak. 5G will allow responders and the public to send and receive greater quantities of data much faster, significantly increasing response time and lives saved.

Impact on Responder Environment:

There are a number of ways in which 5G can impact the response environment.

1. Increased network speed and decreased latency will allow responders to receive and download data (e.g., voice, text, images, video) much more quickly.
2. The current high cost of deploying 5G nodes inhibits municipal adoption for public safety purposes.
3. 5G nodes have less range than 4G towers. The lack of fixed 5G nodes outside of urban areas hinders its utility outside in rural or remote locations.
4. 5G signals are currently less able to penetrate building materials or reach floors in tall buildings (unless nodes are attached within the building). This can prove especially problematic for responders in urban areas with high rise buildings or complexes.

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171 Ibid.
5. 5G networks can further enable other technologies such as artificial intelligence (AI), augmented reality, autonomous vehicles, Internet of Things (IoT), unmanned aircraft systems (UAS) and others.

6. 5G could enrich the data provided to emergency services through more high-definition video and imaging.

7. Currently, the permanent unique identifiers associated with mobile devices can be used to obtain information about the user (e.g., location). With 5G these identifiers are replaced with temporary ones that destruct after connection to a cell tower, thus making it more difficult to obtain information about mobile device users.

8. 5G complicates digital evidence gathering and surveillance. Currently, mobile devices transfer data through a single medium (e.g., Wi-Fi or cell tower). 5G allows devices to obtain partial data from a network tower and other data through alternative means such as Wi-Fi, satellite, etc.

9. Municipalities often approve the location and providers will choose to place equipment in the most profitable areas first. This can result in an inequitable distribution of 5G network technology across a jurisdiction.

10. Those jurisdictions that continue to rely on non-standalone 5G may experience network congestion because the system is dependent on saturated 4G service.

11. Some members of the public are afraid of 5G due to perceived health hazards. This fear has led communities to block the deployment of network equipment.

**5G Associated Capability Needs:**

SA.1  SA.2  CIS.11  CIS.12  CCC.1  CCC.6  RHS.6  LRM.7
SA.3  SA.5  CIS.14  CIS.15
SA.7  SA.8  CIS.20  CIS.21
SA.10  SA.12  CIS.25  CIS.27
SA.16  SA.17  CIS.29  CIS.30
SA.20  SA.30  CIS.32  CIS.33
SA.48  SA.49  CIS.36

RAP.10  II.25  II.31  OPS.29  OPS.33  OPS.58
Overview: Augmented reality (AR) is the “result of using technology to superimpose information — sounds, images and text — on the world we see.” In other words, AR overlays digital information on real-world elements to add to the reality of the environment we are already experiencing. AR platforms use devices such as heads-up displays, smartphones, tablets, smart lenses, and AR glasses.

The market for AR technology is anticipated to grow quickly, with estimates projected at over $18 billion in 2023. Common AR applications include medical training, retail, repair and maintenance, design and modeling, business logistics, tourism, classroom education, field service, and public safety. AR has also shown great promise in solving many of the challenges of emergency response, including disaster management. For example, AR can be used to manage a disaster rescue operation effectively and efficiently by addressing these risks and anticipating others.

AR differs from virtual reality (VR) in that VR platforms generate environments that users interact with and are totally immersed in. Users put on a head-mounted display or a VR headset that is commonly connected to a computer or console that enables the virtual experience. Mixed reality (MR) combines elements of both AR and VR, combining the real and virtual worlds. It allows real-world inputs to impact the virtual environment (e.g., the appearance or placement of real obstacles, hazards, persons).

Responders currently use AR in limited applications. Training tools, such as DHS S&T’s EDGE system, use AR to teach processes/procedures or allow responders to exercise operations for specific incidents. Similar training applications have been developed using VR, but these are currently limited to scenario or location. Augmentation of self-contained breathing apparatus (SCBA) facepieces is another current and emerging application for AR. Primarily limited to advanced models, current technology allows firefighters to access thermal image overlays and additional sensor readings. However, it is envisioned that this technology might provide responders — whether wearing a heads-up display, glasses, or other gear — with significantly more data to enhance situational awareness.

176 Ibid.
**Table 3. Augmented, Virtual, and Mixed Reality**

<table>
<thead>
<tr>
<th>Augmented Reality</th>
<th>Virtual Reality</th>
<th>Mixed Reality</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Superimposes digital elements onto live view of surroundings</td>
<td>▪ User is immersed in entirely virtual world</td>
<td>▪ Combines elements of augmented and virtual reality</td>
</tr>
<tr>
<td>▪ User is able to distinguish between virtual and real worlds</td>
<td>▪ Hard for user to differentiate between virtual and real worlds</td>
<td>▪ Users interact with virtual objects that are placed in real world</td>
</tr>
<tr>
<td>▪ Integrates with heads-up displays, smart phones, tablets, glasses</td>
<td>▪ Integrated into head-mounted display or headset</td>
<td>▪ Utilizes headset with holographic elements</td>
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</tbody>
</table>

**Impact on Responder Environment:**

There are a number of ways in which augmented/virtual/mixed reality can impact the response environment.

1. AR can provide more in-depth navigation and situational awareness.
2. AR can enable hands-free operations.
3. AR may assist with monitoring of patient vital signs and call data.
4. AR can assist responders with seeing through walls during attack or hostage situations.
5. VR can assist with the recreation of a crime or disaster scene for investigative or trial purposes.
6. The technology has the potential to reduce friendly fire incidents by integration of Identification Friend or Foe (IFF) capability.
7. AR can enable training for high risk, low frequency situations without real-life consequences.
8. The technology has the potential to allow bad actors to learn emergency response processes, building layouts, etc.
9. AR presents some physical safety concerns such as the slowing of response times, misjudging the speed of oncoming cars, underestimating reaction time, and unintentionally ignoring hazards.
10. The technology can aid with capturing and storing biometric, behavior, and movement data.
11. AR/VR devices are susceptible to hacking or compromise. This could be problematic if responders are using AR as part of navigation or operations.

12. The technology has the potential to foster extremist views or terrorist actions by allowing for the creation of virtual training camps, connecting planners with potential operatives.\(^\text{178}\)

13. Current AR training systems have limited ability to incorporate props or real equipment (e.g., weapons, hoses). Although systems are in development to add these components, current platforms have limited capability to replicate and integrate hand-held or body-worn tools and technology.

**AR/VR Associated Capability Needs:**

Overview: Artificial Intelligence (AI) is a branch of computer science that focuses on building smart machines capable of performing tasks that typically require human intelligence. It is used for solving very specific problems, resulting in systems that are able to complete tasks more quickly and efficiently than humans. These systems rely on significant amounts of training data that are applied to solve problems. A lack of training data within agencies may present a barrier to the adoption of AI in some responder applications. Figure 31 below illustrates the components of artificial intelligence.\(^\text{179}\)

Recently, researchers have found that AI can also be used to predict and monitor for numerous types of natural disasters (e.g., earthquakes, floods, volcanic eruptions, hurricanes). This is largely due to the availability of good quality data sets, advanced mapping and modeling and predictive analytics software. For example, AI can use seismic data collected by researchers to analyze the magnitude and patterns of earthquakes. Researchers can collect this type of data using technologies like sensors, unmanned vehicles and aerial robotics which can be employed to continuously monitor an area (e.g., a drone with thermal imaging camera can monitor wildfires) and provide disaster assessments.

In 2017, nearly 335 natural disasters affected over 95.6 million people, and resulted in 9,697 deaths, costing approximately $335 billion.\(^\text{180}\) The ability to predict these disasters earlier and more accurately would allow responder and government agencies to better prepare and prioritize response efforts as well as make data-driven decisions well ahead of an event. For instance, during the 2019 California wildfires, an AI solution analyzed satellite imagery to determine the location of the fires within minutes. Ultimately, the ability to use AI to more

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rapidly and accurately predict and monitor natural disasters could save numerous lives (including responders) and significantly reduce damage to critical infrastructure and personal property.\footnote{Ibid.}

There are numerous other potential AI applications beyond disaster monitoring. The potential to enhance search and rescue operations, identify changing fire characteristics, or support decision-making through data or course-of-action analysis are among multiple projects being explored by DHS S&T and the federal community. Other systems currently available or in development provide hazard scores based on the potential for weather conditions, provide navigation using real-time data, monitor social media feeds, and translate speech-to-text for 9-1-1 and dispatch traffic, among many others.

A key issue at this point is the lack of public safety data sets. Due in part to the fragmented nature of emergency response agencies in the United States, there are a limited number of data collections that are available for training AI systems. Those data sets currently in use may cause AI systems to provide data or analysis that is erroneous, leading responders to make incorrect assumptions and actions. For example, several cities have stopped using or refuse to use systems used for predictive policing (i.e., using data and algorithms to forecast future criminal behavior) because of concerns that the underlying data is biased because of the components of the data set. Further, some of these programs use techniques or analysis methods that are not equally as appropriate for different types of crimes or incidents.\footnote{Perry, W. et al, Predictive Policing: The Role of Crime Forecasting in Law Enforcement Operation Operations, The Rand Corporation, 2013; p. 44.}

\textbf{Impact on Responder Environment:}

There are several ways in which artificial intelligence can impact the response environment.

1. The technology could be used for predicting and monitoring natural disasters, including predicting the location of earthquakes and aftershocks, floods, volcanic eruptions, and the path and intensity of hurricanes.\footnote{“How AI Can and Will Predict Disasters,” Forbes, March 15, 2019. \url{https://www.forbes.com/sites/cognitiveworld/2019/03/15/how-ai-can-and-will-predict-disasters/?sh=415320b95be2}}
2. AI could be useful in reducing time needed to assess damage.
3. The technology could be used to guide search and rescue efforts.
4. AI has the potential to be useful in identifying anomalies in images and video as well as behavior before attacks.
5. The technology has been employed to interpret social media feeds to find mentions of threats, persons or groups in need of assistance, and to identify spread of misinformation.
6. AI could be used to prompt command and on-scene staff with cues and guidance as to what decisions to make or actions to take during an incident.
7. The technology could be employed to perform dangerous tasks with a high degree of accuracy.

8. AI systems are susceptible to hacking. The introduction of purposefully false data into a system could have disastrous consequences.

9. AI systems are susceptible to bias based on the data sets used for training. Incomplete or non-representative data sets can cause the AI system to provide inaccurate results.

10. Lack of common terminology across data sets could cause problems in training AI systems.

**AI Associated Capability Needs:**
DATA ANALYTICS

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**Overview:** Data analytics is the science of analyzing raw data to draw conclusions and reveal trends, associations, and patterns that would otherwise be lost in a large amount of information. It involves “applying an algorithmic or mechanical process to derive insights” through data to look for meaningful correlations.\(^\text{184}\) Qualitative and quantitative approaches are used for deriving valuable insights from structured data.

Big data refers to the large volume of data — both structured and unstructured — that is difficult to process using traditional methods due to its size or complexity.\(^\text{185}\) Currently in the United States, 2.5 quintillion bytes of data are created each day.\(^\text{186}\) Big data is relevant to numerous industries and has several applications in the emergency response realm, one of which is using past information to provide better responses in the future. This is formally called predictive analytics and is designed to make predictions about future outcomes.\(^\text{187}\) In addition to predictive analytics, there are three other data analytics categories as described in Figure 33 below.

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Each type of analytics offers emergency responders the ability to transform existing, unstructured data into actionable information. Descriptive and diagnostic analysis, for example, are used in the development of after-action reports that explain what happened during an incident and why the outcomes occurred as they did. Some after-action reports use prescriptive analysis to suggest how operations or activities may be done better in the future. However, these reports highlight the limitations of current capability for data analysis.

The goal is to use data to help responders understand what has happened and determine how to act in the future. In order to do this, responders first need access to appropriate and comprehensive data. There is currently a lack of comprehensive public safety data sets within jurisdictions, much less those that draw from across the nation. In addition, participants stated that there is limited consensus on priorities for data analysis or even understanding of the outputs that could be of value. Finally, there are limited capabilities to visualize or clearly illustrate the outputs of data analysis.

While much of this capability exists throughout private industry, the fragmented nature of jurisdictions and response agencies makes it extremely difficult to collect the large data sets necessary for comprehensive analysis and to feed other technologies such as artificial intelligence or augmented/virtual reality.

The predictive analytics market is projected to reach approximately $10.95 billion by 2022 and is supported by a wide range of organizations.¹⁸⁸

**Impact on Responder Environment:**

There are a number of ways in which data analytics can impact the response environment.

1. A longitudinal analysis of incidents and operations (by jurisdiction, region or national) could provide significant insight into smart practices for future response.

2. Advancements in data analytics are enhancing the ability of response agencies to harness data from social media feeds, although limited skills or training by staff currently hinder the ability to access or use this information.

3. Predictive analytics has been used by law enforcement to predict criminal activity, however issues with the data sets have caused many agencies or jurisdictions to abandon these systems. Further, many communities are resistant to law enforcement activities that are driven by technology or access to public data. For example, law enforcement is no longer able to access multiple genealogy databases because of privacy concerns.

4. The potential topics for data analysis in the public safety realm are limitless. Examples of potential outputs include the ability to estimate fire risk for various locales, predict the path of wildfires, assess patient outcomes, optimally design stations or apparatus, and improve response times.

¹⁸⁸ ibid.
5. Open Data Initiatives across many communities are fueling the collection of public and private data sets.
6. The visualization of analytical outputs on dashboards or jurisdiction/incident-specific maps may significantly enhance responder situational awareness. Figure 34 illustrates such a dashboard from early in the pandemic.\textsuperscript{189}

![Figure 34. COVID-19 dashboard from the Johns Hopkins Coronavirus Research Center](https://coronavirus.jhu.edu/map.html)

7. Responders already face data overload. Although the purpose of analysis is to develop actionable information, without assessment of proper methods for distribution or visualization, additional information will not be beneficial.
8. Many response agencies do not have sufficient staff to be able to collect or analyze internal data.
9. Many agencies do not have sufficient storage capacity for the data that they do have, much less the outputs of analytical processes.
10. Public safety data sets may be vulnerable to hacking and data theft. The introduction of false data could produce dangerous outcomes.
11. It is possible to manipulate data to show incomplete or misleading results. Attention to algorithms and analytical methods is critical to ensuring the accuracy and validity of outputs.
12. Data analytics is hindered by a lack of common terminology (type and kind, key performance indicators) and interoperability between systems.

\textsuperscript{189} COVID-19 Dashboard by the Center for Systems Science and Engineering at Johns Hopkins University.
https://coronavirus.jhu.edu/map.html
## Data Analytics Associated Capability Needs:

<table>
<thead>
<tr>
<th>SA.1</th>
<th>SA.2</th>
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<th>CCC.1</th>
<th>RHS.2</th>
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<th>RAP.3</th>
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<td></td>
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<td>II.38</td>
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</tbody>
</table>
Overview: Blockchain can be described as a “shared, distributed ledger of transactions (or records) to which all relevant parties have instant access”. Blockchain works by maintaining blocks (ordered records) that have a timestamp and a link to the previous block. Users are only able to edit the parts of the blockchain that they “own” by possessing the private keys necessary to write to the file. The data in a blockchain ledger is stored in a distributed network of nodes, making it resistant to compromise by hacker or by technical failure. Figure 35 below illustrates how blockchain works:

Potential applications for blockchain in public safety currently focus on disaster response, the Healthcare and Public Health Sector, and the Food and Agricultural Sector. This technology could be particularly helpful to responders during disaster relief and recovery efforts.

A 2019 assessment by the Defense Logistics Agency (DLA), Troop Support highlights the potential for blockchain in humanitarian assistance and disaster relief. Using their experiences responding to Hurricane Maria in 2018, the DLA report identifies specific friction points in the process, from disaster declaration through delivery of resources, that may be improved by the application of blockchain. Examples and blockchain potential solutions include:

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194 Ibid., p. 17
### Table 4. Blockchain potential for disaster relief per DLA assessment

<table>
<thead>
<tr>
<th>ISSUES</th>
<th>BLOCKCHAIN POTENTIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantities, delivery requirement dates, shipping dates, modes of</td>
<td>Smart contracts enable efficient, verifiable exchange of information</td>
</tr>
<tr>
<td>transportation, and requested materials fluctuate during crisis</td>
<td></td>
</tr>
<tr>
<td>response</td>
<td></td>
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<tr>
<td>Multiple suppliers, modes of</td>
<td>Enable data analytics to evaluate alternative transportation solutions in real time;</td>
</tr>
<tr>
<td>transportation, constantly changing storage and climate conditions</td>
<td>considers multiple sources of input simultaneously including international support</td>
</tr>
<tr>
<td>contribute to chaos of determining optimal solutions</td>
<td></td>
</tr>
<tr>
<td>Multiple organizations resulted in a lack of visibility for contractual</td>
<td>Provide real time, agile response to changing conditions</td>
</tr>
<tr>
<td>requirements, e.g., delivery point, quantity, date of shipment and</td>
<td></td>
</tr>
<tr>
<td>expected arrival dates</td>
<td></td>
</tr>
<tr>
<td>Depleted inventory stores from earlier disasters resulted in lower</td>
<td>Allow immediate visibility of needs as storms are forming, allowing proactive action</td>
</tr>
<tr>
<td>than usual surge item availability</td>
<td>ahead of impact</td>
</tr>
</tbody>
</table>

In the **Healthcare and Public Health Sector**, blockchain can be used to store patient records and prescription data. This has implications for EMS access to patient history in the field when knowledge of medical history and potential drug interactions can improve patient treatment. In the **Food and Agricultural Sector**, blockchain would be able to track the origins of products containing food-borne illness at first detection, instead of the days or weeks that it currently takes. It is this delay that causes people to become ill as it takes too long to remove contaminated items from the supply chain.

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Impact on Responder Environment:

There are a number of ways in which blockchain can impact the response environment.

1. Blockchain can allow response agencies to maintain a common, integrated record of resources available for incident response.
2. Blockchain can allow agencies to track the status of resource requests in real time.
3. Blockchain can allow those impacted by natural disasters and other incidents to more quickly receive financial assistance, reducing the burden on communities for housing and support.
4. If used to store patient records, blockchain will allow EMS personnel to perform more accurate triage of the medical emergency and improve patient safety.
5. Blockchain could decrease the number of people impacted by food-borne illness by allowing officials to immediately identify the source of the contamination and notify stores to remove those items from the shelves.

Blockchain Associated Capability Needs:
QUANTUM COMPUTING

Overview: Quantum computing is based on quantum theory, a branch of physics that studies atomic and subatomic computers. A quantum computer is any device for computation that directly uses quantum mechanical phenomena to perform operations on data. Quantum computers use qubits (quantum bits), which are typically subatomic particles such as electrons or photons, instead of the information stored as bits that today’s computers use. Qubits have quantum properties that mean a connected group of them can provide significantly more processing power than the same number of binary bits. Quantum computers have the potential to calculate many problems in a fraction of a second.

Increased processing power makes quantum computers capable of solving complex tasks and searching through unsorted data for applicable pieces of information or patterns. Researchers believe that quantum computers will be able to enhance weather and geologic forecasting and continually assess the health of power grids and other utility systems.

Quantum computing has long-term potential for public safety. Based upon current costs, a useful universal quantum computer costs around $10 billion today.

Impact on Responder Environment:

There are a few ways in which quantum computing can impact the response environment.

1. These computing platforms would enable use of technologies such as AI, IoT, big data analytics, and machine learning.
2. Quantum computers are forecasted to be able to break current encryption algorithms by 2023.
3. These computers would assist with ensuring data and communications safety by helping to build stronger encryption algorithms. This encryption would allow for access to patient data when someone calls 9-1-1 while maintaining Health Insurance Portability and Accountability Act (HIPAA) laws compliance.

---

Quantum Computing Associated Capability Needs:
NANOPARTICLES

Overview: A nanoparticle is a microscopic particle with at least one dimension of less than 100 nanometers (nm). For reference, the thickness of a piece of paper is 100,000 nm.\textsuperscript{201} Using nanotechnology, materials can be made stronger, lighter, more durable, more reactive, better electrical conductors, etc.\textsuperscript{202} Nanoparticles have a very large surface area to volume ratio, enabling them to possess unexpected optical, physical, and chemical properties.\textsuperscript{203}

Nanomaterials can be developed to perform very specific roles and the potential is nearly limitless. Nanoparticles have a wide range of public safety applications in information technology, medicine, transportation, energy, food safety, environmental science, etc.\textsuperscript{204} For example, carbon nanotubes are being developed that can detect disease-causing bacteria — a process that currently takes hours to weeks.\textsuperscript{205} These materials have the potential to significantly increase responder and public safety.

Impact on Responder Environment:

There are a number of ways in which nanoparticles can impact the response environment.

1. Nanoparticles can increase responder safety through vaccine or medicine delivery. Lipid nanoparticles are components of both the Pfizer/BioNTech and Moderna mRNA COVID-19 vaccines that protect and help transport the messenger ribonucleic acid (mRNA).\textsuperscript{206} Figure 36 above illustrates how mRNA can be organized inside the nanoparticle.

2. Nanoparticles may allow for the rapid detection of chemical, biological, radiological, nuclear, and explosive (CBRNE) and incendiary agents and threats.

\textsuperscript{201} “What are Nanoparticles? Definition, Size, Use and Properties,” TWI. \url{https://www.twi-global.com/technical-knowledge/faqs/what-are-nanoparticles}

\textsuperscript{202} “Benefits and Applications.” \textit{National Nanotechnology Initiative}, \url{www.nano.gov/you/nanotechnology-benefits}.

\textsuperscript{203} “Nanoparticle.” \textit{ScienceDaily}, ScienceDaily, \url{www.sciencedaily.com/terms/nanoparticle.htm}.


\textsuperscript{206} “Understanding the nanotechnology in COVID-19 vaccines,” American Chemical Society. \url{https://www.cas.org/resource/blog/understanding-nanotechnology-covid-19-vaccines}
3. The use of nanoparticles in PPE (e.g., SCBA cylinders) may reduce the weight burden on responders.
4. The use of nanoparticles in responder garments can improve protection from thermal energy.
5. Nanoparticles may replace current ceramic material in body armor, decreasing weight, increasing flexibility, and improving ballistic protection.
6. The integration of nanoparticles into building materials or vehicle components can increase fire resistance.
7. Fire suppression systems may use chemical mixtures broken down to nanoparticle size to better extinguish fires.\(^{207}\)
8. Nanoparticles can be injected into responder garments to produce a better form of camouflage.\(^{208}\)
9. Nanoparticles can produce self-cleaning surfaces, allowing for easier decontamination of public safety equipment and tools.\(^{209}\)
10. The solar absorption rate of nanoparticles is much higher than traditional materials. This has implications for the capture and storage of solar energy for responder applications.\(^{210}\)
11. The detection of nanoparticles at crime or incident scenes could provide additional evidence for identification of cause or attribution.\(^{211}\)

Nanoparticles Associated Capability Needs:


\(^{208}\) “What are Nanoparticles? Definition, Size, Use and Properties,” TWI. [https://www.twi-global.com/technical-knowledge/faqs/what-are-nanoparticles](https://www.twi-global.com/technical-knowledge/faqs/what-are-nanoparticles)

\(^{209}\) Ibid

\(^{210}\) Ibid

Overview: Robotics includes the development of programmable machines, called robots, that carry out human actions. Robotics has relevance in nearly every industry, from manufacturing to surgery. The most commonly known uses of robots in public safety are those used for explosive ordnance (i.e., bomb) disruption and disposal. In these instances, machines are sent in to conduct missions that are extremely dangerous for emergency responders. As the technology advances, these systems are able to expand their mission potential. Innovative robots are able to fly, crawl, walk, and traverse difficult or hazardous terrain. Robots as small as insects or larger than humans can be used to obtain situational awareness, act as communications relays, or transport equipment and supplies to support response operations.

Advances in robotics will continue to improve the safety of emergency responders. Firefighting robots, for example, are able to transport and deploy hoses into structures that are too dangerous for responders to enter. So-called robot paramedics are able to carry out chest compressions on cardiac victims, and in early 2021, New York City tested a four-legged robot to enhance situational awareness. However, the City ended the test early due to public concerns and cost.

When incorporated with AI into the overall design, the combination gives the machine an increased level of autonomy allowing it to analyze and evaluate the best action to take next given the data provided from the outside world (e.g., IoT sensors) without human intervention.

The market for robotics is expected to increase to $189.36 billion by 2027, growing at a Compound Annual Growth Rate (CAGR) of 13.5 percent from 2020 to 2027.212

Impact on Responder Environment:

There are a number of ways in which robotics can impact the response environment.

1. Robots are able to enter places currently hazardous or unreachable by humans. In a rubble pile, for example, small robots are able to traverse debris to search for signs of life.

2. In hazardous conditions (e.g., viral pandemics), robots may be able to monitor or transport patients to healthcare facilities.

3. Small robots may be able to infiltrate barricaded areas to provide situational awareness and hazard sensing.

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Robotics Associated Capability Needs:

SA.2  SA.3
SA.7  SA.11
SA.13  SA.15
SA.33  SA.38
SA.42  SA.44

CM.1  CM.2
CM.16  CM.22

LRM.14  LRM.15
OPS.5  OPS.6
OPS.22  OPS.34
OPS.38  OPS.39
OPS.40
Overview: According to the National Institute of Justice (NIJ), digital evidence is information stored or transmitted in binary form that may be relied on in court. Digital evidence may be found on a computer hard drive or a mobile phone and smart home devices like Amazon Alexa, among others. It can be used to help solve electronic crimes (e-crime), such as credit card fraud, but also for other types of crime. For instance, a person of interest’s e-mail or mobile phone files could contain critical information regarding their intent, alibi, and relationships that could be used as evidence. Digital forensics is the analysis of electronic data, with the aim of preserving evidence. In order for digital evidence to be accepted into a court of law, it must be investigated within specific requirements. The steps of digital forensics include:

![Figure 36. Steps of digital forensics](image)

In the past two decades, there have been shifts in the information technology landscape which have made the collection and analysis of digital evidence an increasingly important tool for solving crimes and preparing court cases. A study by University of California at Berkeley scientists determined that 93 percent of all information never leaves the digital domain; thus, highlighting the importance of digital investigations. Digital forensics is critical for the investigation of cybercrime, child pornography, human trafficking, and other activities planned or conducted over the internet.

The market for digital forensics is expected to increase to $9.68 billion by 2022, growing at a CAGR of 15.9 percent. Law enforcement agencies are now incorporating the collection and analysis and collecting of digital evidence as a way to fight crime.

Impacts on Responder Environment:
There are a number of ways in which digital forensics can impact the response environment.

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217 Ibid.
1. Analysis of data and metadata from digital files can provide responders with the evidence needed to prosecute persons that use phones, computers, tablets, or other electronic devices to commit crimes.

2. Digital forensics allows for the analysis of audio, image, and video files to ascertain validity and identity (when integrated with biometric data sets).

3. Analysis of digital data allows investigators to find the origin of cyberattacks.

4. Responders report that there is a shortage of people trained in digital forensics. Private companies exist that are able to provide this service, but the sensitive nature of some investigations (e.g., child pornography) prohibits their involvement.

**Digital Forensics Associated Capability Needs:**
INTERNET-OF-THINGS

Overview: The Internet-of-Things (IoT) is essentially a massive network of devices that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices over the internet. Each IoT device has its own Internet Protocol (IP) address. These devices collect data and transmit it to a receiving station, which can then process the data. IoT devices are used extensively by the public, from smart home appliances to automated vehicle maintenance notifications.

Another application is as a component of smart cities, which use IoT devices such as connected sensors, lights, and meters to collect and analyze data. They also use advanced mapping and modeling which can help simulate and predict events before they happen. Smart technology within cities can be valuable in emergency preparedness and improving environmental awareness, infrastructure management and maintenance, security, reduction in the use of energy, improved communication capabilities and traffic flow, and congestion prevention. City planners and response agencies are able to use the information derived from this data to make decisions and allocate resources to respond to real-time conditions. Smart city initiatives are expanding across the United States, many focusing on intelligent traffic management, analysis of utility and water usage, provision of Wi-Fi to the public, and intelligent lighting.

The number of IoT devices in 2021 is estimated to reach 46 billion and is expected to jump to 125 billion in 2030. However, IoT devices face security challenges such as being a target for hackers and cyber criminals.

Impact on Responder Environment:

There are a number of ways in which Internet-of-Things (IoT) can impact the response environment.

1. The technology enables responders to efficiently and accurately track the environment and critical infrastructure.
2. IoT devices could enhance public early warning systems, allowing earlier notification of potential hazards (e.g., water inundation levels).

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3. Smart sensors deployed in homes could automatically contact emergency services if hazards are identified (e.g., smoke, carbon dioxide). This same technology can be used to identify natural hazards (e.g., the ignition of wildfires) or alert to conditions that may cause disasters (e.g., soil moisture content, infrastructure stability).

4. Smart medical devices could alert to potential health problems that require immediate attention. These devices could continue to provide real-time data to on-scene response personnel.

5. Equipment embedded with IoT sensors could provide alerts to needed maintenance, expiration dates, etc.

6. Wearables and/or smart textiles can provide vital sign data, allowing command or medical personnel to monitor the health status of on-scene responders.

7. A potential drawback is that the increased amount of data derived from IoT sensors may overwhelm or distract responders from their critical activities.

**IoT Associated Capability Needs:**

SA.2  SA.3  CIS.20  CCC.1  RHS.6  RHS.24  LRM.5  LRM.12  LRM.13  LRM.18
SA.4  SA.5  SA.7  SA.8  SA.11  SA.12  SA.13  SA.16  SA.17  SA.18  SA.34  SA.39  SA.48  SA.49
CM.2  CM.22  RAP.3  RAP.6  II.15  II.25  II.31  II.32  OPS.29  OPS.37  OPS.38  OPS.50  OPS.61
SMART TEXTILES

<table>
<thead>
<tr>
<th>NEAR</th>
<th>MID</th>
<th>LONG</th>
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**Overview:** Smart textiles have the ability to sense, react, and adapt to external conditions or stimuli. For the purposes of this report, responder garments are discussed in this section, while accessories (e.g., watches, glasses) are discussed in the Wearables section. A distinguishing quality is that smart textiles are “soft” materials with flexibility and drapability. There are multiple types of smart textiles that have application for emergency responders:

<table>
<thead>
<tr>
<th>TEXTILE</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td><strong>Electronic textiles:</strong></td>
<td>Includes electronic components or conductive fibers woven together with fabric that result in functions capable of sensing, heating, lighting, or transmitting data.</td>
</tr>
<tr>
<td>▪ Conductive yarns/inks</td>
<td></td>
</tr>
<tr>
<td>▪ Optical fiber yarns</td>
<td></td>
</tr>
<tr>
<td>▪ Electroluminescent yarns/inks</td>
<td></td>
</tr>
<tr>
<td>▪ Embedded LEDs</td>
<td></td>
</tr>
<tr>
<td>▪ Energy storage textiles</td>
<td></td>
</tr>
<tr>
<td><strong>Shape Memory fibers/yarns/textiles</strong></td>
<td>Remember and recover shape after exposure to chemicals, temperature, etc.</td>
</tr>
<tr>
<td><strong>Biotextiles</strong></td>
<td>Sustainable materials grown from live microorganisms (e.g., bacteria, algae). Material attributes can be programmed into the DNA of the microorganism.</td>
</tr>
<tr>
<td><strong>Cosmeto-Textiles</strong></td>
<td>Use microencapsulation to release products over time</td>
</tr>
<tr>
<td><strong>High Performance Textiles</strong></td>
<td>Designed to resist abrasion, chemicals, heat, cutting, and other damage</td>
</tr>
<tr>
<td><strong>Photoluminescent/Thermochromic yarns/inks</strong></td>
<td>Allows fabric to glow in the dark, emit light, or change color</td>
</tr>
</tbody>
</table>

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225 “What Are Biofabrics and How Sustainable Are They?,” Common Objective. [https://www.commonobjective.co/article/what-are-biofabrics-and-how-sustainable-are-they](https://www.commonobjective.co/article/what-are-biofabrics-and-how-sustainable-are-they)
Impact on Responder Environment:

There are a number of ways in which smart textiles can impact the response environment.

1. Smart textiles could be useful in measuring responder physiological data and health status.
2. Smart textiles could be used to increase visibility in dark conditions (e.g., confined spaces, traffic duties).
3. Smart textiles may be used to create a one-size-fits-all garment that conforms to the measurements of the wearer.
4. The ability to maintain a stable body temperature and moisture levels can be enabled by smart textiles.
5. These textiles may be able to capture and harness energy from human movement, potentially powering the equipment carried by responders.
6. Responder garments could be designed to sense and alert to certain conditions (e.g., chemical exposure, external temperature).
7. Responder garments could be integrated with communications components or other sensor systems.
8. Smart textiles are able to resist contamination, increasing the lifespan of garments.
9. Protective equipment (e.g., tourniquets) can be integrated into responder garments, improving responder safety in case of emergency.
10. Smart textiles used for public safety purposes may not succeed if they cannot be laundered in home or in station.

Smart Textiles Associated Capability Needs:
## BIOMETRICS & DNA

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<tr>
<th>NEAR</th>
<th>MID</th>
<th>LONG</th>
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**Overview:** Biometrics are the measurement and analysis of unique physical or behavioral characteristics, especially as a means of identifying personal identity. Fingerprint mapping, facial recognition and retina scans are the most prominent forms of biometric technology. Behavioral biometrics include typing patterns, physical movements, navigation patterns, technology engagement patterns, and reading speed. Biometric authentication relies on a scanner to capture data, the ability to process the data into a distinct format, comparison of the data against an existing data set, and adjudication of identity. Advances in biometrics will allow for the identification of individuals that are purposely trying to disguise or camouflage biometric markers. Researchers are also working on recognition of blood vessel patterns as an additional marker.

Commonly in use to access consumer electronics and restricted areas, biometric authentication is also used by airlines to speed up the boarding process. The Transportation Security Administration (TSA) and U.S. Customs and Border Protection have also been experimenting with the technology to strengthen the airport screening process. Portable fingerprint scanners have been available to law enforcement for several years. Concerns about contamination associated with the COVID-19 pandemic spurred other organizations such as sports franchises to test the utility of biometrics for touchless admission systems.

Deoxyribonucleic acid (DNA) is the genetic material in humans and most living organisms. Because every person has a unique DNA profile, it is useful for identifying people involved in a crime. Common sources of DNA include blood, semen, saliva, urine, feces, hair, teeth, bone, tissue and cells. There are multiple public ancestry databases that can identify those who share one percent of DNA and are five or more generations removed. Investigators are able to access distant and near relatives of suspects using these databases. However, the use of these databases is limited to the investigation of criminal cases and identification of remains. Use of this technology has led to arrests in at least 66 cold cases and 300 active cases (including 14 serial killers and rapists) around the United States. However, these searches raise privacy concerns. Therefore, these ancestry sites must inform users that law enforcement agencies may search data. This notification of opt-in policies has resulted in a reduction of 90% of the number of profiles that agencies can now search.

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228 Ibid.

Impact on Responder Environment:

There are a number of ways in which biometrics and DNA can impact the response environment.

1. This technology has the potential to provide in-field and immediate identification of patients, especially for those that are unconscious or unresponsive.
2. Advances in biometric technology will allow responders to more rapidly identify subjects on scene.
3. Analysis of biometric data sets can allow rapid identification of remains.
4. Current wait times for DNA analysis can significantly hinder investigations and prosecution of perpetrators.
5. The integration of some biometric data sets into public safety operations have raised privacy concerns if being used for surveillance.
6. The growth of at-home DNA kits may allow law enforcement to identify persons under investigation by using familial markers.

Biometrics & DNA Associated Capability Gaps:
Overview: The focus of this section is not on renewable energy sources (e.g., wind turbines, solar energy), but on the availability of portable power sources for responders on an incident scene. Response operations consume a significant amount of power. Many tools and pieces of equipment are reliant on single-use or rechargeable batteries. Often these batteries are proprietary in shape or chemical composition to fit specific items, further complicating logistical issues when different agencies come together during mutual aid operations.

A battery is composed of a positive electron (anode), a negative electron (cathode), a separator, and an electrolyte in each cell. It converts chemical energy to electrical energy by allowing the flow of electrons through the electrolyte. Technology advances for existing batteries (e.g., lithium-ion) adapt the chemical compositions in the liquid electrolyte to increase energy density. Advances such as the use of carbon nanotubes direct the flow of electrons. The increased efficiency can significantly improve power density, allowing for decreased battery size and time required for charging. Other advancements are occurring in wireless battery charging (allowing users to replenish the power to their devices just by being in proximity to a charger) and the potential to replace heavy metals in battery construction.

Solid-state batteries replace the liquid electrolyte with a solid material that still allows the electrons to move. Solid-state batteries are currently used in electric vehicles, laptop computers, medical devices, etc. However, they are not currently used in public safety tools or equipment. Solid-state batteries are lighter, more stable (i.e., safe) and can have greater energy capacity at the same or smaller sizes. Currently these batteries have a higher cost than other advanced batteries.

Solar kits capture the energy from the sun, which is transformed into electrical charges. The size of solar kits is decreasing, allowing for portable units that can be transported as needed. These kits are commercially available and used in recreational vehicles and for other outdoor activities. Photovoltaic solar textiles have emerged as a potential application for incorporation into next generation wearables. These novel solar textiles could be used for wearable self-powered portable electronics.\(^\text{230}\)

Kinetic technology harvests energy from movement. Multiple systems are in development for warfighters (and potentially responders) that use wearable devices to capture and transform energy.

Impact on Responder Environment:

There are a number of ways in which power advancements can impact the response environment.

1. Next generation power sources, especially capture of kinetic energy, could reduce the weight burden on emergency responders.

2. Next generation power sources could reduce logistical challenges for responders, potentially reducing the need to frequently charge or replace batteries.

3. Some battery types are not allowed on commercial aircraft, complicating mutual aid support.

4. It is not possible to “de-energize” solar panels during fire suppression activities (e.g., vertical ventilation, size-up) or when roof access is needed.

5. Energy storage facilities produce novel hazards for responders including HAZMAT issues, thermal runaway concerns, battery explosion and re-ignition, and off gassing.

6. When electric vehicles are involved in traffic accidents, new threats are posed to responders, including lack of knowledge in how to isolate power, particularly in order to immobilize the vehicle, locating the battery, difficulty in extinguishing battery fires, and risk of reignition.

**Power Advancements Associated Capability Needs:**

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MALICIOUS MISINFORMATION

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**Overview:** Misinformation refers to information that may or may not be intentionally false or inaccurate and is typically spread widely by others regardless of affect. Disinformation is a type of misinformation that is designed to be deliberately deceptive and shared widely. Misinformation turns into disinformation, or malicious misinformation, when it is shared by someone who knows that it is wrong or is actively trying to distribute a false narrative. Manually created fake social media accounts can impersonate real or fictitious individuals or organizations and be used to spread misinformation. The nature of social media platforms – where people curate more relationships with those people and organizations that agree with their views – makes an ideal setting for the spread of misinformation. Further, the tendency for people to share information without validating its source or accuracy exacerbates this problem.

Malicious information is not only spread by people. Bots are automated programs created on social media sites to mimic human users. They are used to amplify the spread of information – or misinformation – by increasing the number of supposed viewers. Many social media platforms have algorithms to detect bots and fake accounts with some success, but more sophisticated accounts are being created continuously. Many bots and fake accounts originate outside of the United States in an effort by foreign state actors to negatively impact domestic conditions. Russia, China, Iran, and North Korea have sophisticated influence and disinformation capabilities. For example, in 2016, fake Russian social media accounts claimed to be affiliated with the Black Lives Matter movement and shared inflammatory content intended to stoke racial tensions.

“Deep fakes” are video or audio recordings that have been manipulated to look or sound realistic, often portraying someone saying or doing something that he or she never said or did. When created by artificial intelligence systems, these videos are very hard to identify and validate. Publicly available software tools make the creation of these files accessible to anyone. As of early 2020, there were 14,678 deep fake videos on the Internet which is an 84 percent increase from December 2018. Politicians and celebrities are the most common victims of deep fakes. Ultimately, falsehoods and conspiracy theories are being spread faster

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233 Ibid, p. 14-25

than ever before. This spread of disinformation has triggered incidents that further complicate response to an already occurring event.235

Impact on Responder Environment:
There are a number of ways in which malicious misinformation can impact the response environment.

1. The increase in software to create “deep fakes” makes it easier to portray someone saying or doing something he or she never said or did.
2. Misinformation can trigger incidents or lead to investigation of the wrong person.
3. The proliferation of disinformation has led the public to develop a reluctance to trust video as evidence in police investigations and other instances. Most agencies have limited capacity to identify altered images or video.
4. The potential exists to use altered video to place people at crime scenes or show them committing a crime.

Malicious Misinformation Associated Capability Needs:

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THE DARK WEB

Overview: A site on internet can be located in one of three layers:

Table 5. Layers of the internet

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<th>Layer</th>
<th>Percentage</th>
<th>Description</th>
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| Surface Web      | 4%         | ▪ Public-facing websites  
▪ Standard search engines                                                   |
| Deep Web         | 90%        | ▪ Sites that are not indexed by search engines  
▪ Requires login credentials or specific address  
▪ Private entity (e.g., corporate) internal data  
▪ Government data  
▪ Medical records  
▪ Subscription-based data |
| Dark Web         | 6%         | ▪ Encrypted sites that require specialized software for access  
▪ Users have anonymity  
▪ Used to sell or distribute illegal content236 |

The Dark Web consists of encrypted networks that require special software for access. One such encrypted network commonly used is Tor which was originally created by the U.S. Naval Research Laboratory as a tool for anonymous communication online. In 2002 Tor went live, making the dark web widely accessible to the public.237

The Dark Web may be used for non-malicious or legitimate purposes, but it is also often used to conceal criminal or malicious activities. For example, this section of the web includes nefarious items such as stolen and illegal information, illegal pornography, etc. It can also be used to connect individuals for recruitment into terror groups or incident planning activities. Some use the Dark Web to deceive, mislead or harm others through creating or disseminating fake news and disinformation.238 The Dark Web offers pornography, illegal and prescription drugs, weapons, financial and identity data, human trafficking, cyber services, cybercurrency, and extremist group communication and recruiting.


238 Ibid.
Most response agencies do not have skills or training to access these sites or obtain data for investigative or prosecution purposes.

**Impact on Responder Environment:**

There are a number of ways in which the dark web can impact the response environment.

1. The dark web offers unprecedented capability for global communication among persons who wish to hide their activities as well as commerce of illegal products and services. Many criminal activities (e.g., homicide, stalking, denial of service) can be commissioned from dark web sites.

2. Users are able to navigate the dark web anonymously, preventing investigators from determining the identity of those offering illicit products or criminal behavior.

3. Responders are often unable to access or analyze data posted to deep or dark web sites. It is difficult for public safety agencies to recruit and retain personnel with technical and analytical skills.

4. There is a concern that as extremist groups and views are denied access to traditional social media sites, they will turn to communication on the dark web, thereby hindering investigation.

**Dark Web Associated Capability Needs:**

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SOCIAL MEDIA (AS AN INVESTIGATIVE TOOL)

| NEAR | MID | LONG |

Overview: An overview of social media usage is provided in the discussion of social media as a communications tool. This discussion focuses on the way that social media platforms can be used to improve situational awareness and aid in investigations.

Social media posts are now being used in court as supplemental evidence to establish character, support alibis, and provide other valuable information relevant to court cases. Such investigation involves looking into the social media posts, status updates, photos, and conversations of an individual of interest. Social media can be used to identify people of interest, as well as to monitor incidents and events from a distance. The platforms can provide a wealth of benefits including direct and corroborative evidence but combing through all of the data can be very time consuming and presents a possible violation of legal ethics.

Additionally, some social media platforms allow for information to be posted that lasts a short period of time before disappearing. This is a concern to social media investigators because that evidence is potentially gone.

These posts can contain a significant amount of situational awareness information that can aid responders. Posts from victims can provide critical data on casualty location, real-time images and video, health status, and threats and hazards and help response agencies to allocate resources. These platforms are often available when degraded cellular connections prevent voice calls. Users sent over 20 million posts to one social media platform in the five days after Hurricane Sandy. Often, however, agencies do not have sufficient (or any) trained staff that is able to access, ingest, and analyze this data in order to transform it into actionable information. In addition, data storage constraints prevent most agencies from using social media data for post-incident analysis.

Bad actors use public and Dark Web-based social media sites to post threats, manifestos, recruitment information, and other data. Sex traffickers have been known to use social media posts to groom potential victims. In addition, perpetrators have begun to live-stream terror attacks and other similar incidents on social media sites, leading to the glorification of such acts and promotion of the ideologies. Social media sites use AI to spot violating content and remove it as quickly as possible. However, this is not always able to happen quickly enough. For example, when the Christchurch terrorist attack was streamed on its network, it did not

240 Ibid.
have enough first-person footage of violent events for the system to match up against it and remove it more quickly.\textsuperscript{242}

Social media posts and livestreamed videos during the events at the U.S. Capitol on January 6, 2021 allowed federal investigators to identify those who gained entrance into the Capitol building and attacked police officers. Not only law enforcement officers use this data; numerous offenders were turned in by friends and family who saw their social media posts. Similar capabilities were used to identify and arrest perpetrators from the civil unrest in Portland, Oregon and Philadelphia, Pennsylvania in 2020.\textsuperscript{243}

Social media data can also give responders advanced warning of when an event is occurring.

**Impact on Responder Environment:**

There are a number of ways in which social media as an investigative tool can impact the response environment.

1. Public safety agencies could gather significant amounts of real-time situational awareness data if they were able to access, ingest, and assess social media posts.
2. Social media platforms have the potential to provide responders with advanced warning of potential attacks. However, many agencies are unable to effectively monitor social media sites like 4chan and 8chan where manifestos are often posted just prior to attacks.
3. The rise in smartphone users worldwide has led to an increase in the livestreaming of attacks on social media sites which promote and glorify such acts and the ideologies that drive them.
4. Social media posts can be used to identify perpetrators and provide evidence of criminal activity during prosecution.
5. In addition to the need to constantly monitor social media networks, there is a need for high sensitivity and consistency in the flagging of data that comes from these networks — all of which would require extensive dedicated resources that many public safety agencies do not possess.
6. The public has demonstrated a growing reliance on information from social networks before, during, and after an incident. Additionally, the threat of the spread of disinformation with the intent to deceive, mislead, or manipulate the public and the inability to validate data disseminated on these networks presents an exponentially growing issue for responders.
7. Malicious misinformation, including deep fake images and video, may cause investigators to rely on inaccurate information as part of an investigation.


PROJECT RESPONDER 6
EVOLVING RESPONSE ENVIRONMENT: TECHNOLOGY ADVANCEMENT

Social Media (as an Investigative Tool) Associated Capability Needs:

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WEARABLES

Overview: Wearable technology ("wearables") are electronic devices that can be worn as accessories, embedded in clothing, implanted, or tattooed. Modern wearable technology incorporates a microprocessor and a network connection. The growing popularity of IoT and connected devices drives the demand for wearables.244 Wearable sensors attached to or carried by responders can provide incident command with information about the responder’s health status and specific hazards on the scene. This can help incident command to make better decisions that increase the safety of responders and the population.

Wearable technology includes smart watches, garments, accessories, and face shields/glasses. Smart watches are the most ubiquitous wearable device. These devices may be able to measure biometrics, such as heart rate, electrocardiogram (ECG) waveform, respiration rate, blood pressure oximetry, and biomarkers.245 Further, they can provide text and audio communications and provide navigation information.

Body-worn devices can also enhance responder operations. Cameras are used – primarily those in law enforcement – to capture images and video from the scene. Although many of these systems require agencies to download data periodically, new versions have been introduced that allow simultaneous recording and streaming functionality. Other body worn devices include those that can harvest kinetic energy from movement, provide emergency alerts, geolocate the wearer, function as a digital assistant, predict falls, and deliver medications, among others.

Smart glasses, contacts, face shields, and heads-up displays are an emerging technology. Integrated with network connectivity and/or augmented reality technology, these devices allow users to see or hear additional data. A number of new models have been or are anticipated to be released in 2021.

Discussion of garment technology can be found in the Smart Textiles section of this report.

Impact on Responder Environment:

There are a number of ways in which wearables can impact the response environment.

1. Wearables can provide information on responder vital signs to command and health personnel.
2. Wearables can function as a communications device, allowing responders to receive critical information without having to carry a radio.

3. Wearable devices can provide real-time incident data (e.g., audio, images, video) to enhance situational awareness for command or other responders.

4. If augmented with **AR** technology, smart face shields/glasses could allow responders to see critical data (e.g., building blueprints, navigation) superimposed on their field of view.

5. Smart bandages can release drugs or compounds, sense wound data (e.g., pH, temperature, moisture, enzymes), allowing for more effective treatment of injured persons.²⁴⁶

6. Wearables can integrate with on-scene sensors and IoT devices to provide improved situational awareness for responders.

7. Data derived from wearable devices can be hacked, potentially endangering responders or the security of the incident/investigation.

8. Responders may object to mandated usage of body-worn devices, especially those that monitor health data.

### Wearables Associated Capability Needs:

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| CM.2  | CM.21 | TE.3   |

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Overview: Unmanned aircraft systems (UAS) are any aircraft without a human pilot onboard that are designed to operate autonomously or be remotely piloted. The system typically consists of 1) an aircraft with no pilot on board, 2) a remote pilot station, 3) a command-and-control link, and 4) a payload specific to the intended application/operation.\textsuperscript{247}

The FAA regulates use of UAS for civilians and government agencies. Public safety agencies have the option to operate under 14 CFR part 107, which allows flight of small (under 55 pounds) aircraft within visual line-of-site.\textsuperscript{248} An expansion of FAA regulations, Operations Over People (April 2021), expanded part 107 and now allows pilots to fly UAS at night and over people and moving vehicles without a waiver.\textsuperscript{249} Agencies also have the option to obtain a Certificate of Waiver or Authorization to operate outside of part 107 restrictions.

Public safety UAS are used to support firefighting and search and rescue operations, monitor and assess critical infrastructure, and provide disaster relief by transporting emergency medical supplies to remote locations.\textsuperscript{250} These systems also have the ability to deliver food, water, or medical supplies to people that are trapped but unreachable by responders.

Not only do response agencies use UAS for operational tasks, but they must also be able to mitigate the impacts of use of drones by others. Civilian hobbyists often fly drones over restricted spaces or in interference with response operations. As of April 19, 2021, the FAA reports a total of 873,450 drones registered: 367,848 commercial and 502,105 recreational drones.\textsuperscript{251} Bad actors could use drones to surveil responders or as a delivery method for explosives or other threats. Counter-UAS (C-UAS) operations are designed to detect and mitigate threats caused by unmanned aircraft systems. There are four steps in

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\textsuperscript{248} “Operate a Drone, Start a Drone Program,” Federal Aviation Administration. https://www.faa.gov/uas/public_safety_gov/drone_program/

\textsuperscript{249} “Operations Over People General Overview,” Federal Aviation Administration. https://www.faa.gov/uas/commercial_operators/operations_over_people/

\textsuperscript{250} “Unmanned Aircraft Systems (UAS) – Critical Infrastructure,” DHS Cybersecurity & Infrastructure Security Agency.

\textsuperscript{251} UAS by the Numbers, Federal Aviation Administration, 19 Apr. 2021, www.faa.gov/uas/resources/by_the_numbers/.
the DHS UAS processing chain to deal with potential threats caused by UAS. Figure 39 illustrates this process.

![UAS Process Chain Diagram]

Whether due to inadvertent or intentional misuse, UAS can pose a serious risk to individuals below. Responders report that they currently have very limited means to recognize whether a platform is friend or foe, intercept unknown UAS, or remove them from the sky. While there are multiple options for detecting unknown UAS (e.g., radar, electro-optical and infrared cameras, acoustic sensors), there are limited options for the other components of the C-UAS process chain. Electronic techniques such as jamming or spoofing systems and kinetic devices (e.g., net guns, projectiles, lasers) are able to be used by non-Federal agencies. See the State of Technology description associated with SA.44, the ability to mitigate specific UAS in a set airspace, for further information on these restrictions. In addition, because there are potential risks of UAS debris or payloads falling from the sky, there may be scenarios where it would be preferable to divert a rogue UAS to a designated location.

**Impact on Responder Environment:**

There are a number of ways in which unmanned aircraft systems can impact the response environment.

1. UAS can provide surveillance capability that allows responders to have a greater understanding of the incident scene without putting personnel in danger.
2. UAS have been used to carry and hover to deliver fire suppression materials to upper floors of high-rise buildings.
3. UAS can carry and drop supplies to remote areas.
4. Unmanned systems are able to drop supplies to remote areas or in advance of responder arrival on scene.
5. UAS can provide aerial threat sensing over an incident scene.
6. UAS have been able to track the movement of individuals on the ground.
7. UAS can be used to provide additional lighting or network connectivity nodes for on-scene responders.
8. Unmanned systems can be used to conduct surveillance in advance of attacks.
9. UAS can be weaponized or used to carry payloads of illicit materials.

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10. Many UAS cannot fly in poor weather conditions, limiting their utility during weather events.

11. The inability to mitigate UAS is especially problematic for response agencies and options that are legal for public safety agencies are not anticipated in the near term.

**UAS/C-UAS Associated Capability Needs:**

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Overview: Additive manufacturing – also known as 3D printing – uses digital data, such as computer-aided design (CAD) files, to create three dimensional objects. Traditional manufacturing uses subtractive processes, where an object is cut out of a material. Conversely, additive manufacturing creates objects by adding material layer by layer. Costs for 3D printers have decreased significantly in recent years. Budget 3D printers can be purchased for as little as $100, while industrial models cost more than $10,000.

Online libraries contain millions of stereolithography (STL) and .OBJ files that can be downloaded — many without cost — that provide a 3D printer with the coordinates to create objects. These files do not have unit specifications — meaning that objects can be printed in any size. Users are also able to design their own CAD files. Coupled with technology like a 3D scanner (also decreasing in cost), users can capture the specifications of an object and print a replacement. Similarly, users could scan a void or hole and print a plug.

Potential applications for 3D printers are nearly limitless. Beyond common uses such as the creation of spare/replacement parts and tools, 3D printers are able to print body parts (e.g., functioning organs, skin, bones), homes, and food. During the COVID-19 pandemic users uploaded many files for use by hospitals and response agencies (e.g., ventilator valves, roller clamps, face shields, mask components).

There are potential problems for emergency responders associated with 3D printing. Design files for firearms, handcuff and building master keys, and currency plates are all currently available. The ability to develop designs for counterfeit items (e.g., badges), critical parts that have intentional design flaws (intended to cause failure), and those to print drugs, explosives, viruses, etc. are not only technically feasible now, but likely to cause significant issues for responders in the future. Although many of these files are not available on public sites, they are traded and sold on private platforms and the Dark Web.

Impact on Responder Environment:
There are a number of ways in which additive manufacturing can impact the response environment.

1. Additive manufacturing has the potential to address challenges in disaster aid supply chains by printing critical parts or those in short supply.

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255 “7 amazing body parts that can now be 3D printed,” MDLinx. https://www.mdlinx.com/article/7-amazing-body-parts-that-can-now-be-3d-printed/lfc-2668
2. The technology could allow an agency to print spare parts, saving costs for maintenance and repair, as well as time needed for delivery.

3. Since 3D printers can be powered off the grid, such as by car battery, generator, or solar power, they have great potential for use in emergencies where power is not readily available.

4. 3D printing can be used to build homes for the homeless or people displaced by disasters. Through partnership with private industry, a non-profit used a portable, lightweight 3D printer with a built-in generator to print homes for approximately $4,000 each within 24 hours. The U.S. Marine Corps printed a 500 square foot barracks hut in 40 hours. Responders could use similar technology to build shelter during extended response operations.

5. 3D printing can be used to create inexpensive surveillance capability. The U.S. Marine Corps has developed small fixed-wing and quadcopter drones that can be 3D printed in the field. 3D printed drones could also be used to deliver supplies to responders or teams in remote locations.

6. 3D printing has been used to recreate crime scenes, weapons, or bodies to support investigations.

7. Parts created using a 3D printer may be designed to conceal voids where illicit substances (e.g., drugs, explosives) can be hidden.

8. 3D printed firearms have no serial number and are untraceable. Depending on the material used, they may also be undetectable by current systems (e.g., metal detectors). They can be printed at home by persons who have been restricted from having firearms due to previous felony, court order, or medical restriction.

9. Edged weapons (e.g., knives, swords, daggers) can also be easily 3D printed.

10. The combination of 3D scanning and printing could be used to spoof biometric systems.

11. Dust from 3D printers can be combustible, creating a potential hazard.

Additive Manufacturing Associated Capability Needs:


259 “Marines take 3D printed drones from the lab to the field,” Defense Systems. https://defensesystems.com/articles/2017/05/08/marinecorpprint.aspx
**Overview:** An autonomous vehicle (AV) is one that is able to operate itself and perform necessary functions without any human intervention, using its ability to sense its surroundings. It is made up of cameras and sensors such as Lidar (Light Detection and Ranging) and RADAR (Radio Detection and Ranging) systems, which work concurrently to carry out operations automatically without the help of drivers. Autonomous vehicles have six different levels of automation and, as the levels increase, the extent of the driverless car’s independence regarding operation control increases. At level 0, the car has no control over its operation and the human driver does all of the driving. Level 5 is full automation whereby the vehicle is able to perform all tasks in all conditions, and no driving assistance is required from the human driver.\(^\text{260}\)

The levels of automation are illustrated in the Society of Automotive Engineers Automation graphic below:

*Figure 39. Levels of Vehicle Automation*

Benefits to full automation include safety, economic and societal benefits, efficiency and convenience, and mobility. Some analysts predict that full automation of vehicles by 2030 and many vehicle manufacturing companies have reported plans to expand to Level 4 automation by 2025.

**Impact on Responder Environment:**

1. Autonomous vehicles have the potential to reduce traffic accidents and save lives. According to the National Highway Traffic Safety Administration (NHTSA), 94% of

\(^{260}\) Ibid.
serious crashes are due to human error. Given that 35,000 people die each year in motor-vehicle related crashes, the potential to reduce these accidents is significant if human error is reduced.

2. AVs may be programmed to automatically yield to emergency vehicles and apparatus, thereby improving the ability to navigate to incident scenes or calls for service.

3. If a responder does not have to concentrate on driving to the incident scene, they may be able to ingest more data, improving situational awareness upon arrival.

4. These vehicles could serve as mobile observation platforms for law enforcement. Potential applications could include equipping the vehicles with cameras, license plate readers, radar, and gunshot detection systems. This would give law enforcement the ability to patrol autonomously based upon current threats, patterns, and requests.

5. These vehicles could minimize duplication of effort in search and rescue operations by programming AVs accordingly.

6. Potential threats to the use of these vehicles include use of AVs to transport illicit goods and people and the hacking of AVs to program them to perform dangerous maneuvers (e.g., aim for people on sidewalks).

7. Autonomous vehicles may create changes in emergency response unit composition. Without the need for a driver, units or teams may adapt to include other skills or reduce in size.

8. Traffic enforcement may become less relevant and reduced as a source of income for law enforcement agencies.

9. AVs could be used to deliver supplies in hazardous conditions (e.g., wildland fire line).

Autonomous Vehicles Associated Capability Needs:

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WEATHER, CLIMATE, & GEOLOGIC HAZARDS

WEATHER HAZARDS

CLIMATE HAZARDS

GEOLOGIC HAZARDS

The intent of this section is not to discuss the causes of change to the environment. This discussion of the environment uses data to show where there have been demonstrable changes that impact natural weather patterns and events. The study team focused on using U.S. Government and other recognized sources. Note that some U.S. Government sources have not published climate data since 2016 and the most recent (4th) National Climate Assessment was published in 2018. Every effort has been made to present an impartial discussion of the topic without adding subjective analysis or opinion.

This section includes three issues related to the environment that impact the emergency response community. Whether an individual event or a sustained series, natural disasters can take a heavy toll on responders. They are often accompanied by casualties and significant property damage, among other impacts. Concurrently, responders are often worried about the safety of their own families.

All associated capability needs can be found at the conclusion of the section due to similarities across hazard types.
Overview: Weather reflects short-term conditions of the atmosphere. An extreme weather event is something that falls outside the realm of normal patterns. Extreme weather events are, themselves, troublesome, but the effects of such extremes, including increasing casualties and property damage, can be devastating. Severe weather includes local, intense and damaging events such as thunderstorms, hailstorms, and tornadoes, but it can also describe more widespread events such as tropical cyclones (i.e., hurricanes), blizzards, “nor’easters,” and derechos.262 These storms are also becoming more costly. Per NOAA’s National Center for Weather Information, there were 22 separate billion-dollar weather events in 2020 and 290 of them since 1980.263 These events are shown in Figure 41. Of the costly storms since 1980, 132 of

![U.S. 2020 Billion-Dollar Weather and Climate Disasters](image)

*Figure 40: Increase in extreme weather events. Graphic courtesy of NOAA.*

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262 Severe Weather Data, National Oceanic and Atmospheric Administration, [https://www.ncdc.noaa.gov/data-access/severe-weather](https://www.ncdc.noaa.gov/data-access/severe-weather).

them (46 percent) have been severe storms, 19 winter storms (7 percent), and 52 tropical cyclones (18 percent). Annual numbers and costs are illustrated in Figure 42.


*Figure 41. Number and total cost of extreme storms in the United States from 1980-2021. Chart courtesy of NOAA.*

These storms geographically impact some parts of the United States more than others. Texas, for example, has had 124 billion-dollar disasters since 1980 – more than any other state. The total costs of these storms exceed $250 billion for that state alone. The maps below

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266 Ibid.
(figures 43 and 44) illustrate both the frequency and total cost of these disasters across the United States.

The seven types of events are described further in the following table. The impacts listed below provide a more comprehensive picture of the effects of extreme weather than are typically discussed.

Table 6. Weather-related hazards

<table>
<thead>
<tr>
<th>Data</th>
<th>Impact</th>
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| ![Image](image1.png) | • Crop/pasture losses<sup>267</sup>  
• Water restrictions/shortages  
• Increased incidence of illness and disease  
• Port and waterway transportation supply chain disruptions  
• Increased probability of large-scale wildfires  
• Water quality impacts  
• Land cover transitions |

### Evolving Response Environment: Environment

#### FLOODS

- The most common disasters in the United States\(^\text{268}\)
- 41 million residents at risk\(^\text{269}\)
- Floodwater carrying raw sewage, leaked chemicals
- Pollution of drinking water sources
- Subsequent bacteria and mold overgrowth
- Damage from debris being moved by water
- Damage to structures and infrastructure
- Displacement from homes
- Need for mass sheltering
- Impact to transportation routes

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*Figure 45. The number of billion dollar flood events in the United States from 1980-2021. Image from NOAA.*

#### FREEZE

- Burst pipes and interior flooding
- Frostbite and hypothermia
- Utility disruptions
- Vehicle accidents
- Flooding resulting from ice jams
- Damage to trees/crops
- Livestock deaths
- Carbon monoxide poisoning

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*Figure 46. Map of billion dollar freeze events in the United States from 1980-2021. Image from NOAA.*

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**SEVERE STORMS**

- Limited warning
- Destruction of buildings and infrastructure
- Crop/pasture losses
- Livestock losses
- Utility disruptions
- Fires resulting from utility disruptions
- Interior flooding
- Subsequent flooding
- Need for mass sheltering
- Traffic accidents
- Increased incidence of disease and illness

---

**TROPICAL CYCLONES**

- Storm surges
- Subsequent flooding
- Destruction of buildings and infrastructure
- Floodwater carrying raw sewage, leaked chemicals
- Need for evacuation
- Evacuation delays
- Need for mass sheltering
- Utility disruptions
- Fires resulting from utility disruptions
- Destruction of coastal ecosystems and natural barriers
- Swiftwater challenges
- Need for search and rescue
- Potential for mass casualties
- Increased incidence of illness and disease

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**Figure 47.** Map of the billion dollar severe storms in the United States from 1980-2021. Image from NOAA.

**Figure 48.** The number of billion dollar tropical cyclones in the United States from 1980-2021. Image from NOAA.
There are three important things to note here. First, the description and graphics above only illustrate the billion-dollar storms. However, the frequency and costs (in terms of casualties and physical damage) of severe weather events are increasing overall. This is true across different types of events. For example, the number of tornadoes per year, the number of tornadoes within large outbreaks, and the number of days with more than 30 tornadoes has been increasing since 1950. Second, the data shows that, despite the category of weather event, many occur along the coasts. The discussion of Human Settlement Trends in the Human Behavior Section addresses the impacts of increasing numbers of people moving to these areas. Third, these are natural disasters. Even when there is a human component (e.g., utility infrastructure causing wildfires), the circumstances have to be suitable for the event to occur. According to the data, the frequency of severe weather events is increasing. There is little that
the public safety community can do to prevent or mitigate the effects of these events, but they will be called on at an increasing frequency to respond.

In addition to economic issues, experiencing natural disasters can affect people both physically and psychologically. Past research studies have indicated that experiencing natural disasters can affect public health outcomes such as mortality, injury, infectious disease, economic impact, and produce a range of psychosocial consequences. Natural disasters such as hurricanes, earthquakes, and floods can lead to post-traumatic stress disorder (PTSD), depression, anxiety disorders, and even elevated rates of suicide.  

**Impact on Responder Environment:**

There are a number of ways in which more extreme weather events can impact the response environment.

1. Responders are placed in harm’s way while operating during and after these events.
2. Extended events, or multiple events in a series, can result in significant physical and mental health impacts for responders.
3. Extended events, or multiple events in a series, can impact staff availability.
4. Large-scale or extended events can quickly deplete available emergency response resources. The ability to replenish those resources is also often impacted by the incident, making it difficult to safely and effectively carry out response operations.
5. It is difficult to conduct training, exercises, or planning activities when the pace of severe weather events has increased.
6. Weather-related incidents can cause the displacement of a significant part of the population, requiring evacuation, mass-sheltering, and other long-term activities.

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https://www.climatecentral.org/gallery/graphics/largest-tornado-outbreaks-getting-larger

271 Experiencing a Severe Weather Event Increases Concern About Climate Change, Frontiers in Psychology,  
CLIMATE HAZARDS

Overview: Climate describes the average weather conditions for a particular location over a long period of time. The topics in this section are focused on observed phenomenon in the United States over a period of decades. This section discusses three phenomena that impact the response community, either through specific events or through their effects on the weather hazards described above.

Higher Sustained Temperatures 2020 was the second-warmest year on record. The ten warmest years on record have occurred since 2005.\textsuperscript{272} Figures 52 and 53 below illustrate the increase in global surface temperature over time compared to the long-term average and recent temperature trends.

Higher sustained temperatures have impacts on other pillars and weather events as well. There is a greater demand on power grids as people increase their air conditioning usage; water usage increases to keep plants and crops from dying; the elderly, ill, and homeless are more susceptible to the effects of extreme heat. All these factors have cascading impacts on the response community.

Higher sustained temperatures also lead to:

- Higher precipitation levels. Heavy downpours are increasing nationally, especially over the last three to five decades. The heaviest rainfall events have become more substantial, and the amount of rain falling on these rain days has also increased.\textsuperscript{273}


\textsuperscript{273} Extreme Weather, \url{https://nca2014.globalchange.gov/highlights/report-findings/extreme-weather}
Drought. Increased temperatures and the subsequent reductions in soil moisture and human demand for water can lead to drought conditions. According to the Drought Monitor, more than 93 percent of the land area in Utah, Colorado, Nevada, and New Mexico is in some level of drought; 69 percent of Utah is in severe drought, as is 61 percent of Colorado. More than three-quarters of Oregon, Arizona, and Wyoming are also in drought.

Wildfires. High temperatures combined with low humidity, dry vegetation and hot, dry, fast winds create what is known as "fire weather" or "fire season." During fire season, wildfires are more likely to start, spread rapidly and be more difficult to extinguish. There are now two fire seasons – one lasting from June through September that is primarily caused by high heat, low humidity and dry vegetation, and another lasting from October through April that is generally more volatile, as it is fueled by high winds. This 11-month fire season is longer than in past years.

Higher sustained water temperatures also impact water quality. Both freshwater and saltwater systems are experiencing significant effects. Increased water temperatures, paired with chemical runoff, can also lead to excess algae overgrowth. These algal blooms can harm drinking water reservoirs and coastal water systems, and poison freshwater and marine life.

**Sea Levels** The global average sea level has risen eight to nine inches since 1880. Three of those inches have been gained in the last 25 years.

Higher sea levels coincide with more dangerous storms like hurricanes that move more slowly and deposit more rain. This contributes to more powerful storm surges.

More than 8.6 million Americans live in areas susceptible to coastal flooding.

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277 Ibid.


However, this flooding is not just the result of storms and hurricanes. There are also increasing numbers of shallow, non-life-threatening floods caused by higher sea levels; these high tide floods occur when the sea washes up and over roads and into storm drains as the daily tides roll in. These floods are becoming more frequent due to see level rise. In fact, US coastal flooding has doubled in a matter of decades.

Based on sea level projections for 2050, land currently home to 300 million people will fall below the elevation of an average annual coastal flood. By 2100, land now home to 200 million people could sit permanently below the high tide line. In fact, roughly 110 million people currently live on land below high tide line.

**Land Cover Change** This issue focuses on the alteration of vegetation types and soil properties. In addition to the **Human Settlement Trends** discussed above, the United States continues to urbanize – movement to and development of infrastructure away from rural areas. This urbanization is altering surface terrain and composition. Urban development can increase the runoff to streams from rainfall to snowmelt into waterways, leading to subsequent flooding.

Temperature increases can also lead to the adaption of vegetation cover. Changing vegetation can alter the ability of a land area to reflect the sun’s rays (impacting surface temperature) and the ability to absorb precipitation (impacting flood and landslide risk).

Development in the wildland urban interface can introduce new vegetation that is more flammable. For example, some non-native and invasive grasses can increase fire occurrence and mean fire size. Additionally, pests can change vegetation. For example, a combination of drought and sustained higher temperatures leads to higher susceptibility of trees to bark beetle attacks. Increased tree mortality due to bark beetle infestation has also modified landscapes in ways that make them more likely to burn. Multi-year drought and precipitation patterns also contribute to the growth of low vegetation that is prone to combustion when dry, serving as kindling for larger fires.

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281 “U.S. high-tide flooding continues to increase,” NOAA. [https://www.noaa.gov/media-release/us-high-tide-flooding-continues-to-increase](https://www.noaa.gov/media-release/us-high-tide-flooding-continues-to-increase)

282 “What is high tide flooding?,” NOAA. [https://oceanservice.noaa.gov/facts/high-tide-flooding.html](https://oceanservice.noaa.gov/facts/high-tide-flooding.html)


Impact on Responder Environment:

There are a number of ways in which climate hazards can impact the response environment.

1. Responders are placed in harm’s way while operating during and after these events.
2. Extended events, or multiple events in a series, can result in significant physical and mental health impacts for responders.
3. Extended events, or multiple events in a series, can impact staff availability.
4. Climate-related events can have long term impacts on the area.
5. Public safety infrastructure is often not sufficient to meet the size and expectations of growing communities.
GEOLOGIC HAZARDS

<table>
<thead>
<tr>
<th>NEAR</th>
<th>MID</th>
<th>LONG</th>
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**Overview:** This section focuses on hazards that result from the composition and movement of the Earth. While rare, a geologic event could have catastrophic consequences – not just on the surrounding region, but in an extended area as well. There has not been a significant geologic event in the United States since the Oso landslide in 2014, the 1994 Northridge, California earthquake, and the eruption of Mount Saint Helens in 1980. However, this does not mean that the risk is decreasing.

Three types of events are described further in the following table. The impacts listed below provide a more comprehensive picture of the effects of extreme weather than are typically discussed.

*Table 7. Geologic hazards*

**SEISMIC HAZARDS**

- Building and infrastructure damage from ground shaking and surface faulting
- Subsequent tsunamis
- Liquefaction
- Subsequent fires
- Burst pipes from sheering (e.g., water, gas, sewage)
- Utility disruptions
- Vehicle accidents
- Mass casualties
- Need for mass sheltering
- Traffic infrastructure damage

![Figure 54. Areas of the highest level of seismic hazard in the United States. Image from USGS.](image)

**LANDSLIDES**

- Limited warning
- Destruction of buildings and infrastructure
- Burst pipes from sheering (e.g., water, gas, sewage)
- Bodily trauma from fast-moving water and debris
- Fires resulting from utility disruptions
- Need for mass sheltering
- Traffic infrastructure damage

![Figure 55. Landslides in the United States.](image)
Impact on Responder Environment:

There are a number of ways in which geological hazards can impact the response environment.

1. Responders are placed in harm’s way while operating during and after these events.
2. Extended events, or multiple events in a series, can result in significant physical and mental health impacts for responders.
3. Extended events, or multiple events in a series, can impact staff availability.
4. The potentially catastrophic consequences of a geologic event will likely impact responder families and property.
5. Geologic events will likely significantly impact communications infrastructure, with consequences for the ability of response agencies to coordinate operations, request supplies, etc.
6. Geologic events will likely significantly impact transportation infrastructure, water systems, and utility systems, all with potentially devastating consequences for response operations.

Combined Associated Capability Needs for all Weather, Climate, and Geologic Hazards:
PROJECT RESPONDER 6

Evolving Response Environment: Environment

SA.6 SA.7 CIS.7 CIS.9 CCC.6 CCC.7 RHS.6 RHS.9 LRM.8 LRM.10
SA.8 SA.11 CIS.11 CIS.12 CCC.8 CCC.11 RHS.10 RHS.11 LRM.11 LRM.12
SA.12 SA.13 CIS.16 CIS.19 CCC.12 RHS.12 RHS.18 LRM.13 LRM.15
SA.15 SA.16 CIS.20 CIS.21 RHS.19 RHS.24 LRM.16 LRM.18
SA.17 SA.18 CIS.26 CIS.27 RHS.25 LRM.19 LRM.20
SA.19 SA.20 CIS.28 CIS.30 LRM.21 LRM.22
SA.21 SA.22 CIS.31 CIS.32 LRM.23 LRM.26
SA.26 SA.27 CIS.34 CIS.36 LRM.38 LRM.39
SA.28 SA.30 LRM.42 LRM.44
SA.31 SA.34 LRM.45 LRM.46
SA.35 SA.48 LRM.48 LRM.50
SA.49 LRM.53

CM.1 CM.2 TE.2 TE.4 RAP.1 RAP.2 II.12 II.13 OPS.8 OPS.9
CM.15 CM.16 TE.6 TE.14 RAP.3 RAP.4 II.14 II.15 OPS.12 OPS.17
CM.17 CM.18 TE.17 TE.18 RAP.5 RAP.6 II.25 II.30 OPS.21 OPS.23
CM.19 CM.22 TE.20 TE.23 RAP.7 RAP.8 II.31 II.32 OPS.29 OPS.31
RAP.10 RAP.11 II.35 OPS.33 OPS.34
RAP.13 RAP.18
RAP.23 RAP.25
RAP.26 RAP.28
OPS.37 OPS.38
OPS.39 OPS.40
OPS.41 OPS.42
OPS.47 OPS.48
OPS.50 OPS.54
OPS.61 OPS.62
OPS.63 OPS.64

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There are 16 critical infrastructure sectors as defined by DHS; 15 are addressed below, all of which have an impact on emergency response operations. The remaining sector, the Emergency Services Sector (ESS), is responsible for public safety prevention, preparedness, response, and recovery operations. As that is the focus of the entire Project Responder effort, the ESS is not described separately below.

Each of the Infrastructure issues reflect how emergency responders interact with the Nation’s critical infrastructure sectors. There are many interdependencies among these sectors and correlations with other PR6 issues as well. For example, failure of a dam could cause catastrophic consequences for a community. Immediate flooding conditions could inundate Energy sector assets (e.g., power grids), Communications sector equipment (e.g., cellular towers), Transportation sector infrastructure (e.g., roadways, railways), Water & Wastewater sector systems (e.g., treatment plants), etc. The introduction of IoT sensors, enabled by 5G communications could provide a community with advanced warning of when dam conditions require repair. However, these technology advancements require functioning network capability provided by the Information Technology sector. Every effort has been made to present an impartial discussion of the topic without adding subjective analysis or opinion.
Overview: The Chemical sector is responsible for manufacturing, storing, using and transporting the compounds that are relied upon by other critical infrastructure sectors. Recent analysis estimates that over 95 percent of manufactured goods rely on some form of an industrial chemical process.\textsuperscript{289} It is one of the largest manufacturing industries in the United States, supplying both domestic and global markets (responsible for up to 18 percent of global chemical shipments). Within the United States, more than 13,000 firms produce 70,000+ products and the chemical sector recorded sales exceeding $765 billion while directly employed more than 529,000 workers.\textsuperscript{290} Sector facilities range from petrochemical manufacturers to chemical distributors. Most of these facilities involved in manufacturing, transportation, storage, and warehousing are privately owned.\textsuperscript{291}

Chemical facilities are spread throughout the United States, but often geographically concentrated near the coastal ports. This can lead to cascading disasters in the event of a chemical incident.

There are five segments of the chemical sector: Basic, Specialty, Pharmaceutical, Consumer, and Agricultural, each with unique threats and hazards. Specialty chemicals, for example, include the manufacture of explosive compounds. The Agricultural segment includes the production of fertilizers, as were used in the 1995 bombing of the Alfred P. Murrah Federal Building in Oklahoma City.

Many chemicals can cause significant injuries and damage if released, whether accidentally or intentionally. High risk assets are subject to multiple federal agency rules and regulations. Not only are there hazards related to terrorist attacks and accidental release, but many of these facilities are susceptible to damage by natural disasters. The Alabama Gulf Coast Chemical

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\hline
CHEMICAL SECTOR & NEAR & MID & LONG \\
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\textsuperscript{290} Chemical Spotlight: Overview, Select USA, \url{https://www.selectusa.gov/chemical-industry-united-states}.

Corridor, for example is situated near Mobile Bay, which empties into the Gulf of Mexico. Nearly 30 chemical facilities are located within the Corridor, which has been in the path of multiple hurricanes.

Identified threats to this sector include:

- Insider threat
- Cyber threats
- Natural disasters and extreme weather
- Deliberate attacks and terrorism
- Biohazards and pandemics

Response to chemical incidents may require close collaboration with DHS, the U.S. Department of Justice (DOJ) Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF), the U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration, chemical manufacturers, agricultural facilities, distributors, universities, local suppliers (e.g., hardware stores), public health, and healthcare infrastructure.

**Impact on Responder Environment:**

There are a number of ways in which the chemical sector can impact the response environment.

1. Responders often do not know the specifics of what chemicals are being manufactured or distributed within their jurisdiction. Large chemical facilities may provide data to public safety agencies, but it is often not in a format easily ingested or understood. Additionally, the data may become quickly outdated.

2. Responders rarely know what types of chemicals are being transported through their jurisdictions. Rail, roadway, waterway, and air traffic systems are all used to transport hazardous chemicals with no advance warning of what is traversing through the area.

3. Chemical facility incidents can cause numerous cascading effects that also impact the ability of responders to complete assigned tasks.

4. Chemical facilities are high value terrorist targets.

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### Chemical Sector Associated Capability Needs:

<table>
<thead>
<tr>
<th>SA.2</th>
<th>SA.3</th>
<th>CIS.5</th>
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</table>
Overview: The commercial facilities sector includes diverse sites that draw large crowds for shopping, business, entertainment, or lodging. These facilities are mostly open to the public, meaning that people can generally move freely without encountering many visible security barriers. Most of these facilities are privately owned and operated and have minimal interaction with the federal government or other regulatory entities.

There are eight subsectors:

<table>
<thead>
<tr>
<th>Sector</th>
<th>Description</th>
<th>Count</th>
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</thead>
<tbody>
<tr>
<td>Entertainment and Media</td>
<td>TV and movie production facilities, print media companies, and TV and radio broadcast stations</td>
<td>49,000+ establishments</td>
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<tr>
<td>Gaming</td>
<td>Casinos and associated resorts</td>
<td>1,392 casinos and associated resorts</td>
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<tr>
<td>Lodging</td>
<td>Hotels, motels, conference centers</td>
<td>52,887 hotel-based properties</td>
</tr>
<tr>
<td>Outdoor Events</td>
<td>Theme and amusement parks, fairs, campgrounds, parades</td>
<td>564 amusement and theme parks</td>
</tr>
<tr>
<td>Public Assembly</td>
<td>Stadiums, arenas, movie theaters, and cultural properties such as museums, zoos, libraries, and performance venues</td>
<td>124,000+ establishments</td>
</tr>
<tr>
<td>Real Estate</td>
<td>Office and apartment buildings, condominiums, mixed use facilities, self-storage</td>
<td>1 million office buildings, 5.6 million multi-family rental buildings, and over 48,000 self-storage facilities</td>
</tr>
</tbody>
</table>

Many of these facilities are considered soft targets, meaning that they are vulnerable to attack because of open access and the potential psychological value of violence against citizens/non-combatants.\textsuperscript{294} Many facilities, such as stadiums, malls, and museums, are nationally and internationally recognized symbols and have large population densities when occupied, which increases their likelihood of being targeted.\textsuperscript{295} The Boston Marathon Bombing in 2013 is a key example of terrorist targeting of commercial facilities, as was the mass shooting at the Century 16 movie theater in Aurora, Colorado (2012) and that at the Route 91 Harvest Music Festival in Las Vegas, Nevada (2017).

These facilities and sites are also prone to damage from natural disasters. A 1999 tornado outbreak in Oklahoma hit an outlet mall, for example. While the late-evening tornado did not result in any casualties, it caused severe damage to the structure, requiring it to be torn down. Similarly, the 1989 Loma Prieta earthquake (magnitude 6.9) struck on October 17 in the San Francisco Bay area, causing damage and power outages to the stadium just as a World Series game was about to begin. The high capacity at many of these events and locations results in a high number of potential casualties if these facilities are attacked or damaged.

Identified threats to this sector include:\textsuperscript{296}

- Armed attacker
- Cyberattacks
- Supply chain disruptions
- Explosive devices
- Unmanned Aircraft Systems (UAS)
- Natural disasters and extreme weather

Response to commercial facility incidents may require close collaboration with local security personnel, volunteers, and the healthcare infrastructure.

\textsuperscript{295} Ibid.
Impact on Responder Environment:
There are several ways in which the commercial facilities sector can impact the response environment.

1. As noted, large capacity venues have the potential to become mass casualty incidents.
2. Many venues have limited security barriers, which can go against best practices to protect the public in an emergency.  
3. Public venues will continue to be high value targets for potential terrorists.
4. It is often difficult for responders to reach those with a medical emergency inside locations with crowded conditions or that require closing of roadways.
5. There is an increasing incidence of private UAS at large gatherings. State and local responders are currently unable to mitigate the presence of these potential threats.

Commercial Facilities Sector Associated Capability Needs:

Communications Sector

Overview: Communications is an underlying aspect of the operations of all businesses, public safety organizations, and government. It provides an enabling function required across all other critical infrastructure sectors. The communications sector has evolved from a provider of voice services into an interconnected industry using terrestrial, satellite, and wireless transmission systems. The interconnectivity stems from the dependence of satellite, wireless, and wireline providers on each other to carry and terminate communication traffic and the routine sharing of facilities and technology to ensure interoperability. The majority of the communications sector’s infrastructure is privately owned and operated.298,299

The communications architecture is made up of services and applications that provide voice, video, and data functions, the core network that provides the backbone, and five access networks that reflect the means to access the services and applications: 300

- **Broadcast**: Broadcasting systems consist of free and subscription-based, over-the-air radio and television (TV) stations that provide analog and digital audio and video programming services and data services. Broadcasting has been the principal means of providing emergency alert services to the public. Broadcasting systems operate in three frequency bands: medium frequency (MF (AM radio)), very high frequency (VHF (FM radio and TV)), and ultra-high frequency (UHF (TV)). Radio and TV stations also stream broadcast and additional programming content over the Internet.

- **Cable**: The cable industry is composed of more than 7,700 cable systems that offer analog and digital video programming services, digital telephone service, and high-speed broadband services. The cable systems use a mixture of fiber and coaxial cable to provide bidirectional signal paths to the customer.

- **Satellite**: Platforms are launched into orbit to relay voice, video, or data signals. Earth station antennas transmit signals to the satellite, which are amplified and sent back to Earth for reception by other earth station antennas. Satellites use a combination of terrestrial and space components to perform many types of functions, such as the bidirectional transmission of voice, video, and data services; data collection; event detection; timing; and navigation.

- **Wireless**: Electromagnetic waves (rather than some form of wire) carry a signal over a communication path. Wireless technologies consist of cellular phones, wireless hot

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spots (Wi-Fi), personal communication services, high-frequency radio, unlicensed wireless, and other commercial and private radio services.

- **Wireline:** Circuit- and packet-switched networks transmit signals via copper, fiber, and coaxial transport media. It includes private enterprise data and telephony networks, the core backbone of the Internet, and the public switched telephone network (i.e., landlines).

This architecture is critical to maintain interoperable communications and data sharing in support of response operations. Like other sectors, communications architecture is vulnerable to intentional attacks, accidents, and physical disruption due to natural events. On December 25, 2020, a suicide bomber targeted an AT&T office in Nashville, Tennessee. Destruction of that office was considered a single-point-of-failure, disrupting connection points for regional internet and wireless communications. Disrupted communications included those of the First Responder Network Authority (FirstNet). A further description of FirstNet is below.

Communications equipment is frequently damaged or destroyed during natural disasters. Hurricane Michael hit the Florida panhandle in October 2018, for example, knocking out cellular infrastructure for several weeks. The lack of interoperable communications impacted response operations and slowed recovery efforts. Many cellular providers maintain continuity of operations resources, but wide-ranging incidents, or those that hinder movement into the affected area can overwhelm these resources.

FirstNet is an independent authority within the U.S. Department of Commerce to build and operate a nationwide public safety broadband network for the public safety community. FirstNet provides a dedicated “fast lane” of highly secure communications as well as priority access, preemption, additional network capacity, and a resilient, hardened connection. FirstNet is only available to public safety entities and those agencies that support response and recovery operations (e.g., mitigation, restoration). Since the introduction of FirstNet, other cellular carriers have begun introducing infrastructure dedicated to response agencies as well.

Many parts of the country, especially rural areas, remain without reliable internet access. Per the Federal Communications Commission’s (FCC) 2020 Broadband Deployment Report, 22.3 percent of Americans in rural areas and 27.7 percent of Americans in Tribal lands lack coverage from fixed terrestrial broadband. The same FCC report finds that 91 percent of the country has access to mobile long-term evolution (LTE) coverage. Commercial satellite broadband

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301 FirstNet by the Numbers, viewed 17 April 2021. [https://firstnet.gov/system/tdf/TopTenFAQs_190906.pdf?file=1&type=node&id=679&force=0](https://firstnet.gov/system/tdf/TopTenFAQs_190906.pdf?file=1&type=node&id=679&force=0)


303 Ibid., p. 21. It is important to note that the 91 percent indicates service with a median speed of 10/3 Mbps. However, this speed may not support all interoperability needs.
services offer global internet access, but these systems are currently limited as satellite constellations are being filled.

5G is the fifth-generation mobile network and it promises to provide significant benefits for the public safety community. (See the 5G description in the Technology Advancement pillar for further description of the technology.) Higher speeds for data transmission, the ability to connect sensors and other IoT devices, and fewer delays in obtaining information could significantly enhance the situational awareness and interoperable communications of emergency responders.

Deliberate attacks and terrorism remain a threat to infrastructure in this sector. Additional identified threats include: 304

- Natural disasters and extreme weather
- Supply chain vulnerabilities
- Global political and social implications
- Cyber vulnerabilities

Response efforts involving communications infrastructure may require collaboration with provider technical staff and information technology personnel.

**Impact on Responder Environment:**

There are a number of ways in which the communications sector can impact the response environment.

1. Damaged or destroyed communications infrastructure can significantly hinder response operations if it is not quickly reconstituted.
2. The introduction/expansion of commercial satellite-based broadband could improve interoperability while responding to incidents in rural locations.
3. The integration of IoT devices could provide considerable improvements to incident response operations, as well as daily monitoring of critical infrastructure.
4. Communications equipment may continue to be a target for attacks, especially due to conspiracy theories about the technology.

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Communications Sector Associated Capability Needs:
CRITICAL MANUFACTURING SECTOR

Overview: The Critical Manufacturing sector is a key component of the economy in the United States. The sector represents a range of manufacturers that differ based on function, size, operating standards, and security risks. Products made by this sector are essential to many other critical infrastructure sectors. The sector focuses on nationally significant manufacturing industries that may be susceptible to manmade or natural disasters.

There are four main components to the critical manufacturing sector:

- **Primary metals manufacturing**: processes aluminum, iron, and steel that supports transportation, urban centers, energy supply, clean water, safe food, and defense
- **Machinery manufacturing**: includes engines, turbines, power transmission equipment, and heavy machinery
- **Electrical equipment, appliance, and component manufacturing**: includes specialized power generation equipment, including critical transformers and generators
- **Transportation equipment manufacturing**: includes critical components for cars, trucks, commercial ships, commercial aircraft, and rail parts for both passenger and freight

The primary relationship between this sector and the public safety community is the need to respond to incidents at these manufacturing sites. There are several hazards present at manufacturing facilities, from power equipment to toxic chemicals. As with the chemical sector, responders may have limited knowledge of what is being manufactured within their jurisdiction and the associated hazards until they arrive on scene. In 2006, a propane explosion at an industrial gear facility killed three and injured an additional 47. Firefighters were alerted when the force of the explosion buckled the station door and then immediately dispatched themselves to the scene, calling for more dispatched resources.

Identified threats to this sector include:

- Natural disasters and extreme weather
- Supply chain disruptions
- Global political and social implications

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307 Ibid


- Deliberate attacks and terrorism
- Cyberattacks

Response to incidents at critical manufacturing facilities may require close collaboration with DHS, the U.S. Department of Justice (DOJ) Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF), the U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration, chemical manufacturers, energy utilities, public health, and healthcare infrastructure.

**Impact on Responder Environment:**

There are a number of ways in which the critical manufacturing sector can impact the response environment:

1. Disruptions in the supply chain have caused significant shortages of critical response supplies.
2. Manufacturing facilities may contain hazards that responders are unaware of or unfamiliar with before arrival on scene.

**Critical Manufacturing Sector Associated Capability Needs:**

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<thead>
<tr>
<th>SA.3</th>
<th>SA.11</th>
<th>CIS.5</th>
<th>CIS.16</th>
<th>CCC.1</th>
<th>CCC.4</th>
<th>RHS.16</th>
<th>RHS.18</th>
<th>LRM.28</th>
<th>LRM.29</th>
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<td>RHS.19</td>
<td>RHS.21</td>
<td>LRM.30</td>
<td>LRM.31</td>
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<td>SA.31</td>
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<td>LRM.51</td>
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</table>

| CM.15 | CM.16 | TE.13 | TE.16 | RAP.4 | RAP.6 | II.13 | II.15 | OPS.8 | OPS.23 |
| CM.19 | CM.22 | TE.17 | TE.18 | RAP.18 |       | II.25 | II.33 | OPS.25 | OPS.37 |
|       |       | TE.19 | TE.20 |       |       | II.35 |       | OPS.38 | OPS.39 |
|       |       |       |       |       |       |       |       | OPS.44 | OPS.46 |
|       |       |       |       |       |       |       |       |       | OPS.50 |
Overview: The Dams sector provides critical water retention and control services in the United States, including hydroelectric power generation, municipal and industrial water supplies, agricultural irrigation, sediment and flood control, river navigation for inland bulk shipping, industrial waste management, and recreation. Sector infrastructure includes dam projects, hydropower plants, navigation locks, levees, dikes, hurricane barriers, mine tailings, and other industrial waste collection sites. These assets are owned and maintained by a mixture of public and private entities under regulatory oversight from Federal, State, and local agencies.

Sector assets irrigate at least 10 percent of cropland in the United States, protect over 43 percent of the population from flooding, and generate about 60 percent of electricity in the Pacific Northwest. There are more than 87,000 dams and an estimated 100,000 miles of levees.

There are four primary Dam Sector components: dams, levees, navigation locks, and impoundment structures.

Dams are structural mechanisms designed to hold back water. Complete or partial dam failure could result in sudden downstream flooding that causes casualties; major destruction and property damage; and cascading disruptions. Dams are classified based on their hazard potential, or anticipated consequences in the case of failure. A dam with a high-hazard potential is anticipated to cause a loss of life. The number of high-hazard potential dams is growing; in 2015, there were approximately 15,500 US dams classified as high-hazard potential. Another 11,882 dams are currently labeled as significant-hazard potential, meaning a failure would not necessarily cause a loss of life, but could result in significant economic losses. Only about 80 percent of high-hazard potential dams have
developed emergency action plans. Dam safety programs exist in all states (except Alabama), but they often have limited resources and personnel.

Levees are manmade permanent structures designed to contain, control, or divert water and provide protection against temporary flooding in a set area. Hurricane barriers operate in a similar fashion, but generally consist of large steel gates that can be opened or closed depending on need. Levee systems often stretch across multiple miles and several different communities or governance units, which can complicate or delay repair, response, and mitigation. The U.S. Army Corps of Engineers (USACE) manages about ten percent of the Nation’s levees and 85 percent are locally owned and maintained. Of those overseen by USACE, 91 percent have deficient maintenance. Because there is no federal oversight of the other levees, the structural integrity and level of maintenance is unknown.

Navigation locks consist of chambers on rivers or canals that are used by commercial and recreational water traffic to move between pooled water areas that are not at the same level. Locks are used to make inland waterways navigable year-round. There are 236 lock chambers at 192 lock sites owned and/or operated by USACE – more than half of which are over 50 years old.

Multiple industries (e.g., mining, electrical power generation, manufacturing) use impoundment structures – very similar to dams – to store waste products that are suspended in water. Impoundments pose possible health and safety risks to the surrounding population and property if breached. The Piney Point reservoir incident that occurred in Manatee County, Florida (adjacent to Tampa Bay) in April 2021 illustrates this hazard. One of the reservoir’s retention walls suffered a breach and as a result hundreds of homes were evacuated, and more than 200 million gallons of contaminated wastewater was released into Tampa Bay.

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317 Ibid., p. 6
318 Ibid., p.
319 Ibid, p. 47
320 Ibid., p. 6
In May 2020, heavy rainfall caused significant flooding in central Michigan. The floods resulted in the failure of two dams, forcing thousands of residents to evacuate their homes. It is also believed that the flooding from one of the dam failures breached a local chemical manufacturing facility.322

The ASCE graded the Nation’s dams for the 2021 Infrastructure Report Card. Dams received a grade of “D.” Also of note, the ASCE graded the hazardous waste sector as a “D+,” referencing the fact that 60 percent of hazardous materials sites – to include impoundment structures – are in areas that could be impacted by flooding.323

Identified threats to this sector include:324,325

- Natural disasters and extreme weather
- Erosion and structural issues
- Aging infrastructure and workforce
- Cyberattacks
- Deliberate attacks and terrorism

Response to incidents at dams sector infrastructure may require close collaboration with the U.S. Army Corps of Engineers, Mine Safety and Health Administration, state and local operators and maintenance staff, industrial manufacturers, and energy and water utilities personnel.

Impact on Responder Environment:

There are a number of ways in which the dams sector can impact the response environment.

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1. Many local communities are unaware of the status of local dams and levees.
2. The effects of a dam failure are instantaneous and may allow no time to provide advanced warning or guidance to the community.
3. A dam failure may inundate local transportation routes, potentially cutting off personnel and resources needed for the response.
4. A levee or dam failure may have significant impacts on other critical infrastructure, such as energy utilities and water treatment facilities.
5. Many communities have not assessed the consequences of a dam failure (or cascading dam failures) in their area.
6. Without an incident action plan, responders in the vicinity of high-hazard potential dams may be even further overwhelmed in trying to respond to dam failures.
7. Recent dam failures have illustrated the need to train for these scenarios.
8. A breach from an impoundment structure could have significant public health and public safety impacts. Many communities are unaware of the status of these facilities or unable to take steps to address known issues.

Dams Sector Associated Capability Needs:

<table>
<thead>
<tr>
<th>SA.3</th>
<th>SA.14</th>
<th>CIS.5</th>
<th>CIS.16</th>
<th>CCC.1</th>
<th>CCC.5</th>
<th>RHS.5</th>
<th>RHS.9</th>
<th>LRM.2</th>
<th>LRM.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA.15</td>
<td>SA.16</td>
<td>CIS.20</td>
<td>CIS.34</td>
<td>CCC.11</td>
<td>CCC.12</td>
<td>RHS.12</td>
<td>RHS.18</td>
<td>LRM.4</td>
<td>LRM.8</td>
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</tbody>
</table>
Overview: The Defense Industrial Base (DIB) sector is the complex that enables research and development (R&D), design, production, delivery, and maintenance of military weapons systems, subsystems, and components or parts. There are more than 100,000 companies and subcontractors who perform under contract to DoD, companies providing incidental materials and services to the DoD, and government-owned/contractor-operated and government-owned/government-operated facilities. Industries in the DIB include shipbuilding, aircraft, missile, space, combat vehicle, ammunition, weapons, troop support, information technology, electronics, mechanical, structural, and R&D. This sector provides products and services essential to mobilize, deploy, and sustain military operations.

There are nine segments in the Defense Industrial Base:

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Ships</th>
<th>Tracked &amp; Wheeled Land Vehicles</th>
<th>Electronics</th>
<th>Soldier Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural</td>
<td>Munitions</td>
<td>Space</td>
<td>Mechanical</td>
<td></td>
</tr>
</tbody>
</table>

The primary relationship between this sector and the public safety community is the need to respond to incidents at DIB facilities. Military installations and entities that support them are known terrorist targets.

Identified threats to this sector include:

- Cyber-threats

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• Loss of supply chain integrity
• Insider threat

Much like the ASCE produces the infrastructure report card for some critical infrastructure sectors, the National Defense Industrial Association (NDIA) developed *Vital Signs 2020* which assigns a grade to the DIB. The DIB earned a “C” grade. The sector is dealing with deteriorating conditions for industrial security, reductions in skilled workforce availability, and increasing cost of materials.³³³

Response to incidents at DIB facilities may require close collaboration with components of the DoD; explosive material production facilities; companies, laboratories, and academic institutions developing or manufacturing weapons or other equipment; and the National Guard.

**Impact on Responder Environment:**

There are a number of ways in which the DIB sector can impact the response environment.

1. As with the chemical and critical manufacturing sectors, DIB facilities may contain hazardous materials that can endanger arriving response personnel.
2. The security requirements of DIB facilities may hinder or prevent sharing of information with local response agencies about the nature of threats and hazards.
3. Responding units may be unable to access facilities or infrastructure because of security restrictions.
4. Closed or decommissioned DIB facilities often continue to pose threats to the community and may cause or contribute to incidents.

Defense Industrial Base Sector Associated Capability Needs:
Energy infrastructure in the United States is used to generate, transmit, and distribute electricity.\(^{334}\) The Energy sector provides an “enabling function” across all other critical infrastructure sectors. Virtually all industries rely on electric power and fuels.

The energy infrastructure is divided into three interrelated segments: electricity, oil, and natural gas.

<table>
<thead>
<tr>
<th>ENERGY SECTOR</th>
<th>NEAR</th>
<th>MID</th>
<th>LONG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td></td>
<td></td>
<td>6,400 power plants</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>600,000 miles of transmission lines</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.5 million miles of distribution lines</td>
</tr>
<tr>
<td>Oil</td>
<td></td>
<td></td>
<td>135 oil refineries</td>
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<td></td>
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<td></td>
<td>190,000 miles of oil pipelines</td>
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<tr>
<td>Natural Gas</td>
<td></td>
<td></td>
<td>490,000 producing gas wells</td>
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<tr>
<td></td>
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<td></td>
<td>2.4 million miles of gas pipelines</td>
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</tbody>
</table>

Over 4 trillion kilowatt-hours of electricity were generated in the United States in 2020.\(^{335}\) Approximately 40 percent of electricity is produced by natural gas, 20 percent in nuclear power plants, and 20 percent by renewable sources (solar, wind, and geothermal). Coal-fired power plants produce 19 percent of electricity, and petroleum produced less than 1 percent.\(^{336}\) Figure 62 illustrates the major sources of electricity produced in the United States.

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\(^{334}\) “Energy,” American Society of Civil Engineers, 2021 Report Card for America’s Infrastructure; viewed 16 April 2021. [https://infrastructurereportcard.org/cat-item/energy/](https://infrastructurereportcard.org/cat-item/energy/)


\(^{336}\) Ibid.
On March 5, 2019, hackers attacked a power grid in the western United States, causing “blind spots” in California, Utah, and Wyoming.\textsuperscript{337} There were no customers affected, but this incident illustrates that energy sector infrastructure is vulnerable. A similar attack in the Ukraine in 2015 left hundreds of people without power in December.

Identified threats to this sector include:\textsuperscript{338,339}

- Cyber and physical security threats
- Natural disasters and extreme weather
- Equipment failure and aging infrastructure
- Operational hazards including blowouts, spills, and personal injury


EVOLVING RESPONSE ENVIRONMENT: INFRASTRUCTURE

- Disruption due to political instability, civil unrest, or terrorist activities
- Insider threats

The ASCE gave the Nation’s energy sector a grade of “C-” in the 2021 Infrastructure Report Card. Weather is a continuing threat to the electrical grid, responsible for an increasing number of outages.

Response to incidents involving energy sector infrastructure may require close cooperation with the Federal Emergency Regulatory Commission (FERC); Pipeline and Hazardous Materials Safety Administration (PHMSA); Nuclear Regulatory Commission (NRC); independent utility workers, and pipeline operators.

**Impact on Responder Environment:**

There are several ways in which the energy sector can impact the response environment.

1. Aging gas line infrastructure is leading to ongoing leaks that are too numerous to address which is leading to increased fire calls and safety issues.
2. Because oil pipelines are full, crude oil is being transported via railway leading to unsafe situations (lack of foam to fight explosions, lack of rail cars to hold oil, lack of capability to address issues) linked to transportation and energy infrastructure sectors.
3. Prolonged electricity outages can have significant safety and health effects.
4. Electric vehicle charging stations create new hazards.
5. There are ongoing cyber threats and attacks against the Nation’s power grid and energy infrastructure.
6. Remotely operated control systems are vulnerable to cyberattacks.
7. Solar storms can have a significant impact on terrestrial power grids and could damage or destroy electrical infrastructure.

**Energy Sector Associated Capability Needs:**

- SA.2
- SA.3
- CIS.5
- CIS.16
- CCC.1
- CCC.4
- RHS.11
- RHS.21
- LRM.4
- LRM.26
- SA.4
- SA.5
- CIS.19
- CIS.20
- CCC.11
- CCC.12
- LRM.51
- LRM.53
- SA.11
- SA.13
- CIS.21
- CIS.26
- SA.14
- SA.15
- CIS.34
- CIS.36
- SA.18
- SA.20
- CIS.37
- SA.21
- SA.36
## PROJECT RESPONDER 6

### EVOLVING RESPONSE ENVIRONMENT: INFRASTRUCTURE

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<th>TE.2</th>
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<th>RAP.4</th>
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FINANCIAL SERVICES SECTOR

Overview: The Financial Services sector includes banks and credit unions, providers of investment products, insurance companies, other credit and financing organizations, and the providers of the critical financial utilities and services that support these functions. These organizations are the backbone of the Nation’s financial system and a vital component of the global economy. These organizations are tied together through a network of electronic systems and most services are provided through or conducted on information and communications technology platforms. This sector is not as interconnected to public safety operations as some of the other sectors because of the virtual nature of much of the infrastructure. However, an incident — whether manmade or natural — impacting these systems could have detrimental effects on the entire economy and prevent response agencies from being able to acquire critical resources when needed.

Cyberattacks directed against the financial services sector are increasing. Financial institutions are a key target of DDOS attacks as well as data and identity theft attempts. Market manipulation from misinformation is also an issue. In addition, many facilities in the financial sector are vulnerable to physical destruction from earthquakes, flooding, tornados, terrorist attacks, etc. For example, the events of September 11, 2001 and the landfall of Superstorm Sandy in 2012 caused markets and exchanges to close.

Identified threats to this sector include:

- Cyber threats
- Insider threats
- Large-scale physical events

Impact on Responder Environment:

There are a number of ways in which the financial services sector can impact the response environment.

1. Response agencies may be unable to purchase resources if financial systems are unavailable due to DDOS attacks.
2. Financial systems are dependent on other infrastructure sectors (e.g., water to maintain server temperatures, electricity and network access to conduct business).

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342 Ibid., p. 13
343 Ibid., p 14
Financial Services Sector Associated Capability Needs:
FOOD & AGRICULTURE SECTOR

Overview: The Food and Agriculture sector is composed of complex production, processing, and delivery systems and has the capacity to feed people and animals both within and beyond the boundaries of the United States. The sector is almost entirely under private ownership and is composed of an estimated 2.1 million farms, 935,000 restaurants, and more than 200,000 registered food manufacturing, processing, and storage facilities. This sector accounts for roughly one-fifth of the nation's economic activity.

There are a number of risks to the food and agriculture sector that require the involvement of emergency response, including contaminated food, being the target of anti-government groups trying to defy land ownership restrictions, the outbreak of foreign animal disease, and COVID-19 complications.

- Contaminated food in the United States is estimated to be responsible for approximately 48 million illnesses, 128,000 hospitalizations, and 3,000 deaths per year. Contamination can be caused by improper food handling or unsafe practices during farming/ranching, manufacturing, distribution, or storage. The majority of foodborne illnesses derived from infrastructure and processes can be prevented. However, some groups specifically target food supplies for terrorist attacks. Restaurants, supermarkets, and food at gatherings in the United States have been the targets of biological attacks, as well as foreign-produced food items destined for this country.

- Farm and ranching operations have been the target of anti-government groups trying to defy land ownership restrictions (e.g., Bundy Ranch standoff, Malheur National Wildlife Refuge standoff). Federal, state, and local law enforcement agencies have been involved in the response to these incidents.

- An outbreak of a foreign animal disease can require the destruction of livestock or wildlife. This creates challenges to maintain the safety of responders and the public, conduct surveillance and monitoring to ensure that the disease does not mutate, and safely dispose of culled animals to ensure that the waste does not impact other sectors (e.g., wastewater).

- As of April 2021, at least 89,711 workers (58,741 meatpacking workers, 17,906 food processing workers, and 13,064 farmworkers) have tested positive for COVID-19 and at least 383 workers (291 meatpacking workers, 49 food processing workers, and 43

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347 Ibid., p. 5
farmworkers) have died.\textsuperscript{348} This resulted in over 70 temporary meat plant closures alone.\textsuperscript{349}

Identified threats to this sector include:\textsuperscript{350,351}

- Food contamination and disruption
- Cyberattacks
- Disease and pests
- Severe weather

Response to food and agriculture incidents requires close collaboration with public health epidemiological personnel, veterinarians, farm operations, and park service and land management staff.

**Impact on Responder Environment:**

There are a number of ways in which the food and agricultural sector can impact the response environment.

1. An outbreak of food-borne illness can place a significant strain on a community’s EMS systems.
2. Terrorist groups may continue to target food supplies for biological attacks.
3. Anti-government farming and ranching activities may increase given pardons given to those that participated in the standoff in Oregon.

**Food & Agricultural Sector Associated Capability Needs:**


**GOVERNMENT FACILITIES SECTOR**

**Overview:** The Government Facilities sector (GFS) includes a wide variety of buildings, located in the United States and overseas, that are owned or leased by federal, state, local, and tribal governments. Many government facilities are open to the public for business activities, commercial transactions, or recreational activities. Some that are not open to the public contain highly sensitive information, materials, processes, and equipment. These facilities include general-use office buildings and special-use military installations, embassies, courthouses, national laboratories, and structures that may house critical equipment, systems, networks, and functions. In addition to physical structures, the sector includes cyber elements that contribute to the protection of sector assets (e.g., access control systems and closed-circuit television systems) as well as individuals who perform essential functions or possess tactical, operational, or strategic knowledge.  

Government facilities can be targets of terrorist activities or violence. They are also subject to physical destruction from natural disasters.

- Lone-wolf and terrorist groups have repeatedly targeted government facilities. In 1995, the Alfred P. Murrah federal building was the site of one of the deadliest domestic terror attacks in the United States. On September 11, 2001, American Airlines flight 77 hit the Pentagon and it is believed that United Airlines flight 93 was heading for the Capitol or White House. Because of the potential psychological impacts if a government facility is damaged or destroyed, these buildings and installations will continue to be a preferred target for terrorist incidents.

- Anti-government militia groups. Multiple anti-government groups participated in the assault on the U.S. Capitol on January 6, 2021. Members of the U.S. Capitol Police were violently targeted during that incident. Some of these groups conduct activities against law enforcement personnel (e.g., drive-by shooting of law enforcement personnel, firing automatic weapons at police stations), while others include retired members of law enforcement and other emergency response agencies.

- Protesters in Seattle, Washington declared a “police-free” autonomous zone in June 2020 as part of the racial injustice demonstrations. Some participants targeted the Seattle Police Department’s vacant East Precinct building, vandalizing it and setting parts on fire. In Portland, Oregon, Washington, DC, and other cities, rioters caused damage to government infrastructure.

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Identified threats to this sector include:\(^{353,354}\)

- Terrorist attacks
- Cyberattacks
- Natural disasters and extreme weather
- Public health hazards
- Active shooter threats
- Aging infrastructure

Response to government facility incidents requires close collaboration with U.S. Federal Protective Service personnel and local security staff.

**Impact on Responder Environment:**

There are a number of ways in which the government facilities sector can impact the response environment.

1. There is a potential for significant loss of life if responders are in government facilities when they are targeted by terrorist groups.
2. The loss of public safety buildings and infrastructure during natural disasters can hinder the ability of responders to carry out their tasks.
3. Law enforcement personnel may be required to engage with anti-government militias if government facilities are the site of disputes, civil litigation, or criminal prosecution.
4. Government facilities may require additional security measures if they are in the vicinity of or the targets of civil unrest.
5. Responders may have difficulty accessing secure government facilities without proper clearance or access.

**Government Facilities Sector Associated Capability Needs:**

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**HEALTHCARE & PUBLIC HEALTH SECTOR**

| NEAR | MID | LONG |

**Overview:** Access to healthcare is critical in maintaining national health security. In 2011, Americans made 262 million visits to hospital emergency or outpatient departments. At any one time, almost 50 percent of Americans require one or more prescription medications to mitigate health issues.\(^{355}\) The Healthcare and Public Health (HPH) sector includes publicly available healthcare facilities, public health agencies, laboratories and research centers, manufacturers, fatality management, medical materials, blood services, and a public-private information technology system. Since the vast majority of the sector’s assets are privately owned and operated, collaboration and information sharing between the public and private sectors is essential to increasing resilience. Operating in all states, territories, and tribal areas, the sector plays a significant role in response and recovery across all other sectors in the event of a natural or manmade disaster. While healthcare tends to be delivered and managed locally, the public health component of the sector, focused primarily on population health, is managed across all levels of government.\(^{356}\)

The sector faces significant demands on its infrastructure and personnel:

- According to recent studies, nearly 80 percent of the rural United States is “medically underserved”.\(^{357}\) This lack of services places significant burdens on those who need to take a day off from work or drive significant distances to get medical attention. Once at a hospital, resource shortages have caused long wait times to receive service. Santa Clara County, California reported seven-hour wait times for ambulances to drop off patients during January 2021, at the height of COVID-19 hospitalizations.\(^{358}\)

- There is a national shortage of mental health care providers and facilities. More than half of the counties in the United States have no practicing psychiatrists, 37 percent have no psychologists, and two-thirds have no psychiatric nurse practitioners.\(^{359}\) PR6 participants report that mental health beds or space are often at capacity and mental health centers across the country have closed. In addition, due to the pandemic, many psychiatric beds were repurposed for COVID patients, further reducing the availability

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of space for those experiencing a mental health crisis. Often, responders are forced to bring patients to local jails because there are no other facilities available.

- On January 12, 2021, the United States faced its most significant potential shortage in intensive care unit (ICU) beds. On that date, 82% of ICU beds in the nation were in use.\(^{360}\) While this still shows some capacity nationwide, some jurisdictions ran out of ICU beds — many as early as November 2020.

- Natural disasters also pose a physical threat to healthcare and public health infrastructure. Both the Joplin tornado of 2011 and Superstorm Sandy in 2012 damaged or destroyed healthcare facilities and resources.

- The public health system has been significantly reduced. There are approximately 2,800 local health departments that provide immunizations, conduct surveillance to detect and monitor emerging infectious diseases, protect the food and water supply, and prepare for and respond to disasters, acts of bioterrorism and other health emergencies.\(^{361}\) Since 2010, spending for state public health departments has dropped by 16 percent per capita and spending for local health departments has fallen by 18 percent.\(^{362}\) At least 38,000 state and local public health jobs have been lost since 2008. Those personnel that remain have been working evenings, weekends and holidays to deal with the pandemic. Workforce reductions will continue to be impacted by personnel electing to leave the profession or retire during or after this pandemic response.

- Federal public health funding has also been reduced. CDC funding for public health preparedness and response programs decreased between FY 2019 and FY 2020, from $858 million to $850 million and has been cut in half over the last decade.\(^{363}\) The Hospital Preparedness Program — part HHS’s Office of the Assistant Secretary for Preparedness and Response (ASPR) — is the single source of federal funding to help regional healthcare systems prepare for emergencies. Its budget was $515 million in FY 2004 and $275.5 million in FY 2020.\(^{364}\)

- Before the pandemic, many healthcare systems kept relatively low stockpiles to reduce costs. The HPH Sector Specific Plan warned that the “just-in-time” delivery model may

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\(^{364}\) Ibid.
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leave the system with very limited inventories, diagnostic capabilities, or capacity in an emergency.\textsuperscript{365} Not only did the pandemic cause significant supply chain disruptions, but the movement of many manufacturing centers out of the United States resulted in little domestic ability to address shortages.

Identified threats to this sector include:\textsuperscript{366,367}

- Global supply chain disruption
- Theft and exploitation of medical goods and confidential medical information
- Pandemic and health crises
- Natural disaster, extreme weather, and climate change
- Malicious human acts
- Cyberattacks
- Space weather and electromagnetic pulse (EMP)

Response to incidents involving the HPH sector requires close collaboration with public and private health system staff, insurance companies, laboratory employees, manufacturing and distribution organizations, and public health personnel.

Impact on Responder Environment:

There are a number of ways in which the healthcare and public health sector can impact the response environment.

1. Aging and inefficient healthcare infrastructure is making it difficult to treat victims (e.g., requirements for patient transport).
2. There is a lack of options in healthcare infrastructure (e.g., closure of hospitals, high level trauma centers, and emergency rooms) for patient transport and receiving.
3. There is a lack of healthcare infrastructure options in rural areas.
4. The lack of access to healthcare is causing patients to wait too long to go for care leading to increasingly sick individuals needing emergency service.
5. Lack of access to primary care physicians causes patients to utilize emergency departments as their primary care providers placing an additional strain upon emergency medical services and emergency department resources.
6. Long wait times at hospitals cause EMS assets to be out of service for long periods of time.


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7. The lack of mental health infrastructure causes responders to spend significant amounts of time trying to find appropriate beds for patients or transport them to local jails during a mental health crisis.

8. Health privacy regulations prevent the sharing of many elements of patient data, making it difficult for response agencies to access needed information (e.g., COVID-19 status of persons calling for service).

9. Medical systems are frequent and increasing targets of DDOS and other cyber-attacks. According to recent reports, attacks against healthcare entities have risen 45 percent since November 2020 alone.\textsuperscript{368} In October 2020, the Cybersecurity and Infrastructure Security Agency (CISA), the Federal Bureau of Investigation (FBI), and HHS developed a joint cybersecurity advisory based on imminent threats against the HPH.\textsuperscript{369}

Healthcare & Public Health Associated Capability Needs:

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\end{figure}

\textsuperscript{368} “Attacks targeting healthcare organizations spike globally as COVID-19 cases rise again,” Checkpoint Software Technologies; viewed 15 April 2021. \url{https://blog.checkpoint.com/2021/01/05/attacks-targeting-healthcare-organizations-spike-globally-as-covid-19-cases-rise-again/}

Information Technology Sector

Overview: The Information Technology (IT) sector is central to the Nation’s security, economy, public health, and safety. Businesses, governments, academia, and private citizens are increasingly dependent upon sector functions. The IT sector functions produce and provide hardware, software, and information technology systems and services, and the Internet. The IT sector provides products and services that support the efficient operation of today’s global information-based society. These products and services are integral to the operations and services provided by other critical infrastructure sectors. Information Technology sector functions are operated by a combination of entities that maintain and reconstitute the network, including the Internet. The IT sector is integral to the operations and services provided by other critical infrastructure sectors.

There are six IT Sector functions and the public safety community is reliant on each during routine and catastrophic event response.

- **Provide IT products and services.** Response agencies use hardware and software products across many tasks. From incident management software to IoT devices and mobile data terminals, the successful operation of these components is critical to obtain situational awareness, provide interoperable communications, maintain responder safety and manage resources, among other tasks.

- **Provide incident management capabilities.** The Sector provides incident management capabilities for itself and other Sectors. The reliance of other Sectors on IT products and services to maintain routine tasks and prevent hijacking of operations cannot be overstated. Attacks against oil refineries, electrical grids, gas pipelines, etc. have and could cause significant impacts on critical infrastructure.

- **Provide domain name recognition services.** Attacks such as Domain Name Services (DNS) spoofing and poisoning divert internet traffic to fraudulent servers and cause systems to return to sites that look legitimate. Redirection of data (e.g., from flood sensors, patient medical devices) to fraudulent sites could result in the capture and ransom of critical response information.

- **Provide identity management and associated trust support services.** Authenticating and authorizing access to IT systems, as well as ensuring users are who they purport to be.

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be, is a critical function in public safety and for other sectors. Unauthorized access to
air traffic control systems, for example, could result in catastrophic outcomes. Similarly, ransomware attacks on an electrical grid during extreme heat or cold could cause multiple adverse health effects.

• **Provide internet-based content, information, and communication services.** Public safety agencies and other critical infrastructure sectors are increasingly reliant on internet-based data and communications. Video teleconferencing, critical during COVID-19 social distancing restrictions, is an example of internet-based communications used throughout the critical infrastructure sectors. Likewise, many public safety data repositories (e.g., automated fingerprint identification system (AFIS)) are accessible through the internet. While some repositories allow local caching on servers or system, the ability to access updated data and information would be significantly hampered without Internet access.

• **Provide internet routing, access, and connection services.** In coordination with the Communications Sector, the IT Sector provides and supports the Internet backbone infrastructure. If the Internet was disrupted for any period of time, public safety agencies would have difficulties with communicating, accessing any internet-based data, executing financial transactions, sharing information, and conducting many operations.

Identified threats to this sector include:\(374,375\)

• Cyberthreats
• Attacks targeting Internet-based identity
• Physical attacks on IT infrastructure

Manmade deliberate attacks on any of these functions could prove catastrophic for response operations. Response to incidents involving the IT Sector require close collaboration with private and public information technology professionals throughout hardware, software, application, cybersecurity, and network entities.

**Impact on Responder Environment:**

There are a number of ways in which the information technology sector can impact the response environment.

1. Given the reliance of much of the public on access to the Internet and technical devices, a disruption in IT infrastructure would prove a significant hardship for many sectors.

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2. Cyberattacks on public safety telecommunications, city services, and healthcare facilities can cripple emergency response operations.

3. Internet-based data and communications are a critical part of emergency response operations of today and for the future. Disruption in internet access could prove catastrophic.

**Information Technology Sector Associated Capability Needs:**
Overview: The Nuclear Reactors, Materials, and Waste sector covers most aspects of US civilian nuclear infrastructure from the power reactors that provide electricity to millions to the medical isotopes used to treat cancer patients. For the purposes of Project Responder 6, the study team included radiological materials and waste within this Sector.

The Nuclear Reactors, Materials, and Waste Sector includes:

- 99 Active and 18 Decommissioning Power Reactors in 30 states that generate nearly 20 percent of US electricity
- 31 Research and Test Reactors located at universities and national labs. These reactors produce medical and industrial isotopes used to treat cancer and perform radiographic services, as well as to conduct academic research across multiple fields, including chemistry, physics, and materials science.

Figure 62. The location of nuclear reactors and test reactors in the United States as of 2019. Image from USNRC.

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Eight (8) active nuclear fuel cycle facilities that are responsible for the production and reprocessing of nuclear reactor fuel. These facilities take natural uranium from the ground and enrich it to approximately five percent Uranium-235. This enriched uranium is turned into solid Uranium Dioxide fuel pellets for use in nuclear reactors.

More than 20,000 licensed users of radioactive sources. These radioactive sources are used for medical diagnostics and treatment in hospitals, depth measurements at oil and gas drilling sites, sterilization at food production facilities, research in academic institutions, and examining packages and cargo at security checkpoints.

Over three million yearly shipments of radioactive materials. Special security measures are taken when radioactive materials are shipped to ensure the safety of the transportation workers, and to prevent theft or sabotage of the radioactive material itself.

The International Nuclear and Radiological Event Scale (INES) is used to categorize incidents. There have been 13 significant nuclear plant accidents and incidents in the United States, with the most severe being a partial core meltdown at Three Mile Island (Pennsylvania) in 1979 (INES level 5). There have also been multiple other nuclear and radiological incidents in the United States. These incidents have caused significant health damage, property damage and/or contamination. Some PR6 participants reported that they do not have a confident understanding of the radiological threats in their jurisdiction.

Identified threats to this sector include:

- Natural disasters and extreme weather
- Structural issues
- Aging infrastructure and workforce
- Deliberate attacks and terrorism
- Cyberattacks
- Supply chain disruption
- Source diversion or mishandled and “orphaned” radioactive sealed sources

Response to incidents involving the Nuclear Sector require close collaboration with the Nuclear Regulatory Commission, the National Nuclear Security Administration, plant operators, hospital systems, academic programs, laboratories, and public health personnel.

Impact on Responder Environment:

There are a number of ways in which the nuclear/radiological reactors, material, waste sector can impact the response environment.

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1. Accidents or attacks on nuclear power plants and radiological sources have the potential to cause significant health effects, property damage, and contamination of soil, buildings, waterways, etc.

2. Physical damage or destruction of nuclear sites and radiation sources can be caused by natural disasters (e.g., Fukushima meltdown).

3. Clean-up or restoration after nuclear or radiological incidents can result in long-term effects for water reservoirs and land usage.

4. Many responders do not have the equipment to detect radiation.

5. There is difficulty in conducting realistic exercises focused on nuclear site or radiological source incidents. Responders need access to scenarios, injects, and other exercise materials necessary to execute realistic nuclear response and recovery exercises.

6. Responders would like increased access to JIT and beyond-awareness-level training related to nuclear threats in their jurisdiction.

7. Emergency medical response to a nuclear or radiological incident has the potential to contaminate apparatus and health care facilities.

Nuclear/Radiological Associated Capability Needs:
Transportation Sector

Overview: The Transportation Systems sector in the United States is responsible for quickly, safely, and securely moving people and goods through the country and overseas. Transportation Systems provide lifeline services for communities and are vitally important for response and recovery operations. The vast network of public and private critical infrastructure owners and operators, the infrastructure and services they manage, and the extensive interdependencies among the transportation modes and other sectors indicate the need for coordinated planning and investments to manage all hazards efficiently and effectively. Government entities and transportation critical infrastructure owners and operators share responsibility for managing the security and resilience of the Sector’s infrastructure and systems.

The Transportation Systems Sector consists of seven sub-sectors:

- **Aviation** includes aircraft, air traffic control systems, and about 19,700 airports, heliports, and landing strips. Approximately 500 provide commercial aviation services at civil and joint-use military airports, heliports, and sea plane bases. In addition, the aviation mode includes commercial and recreational aircraft (manned and unmanned) and support services, such as aircraft repair stations, fueling facilities, navigation aids, and flight schools. The ASCE graded the Nation’s aviation infrastructure a “D-” because of performance, inadequate infrastructure, and condition of runways.

- **Highway and Motor Carrier** encompasses more than 4 million miles of roadway, more than 600,000 bridges, and more than 350 tunnels. Vehicles include trucks, including those carrying hazardous materials; other commercial vehicles, including commercial motorcoaches and school buses; vehicle and driver licensing systems; traffic management systems; and cyber systems used for operational management. The road system received a “D” in the 2021 ASCE infrastructure grades, with over 40 percent of the system rated as being in poor or mediocre condition. The ASCE assessment of the roadways is based on congestion and reliability.
  - ASCE assessed the status of the bridges in the United States separately. There are more than 617,000 bridges across the United States. Currently, 42 percent

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of all bridges are at least 50 years old, and 7.5 percent of the nation’s bridges are considered structurally deficient. ASCE rated bridges as a “C.”\(^{385}\)

- **Maritime Transportation System** consists of about 95,000 miles of coastline, 361 ports, more than 25,000 miles of waterways, and intermodal landside connections that allow the various modes of transportation to move people and goods to, from, and on the water. ASCE graded the Nation’s port system as a “B-,” focusing on expansion of capacity and access to other modes of transport.\(^ {386}\)

  - ASCE assessed the status of inland waterways separately as well. There are over 2,000 miles of inland navigation channels as well as an additional 11,000 of intracoastal waterways owned and operated by the U.S. Army Corps of Engineers.\(^{387}\) ASCE graded inland waterways as a “D+” because of availability of channels, impact of increased flooding, and aging lock and dam infrastructure.\(^ {388}\)

- **Mass Transit and Passenger Rail** includes terminals, operational systems, and supporting infrastructure for passenger services by transit buses, trolleybuses, monorail, heavy rail — also known as subways or metros — light rail, passenger rail, and vanpool/rideshare. ASCE rated the Nation’s mass transit systems as a “D-” due to lack of access, ageing infrastructure, and declining ridership.

- **Pipeline Systems** consist of more than 2.5 million miles of pipelines spanning the country and carrying nearly all of the nation’s natural gas and about 65 percent of hazardous liquids, as well as various chemicals. Above-ground assets, such as compressor stations and pumping stations, are also included.

- **Freight Rail** consists of seven major carriers, hundreds of smaller railroads, over 138,000 miles of active railroad, over 1.33 million freight cars, and approximately 20,000 locomotives. An estimated 12,000 trains operate daily.

  - ASCE rated freight rail and passenger rail together, assigning a grade of “B.” Investments in expansion and technology improvements related to accident avoidance were cited in the report.\(^ {389}\)

\(^{385}\) “Bridges,” American Society of Civil Engineers, 2021 Report Card for America’s Infrastructure; viewed 16 April 2021. [https://infrastructurereportcard.org/cat-item/bridges/](https://infrastructurereportcard.org/cat-item/bridges/)

\(^{386}\) “Ports,” American Society of Civil Engineers, 2021 Report Card for America’s Infrastructure; viewed 16 April 2021. [https://infrastructurereportcard.org/cat-item/inland-waterways/](https://infrastructurereportcard.org/cat-item/inland-waterways/)

\(^{387}\) “Inland Waterways,” American Society of Civil Engineers, 2021 Report Card for America’s Infrastructure; viewed 16 April 2021. [https://infrastructurereportcard.org/cat-item/ports/](https://infrastructurereportcard.org/cat-item/ports/)

\(^{388}\) Ibid.

\(^{389}\) “Rail,” American Society of Civil Engineers, 2021 Report Card for America’s Infrastructure; viewed 16 April 2021. [https://infrastructurereportcard.org/cat-item/rail/](https://infrastructurereportcard.org/cat-item/rail/)
• *Postal and Shipping* moves about 720 million letters and packages each day and includes large integrated carriers, regional and local courier services, mail services, mail management firms, and chartered and delivery services.

Identified threats to this sector include: 390, 391

- Terrorism and physical attacks
- Aging infrastructure
- Natural disasters, climate change, extreme weather
- Cyberthreats
- Insider threats
- “Dark targets”
- Malicious actors
- Cascading effects from disruption to critical dependencies
- Mail-based threats
- Attacks using hazardous materials or CBRNE

Response to incidents involving the Transportation System Sector require close collaboration with transit sector employees, port authorities, rail and aviation carriers, pipeline infrastructure, the U.S. Coast Guard, the Department of Transportation, the Transportation Security Administration, the U.S. Army Corps of Engineers, the Federal Railroad Administration, Federal Aviation Administration, National Highway Safety Administration, U.S. Postal Service and private shipping entities, state and local waterways management authorities, and other related entities.

**Impact on Responder Environment:**

There are a number of ways in which the transportation sector can impact the response environment.

1. The poor state of the roadways in the United States can damage the suspension systems of responder apparatus and vehicles.
2. A breakdown of transportation infrastructure will hinder the movement of materiel and personnel to disaster and response sites.
3. Traffic management and congestion is a growing issue in many jurisdictions.
4. A breakdown of transportation infrastructure will hinder evacuation procedures before/during/after a disaster.
5. Aging passenger rail and subway systems are experiencing increasing breakdowns and disruptions in service.

6. Cybersecurity issues have the potential to cause harm to all aspects of the Transportation Sector.

7. Natural disasters routinely affect all Transportation Systems sub-sectors.

8. Response agencies often have little or no awareness of hazardous materials moving through their communities (on a daily basis) via roadways, rail, or inland waterways. Additional hazardous material can travel via air or through ports.

9. Rising sea levels and an increase in more extreme weather incidents are impacting roadways in many areas, leading to road closures and erosion of supporting structures.

10. One tactic of protesters is to close roadways and bridges. This impedes the movement of response vehicles as well as public traffic.

11. According to the National Safety Council, there were over 38,000 fatalities and 4.4 million injuries serious enough to require medical attention from car accidents in 2019.\(^\text{392}\)

**Transportation Sector Associated Capability Needs:**

Overview: Safe drinking water is a prerequisite for protecting public health and all human activity. Properly treated wastewater is vital for preventing disease and protecting the environment.\footnote[93]{Water and Wastewater Sector, Critical Infrastructure & Security Agency, \url{https://www.cisa.gov/water-and-wastewater-systems-sector}} There are three main water and wastewater systems in this sector:

- There are approximately 153,000 public drinking water systems and more than 16,000 publicly owned wastewater treatment systems in the United States. More than 80 percent of the US population receives their water from these systems, and approximately 75 percent of the population has its sanitary sewerage treated by these wastewater systems.\footnote[94]{Water and Wastewater Sector, Critical Infrastructure & Security Agency, \url{https://www.cisa.gov/water-and-wastewater-systems-sector}} The drinking water infrastructure system is made up of 2.2 million miles of underwater pipes, however the system is aging.\footnote[95]{"Drinking Water," American Society of Civil Engineers, 2021 Report Card for America’s Infrastructure; viewed 16 April 2021. \url{https://infrastructurereportcard.org/cat-item/drinking-water/}} There is a water main break every 2 minutes in the United States and contamination of the water supply from lead and copper pipes is an ongoing challenge for many communities.\footnote[96]{Ibid}

- Stormwater is rainwater or melted snow that runs off streets, lawns and other sites.\footnote[97]{"EPA Facility Stormwater Management," United States Environmental Protection Agency; viewed 16 April 2021. \url{https://www.epa.gov/greeningepa/epa-facility-stormwater-management}} When it is not able to be absorbed into soil (e.g., urban areas, already saturated soil, denuded areas), the water runs into storm drains, sewer systems, and drainage reservoirs. However, the aging stormwater systems are often unable to handle the runoff, leading to flooding, erosion of river and stream banks, storm and sanitary system overflows, and contamination of water bodies.\footnote[98]{Ibid} Much of the runoff from pavement is also polluted; nearly 600,000 miles of rivers and streams and more than 13 million acres of lakes, reservoirs, and ponds are considered impaired.\footnote[99]{"Stormwater," American Society of Civil Engineers, 2021 Report Card for America’s Infrastructure; viewed 16 April 2021. \url{https://infrastructurereportcard.org/cat-item/drinking-water/}}

- Wastewater treatment systems include a network of sewer pipes that collect and carry household, business, and industrial effluents. Within these treatment systems, wastewater undergoes processes to remove harmful constituents and reduce pollution prior to being released into nearby bodies of water.\footnote[100]{"Wastewater," American Society of Civil Engineers, 2021 Report Card for America’s Infrastructure; viewed 16 April 2021. \url{https://structurereportcard.org/cat-item/wastewater/}} In many communities, wastewater and stormwater systems are combined into one sewer network. Flooding can cause these systems to be overwhelmed, resulting in large volumes of partially

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\textbf{•} & \textbf{There are approximately 153,000 public drinking water systems and more than 16,000 publicly owned wastewater treatment systems in the United States. More than 80 percent of the US population receives their water from these systems, and approximately 75 percent of the population has its sanitary sewerage treated by these wastewater systems.}\footnote[94]{Water and Wastewater Sector, Critical Infrastructure & Security Agency, \url{https://www.cisa.gov/water-and-wastewater-systems-sector}} & \textbf{The drinking water infrastructure system is made up of 2.2 million miles of underwater pipes, however the system is aging.}\footnote[95]{"Drinking Water," American Society of Civil Engineers, 2021 Report Card for America’s Infrastructure; viewed 16 April 2021. \url{https://infrastructurereportcard.org/cat-item/drinking-water/}} & \textbf{There is a water main break every 2 minutes in the United States and contamination of the water supply from lead and copper pipes is an ongoing challenge for many communities.}\footnote[96]{Ibid} & \\
\textbf{•} & \textbf{Stormwater is rainwater or melted snow that runs off streets, lawns and other sites.}\footnote[97]{"EPA Facility Stormwater Management," United States Environmental Protection Agency; viewed 16 April 2021. \url{https://www.epa.gov/greeningepa/epa-facility-stormwater-management}} & \textbf{When it is not able to be absorbed into soil (e.g., urban areas, already saturated soil, denuded areas), the water runs into storm drains, sewer systems, and drainage reservoirs. However, the aging stormwater systems are often unable to handle the runoff, leading to flooding, erosion of river and stream banks, storm and sanitary system overflows, and contamination of water bodies.}\footnote[98]{Ibid} & \textbf{Much of the runoff from pavement is also polluted; nearly 600,000 miles of rivers and streams and more than 13 million acres of lakes, reservoirs, and ponds are considered impaired.}\footnote[99]{"Stormwater," American Society of Civil Engineers, 2021 Report Card for America’s Infrastructure; viewed 16 April 2021. \url{https://infrastructurereportcard.org/cat-item/drinking-water/}} & \\
\textbf{•} & \textbf{Wastewater treatment systems include a network of sewer pipes that collect and carry household, business, and industrial effluents. Within these treatment systems, wastewater undergoes processes to remove harmful constituents and reduce pollution prior to being released into nearby bodies of water.}\footnote[100]{"Wastewater," American Society of Civil Engineers, 2021 Report Card for America’s Infrastructure; viewed 16 April 2021. \url{https://structurereportcard.org/cat-item/wastewater/}} & & \\
\hline
\end{tabular}
\end{table}
treated or untreated wastewater bypassing the treatment process and entering local bodies of water.\textsuperscript{401}

The ASCE graded the drinking water, stormwater, and wastewater infrastructures for the 2021 Infrastructure Report Card. Drinking water received a grade of “C-,” stormwater received a “D,” and wastewater received a “D+”.

Water and wastewater system operators are non-traditional responders that support operations for natural disasters, accidents, and man-made incidents. Pipelines, tanks, reservoirs, pumps, lift stations, wells, and the structural stability of treatment facilities are all exceptionally vulnerable in an earthquake, for example.\textsuperscript{402} There are also notable cyber threats. A water treatment facility near Tampa, Florida was the site of an attempted attack in February 2021. Hackers remotely accessed the facility systems and increased the amount of sodium hydroxide (i.e., lye) being added to the water supply. Facility staff immediately noticed the actions and were able to reverse them with minimal impact.\textsuperscript{403}

Identified threats to this sector include:\textsuperscript{404}

- Chemical, biological, or radiological contamination
- Natural hazards
- Physical and cyberattacks by terrorists, homegrown extremists, or disgruntled insiders

**Impact on Responder Environment:**

There are a number of ways in which the water and wastewater sector can impact the response environment.

1. Aging water infrastructure is making firefighting more difficult (e.g., lack of water for fire suppression, water hammers blowing pipes when firefighting equipment is turned off).
2. Drinking water, needed for responder hydration, may not be available if water systems are disrupted during an incident.
3. Overwhelmed stormwater systems can cause sinkholes, flash floods, collapsed roadways, an inundation into sanitary systems.\textsuperscript{405}

\textsuperscript{401} Ibid.
\textsuperscript{405} “Stormwater,” American Society of Civil Engineers, 2021 Report Card for America’s Infrastructure; viewed 16 April 2021. https://infrastructurereportcard.org/cat-item/drinking-water/
4. Overwhelmed wastewater systems can cause untreated sewage to spill into local water bodies and reservoirs. A drinking water contamination would have significant community health and public safety impacts.

**Water & Wastewater Associated Capability Needs:**

SA.3  SA.11  CIS.5  CIS.15  CCC.1  CCC.11  LRM.5  LRM.30  
SA.15  SA.17  CIS.16  CCC.12  LRM.35  LRM.51  
SA.20  

TE.13  TE.17  RAP.7  RAP.8  II.25  II.30  OPS.21  OPS.27  
TE.20  RAP.11  RAP.12  
RAP.13  RAP.18  
RAP.22  OPS.28  OPS.38  
OPS.43  OPS.50
On January 21, 2020, the CDC confirmed the first case of the novel coronavirus, SARS-CoV-2 in the United States. A rapid increase in deaths in China led their government to lock down cities near the epicenter of the outbreak. The World Health Organization (WHO) quickly declared a Global Health Emergency. Within three days, the United States began to impose air travel restrictions. Throughout February and early March 2020, confirmed cases of infection and resulting deaths began to rise in the United States.

There are three factors that signify a pandemic: illness resulting in death; sustained person-to-person spread; and worldwide spread. On March 11, 2020, the WHO declared COVID-19 a pandemic. In the United States, a confirmed case before a National Basketball Association (NBA) game caused the NBA to suspend its season. Within hours, the National Collegiate Athletic Association (NCAA) cancelled its basketball and wrestling championships, and communities across the country postponed or cancelled public parades and gatherings. Colleges and universities sent students home and the Nation’s public school systems shifted to online education for the rest of the school year. This was the date that the pandemic became real for many Americans. On March 19, California issued the Nation’s first stay-at-home order. Other states quickly followed suit.

Since that time, the United States – and the rest of the world – has experienced significant hardships. As of December 31, 2021, there have been over 54.8 million cases of COVID-19 in the United States and 827,800 attributed deaths. Additionally, hundreds of thousands of businesses have closed, causing unemployment and extended economic hardship for tens of millions of Americans.

While many worked or attended school from home, most emergency responders continued to respond to calls for service from their station or department. The section below provides an overview of the impacts of the COVID-19 pandemic on the emergency response community. Unlike the previously discussed pillars, COVID-related impacts vary because of multiple factors

(e.g., political, cultural). For this reason, the impacts of the COVID-19 pandemic are presented using the Project Responder capability domains.

There have been multiple phases to this pandemic, from the widespread lockdowns in the Spring of 2020 through surges in the fall and winter of 2020-21, the national vaccination effort, and subsequent peaks related to virus variants. The descriptions below attempt to address impacts through all stages as identified during the PR6 timeframe. The study team also drew data from the Operational Impacts of COVID-19 Survey.410

Like other issues discussed in the Evolving Response Environment section, there are political influences and disagreements. Every effort has been made to provide an unbiased assessment of what occurred. All discussions of impact are drawn from the emergency response community who were engaged in response operations during the pandemic.

**Situational Awareness**

In the context of the COVID-19 pandemic, impacts in this domain focus on the need of responders to have data and information on the quarantine and infection status of the jurisdiction, the response community and the public.

The most critical issue discussed by participants was awareness of whether the call they were responding to involved an exposed or infected person. According to the COVID-19 impacts survey, 71 percent of agencies were able to notify their personnel.

Most CAD systems allow responders to include notations about specific addresses and some communities were able to use this functionality to mark the status of locations where there were known COVID patients. However, given the economic disruption caused by the pandemic, many people changed residence and as a result much of the address data was quickly outdated. In other cases, public safety telecommunicators were able to provide this information to responding units while dispatching them to the scene. Other communities were unable to provide any infection status data and responders arrived on scene with no awareness of COVID threats. Similarly, responders wanted to obtain accurate information on current infection rates, hot spots in the community, etc. Some communities provided detailed information via publicly available web-based dashboards; others provided little or no data. Some jurisdictions have since been accused of deliberately concealing data about deaths or infection rates.

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Communications & Information Sharing

In the context of the COVID-19 pandemic, impacts in this domain focus on the ability to obtain and disseminate consistent information about the pandemic and appropriate response procedures.

There were two primary CIS issues that responders faced during the pandemic. The first was the difficulty in obtaining credible and consistent information about SARS-CoV-2. The emergency response community and the public were exposed to conflicting information from different sources about numerous elements of the pandemic (e.g., infection rates, mortality rates, recommended protective actions). Contradictory guidance was provided from among and within levels of government. Guidance also changed over time as more was learned about the novel virus. This inconsistent information made it extremely difficult for jurisdictions and agencies to make decisions, update policies and procedures, and communicate guidance to their residents. The situation was further exacerbated by the amount of misinformation released by traditional and social media. It was difficult for many communities to contradict this misinformation.

In addition, some jurisdictions experienced breakdowns in sharing information with non-traditional response partners. Multiple participants reported difficulties in obtaining information from state and local health departments, especially about patient COVID status. Citing HIPAA restrictions, some health departments did not share information about contagious persons, even when responders had contact with those individuals. As with other elements of this assessment, communications and information sharing success varied widely for jurisdictions.

Command, Control, & Coordination

In the context of the COVID-19 pandemic, impacts in this domain focus on the ability to develop consistent guidance and identify priorities for response.

The Nation’s emergency response community relies on the National Incident Management System (NIMS) and the Incident Command System (ICS) to manage incidents of varying size and complexity. While there continue to be occasional issues with executing NIMS and ICS during routine incidents, the introduction of non-traditional response agencies can be problematic. During the COVID-19 pandemic, the integration of public health departments and the National Guard was contentious for some communities.

An additional issue was the difficulty in developing consistent guidance and priorities among levels of government. Multiple state governments superseded COVID restrictions put in place by local jurisdictions. Political factors and influence further complicated this
issue across many communities. Responders stated that the public safety community often had little or no input into the development of jurisdictional mandates or executive orders. Combined with the inconsistent guidance across levels of government, it was often difficult to enforce public-health related restrictions or interact with residents.

**Responder Health & Safety**

In the context of the COVID-19 pandemic, impacts in this domain focus on the ability to keep personnel healthy so they are able and available to participate in response activities.

There were two primary RHS issues that responders faced during the pandemic. The first issue involved shortages of personal protective equipment (PPE) necessary to shield them from exposure to SARS-CoV-2. Especially in the initial months of the pandemic (as early as March 2020), public safety agencies experienced difficulties in obtaining gowns, protective garments, nitrile gloves, and approved protective masks. Although these shortages abated after some time, the scarcity of basic equipment significantly endangered many responders. Many reported having to wear N-95 masks – designed for single use – for many days in a row. The logistical aspects of this issue are addressed in the Logistics & Resource Management discussion below as well. Data from the COVID Impacts survey illustrates the types of PPE that were in short supply. Numbers indicate how many respondents cited a shortage of each supply type.

![Figure 64. Scarce supplies and equipment during COVID-19 pandemic](chart.png)
The second issue is the physical and mental toll of sustained and often high-intensity response operations. Early in the pandemic, over 40 percent of responders reported mental health challenges for themselves or their peers. Based on discussions during PR6 interviews and workshops, that number increased significantly. Many responders – especially EMS providers – stated that they were overwhelmed by the volume and pace of operations, the rates of severely ill and deceased patients, and anxiety about their own health status (and whether they would expose members of their own families). The workload was exacerbated because many agencies experienced high rates of absenteeism due to exposure or infection. Some participants stated that whole shifts were in quarantine and unable to report for duty. The staffing challenges caused some agencies to mandate that personnel continue working as long as they were not symptomatic. Several participants noted that unless they could prove that they were exposed while they were on shift – made more difficult because many could not obtain subsequent health information about patient status – they would not be paid for time off in quarantine. This further added to mental stress for responders.

The rate of infection by members of the response community will have long-lasting impacts as well. Public safety agencies dealt with severe illness and death of their personnel. Researchers in New York found that the rate of COVID-19 infection among FDNY personnel was 15 times higher than for members of the public. Within the agency, EMS personnel had a higher infection rate and increased odds of more severe infections than did firefighters.\(^\text{411}\) Further, COVID-19 was the leading cause of death for law enforcement personnel in 2020 and 2021, attributable to direct exposure to the virus during the commission of official duties.\(^\text{412}\) The situation is similar for firefighters and EMS personnel. The U.S. Fire Administration anticipates that “COVID-19 may double the overall line-of-duty deaths among the fire service...before it is over.”\(^\text{413}\)

While many agencies and associations are collecting this data separately, there are no known cross-disciplinary studies of the physical and mental effects of COVID-19 on the emergency response community. Multiple participants reported that they have had no mental health counseling and that they have seen signs of post-traumatic stress disorder (PTSD) in their colleagues.


PROJECT RESPONDER 6
EVOLVING RESPONSE ENVIRONMENT: COVID-19 PANDEMIC

Logistics & Resource Management

In the context of the COVID-19 pandemic, impacts in this domain focus on the difficulty in obtaining necessary equipment and supplies.

There were shortages of both personnel and equipment resources during the COVID-19 pandemic. As mentioned in the Responder Health & Safety section immediately above, the inability to find and purchase critical supplies had substantial consequences for responder and public safety.

From a resource management perspective, awareness of the health status of employees and allocation of staff while short-handed because of infection and quarantine were difficult. In fact, LRM.39, *the ability to maintain sufficient staffing levels during short-term surge or long-duration events*, is among the top 10 PR6 capability needs overall. Many participants stated that they maintain staffing availability in spreadsheets, but those were often out-of-date. This was complicated by the fact that responders often work for more than one department, which is especially common in smaller communities or with volunteer departments. Knowledge of who is unavailable, their quarantine durations, shift or unit tracing after exposure, and differing requirements for attendance significantly complicated staff scheduling.

Another LRM issue was the difficulty in managing physical resources, especially equipment inventories. Figure 66 illustrates frequent problems that agencies experienced with trying to acquire and manage supplies:

![Figure 65. Resource acquisition and management issues during COVID-19 pandemic](image-url)
Participants reported that local and national stockpiles were insufficient and often unavailable. Allocation from these stockpiles was also problematic with uncertain or contradictory rationale cited for distribution decisions (e.g., those with the most need were not always prioritized). When agencies tried to purchase supplies on their own, they found that items were unavailable, and prices had skyrocketed – with significant impacts on agency budgets. Agencies then discovered that orders were delayed or unexpectedly cancelled. Supplies that did arrive were sometimes of inferior quality or counterfeit.

Supply chains for public safety and public health items were inadequate and frequently disrupted. A national reliance on low inventories and normally quick delivery of shipments proved completely inadequate during the COVID-19 pandemic. Many agencies were forced to innovate, from the use of air conditioner and vacuum cleaner filter material in handmade fabric masks to 3D printing of face shields. Many private entities altered production lines to manufacture critical supplies for responders and the public (e.g., hand sanitizer and disinfectants).

An additional source of resources was donations. Members of the public donated masks, gloves, and 3D printed materials. Many private companies provided goods and services to public safety agencies. For example, Sherwin Williams donated tens of thousands of N95 masks, protective gloves, and coveralls to first responders, hospitals and clinics. Unfortunately, management of these supplies (e.g., storage location, inventory, financial accounting) was an extra responsibility for already over-burdened staff.

**Casualty Management**

In the context of the COVID-19 pandemic, impacts in this domain focus on patient safety during interactions with emergency responders.

The first contact for an emergency medical call for service often begins with EMS providers. In order to make sure that anyone calling for emergency medical help was not infected by responders, additional PPE requirements were implemented (e.g., use of gowns, face shields) across the country. However, this PPE hampered the ability for responders to do their job efficiently and effectively. It takes time to don additional PPE before entering a house and face shields often fog up, making it difficult to communicate with patients and clearly see fine details (e.g., patient physical signs, medical equipment data). Some agencies altered triage procedures such as speaking with patients outside of their homes or sending in only one person while the rest of the unit remained in the vehicle. Many of these changes in protocol were helpful in reducing patient/responder exposure but also impacted

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response times for all types of medical calls. Law enforcement and fire service personnel experienced similar delays because of protective measures.

Ambulances were often significantly delayed at medical facilities by long wait times to transfer patient care. This resulted in personnel and equipment being occupied for hours as they waited outside of hospital emergency rooms, further complicating staffing shortages.

Another issue is that there were significant delays in obtaining test results during the multiple surge periods of the pandemic. This means that a responder may not know for up to a week that they tested positive or negative for infection. Trying to trace and notify patients that the responder may have been in contact with (and vice versa) was extremely problematic – even for those jurisdictions that were able to conduct comprehensive tracing activities. A further complication of this issue was the lack of reliability of test results. Significant percentages of false negative results in rapid tests led to COVID-positive persons interacting with others because of a belief that they were healthy – especially for those who were asymptomatic.415

Communities also experienced problems with fatality management. Many jurisdictions exceeded their capacity to store remains and needed to bring in additional capacity (e.g., refrigerated trailers) for storage. In addition, it was reported that funeral homes across the country were concerned about or unwilling to take the remains of people that died from COVID due to fears of contamination.

There are many other findings related to patient safety in the healthcare setting. However, that is outside of the scope of this report. As with other impacts of COVID-19, these findings need to be gathered and assessed to develop community and national-level after action reports on the pandemic.

Training & Exercise

In the context of the COVID-19 pandemic, impacts in this domain focus primarily on the inability for many agencies to conduct routine or necessary training and exercise activities.

Many agencies completely suspended training and exercise for several months during the pandemic primarily due to social distancing restrictions and reallocated budgets. Participants reported particular issues with obtaining just-in-time (JIT) training on new PPE

and decontamination procedures/equipment. Responders reported that they need additional options for completing training requirements remotely combined with additional courses or topics available via distance learning.

Fewer than 50 percent of survey participants reported that they had participated in pandemic training or exercises before 2020. Of those that had, most activities focused on Ebola or H1N1 response.

**Risk Assessment & Planning**

In the context of the COVID-19 pandemic, impacts in this domain focus on the lack of existing pandemic plans and difficulties with assessing the impacts on the community.

Just over 40 percent of survey participants reported that their community had a pandemic plan before 2020. Notably nearly 25 percent did not know if they had a plan, meaning that if one did exist that it was not well circulated. Of those with a plan, 41 percent noted that it was insufficient for the extent of the COVID-19 pandemic. Participants noted that planning assumptions proved erroneous. For example, many communities did not anticipate difficulties with getting supplies from the Strategic National Stockpile (SNS) or they did not realize the extent that other jurisdictions maintained contractual agreements for the same limited supplies.

Communities are still grappling with the long-term effects of the pandemic. The pandemic has had severe ramifications for state and local government finances. Many will be forced to cut public safety budgets. The end of eviction moratoriums will likely increase homeless populations, and strains on the healthcare system will be ongoing, among a multitude of other impacts. Jurisdictions and agencies have limited capacity to assess how they will measure these implications, identify steps forward, or fund related activities.
Intelligence & Investigation

COVID-related intelligence and investigation activities are primarily centered around epidemiological contact tracing and investigation of pandemic-related threats or fraud.

The ability for communities to conduct contact tracing activities varied significantly across the country. Differences in reporting requirements, patient data restrictions, and political influences all factored into the success or failure to track COVID-19 throughout the community. Many people in the United States that contracted COVID were not contacted at all to determine exposure. Other people refused to divulge who they had been close to, most citing privacy concerns. While contact tracing remains one of the best, and most commonly used tools for containing infectious disease, attempts failed for many parts of the United States.

Some used the pandemic as an opportunity to engage in criminal behavior. Adults and children spent notably more time on the internet to participate in video teleconferences and virtual learning. There were several notable consequences of this increase in online activity. Many people spent more time on social media sites. This led to an escalation of propaganda and misinformation on many sites and subsequently the use of the internet for recruiting by extremist groups. A second consequence is the increase of online enticement of minors. With children and young adults being online as a requirement of learning, they often explored other sites and forums on the internet. The FBI reports an increase in reports of possible online exploitation of a minor.\textsuperscript{416} Third, there was an increase in teleconference hacking and cyberattacks against intellectual property. All of these behaviors require investigation by law enforcement agencies that are both understaffed and overburdened with other responsibilities.

Operations

In the context of the COVID-19 pandemic, impacts in this domain focus on modifications to protocols and procedures.

Participants reported a wide variety of operational adjustments because of COVID ranging from new protocols for decontamination to altered standards of care and PPE requirements, among many others. Figures 69 and 70 below illustrate the number of participants that report changes in procedures and the operational issues that responders have been dealing with over the long duration of the pandemic.

Skyrocketing hospital admittances combined with equipment shortages (e.g., ventilators) caused many health care facilities to consider or implement crisis standards of care. These new procedures changed the commonly used criteria for deciding on treatment or allocating scarce resources. The dramatic increase in the use of telemedicine for healthcare appointments was another operational impact of the COVID-19 pandemic. According to the CDC, the number of health centers capable of providing care via telemedicine increased from 43 percent in 2019 to 95 percent by the end of 2020.417

Also of note is the fact that some responders were given additional roles during the pandemic. Law enforcement, for example was asked to enforce public health mandates (e.g., mask requirements) in many communities. Further complicated by political influences, this additional tasking caused an increase in confrontations with some members of the public during an already intense time period (see the Protests/Civil Unrest discussion below).

As noted above, there is a need to capture the lessons learned and best practices of this pandemic for the public safety community. It is possible that another pandemic will occur in the future. Therefore, it is essential to assess the outcomes of the COVID-19 pandemic to alter plans, procedures, and resources to be ready for the next one.

COVID-19 Associated Capability Needs:

SA.12  SA.13  CIS.1  CIS.5  CCC.1  CCC.2  RHS.2  RHS.3  LRM.5  LRM.6
SA.24  SA.30  CIS.6  CIS.8  CCC.3  CCC.4  RHS.4  RHS.5  LRM.8  LRM.9
SA.31  SA.50  CIS.9  CIS.24  CCC.6  CCC.7  RHS.6  RHS.9  LRM.10  LRM.11
SA.51  SA.52  CIS.25  CIS.36  CCC.8  CCC.9  RHS.10  RHS.12  LRM.12  LRM.15
        CCC.10  CCC.11  RHS.13  RHS.14  LRM.16  LRM.17
        CCC.12  CCC.15  RHS.15  RHS.16  LRM.18  LRM.19
        CCC.16  RHS.17  RHS.18  LRM.20  LRM.24
             RHS.21  RHS.24  LRM.25  LRM.28
             RHS.25  RHS.26  LRM.30  LRM.31
                             LRM.32  LRM.33
                             LRM.34  LRM.35
                             LRM.36  LRM.37
                             LRM.38  LRM.39
                             LRM.40  LRM.41
                             LRM.42  LRM.43
                             LRM.45  LRM.46
                             LRM.47

CM.15  CM.19  TE.20  TE.21  RAP.9  RAP.14  II.8  II.9  OPS.8  OPS.10
CM.20  CM.21  TE.22  TE.23  RAP.15  RAP.16  II.11  II.12  OPS.11  OPS.12
CM.24  CM.25  RAP.17  RAP.24  II.13  II.15  OPS.29  OPS.51
CM.26  CM.27  RAP.28  II.19  II.23  OPS.53  OPS.54
CM.28  CM.29  II.24  II.25  OPS.55  OPS.56
CM.30  CM.31  II.31  OPS.57
As with the COVID-19 pandemic and discussions of the environment, the topic of how protests and civil unrest continue to change the response environment is controversial. Also, like the COVID-19 section, this section addresses findings through the structure of the Project Responder capability domains, looking methodologically at impacts as described during the PR6 interviews, focus group meetings, and workshops. Additional research is provided in the introduction to add contextual information. In an effort to prevent the introduction of differing political views into the analysis, the study team endeavored to refrain from reference to any particular group – the only such references are to the type of incident. Every effort has been made to present an impartial discussion of the topic without adding subjective analysis or opinion.

The First Amendment of the U.S. Constitution gives its citizens the right to peaceably assemble and petition the Government for a redress of grievances. That Amendment, however, does not include the right to commit criminal actions. This section attempts to distinguish between protests (non-violent, although where illegal acts may have occurred) and incidents of civil unrest (violent activities) and describe the corresponding impacts on the response community. According to the U.S. Crisis Monitor, there were more than 22,900 events of protest and civil unrest in the United States in the year 2020. Figure 71 below depicts the number of protests per day across the United States. These events had a serious and lasting impact on the Nation’s emergency responders physical, mental and professional health.

Figure 70. Number of demonstrations per day from April 1, 2020 to January 29, 2021


These events occurred across all 50 states and the District of Columbia. There were significant shifts over the year in the purpose and make-up of protests. The maps below illustrate the number of events by location and by type.420

For the purposes of this analysis, the study team asked participants about the prevalence and types of protest and civil unrest events, including racial injustice, white supremacy/militia, anti-fascist, economic re-opening, COVID-19 restrictions, and election disputes. Participants discussed the number of events, the conduct of participants (i.e., peaceful versus violent), and the response activities required.

According to overall counts from the U.S. Crisis Monitor, 47 percent of the events (10,330) explicitly cited the Black Lives Matter (BLM) movement as a driver for the protests.421 Right-wing militia groups and groups organized 2,350 events, and nearly 4,000 events were directly related to the pandemic.422,423

Sources such as ACLED and the Major Cities Chiefs Association (MCCA) are in agreement that approximately 93 percent of the protests were non-violent, however many of these featured acts of civil disobedience (e.g., blocking traffic, trespassing).424 The primary discipline tasked with responding to these incidents is law enforcement, however, police agencies were often cited as a reason for protests. Many law enforcement agencies are experiencing long-term impacts from the events of 2020. Efforts in some communities to decrease police budgets and repeal the Law

422 Ibid.
423 Ibid.
Enforcement Bill of Rights will change the scope of the law enforcement mission and the extent to which law enforcement personnel can be held responsible for their actions.

The following section provides an assessment of how the protest and civil disturbance incidents of 2020 and 2021 have already changed and continue to change the response environment.

**Situational Awareness**

In the context of Protests and Civil Unrest, impacts in this domain focus primarily on the ability of public safety agencies to maintain community safety through legal monitoring of demonstrations, detect threats and hazards on-scene, and identify criminal behavior that may occur at a large-scale demonstration or protest event.

The rationale for protest activities is usually not in question as the host often promotes the event via open and online sources. However, once crowds gather, the ability to monitor for criminal behavior occurring toward, within, or around the group becomes an issue. Criminals have used the crowds as a buffer to keep law enforcement at bay while they complete their desired unlawful actions. This can include assaults directed against the participants of the protest or hijacking the event and redirecting the crowd toward specific targets or goals.

Emergency responders currently have limited means to monitor what is happening inside of the crowd during protests and demonstrations. Intelligence, surveillance, and reconnaissance (ISR) assets primarily include imaging systems mounted on the responder (e.g., body-worn cameras), their vehicles, nearby structures, and/or from the air (e.g., helicopters, UAS). However, there are a number of barriers that hinder the use of these assets. In many locations, it is not legal to film peaceful protests. Considering that many incidents of civil unrest originate as peaceful protests, this makes it difficult for responders to identify when violent or criminal actions originate and provide the foundation for law enforcement response. It also means that someone wearing a body-worn camera, for example, will not be able to capture the precipitating criminal behavior for investigative and accountability purposes. Without having cameras activated, the only information available for situational awareness and subsequent review is what occurs during and after the law enforcement response – not the whole incident. The use of ISR assets is further limited by the ability to process, integrate, and store images and video to create actionable information.

Another issue during the protests of 2020 and 2021 was that some agencies were provided with ISR and other assets that they normally cannot access. The intelligence community and other federal agencies lent UAS and image analysis software that were used to identify potential threats and hazards. For example, some UAS were used to identify the ignition of fires in areas of civil unrest before anyone placed a call to 9-1-1. This placed demands on agencies and jurisdictions to staff information processing centers, often when staffing...
levels were already stretched. However, these assets were returned after the protest activity declined, reducing the agencies situational awareness at future events.

A further component of situational awareness involves liaison with protest organizers. Many protest groups do not want their event to become violent and will coordinate with law enforcement to provide information (e.g., anticipated crowd size, intended route) that is helpful for planning and operations. In return, law enforcement has been able to let protester organizers know if they receive intelligence that people not aligned with the host group intend to interfere with or overtake the group’s purpose and intent. Conversely, a number of groups specifically avoided communicating with law enforcement in the belief that this would hinder the ability of responders to impact the group’s actions. Monitoring social media platforms is another way to obtain some of this awareness, but there are privacy and constitutional concerns related to this monitoring as well. Having the appropriate number of resources and capability to perform this function is also a concern for many jurisdictions.

Communications & Information Sharing

In the context of Protests and Civil Unrest, impacts in this domain focus primarily on the ability to connect traditional and non-traditional response agencies and convey accurate information to those participating in the protests as well as with the general public.

Communication among participating agencies and jurisdictions posed a challenge during response to civil unrest incidents. Some areas found the integration of mutual aid and non-traditional assets (e.g., National Guard) with different radio frequencies to be difficult. While frequency patching procedures and solutions exist to connect separate frequencies, insufficient numbers of technical staff and competing demands made this process difficult. Some jurisdictions were able to bring in supplemental cellular network capability while others were confronted with interoperability issues because of the number of frequencies and/or lack of capacity. An additional issue is the lack of capability to maintain encrypted communications and information sharing. Radios that feature encrypted capabilities are costly and many agencies do not have them or access to encrypted devices is restricted to a few select units or personnel. Further, the Department of Justice requires some transparency for the public into what is going on in their communities. Several participants cited that protesters were actively monitoring law enforcement communications. In some cases, groups were actively monitoring the police radio channels and posting the police commands to social media pages, in near real time, in an effort to warn of upcoming police actions or movements. This poses safety and security concerns for responders and can endanger the community.

During larger events, communications with protesters can be difficult, especially when trying to connect with individual participants. By nature, protests often involve loud chants or songs that can block other noise or communication. Some events also included the use of noise
machines as a weapon against the responders. The loud atmosphere makes it difficult for responders to communicate among themselves, provide legal warnings, and communicate directly with the crowd.

Social media (as a communications tool) was used to a greater extent by some jurisdictions to provide information about the site of planned protests and to warn residents away from areas of civil unrest. However, PR6 participants also stated that social media is a double-edged sword – one that can often harm public safety agencies as much as benefit them. While the additional situational awareness is helpful, the proliferation of rumors and misinformation (both malicious and accidental) can cause or exacerbate an incident, turning a peaceful protest into a civil unrest event. For example, inaccurate warnings of incoming protesters led many citizens to post armed guards to protect business areas in areas where no protests were planned. An overreaction to misinformation derived from social media reduces resources from other potential locations where a real need is present. It is also difficult for overburdened public safety communities to share information via multiple social media platforms at the same rate that they are finding it posted on other sites. One participant summed this up by noting that it is hard to communicate at the speed of Twitter – often multiple events are happening faster than agencies can react to them. Again, the dearth of technical staff at public safety agencies inhibits their capabilities.

An additional challenge is interaction with the community. Many jurisdictions maintain good relationships with their citizens and some PR6 participants reported that those relationships improved during the past year as the community showed support for law enforcement. However, in some areas, the views of and interactions with police agencies were degraded. Participants reported a dramatic increase in complaints against officers, as well as departmental policies and procedures. In combination with the reduced respect for authority, law enforcement personnel are seeing disrespect and disregard from new segments of their community.

As described above, communication with protest organizers increased throughout the events of 2020 and 2021. PR6 participants noted that responders are now more engaged with the organizers, often from the beginning of event planning. Many of the groups that were actively protesting against law enforcement were willing to work with those agencies to prevent unwanted violent behavior and to receive protection from counter-protesters. Conversely, many organizers did not want to collaborate with law enforcement. A survey from the MCCA found that “lack of protest organizer cooperation” was the most significant challenge in dealing with protest-related incidents.425 426 This lack of communication limits the ability of

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law enforcement to manage the controllable aspects of the event (i.e., traffic flow), while also hindering the ability to maintain safety of the event from potential action from inside or outside the protest group.

**Command, Control, & Coordination**

In the context of Protests and Civil Unrest, impacts in this domain focus primarily on the ability of decision-makers to integrate multiple agencies into the response and to develop operational plans that balance First Amendment rights with the safety of protesters, the community, and emergency responders.

The protest events of 2020 and 2021 spanned the scale from those that were entirely peaceful to burning and destruction of civic and private buildings to deliberate attacks on police officers during an assault on the U.S. Capitol. A number of major cities saw an increase in assaults on officers during the protests and civil unrest incidents of 2020-2021. There were also many events where protesters were injured during the event. These factors are not completely new to planning for demonstration events, however the level and intensity appears to have grown dramatically, forcing planning efforts to cover more contingencies.

The intelligence available for planning activities also differed greatly. Those in positions of command had to make difficult choices as to how to respond and what was appropriate for one jurisdiction may not have been an option for their neighboring jurisdiction(s).

The inclusion of additional personnel resources required active and collaborative interagency coordination of policies and procedures. While many jurisdictions collaborate with neighboring communities, some required multiple resources from outside their immediate area, including state or federal resources. One mutual aid partner, for example, had different tactics for engaging protesters than some civilian agencies. In one example cited by a participant, mutual aid personnel did not carry any non-lethal options (e.g., tear gas) and did not have the correct PPE (e.g., gas masks) to deal with the on-scene operations. Not all policy, equipment, and PPE discrepancies between the responding agencies were identified in advance and caused issues with both responder safety and communications with the public. Some agencies were able to use additional mutual aid resources in a support function, such as communications interoperability, so that local law enforcement could focus on its mission.
Responder Health & Safety

In the context of Protests and Civil Unrest, impacts in this domain focus primarily on the ability to maintain the physical and mental health of those involved with response operations.

Per the Officer Down Memorial Page, one law enforcement officer, Brian Sicknick, was killed in the line of duty responding to civil unrest.\(^\text{427}\) However, according to data from the Major Cities Chiefs Association, more than 2,000 police officers were injured between May 25 and July 31, 2020 in member cities.\(^\text{428}\) In addition, a number of law enforcement suicides have been attributed to participation in the response to civil unrest events.

The protests of 2020 and 2021 also took a significant toll on the physical and mental health of emergency responders. Even during those protests that remained entirely non-violent, officers faced frequent insults and taunting during exceptionally long work shifts and covering multiple days. Extended periods of facing this behavior have had psychological impacts and left many with a feeling of being continually under siege and not supported by the community. For example, officers in Portland, Oregon faced over 180 straight days of protests and civic unrest, which is mentally taxing on its own, but becomes amplified when an officer is the target of threats and insults every day.

Multiple PR6 participants cited concerns with the quality and coverage of PPE that was issued to them during protest and civil unrest response operations. Many law enforcement officers were issued helmets and shields, but these did not protect them from many of the threats and hazards on scene. Participants cited specific needs for increased protection from incendiary threats, additional hand protection, improved helmet design, and eye and hearing protection. Currently there is no national standard for an anti-riot ensemble (protective garments and equipment) as there is in other countries such as the United Kingdom. The current National Institute of Justice (NIJ) standard 0104.02 (Riot Helmets and Face Shields) was published in 1984.\(^\text{429}\) However, participants reported that a new standard is currently in development. This lack of standards leaves agencies to purchase whatever is available within their limited budget or to believe the claims of manufacturers.

As mentioned above, sound can and has been used as a weapon. Some of the civil unrest events saw the deployment of amplified acoustic devices both by and against law enforcement. Referred to as “sound cannons,” these devices emit piercing noise that has a

physical effect on those in the vicinity. They can also be used as traditional speaker systems to make public announcements. Law enforcement utilizes these under certain criteria to provide legal notice or warnings for arrest and can utilize them to reduce violence or significant property damage. Demonstrators using these “sound cannons” as a weapon against law enforcement responders have no limitations on volume or duration of use. One agency advised the use of a “sound canon” by protesters lasted hours while directed at responders. Not all responders on scene had protection from these weapons and were subsequently affected by them. Participants stated that they need to be able to bi-directionally communicate with the crowds but also be protected from excessively loud devices that cause harm to the responders. Additionally, agencies reported that some protestors directed lasers into the eyes of the responders on the ground and against pilots of aviation platforms. These lasers are designed to send intense light both focused and strong enough that it can cause temporary or permanent damage to the human eye to include blindness to the responder.

According to the MCCA report, 49 percent of agencies in their assessment experienced the use of incendiary devices (e.g., Molotov cocktails) against their personnel. Current garments and gear have no protection from fire as a weapon, and one participant shared knowledge of a responder that received serious burns during an event. Responders also faced thrown rocks, bricks, and bottles; fireworks; wooden and metal bats, poles; and home-made shields (with improvised sharps built into the frame or body). Some responders had their own shields used against them. The increase in armed subjects at demonstrations or protests over the last few years and specifically this last year increases the likelihood of an act of violence occurring. A number of jurisdictions have had shots-fired incidents and with some resulting in panic, injury, and death.

Some emergency response agencies (fire service, EMS, and law enforcement) deployed surreptitious staff behind their operational units to provide cover and situational awareness.

**Logistics & Resource Management**

In the context of Protests and Civil Unrest, impacts in this domain focus primarily on the ability to maintain the supplies and personnel needed to conduct response operations.

Because of the confluence of the protests with the COVID-19 pandemic, staffing was the most common logistics and resource management issue cited by PR6 participants. Successive instances of quarantine and responder infection impacted staff availability. In
addition, protests are resource-intensive, and this left little time to respond to other calls. Many jurisdictions called for mutual aid support, but this was complicated by differences in procedures, radio systems, and available PPE, as well as the need for mutual aid agencies to maintain law enforcement response capabilities within their own jurisdictions. While staffing remained the number one logistical issue, other resource concerns included the availability of masks, gloves, water, food, adequate transportation, personal and area lighting, and appropriate less-lethal capabilities. Ongoing planning and coordination during large-scale events are an ongoing coordination issue.

Casualty Management

Casualty management issues with regard to protests and civil unrest primarily deal with injuries to participants – apart from those to responders (which are covered in the Responder Health & Safety discussion above).

Public safety personnel can use tear gas and other chemical irritants (CI) during episodes of civil unrest under certain circumstances. In a study commissioned by the NIJ, authors found that less-lethal tools (including CI) reduced the rates of injuries for law enforcement personnel and offenders compared to using physical force. In order to control crowds in 2020, law enforcement used CI in at least 100 jurisdictions during some of these events. These compounds are designed to cause sufficient physical discomfort so that subjects cease their behavior.

The use of these compounds is controversial and there are multiple efforts to develop other less-lethal options. A concern with CI is that emergency responders do not have the ability to detect the extent of impact caused by riot control agents because it depends on the amount of exposure, the location of exposure (indoors versus outdoors), how the person was exposed, and the length of time of the exposure. Further, the volume and concentration of the chemical in each spray and aerosol vary considerably among


433 Ibid.
manufacturers and countries, which may be misleading. The unknown effects and lack of studies on chemical agents in crowd control presents a challenge for law enforcement.

While most participants stated that they did not have impacts in treating patients during the protests and civil unrest, there were specific instances when emergency medical help was delayed because of dangerous conditions. For example, the Seattle Fire Department was unable to reach a patient with gunshot wounds because of conditions in the autonomous zone. The Department routinely waits for law enforcement escorts where there are active threats and hazards, which is in compliance with guidelines developed by the National Fire Protection Administration.

**Training & Exercise**

In the context of Protests and Civil Unrest, impacts in this domain focus primarily on the ability to prepare staff for protest and civil unrest events.

While there have been large-scale racial justice protests in the past decade (e.g., Ferguson, Missouri, Baltimore, Maryland), the unique and relatively unprecedented nature of months of protest activity were not something for which the jurisdictions had planned. Further complicated by social distancing restrictions and the use of facial masks related to COVID-19, as well as the show of arms by civilians during the pandemic and election protests, the set of circumstances was beyond that which most agencies had foreseen or could realistically prepare.

The lack of training and exercises in advance of the summer of 2020 was further compounded by cuts to state and local municipal budgets due to COVID-19 stay at home orders, physical distancing, and occupancy restrictions. Due to existing workload, an agency generally needs to bring in staff members outside of their normal work hours and pay them overtime to complete required training. One participant stated that to train all operational personnel within the department on an eight-hour topic, the cost is $3.2 million in overtime. Municipal budgets do not support that right now.

Having trained and experienced personnel readily available to handle large crowd issues is challenging due to significant turn-over, the number of young people entering the

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emergency response field, and the need to coordinate with non-traditional partners. Many believe that training for these expanding and demanding events is critical. However, the training should be readily available to regional and state partners, and cost and time effective for all agencies to receive. While the pace of protests has recently decreased overall, any jurisdiction or agency may face another eruption of demonstrations at any moment.

**Risk Assessment & Planning**

In the context of Protests and Civil Unrest, impacts in the Risk Assessment & Planning domain focus primarily on the ability to identify and manage known, likely, and spontaneous First Amendment activities.

Most of the protests were planned and posted in advance, often advertising the location and full route of marching or movement. This allows emergency managers and command staff to develop deployment response plans. Although protest response guidelines were not available in advance of the events of 2020 and 2021, new resources are available. In April 2021, the Major Cities Chiefs Association released an assessment of best practices and tactics to support planning and command for First Amendment Assemblies, which includes lessons learned from the protests and civil unrest throughout the previous year.437

While many of the protests were planned in advance, what happens on the scene can be very fluid. The arrival of counter-protesters, the open display of weapons such as rifles or handguns (where legal) and/or homemade weapons, or the criminal actions by one person could change the nature of a peaceful protest to an incident of violent civil unrest. Responders had to be ready for changes throughout the duration of the event. This expectation of readiness requires commanders to deploy more resources and retain them longer in order to address reasonable contingencies that may occur. Some jurisdictions noted that well-organized and community-based events were later hijacked by infiltrating groups. These infiltrating groups initiated property damage or violence, thereby creating a situation where law enforcement, fire, or EMS had to respond. A risk assessment that includes this type of takeover action is often difficult to develop because the violent group or individual doesn’t always announce participation beforehand.

Spontaneous demonstrations also require a plan and assessment to provide for community safety. Spontaneous events may or may not achieve large crowd numbers, however some jurisdictions experienced smaller-size demonstrations that were more violent or caused more property damage to the community than many larger crowds. Often with

spontaneous actions it is difficult to complete a risk assessment until responders arrive on scene, make contact with the organizer(s), or determine the intent of the crowd through observations of behavior.

Intelligence & Investigation

In the context of Protests and Civil Unrest, impacts in this domain focus primarily on the ability to identify incipient criminal behavior and identify those who have committed unlawful acts.

As noted above, many of the protest events were planned. This allowed responders to monitor the event for criminal acts and negative community impacts. Groups with known potential for violence can exercise their First Amendment rights to protest like anyone else. However, knowledge that extremist groups would be in attendance allowed agencies to change plans and operations to avoid direct conflict between the groups or with law enforcement. This is specifically the case when counter-protests were planned at the same time and location and the originally posted demonstration. Awareness of the presence of a known instigator(s) or out-of-state organizers provides agencies with additional information about how an event might evolve. The ACLED information show a seven-fold increase in the appearance of counter-protesters in 2020 than in 2019.438

The ability to use social media to identify posted statements calling for criminal behavior before, during, or after an event is unparalleled. Social media posts before an event can provide early notification that allows response agencies to prepare for a potentially aggressive or violent incident. Monitoring open-source media during an event provides updates to the risk assessment and allows for modification to the response plan in real time, reducing the potential for conflict or preventing it all together.

In the aftermath of the assault on the U.S. Capitol, federal law enforcement officials have been able to analyze social media posts across multiple platforms. Because the participants used social media platforms to plan the event and then document their activities, this data is helping investigators to prove individuals’ roles in the event. However, there is limited ability within most non-federal agencies to access, review, manage, investigate and store this digital evidence.

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In the context of Protests and Civil Unrest, impacts in this domain focus primarily on the ability to carry out tactics, techniques, and procedures to respond to peaceful protests and violent incidents of civil unrest.

Operations in support of protests and civil unrest events evolved over the months from May 2020 through the present day. Protests regarding COVID-19 restrictions and election disputes seem to have diminished while racial injustice demonstrations remain ongoing. The presence of counter-protestors and armed protestors, incidents of significant property destruction, and assaults against the public and responders continue to occur.

Law enforcement participants stated that officers are more hesitant to use force now, even in situations that necessitate it. Although the use of force is generally used to rapidly de-escalate a situation, this is not always seen as the case by the public. This is complicated by the fact that some officers use force which is not appropriate, fanning the increasing public discontent with law enforcement across the nation. This public perception that the police are wrong to use force, combined with the constant presence of citizen journalists, can cause an officer to hesitate or change their approach. While some in the public argue that this hesitation is necessary, it could have significant consequences in terms of public or responder safety. As noted in the Casualty Management section above, the use of less-lethal weapons is controversial. The use of these devices is intended to provide additional options for law enforcement to avoid serious or deadly consequences. However, some communities criticize the use of these options and claim law enforcement uses them against peaceful protesters. The use of Cl against protesters in Lafayette Park on June 1, 2020 sparked a national debate over the use of these compounds in protest and civil unrest events.

The presence of weapons at protests creates an additional issue for responders. Weapons present at protests include (but are not limited to) rifles, handguns, Molotov cocktails, high intensity lasers, road flares, improvised spears and cutting devices, thrown items such as metal rebar, rocks, bricks, and bottles, improvised explosives and commercial-grade fireworks, wooden and metal bats and poles, homemade shields, balloons filled with unknown fluids or paint, and other improvised weapons.

State rights vary widely on open and concealed carry of firearms. Some states do not allow open carry of weapons at any time. However, in those states where it is allowed, protesters routinely carry assault-style weapons through the crowd. In some locations, this led to deadly shootings among protest groups. PR6 participants also cited assessment of the number of weapons and types of weapons as a means for determining the potential for violence.

A new kind of event that law enforcement must be prepared for in the future is the creation of “autonomous zones”. A number of jurisdictions experienced or faced the possibility of a
self-proclaimed autonomous zone where participants denied the ability of the government to oversee the area. Restrictions into the area were specifically directed at law enforcement but applied to other government functions as well (e.g., power, water, transportation). In Seattle, organizers and participants actively took steps to prevent police engagement in the area. A self-proclaimed armed security force deployed around the multiblock venue. Over the course of three weeks, however, two people were killed within the autonomous zone and other people reported burglaries, arson, and assaults.

It is interesting to note that several participants expressed hesitation about a national mandate for protest and civil unrest response. Because of the fluid nature of many of the events and the differences in local laws and views regarding protest response, a one-size-fits-all mandate may not be practical or adoptable by every jurisdiction.

Impact on Responder Environment:

There are a number of ways in which protests and incidents of civil unrest can impact the response environment.

1. Responders can be physically endangered by civil unrest response activities. Law enforcement officers faced a myriad of weapons during the response activities of 2020 and 2021.
2. Responder mental health is also endangered. Changing public views on law enforcement and reduced respect for authority combine to impact the mental and cognitive ability of many.
3. The increasing number and duration of protests can further exacerbate the physical and mental toll on responders.
4. When criminal behavior occurs near or within protected First Amendment activity, it can be difficult for responders to detain the individuals engaged in the criminal behavior within the larger crowd.
5. Differing response philosophies and policies among agencies can have significant consequences when units combine for mutual aid operations.
6. Insufficient PPE can contribute to responder injuries. Reports of shattered shields at the U.S. Capitol assault that were used against responders illustrate how providing responders with inferior tools and garments can put them in danger.
7. Fire as a weapon against responders is a capability need that has not yet been addressed.
8. Clear communication between different jurisdictional and mutual aid response participants is still an issue for commanders to ensure continuity of mission and action during large scale events.
### Protests/Civil Unrest Associated Capability Needs:

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Conclusions and Path Forward

The number of capability needs identified in previous iterations of Project Responder has not been close to the number identified and prioritized in PR6. Changes in both the methodology and period of performance for this effort allowed the study team to conduct significantly more in-depth responder collaboration than any iteration since the first was completed in 2004.

The extension of the period of performance also allowed a greater degree of research and analysis into the evolving response environment than previous iterations. As a result, this report represents a detailed assessment of what is needed to improve the capability to respond and the forces that are currently – or will likely – shape public safety operations for the foreseeable future. However, as always, this is one snapshot in time. Assessments of near-, mid-, and long-term needs and issues will help to guide research and development efforts. However, the events of 2020 illustrate how quickly the response environment can change.

Through the process of assessing the outcomes and findings of PR6, the study team identified three overarching themes of note:

- The large number of needs related to accessing, integrating, assessing, visualizing, and protecting data;
- The reliance of many response tools and tasks on network and communications system connectivity; and
- The significant increase in needs associated with pandemic response and civil unrest.

Prevalence of Data-Related Needs

The study team reviewed the individual requirements identified in Part 1 – which details the highest prioritized capability needs in each domain – to assess the incidence of requirement types. For each of the 32 needs, the team identified like requirements to identify notable findings. Primary among these findings is frequency with which responders identified requirements associated with data. Some needs focus on the ability to access or integrate data sources while others emphasize the ability to develop actionable information from raw data. Many of the capability needs involve multiple data requirements. Figure 74 below illustrates the occurrence of types of data requirements among those needs described in Part 1 of this report.
PROJECT RESPONDER 6

CONCLUSIONS

The team applied this process to a review of all PR6 capability needs. Without doing a full assessment of requirements for each of the 373 needs, it is not possible to assess data requirements by type overall. Instead, the study team reviewed each capability need statement to identify where the need is foundationally related to or dependent on data. For example, SA.30 is the ability to integrate situational awareness data from individual on-scene responders. The team assessed and assigned a data type schema to each need statement. Each need statement was categorized as:

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The study team first examined the data-related needs by domain. Figure 75 below illustrates this assessment.

This graphic illustrates that capability needs in the Situational Awareness and Intelligence & Investigation domains are much more focused on the use of data. This is not surprising because it is precisely the access to and analysis of data that provides advantage to emergency responders.

The study team then assessed the category of the needs overall (using the schema described above). Of the 373 capability needs, 189 are related to or dependent on data (51 percent). Figure 76 on the following page illustrates the results of this assessment.
As is evidenced by the graphic above, a greater number of data-related needs are focused on #access (40 percent), #analysis (29 percent), or a combination of data requirements. The findings of this study have repeatedly focused on the fact that increasing amounts of data are available to the response community. This has, in fact, been the topic of multiple iterations of Project Responder. (See Appendix Q: Project Responder Priorities Across Time for further information.) However, the ability of responders to utilize this information has not increased at the same rate. Critical data feeds are unavailable for a host of reasons, barriers prevent the integration of accessible data sets (which may be outdated), and there is limited ability to visualize or transmit the data to those who need it most. Another finding from the Project Responder effort is that there is limited technical capacity within many response agencies. Participants discussed how many agencies lack staff that can execute basic spreadsheet functions, much less perform complex analysis or create visualizations that allow for the development of actionable information. It is not that these systems do not exist, but often that these skills are not prioritized by agencies with limited budgets, insufficient staff levels, and competing operational and maintenance priorities. The cadre of public safety agencies across the United States must find some way to increase their in-house data management and analysis skills in the face of conflicting priorities.

Reliance on Connectivity

A related issue is the reliance on internet or communications connectivity. The study team assessed the PR6 capability needs and found that 136 (36 percent) are dependent on network or communications system access. In the assessment of the Communications Sector, the study team noted that there are areas in the United States (primarily rural and Tribal lands) that do not have reliable access to the Internet or cellular networks at speeds that would enable data transfer or dependable voice communications. Even when robust communications infrastructure exists, it
can be damaged or destroyed during manmade attacks, accidents, or natural disasters. The loss of network or communications system connection could prove catastrophic to modern-day response operations. It is not infrequently that some participants in Project Responder raise concerns about public safety reliance on technology and connectivity. However, the technology advancements throughout the rest of society demand that the response community capabilities keep pace. Although the expansion of public safety broadband and satellite-based public networks may significantly help to address this issue in the future, the issue remains for the near- and likely mid-term.

This issue also has significant implications for cybersecurity. Encryption or safekeeping of public safety data sources and transmissions is essential. Hacking, interference with, or ransom of public safety data and functions could cause dire consequences. Response agencies have already had to deal with DDOS attacks, for example, that left them unable to conduct normal operations. To date, the Project Responder study series has examined data and communications security in the lens of specific requirements for high-priority capability needs. DHS’s Cybersecurity and Infrastructure Security Agency (CISA) is solely focused on defending against cyberattacks, including against the Nation’s response agencies. However, a more focused assessment of the correlation between the cybersecurity needs of individual response functions or domains may be necessary. Like the previous discussion of data management and analysis skill sets, many agencies maintain limited or no staff with experience or tools to improve data and network security. Further, they can ill afford (financially) to solicit help from private firms, again because of competing priorities.

**Novel Needs**

As with each iteration of Project Responder, participants identified new capability needs that had not been included in previous versions. Because of recent events, the number of new needs was significantly higher. The extent and consequences of COVID-19 pandemic were unprecedented in modern history. The impact of this pandemic on the Nation’s emergency response community is detailed in the COVID-19 section of the Evolving Response Environment findings. What is notable here is the sheer number of newly identified capability needs correlated with this event. Likewise, operations to secure peaceful protests and respond to civil unrest resulted in a plethora of new needs. Figure 78 illustrates the number of needs overall and by discipline.
In addition to these needs focused on pandemic and civil unrest response, the introduction of needs focused on protecting responder data, observing or suspending livestreamed attacks, and identification of malicious misinformation reflect how quickly information — valid or not — can be disseminated. As was discussed throughout this report, misinformation can provoke incidents or impact the decision-making of public safety personnel and the general public. This issue will continue to have the potential to significantly impact the safety of responders and the public for the foreseeable future.

Path Forward

Project Responder remains as the only independent, multi-disciplinary assessment of emergency response capability needs on a national scale. The needs in Project Responder are identified, validated, and prioritized by a field of responders from across the United States. The study is based on a methodology designed to obtain a diverse assortment of perspectives — with participants drawn from different regions of the country, agencies and jurisdictions of varying size, level of government, and employment status (e.g., career, volunteer), and traditional and non-traditional disciplines. Project Responder findings are not based on the loudest voice in the room or the influences of leadership. DHS S&T can be confident that research and acquisition decisions made based on Project Responder findings are based on the direct input of the public safety community. Likewise, other consumers of these study findings (e.g., academia, private industry) can use these results (and have done so in the past) as the basis for future study, program development, or solution enhancement.

Due to the decentralized nature of the response community — with each entity responsible for budget allocations, spending priorities, and resource needs — there is no entity other than DHS S&T that has the responsibility and capability to conduct this assessment. In addition, DHS S&T has the responsibility to conduct public safety research and development activities to address...
CONCLUSIONS

many of the capability needs identified in this study. While some are hindered by cultural or legal barriers, there are a large number of needs that can be resolved – in whole or in part – through the application of technology. DHS S&T, in partnership with other federal agencies, is able to set standards, develop guidance, or contribute research and development efforts for these needs.

There is nothing about the evolving response environment that is going to stop evolving. A recurring assessment of emergency response capability needs is critical to ensure that the public safety community is, and continues to be, equipped with the tools and skills to safely, efficiently, and effectively respond. The end-user centered approach of Project Responder ensures that needs that are consistent across disciplines are identified and not developed in separate silos. The development of solutions such as EDGE and POINTER highlight the advantage of generating solutions that can benefit responders of all disciplines.

Potential future iterations of Project Responder may consider the addition of two additional domains – public health and cybersecurity. As noted previously, there are entire Federal agencies with roles and responsibilities in these areas. However, it is the intersection of operational planning, mitigation, response and recovery activities with these areas where additional analysis is needed. For example:

- What type of cyberattacks are most common against public safety agencies?
- What are the likely consequences of these attacks?
- What elements of common public safety network configurations and system architectures are most vulnerable?
- What specific cybersecurity capability needs do emergency responders have?
- Where (specifically) is the overlap between public safety and public health?
- What are the barriers to a more integrated response?
- What specific public health capability needs exist (related to daily or large-scale response operations)?

Future iterations may be able to get a greater degree of participation from Tribal and Territorial representatives. The PR6 study team made multiple efforts to increase contributions from this sector but was not as successful as would have been ideal. Additional representation from responders based in minority communities would also provide additional perspectives.

Finally, analysis of available funding mechanisms for high priority needs would be beneficial. For example, are there opportunities for DHS S&T or individual agencies to collaborate with academia? What global efforts are ongoing where cooperation may be valuable (e.g., International Forum to Advance First Responder Innovation (IFAFRI), Horizon Europe)? While it is not helpful to only develop new public safety solutions in disciplinary silos (as appropriate), the same is often true internationally. Responders across the globe face many of the same issues – a more detailed correlation of capability needs across borders may be beneficial.
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Appendix A: History of Project Responder

The table below provides an overview of the previous five iterations of Project Responder:

<table>
<thead>
<tr>
<th>VERSION</th>
<th>DATE</th>
<th>DESCRIPTION</th>
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<tr>
<td></td>
<td></td>
<td>The initial iteration of Project Responder, running from 2001 to 2004, was funded through a Department of Justice grant to the Oklahoma City National Memorial Institute for the Prevention of Terrorism (MIPT). The original intent was to identify operational needs, shortfalls and priorities for response to catastrophic incidents and develop a technology investment plan to meet identified capability deficits. Shortly after inception, the focus of Project Responder was fundamentally shifted by the terrorist attacks of Sept. 11, 2001. The output of the first iteration of Project Responder was the development of 12 capability areas that defined and described the requirements for response to a catastrophic terrorist event. The capability areas were referred to as National Terrorism Response Objectives (NTROs). Following the identification of capability requirements and consultation with technical subject matter experts, the team developed a national agenda for research and development and a corresponding set of road maps detailing new initiatives designed to close gaps in emergency response capability.</td>
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</table>
DHS S&T initiated the second iteration of Project Responder in 2007 to examine changes in the emergency response environment since the initial report and identify new and enduring capability priorities. Significant shifts in the emergency response mission and needs occurred as a result of an increased focus on “all hazards” (due in part to events like Hurricanes Katrina and Rita, failure of large-scale infrastructure like the I-35 bridge collapse, etc.) and the evolution of national response policy and doctrine with the release of the National Incident Management System and the National Response Plan (which was later revised as the National Response Framework). As a result, the second Project Responder report found significant changes to responder capability needs and related priorities. Description of the 15 capability priorities included assessment of associated challenges in training, technology, management and policy that responders felt constrained further development.

Project Responder 3 (PR3) examined capabilities needed to fill existing gaps and created a vision of emergency response in the future. DHS funded PR3 through a joint relationship between S&T and FEMA’s National Preparedness Directorate. Through facilitated discussions with a diverse set of responders, participants identified 40 capabilities needed to fill existing gaps. Project Responder 3 also produced a vision for potential capabilities that may be required in a future response environment, unconstrained by resource or technical considerations.
<table>
<thead>
<tr>
<th><strong>Project Responder 4</strong></th>
<th><strong>July 2014</strong></th>
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<tr>
<td>Project Responder 4 (PR4) built on previous efforts examining the state of science and technology for opportunities to address the most persistent and highest priority capability needs and developing a plan to address those needs. PR4 focused on 14 capability needs that included enduring needs identified across the previous phases of Project Responder and emerging needs that allow responders to use technological advances occurring in other fields. Participants identified 42 response technology objectives (RTOs) that address the PR4 capability needs. The 2014 Plan identified a high-level technology solution (or part of a solution) designed to improve the capabilities of the response community. PR4 also contains a series of technology road maps that illustrate the project timelines and resource requirements for each RTO.</td>
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<table>
<thead>
<tr>
<th><strong>Project Responder 5</strong></th>
<th><strong>August 2017</strong></th>
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<tbody>
<tr>
<td>Project Responder 5 (PR5) examined emergency response capability needs for large-scale incidents in light of changes to the response environment, including the increase in incidence and severity of natural disasters and weather-related events, the growth of mass civil disturbance and riot events, and the introduction of violent targeting of emergency responders. The PR5 report describes 37 capability needs, responder-articulated goals for addressing those needs and related standards and technology programs.</td>
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Appendix B: List of Incidents Reviewed

The table below contains a list of major incidents that have occurred since publication of the Project Responder 5 report in 2017. The timeline for these events runs from 2017 to May 2021. Events listed in this table involve significant casualties and deaths or billions of dollars in damage and economic impact. These events include major natural disasters and extreme weather events, manmade and infrastructure disasters, the global pandemic, mass shooting events, significant cyberattacks, and protest/civil unrest incidents. Each event listed in this table has some correlation with the issues examined in PR6 as part of the Evolving Response Environment.

Natural disasters and extreme weather events were identified through NOAA. Mass shooting events were identified through the gun violence archive and is defined (for this list) as 4+ victims killed excluding the suspect in a single location. Pandemic data was obtained from the CDC. The states listed in this table are the top 8 in the United States with COVID-related deaths and cases as of 2 April 2021. New York City data is called out separately due to the high level of disease in the city.

<table>
<thead>
<tr>
<th>INCIDENT</th>
<th>TYPE</th>
<th>PR6 CORRELATION</th>
<th>YEAR</th>
<th>LOCATION</th>
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<td>Energy Sector</td>
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<td>COVID Surge California</td>
<td>Pandemic</td>
<td>COVID-19</td>
<td>2020-21</td>
<td>California</td>
</tr>
<tr>
<td>COVID Surge Texas</td>
<td>Pandemic</td>
<td>COVID-19</td>
<td>2020-21</td>
<td>Texas</td>
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<tr>
<td>COVID Surge Florida</td>
<td>Pandemic</td>
<td>COVID-19</td>
<td>2020-21</td>
<td>Florida</td>
</tr>
<tr>
<td>COVID Surge Illinois</td>
<td>Pandemic</td>
<td>COVID-19</td>
<td>2020-21</td>
<td>Illinois</td>
</tr>
<tr>
<td>COVID Surge Georgia</td>
<td>Pandemic</td>
<td>COVID-19</td>
<td>2020-21</td>
<td>Georgia</td>
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<tr>
<td>COVID Surge Pennsylvania</td>
<td>Pandemic</td>
<td>COVID-19</td>
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<td>Pennsylvania</td>
</tr>
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<td>Event Description</td>
<td>Category</td>
<td>Description</td>
<td>Location</td>
<td>Year</td>
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<td>COVID Surge Ohio</td>
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<td>COVID-19</td>
<td>Ohio</td>
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<tr>
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<td>Pandemic</td>
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<td>New York</td>
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<td>Attack Behavior</td>
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<td>2021</td>
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<td>Essex Mass Shooting</td>
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<td>Attack Behavior</td>
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<td>Boulder Mass Shooting</td>
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<td>Acworth Mass Shooting</td>
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<td>Phoenix Mass Shooting</td>
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<td>Muskogee Mass Shooting</td>
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<td>Evanston Mass Shooting</td>
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<td>January 6 U.S Capital Insurrection and Protest</td>
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<td>2021</td>
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<td>Details</td>
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<td>Political Protest</td>
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<td>West Virginia</td>
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<td>Tropical Storm</td>
<td>Weather Hazards, Climate Hazards</td>
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<td>Hurricane Zeta</td>
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<td>Hurricane Delta</td>
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<td>Louisiana</td>
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<td>Weather Hazards</td>
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<td>Texas</td>
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<td>South, Central, and Eastern Severe Weather</td>
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<td>Weather Hazards</td>
<td>2020</td>
<td>Multiple</td>
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<td>Central and Eastern Severe Weather</td>
<td>Severe Storms</td>
<td>Weather Hazards</td>
<td>2020</td>
<td>Multiple</td>
</tr>
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<td>Central, Southern, and Eastern Severe Weather</td>
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<td>Weather Hazards</td>
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<td>Multiple</td>
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<td>Southern Severe Weather</td>
<td>Severe Storms</td>
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<td>Weather Hazards</td>
<td>2020</td>
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<tr>
<td>Tennessee Tornadoes and Southeast Severe Weather</td>
<td>Tornado/Severe Storms</td>
<td>2020</td>
<td></td>
<td></td>
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<tr>
<td>South, East, and Northeast Severe Weather</td>
<td>Severe Storms</td>
<td>2020</td>
<td></td>
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<tr>
<td>Midwest Severe Weather</td>
<td>Severe Storms</td>
<td>Weather Hazards</td>
<td>2017</td>
<td>Multiple</td>
</tr>
<tr>
<td>Minnesota Hailstorm and Upper Midwest Severe Weather</td>
<td>Hailstorm/Severe Storms</td>
<td>Weather Hazards</td>
<td>2017</td>
<td>Multiple</td>
</tr>
<tr>
<td>Colorado Hailstorm and Central Severe Weather</td>
<td>Hailstorm/Severe Storms</td>
<td>Weather Hazards</td>
<td>2017</td>
<td>Multiple</td>
</tr>
<tr>
<td>Missouri and Arkansas Flooding and Central Severe Weather</td>
<td>Flooding/Severe Storms</td>
<td>Weather Hazards</td>
<td>2017</td>
<td>Multiple</td>
</tr>
<tr>
<td>South/Southeast Severe Weather</td>
<td>Severe Storms</td>
<td>Weather Hazards</td>
<td>2017</td>
<td>Multiple</td>
</tr>
<tr>
<td>Southeast Freeze</td>
<td>Severe Freeze</td>
<td>Weather Hazards</td>
<td>2017</td>
<td>Multiple</td>
</tr>
<tr>
<td>Midwest Tornado Outbreak</td>
<td>Tornado</td>
<td>Weather Hazards</td>
<td>2017</td>
<td>Multiple</td>
</tr>
<tr>
<td>Central/Southeast Tornado Outbreak</td>
<td>Tornado</td>
<td>Weather Hazards</td>
<td>2017</td>
<td>Multiple</td>
</tr>
<tr>
<td>California Flooding</td>
<td>Flooding</td>
<td>Weather Hazards, Climate Hazards</td>
<td>2017</td>
<td>California</td>
</tr>
<tr>
<td>Southern Tornado Outbreak and Western Storms</td>
<td>Tornado/Severe Storms</td>
<td>Weather Hazards</td>
<td>2017</td>
<td>Multiple</td>
</tr>
<tr>
<td>Amtrak Passenger Train Derailment</td>
<td>Rail Accident</td>
<td>Transportation Sector</td>
<td>2017</td>
<td>Washington</td>
</tr>
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</table>
Appendix C: Association Gaps

The table below contains a list of capability needs and gaps identified by other organizations and associations that correlate with PR6 capability needs.

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>NEED STATEMENT</th>
<th>DOMAIN</th>
<th>PR6 CAPABILITY NEED CORRELATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020 IAB R&amp;D Priority List</td>
<td>Indoor 3-D tracking of personnel</td>
<td></td>
<td>The ability to accurately geolocate responders (in three dimensions) inside of buildings (e.g., commercial facilities, public buildings)</td>
</tr>
<tr>
<td></td>
<td>Use of unmanned aircraft systems</td>
<td></td>
<td>The ability to mitigate specific UAS in a set airspace</td>
</tr>
<tr>
<td></td>
<td>Responder/receiver mental health and wellness</td>
<td></td>
<td>The ability to monitor the mental health of traditional and non-traditional responders and receivers (e.g., fire, law enforcement, EMS, public safety telecommunicators, front-line medical personnel)</td>
</tr>
<tr>
<td></td>
<td>Proximity or robot-based chemical detector</td>
<td></td>
<td>The ability to provide data and information on specific hazards (e.g., radiological sources) to responders in the vicinity of those hazards</td>
</tr>
<tr>
<td></td>
<td>Proximity or robot-based explosives detector</td>
<td></td>
<td>The ability to provide data and information on specific hazards (e.g., radiological sources) to responders in the vicinity of those hazards</td>
</tr>
<tr>
<td></td>
<td>Near real-time sharing of video feed</td>
<td></td>
<td>The ability to integrate situational awareness data from individual on-scene responders</td>
</tr>
</tbody>
</table>
### 2020 IAB R&D Priority List

<table>
<thead>
<tr>
<th>Ability</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to interface multiple databases and services with currently utilized first responder communications</td>
<td>The ability to integrate data from multiple sources for analysis</td>
</tr>
<tr>
<td>Alternative crowd dispersal device</td>
<td>The ability to safely enter areas of civil unrest to conduct response operations</td>
</tr>
<tr>
<td>Near real-time sharing of screen display</td>
<td>The ability to integrate situational awareness data from individual on-scene responders</td>
</tr>
<tr>
<td>Small unmanned aerial system (sUAS) with multi-gas metering for operation in flammable gas environments</td>
<td>The ability to mitigate specific UAS in a set airspace</td>
</tr>
<tr>
<td>Sharing Biometric Data from Foreign Terrorist Fighters with National and International Databases</td>
<td>The ability to integrate data from multiple sources for analysis</td>
</tr>
</tbody>
</table>

### Fourth Needs Assessment of the U.S. Fire Service

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal and Their Capabilities: Staffing</td>
<td>The ability to accurately determine available staffing levels during times of emergency</td>
</tr>
<tr>
<td>Personal and Their Capabilities: Health &amp; Wellness</td>
<td>The ability to monitor the mental health of traditional and non-traditional responders and receivers (e.g., fire, law enforcement, EMS, public safety telecommunicators, front-line medical personnel)</td>
</tr>
<tr>
<td>Voices of First Responders: Identifying Public Safety Communication Problems: Findings from User-Centered Interviews, Phase 1, Volume 1</td>
<td>Improved location tracking - e.g., provide exact locations (including z-axis) of responders, units, callers and building occupants</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Real-time information for situational awareness - e.g., provide visual information to augment audio communication from radios and cell phones</td>
<td>The ability to accurately geolocate (in three dimensions) calls for service inside of buildings (e.g., office buildings, shopping malls)</td>
</tr>
<tr>
<td>Heads up display (HUD) - e.g., provide environment and operational information</td>
<td>The ability to provide data and information on specific hazards (e.g., radiological sources) to responders in the vicinity of those hazards</td>
</tr>
<tr>
<td>Smart buildings - e.g., provide smarter intelligence (e.g., occupant number and locations) or to put its own fire out</td>
<td>The ability to access building information (e.g., blueprints, egress routes, known hazards, medical caches, communications centers, utility layouts) within facilities in real time</td>
</tr>
<tr>
<td>Top Problems Identified: Radio</td>
<td>The ability to maintain communications between units inside and outside of facilities (e.g., shopping malls, office/school buildings)</td>
</tr>
<tr>
<td>Top Problems Identified: Connectivity</td>
<td>The ability to provide responders with sufficient technology/connectivity to work remotely as needed</td>
</tr>
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</table>
### Top Problems Identified:

<table>
<thead>
<tr>
<th>Problem</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio Clarity</td>
<td>The ability to maintain communications between units inside and outside of facilities (e.g., shopping malls, office/school buildings)</td>
</tr>
<tr>
<td>Overwhelmed</td>
<td>The ability to avoid information overload throughout the duration of an incident</td>
</tr>
<tr>
<td>Body Camera</td>
<td>The ability to integrate situational awareness data from individual on-scene responders</td>
</tr>
<tr>
<td>Video</td>
<td>The ability to integrate situational awareness data from individual on-scene responders</td>
</tr>
<tr>
<td>Radio</td>
<td>The ability to maintain communications between units inside and outside of facilities (e.g., shopping malls, office/school buildings)</td>
</tr>
<tr>
<td>Connectivity</td>
<td>The ability to provide responders with sufficient technology/connectivity to work remotely as needed</td>
</tr>
<tr>
<td>Audio Clarity</td>
<td>The ability to maintain communications between units inside and outside of facilities (e.g., shopping malls, office/school buildings)</td>
</tr>
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Appendix D: Universal Needs

This appendix contains a list of those capability needs that are considered “universal needs,” meaning that every respondent agreed that the need was valid for their jurisdiction and provided a priority rating. There are ten universal PR6 capability needs:

<table>
<thead>
<tr>
<th>DOMAIN</th>
<th>ID</th>
<th>CAPABILITY NEED STATEMENT</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>SA.18</td>
<td>The ability to continually assess threats associated with hazardous (or potentially hazardous) facilities (e.g., ammunition plants, radiological sources, closed facilities)</td>
</tr>
<tr>
<td></td>
<td>CCC.1</td>
<td>The ability to incorporate real-time incident data into decision-making</td>
</tr>
<tr>
<td></td>
<td>CCC.10</td>
<td>The ability to maintain the ICS structure during public health emergencies</td>
</tr>
<tr>
<td></td>
<td>CCC.11</td>
<td>The ability to effectively incorporate non-traditional response agencies into ICS protocols and procedures for collaboration and information sharing (e.g., public health, medical personnel, National Guard)</td>
</tr>
<tr>
<td></td>
<td>CCC.12</td>
<td>The ability to efficiently integrate the arrival of additional personnel (e.g., volunteers, mutual aid), including those from non-traditional response agencies</td>
</tr>
<tr>
<td></td>
<td>RHS.6</td>
<td>The ability to avoid information overload throughout the duration of an incident or shift</td>
</tr>
<tr>
<td></td>
<td>LRM.24</td>
<td>The ability to adequately account for each item that has been used/contaminated/destroyed</td>
</tr>
<tr>
<td></td>
<td>LRM.38</td>
<td>The ability to maintain sufficient staffing levels during short-term surge or long-duration events</td>
</tr>
<tr>
<td></td>
<td>TE.2</td>
<td>The ability to conduct community-level and national-level after action reports to determine lessons learned and impacts</td>
</tr>
<tr>
<td></td>
<td>TE.23</td>
<td>The ability to provide leadership training to staff during extended response operations</td>
</tr>
</tbody>
</table>
Appendix E: PR6 Participants

This appendix contains a list of those people that participated in Project Responder 6 through interviews, in-person focus group meetings, virtual workshops, and/or technical review.

<table>
<thead>
<tr>
<th>PARTICIPANT</th>
<th>AGENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bruce Arvizu</td>
<td>Los Angeles County Fire Department (Ret)</td>
</tr>
<tr>
<td>Brett Bailey</td>
<td>Tulsa Police Department</td>
</tr>
<tr>
<td>Scott Baldwin</td>
<td>St Clair County Sheriff's Office</td>
</tr>
<tr>
<td>Oren Bersagel-Briese</td>
<td>Castle Rock Fire Department</td>
</tr>
<tr>
<td>Steve Birnbaum</td>
<td>Montgomery County Fire &amp; Rescue Service</td>
</tr>
<tr>
<td>Megan Bixler</td>
<td>APCO International</td>
</tr>
<tr>
<td>Lori Brill</td>
<td>Golden Gate Fire Protection District</td>
</tr>
<tr>
<td>Shannon Buhl</td>
<td>Cherokee Nation Marshal Service</td>
</tr>
<tr>
<td>Alan Butsch</td>
<td>Montgomery County Fire &amp; Rescue Service</td>
</tr>
<tr>
<td>Matt Canino</td>
<td>Denver Police Department</td>
</tr>
<tr>
<td>Tony Cipolla</td>
<td>San Luis Obispo County Sheriff's Office</td>
</tr>
<tr>
<td>Craig Cooper</td>
<td>Las Vegas Fire Department</td>
</tr>
<tr>
<td>Carol Cunningham</td>
<td>Ohio Department of Public Safety, Division of EMS</td>
</tr>
<tr>
<td>Jeremy DeMar</td>
<td>Mountain Valley Emergency Communications</td>
</tr>
<tr>
<td>Josh Dennis</td>
<td>Chicago Fire Department</td>
</tr>
<tr>
<td>Robert Doke</td>
<td>Oklahoma State Fire Marshal’s Office</td>
</tr>
<tr>
<td>Tim Dorsey</td>
<td>Lake Ozark Fire Protection District</td>
</tr>
<tr>
<td>Scott Eckles</td>
<td>Denver Fire Department</td>
</tr>
<tr>
<td>Scott Edson</td>
<td>Los Angeles Regional Interoperable Communications System</td>
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<tr>
<td>Spenser Fomby</td>
<td>Berkeley Police Department</td>
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<tr>
<td>Tracy Frazzano</td>
<td>Marco Island Police Department</td>
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<tr>
<td>Robert Gaskill-Clemons</td>
<td>City of St. Louis</td>
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<tr>
<td>Xenophon Gikas</td>
<td>Los Angeles Fire Department</td>
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<tr>
<td>Red Grasso</td>
<td>First Responder Network Authority</td>
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<tr>
<td>Randall Griffin</td>
<td>City of Oswego</td>
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<tr>
<td>Jay Hagen</td>
<td>Bellevue Fire Department</td>
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<tr>
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<tr>
<td>Alan Hanson</td>
<td>Fairfax Police Department</td>
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<tr>
<td>Greg Herbster</td>
<td>Moore Fire Department</td>
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<td>Joe Holloway</td>
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<tr>
<td>Alice Hong</td>
<td>National Urban Security Technology Laboratory</td>
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<tr>
<td>George Hough</td>
<td>Fire Department of New York (Ret)</td>
</tr>
<tr>
<td>Amanda Hughes</td>
<td>Brigham Young University</td>
</tr>
<tr>
<td>Anne Marie Jensen</td>
<td>San Diego Fire &amp; Rescue</td>
</tr>
<tr>
<td>Alison Kahn</td>
<td>Public Safety Communications Research</td>
</tr>
<tr>
<td>Justin Kates</td>
<td>City of Nashua Office of Emergency Management</td>
</tr>
<tr>
<td>Alisha King</td>
<td>State of Washington IT &quot;WaTech&quot;</td>
</tr>
<tr>
<td>Eric Kukula</td>
<td>Noblis</td>
</tr>
<tr>
<td>Aaron Kusterman</td>
<td>Illinois State Police, Statewide Terrorism Intelligence Center</td>
</tr>
<tr>
<td>Bart Lace</td>
<td>Stafford County Fire &amp; EMS</td>
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<tr>
<td>Greg Lefebre</td>
<td>Boulder Police Department</td>
</tr>
<tr>
<td>Carolyn Levering</td>
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</tr>
<tr>
<td>James Luplow</td>
<td>Houston Police Department</td>
</tr>
<tr>
<td>Tyler Mackanin</td>
<td>National Urban Security Technology Laboratory</td>
</tr>
<tr>
<td>Carl Makins</td>
<td>Charleston County Sheriff’s Department</td>
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<tr>
<td>Mike Marsh</td>
<td>Global Medical Response</td>
</tr>
<tr>
<td>Mark Maziarz</td>
<td>Tampa Police Department</td>
</tr>
<tr>
<td>Paul McDonagh</td>
<td>Seattle Police Department</td>
</tr>
<tr>
<td>Rob Mc Lafferty</td>
<td>Butler County Emergency Services</td>
</tr>
<tr>
<td>Ben Miller</td>
<td>Colorado Center of Excellence for Advanced Technology Aerial Firefighting</td>
</tr>
<tr>
<td>Erin Miller</td>
<td>University of Maryland</td>
</tr>
<tr>
<td>Matt Monetti</td>
<td>National Urban Security Technology Laboratory</td>
</tr>
<tr>
<td>Anthony Natale</td>
<td>ConEdison</td>
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<tr>
<td>Mary Nelan</td>
<td>University of North Texas</td>
</tr>
<tr>
<td>Milt Nenneman</td>
<td>Department of Homeland Security Science &amp; Technology Directorate</td>
</tr>
<tr>
<td>Lisa Pine</td>
<td>Colorado Division of Fire Prevention and Control</td>
</tr>
<tr>
<td>Name</td>
<td>Organization</td>
</tr>
<tr>
<td>--------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>Jeff Race</td>
<td>Pineville Volunteer Fire Department</td>
</tr>
<tr>
<td>Mark Ratzlaff</td>
<td>Janesville Police Department</td>
</tr>
<tr>
<td>Rodney Reed</td>
<td>Harris County Fire Marshal’s Office</td>
</tr>
<tr>
<td>Brady Robinette</td>
<td>Lubbock Fire Rescue</td>
</tr>
<tr>
<td>Jeff Rubin</td>
<td>Tualatin Valley Fire &amp; Rescue</td>
</tr>
<tr>
<td>Patrick Sheehan</td>
<td>Tennessee Emergency Management Agency</td>
</tr>
<tr>
<td>Jim St. John</td>
<td>Jefferson County Emergency Management</td>
</tr>
<tr>
<td>Jeff Stern</td>
<td>Emergency Management Institute</td>
</tr>
<tr>
<td>Chris Strattner</td>
<td>Rockland County Police Department</td>
</tr>
<tr>
<td>Justin Sypolt</td>
<td>City of Pittsburgh Bureau of EMS</td>
</tr>
<tr>
<td>Gregory Tabeek</td>
<td>Palm Beach County Fire Rescue</td>
</tr>
<tr>
<td>Adam Thiel</td>
<td>City of Philadelphia</td>
</tr>
<tr>
<td>Steve Vandewalle</td>
<td>San Diego Fire &amp; Rescue</td>
</tr>
<tr>
<td>Jamie Vickery</td>
<td>University of Colorado Boulder</td>
</tr>
<tr>
<td>Stephen Watson</td>
<td>Parker County Emergency Services District</td>
</tr>
<tr>
<td>Andrew Werner</td>
<td>Orange County Emergency Services</td>
</tr>
<tr>
<td>Drew Williams</td>
<td>Golden Police Department</td>
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<tr>
<td>Susanna Williams</td>
<td>Raleigh Fire Department (Ret)</td>
</tr>
<tr>
<td>Jason Winsky</td>
<td>Tucson Police Department</td>
</tr>
<tr>
<td>Andy Wordin</td>
<td>Los Angeles Fire Department</td>
</tr>
</tbody>
</table>
## Appendix F: Top 50 Capability Needs

The table below contains a list of the 50 highest prioritized PR6 capability needs.

<table>
<thead>
<tr>
<th>IDENTIFIER</th>
<th>SCORE</th>
<th>CAPABILITY NEED STATEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCC.1</td>
<td>4.13</td>
<td>The ability to incorporate real-time incident data into decision-making</td>
</tr>
<tr>
<td>SA.48</td>
<td>4.11</td>
<td>The ability to accurately geolocate responders (in three dimensions) inside of an enclosed/semi-enclosed structure (e.g., commercial facilities, public buildings)</td>
</tr>
<tr>
<td>CIS.15</td>
<td>4.06</td>
<td>The ability to maintain communications (voice and data) between units inside and outside of facilities (e.g., shopping malls, office/school buildings, subways)</td>
</tr>
<tr>
<td>CCC.6</td>
<td>4.00</td>
<td>The ability to maintain sufficient qualified staff for leadership roles during long-duration or simultaneous events</td>
</tr>
<tr>
<td>SA.44</td>
<td>4.00</td>
<td>The ability to mitigate specific unmanned aircraft systems (UAS) in a set airspace</td>
</tr>
<tr>
<td>CCC.12</td>
<td>3.97</td>
<td>The ability to efficiently integrate the arrival of additional personnel (e.g., volunteers, mutual aid), including those from non-traditional response agencies</td>
</tr>
<tr>
<td>TE.20</td>
<td>3.96</td>
<td>The ability to realistically exercise low-frequency, high-consequence incidents</td>
</tr>
<tr>
<td>CCC.8</td>
<td>3.93</td>
<td>The ability to increase cooperation and coordination between agencies and jurisdictions when they are competing for scarce resources</td>
</tr>
<tr>
<td>RHS.2</td>
<td>3.93</td>
<td>The ability to monitor the mental health of traditional and non-traditional responders (e.g., fire, law enforcement, EMS, public safety telecommunicators, front-line medical personnel) during routine and extreme/extended operations</td>
</tr>
<tr>
<td>LRM.38</td>
<td>3.92</td>
<td>The ability to maintain sufficient staffing levels during short-term surge or long-duration events</td>
</tr>
<tr>
<td>SA.49</td>
<td>3.86</td>
<td>The ability to automatically and accurately geolocate (in three dimensions) the physical location of an emergency/situation</td>
</tr>
<tr>
<td>RHS.23</td>
<td>3.86</td>
<td>The ability to protect the private information of public safety and public health personnel (e.g., address, family information, schools)</td>
</tr>
<tr>
<td>Capability</td>
<td>Score</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>OPS.5</td>
<td>3.86</td>
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</tr>
<tr>
<td>SA.2</td>
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<td>RHS.3</td>
<td>3.83</td>
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<tr>
<td>OPS.29</td>
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<td>SA.30</td>
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<td>OPS.6</td>
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<td>CIS.33</td>
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<tr>
<td>OPS.30</td>
<td>3.64</td>
<td></td>
</tr>
<tr>
<td>CIS.1</td>
<td>3.63</td>
<td></td>
</tr>
</tbody>
</table>

The ability to safely enter areas of civil unrest to conduct traditional and non-traditional response operations (e.g., law enforcement, emergency medical, fire, public works).

The ability to view building information (e.g., blueprints, egress routes, known hazards, medical caches, communications centers, utility layouts) electronically in real time.

The ability to monitor and assess the impact of responder mental health during extreme or extended operations (e.g., weather events, wildfire response, civil unrest).

The ability to maintain the security and integrity of the public safety answering points (PSAP) and the emergency communications center.

The ability to integrate situational awareness data from individual on-scene responders.

The ability to provide data and information on specific hazards (e.g., radiological sources) to responders in the vicinity of those hazards.

The ability to mitigate the impact of misinformation into decision-making (public safety and public).

The ability to avoid information overload throughout the duration of an incident or shift.

The ability to extract critically-injured persons from a crowd.

The ability to assess life safety conditions before arrival or introduction of response assets.

The ability for on-scene responders to receive updated information and data in real time (e.g., optimal navigation routes, situational awareness data) without relying on push-to-talk communications.

The ability to provide responders with sufficient technology/connectivity to work remotely as needed.

The ability to maintain the security and integrity of dispatch functions and connectivity.

The ability to provide factual information via social media at sufficient pace to pre-empt or counter misinformation.

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439 Participants in the PR6 workshop chose to combine two of the capability needs in this domain. RHS.3 was integrated with RHS.2 to create a more comprehensive statement of need.
<table>
<thead>
<tr>
<th>Code</th>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA.29</td>
<td>3.58</td>
<td>The ability to obtain awareness of the initiation of attacks in real time</td>
</tr>
<tr>
<td>CIS.12</td>
<td>3.58</td>
<td>The ability to provide emergency life safety information directly to individual responders (e.g., optimal escape routes)</td>
</tr>
<tr>
<td>CCC.11</td>
<td>3.58</td>
<td>The ability to effectively incorporate non-traditional response agencies into ICS protocols and procedures for collaboration and information sharing (e.g., public health, medical personnel, National Guard)</td>
</tr>
<tr>
<td>SA.3</td>
<td>3.55</td>
<td>The ability to access real-time data about the status of critical infrastructure (e.g., dams, bridges, rail)</td>
</tr>
<tr>
<td>CIS.21</td>
<td>3.55</td>
<td>The ability to increase the amount and speed of information from the dispatcher to responders in the field</td>
</tr>
<tr>
<td>CIS.28</td>
<td>3.55</td>
<td>The ability to prevent jamming of or interference with public safety critical transmissions</td>
</tr>
<tr>
<td>CCC.10</td>
<td>3.55</td>
<td>The ability to maintain the ICS structure during public health emergencies</td>
</tr>
<tr>
<td>TE.23</td>
<td>3.55</td>
<td>The ability to provide leadership training to staff during extended response operations</td>
</tr>
<tr>
<td>RHS.5</td>
<td>3.54</td>
<td>The ability to provide resources to accommodate responder family responsibilities (e.g., childcare)</td>
</tr>
<tr>
<td>CIS.16</td>
<td>3.52</td>
<td>The ability to maintain interoperable communications with commercial, government, public, and private facility security staff</td>
</tr>
<tr>
<td>SA.52</td>
<td>3.51</td>
<td>The ability to ascertain whether the address of the call for service is associated with potential communicable conditions or with quarantining persons</td>
</tr>
<tr>
<td>SA.1</td>
<td>3.50</td>
<td>The ability to integrate real-time images and video being broadcast or posted from the scene</td>
</tr>
<tr>
<td>RHS.1</td>
<td>3.50</td>
<td>The ability to regularly institute incident debriefings after traumatic calls for service</td>
</tr>
<tr>
<td>II.31</td>
<td>3.50</td>
<td>The ability to identify specific strategic and operational needs that can benefit from advanced analytics</td>
</tr>
<tr>
<td>CIS.14</td>
<td>3.48</td>
<td>The ability to utilize state-of-the-art communications devices (e.g., smart phone vs. LMR) for reliable public safety communications</td>
</tr>
<tr>
<td>Code</td>
<td>Section</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>---------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>CIS.27</td>
<td>3.48</td>
<td>The ability to enhance communications bandwidth during incident response</td>
</tr>
<tr>
<td>OPS.25</td>
<td>3.48</td>
<td>The ability for smart buildings to interact with responders who do not have access to smart features (e.g., keyless entry, elevator access)</td>
</tr>
<tr>
<td>TE.5</td>
<td>3.46</td>
<td>The ability to exercise operational plans in advance of pre-planned events using immersive capabilities</td>
</tr>
<tr>
<td>OPS.2</td>
<td>3.46</td>
<td>The ability to safely de-escalate tensions/violent actions by a crowd</td>
</tr>
<tr>
<td>CIS.4</td>
<td>3.45</td>
<td>The ability to quickly and consistently communicate accurate and up-to-date incident-related facts and data to the public in all languages and accessible formats</td>
</tr>
<tr>
<td>CCC.7</td>
<td>3.45</td>
<td>The ability to develop regional response assets (e.g., HAZMAT, EMS) the provide a higher cumulative level of capability for all participating jurisdictions</td>
</tr>
<tr>
<td>OPS.10</td>
<td>3.45</td>
<td>The ability to maintain mission functions during periods of extended budget impacts</td>
</tr>
<tr>
<td>OPS.12</td>
<td>3.45</td>
<td>The ability to effectively and safely conduct response operations during periods of extremely high volume</td>
</tr>
<tr>
<td>SA.15</td>
<td>3.44</td>
<td>The ability to analyze incident image and video data in real time for response planning and operations</td>
</tr>
</tbody>
</table>
Appendix G: Prioritized Situational Awareness Capability Needs

This appendix contains a list of the 52 Situational Awareness capability needs in priority order by mean score.

<table>
<thead>
<tr>
<th>IDENTIFIER</th>
<th>SCORE</th>
<th>CAPABILITY NEED STATEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA.48</td>
<td>4.11</td>
<td>The ability to accurately geolocate responders (in three dimensions) inside of buildings (e.g., commercial facilities, public buildings)</td>
</tr>
<tr>
<td>SA.44</td>
<td>4</td>
<td>The ability to mitigate specific unmanned aircraft systems (UAS) in a set airspace</td>
</tr>
<tr>
<td>SA.49</td>
<td>3.86</td>
<td>The ability to automatically and accurately geolocate (in three dimensions) the physical location of an emergency/situation</td>
</tr>
<tr>
<td>SA.2</td>
<td>3.85</td>
<td>The ability to view building information (e.g., blueprints, egress routes, known hazards, medical caches, communications centers, utility layouts) electronically in real time</td>
</tr>
<tr>
<td>SA.30</td>
<td>3.78</td>
<td>The ability to integrate situational awareness data from individual on-scene responders</td>
</tr>
<tr>
<td>SA.14</td>
<td>3.75</td>
<td>The ability to provide data and information on specific hazards (e.g., radiological sources) to responders in the vicinity of those hazards</td>
</tr>
<tr>
<td>SA.13</td>
<td>3.71</td>
<td>The ability to assess life safety conditions before arrival or introduction of response assets</td>
</tr>
<tr>
<td>SA.29</td>
<td>3.58</td>
<td>The ability to obtain awareness of the initiation of attacks in real time</td>
</tr>
<tr>
<td>SA.3</td>
<td>3.55</td>
<td>The ability to access real-time data about the status of critical infrastructure (e.g., dams, bridges, rail)</td>
</tr>
<tr>
<td>SA.52</td>
<td>3.51</td>
<td>The ability to ascertain whether the address of the call for service is associated with potential communicable conditions or with quarantining persons</td>
</tr>
<tr>
<td>SA.1</td>
<td>3.5</td>
<td>The ability to integrate real-time images and video being broadcast or posted from the scene</td>
</tr>
<tr>
<td>SA.15</td>
<td>3.44</td>
<td>The ability to analyze incident image and video data in real time for response planning and operations</td>
</tr>
<tr>
<td>SA.8</td>
<td>3.43</td>
<td>The ability to provide on-scene images and video to personnel responding to call for service in advance of arrival</td>
</tr>
<tr>
<td>Code</td>
<td>Section</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>SA.33</td>
<td>3.43</td>
<td>The ability to identify the presence of booby-traps at incident scenes (e.g., narcotics or home-made explosive (HME) production facilities)</td>
</tr>
<tr>
<td>SA.26</td>
<td>3.42</td>
<td>The ability to map the location of known individuals that have not evacuated</td>
</tr>
<tr>
<td>SA.21</td>
<td>3.37</td>
<td>The ability to visualize virtual schematics, blueprints, topographies, etc. on top of real-time operations</td>
</tr>
<tr>
<td>SA.40</td>
<td>3.35</td>
<td>The ability to identify dangerous substances and precursors for first-line officers and staff</td>
</tr>
<tr>
<td>SA.22</td>
<td>3.3</td>
<td>The ability for 9-1-1 call takers to visualize key response locations (e.g., evacuation areas, inundation maps, closed perimeters) on a jurisdiction map</td>
</tr>
<tr>
<td>SA.20</td>
<td>3.22</td>
<td>The ability to mark potential hazards on digital maps from mobile data terminals and hand-held devices available to all response disciplines</td>
</tr>
<tr>
<td>SA.18</td>
<td>3.19</td>
<td>The ability to continually assess threats associated with hazardous (or potentially hazardous) facilities (e.g., ammunition plants, radiological sources, closed facilities)</td>
</tr>
<tr>
<td>SA.27</td>
<td>3.19</td>
<td>The ability to track the status of evacuation by location, facility, or identified persons within the jurisdiction</td>
</tr>
<tr>
<td>SA.43</td>
<td>3.19</td>
<td>The ability to assess unknown UAS in a set airspace (e.g., track, identify, determine friend or foe status)</td>
</tr>
<tr>
<td>SA.5</td>
<td>3.16</td>
<td>The ability to access and integrate data about the security status (e.g., sensor feeds, closed circuit video feeds, breech notifications) of public and private buildings (e.g., schools) into planning and response operations</td>
</tr>
<tr>
<td>SA.19</td>
<td>3.11</td>
<td>The ability to visualize rural or remote incident sites in advance of the arrival of response units</td>
</tr>
<tr>
<td>SA.12</td>
<td>3.08</td>
<td>The ability to effectively monitor other common hazards and threats when consumed by critical or long-duration response operations (e.g., COVID, protests)</td>
</tr>
<tr>
<td>SA.32</td>
<td>3.06</td>
<td>The ability to identify specific incident hazards/source (e.g., toxin) based on the appearance of health symptoms (e.g., blisters, breathing difficulty) or characteristics of incident</td>
</tr>
<tr>
<td></td>
<td>3.06</td>
<td>The ability to identify the initiation of fires within areas of civil unrest</td>
</tr>
</tbody>
</table>
### APPENDICES

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA.7</td>
<td>3.03</td>
<td>The ability to remotely obtain situational awareness data and information in extreme weather (e.g., precipitation, wind) and incident-based environments (e.g., rapidly-shifting wildfires)</td>
</tr>
<tr>
<td>SA.11</td>
<td>3</td>
<td>The ability to continuously monitor key safety, quality (i.e., air, ground, water), and health factors at stand-off distance from known threats (e.g., chemical facilities)</td>
</tr>
<tr>
<td>SA.46</td>
<td>2.97</td>
<td>The ability to identify the presence of individual weapons being carried (overtly or covertly) during protest or civil unrest incidents</td>
</tr>
<tr>
<td>SA.28</td>
<td>2.94</td>
<td>The ability to effectively model evacuation requirements and corridors based on incident-specific data</td>
</tr>
<tr>
<td>SA.31</td>
<td>2.92</td>
<td>The ability to update 9-1-1 call-taker questions based on evolving incident details to provide improved situational awareness</td>
</tr>
<tr>
<td>SA.23</td>
<td>2.84</td>
<td>The ability for command or response personnel to visualize the movement of crowds on jurisdiction-specific maps in real time</td>
</tr>
<tr>
<td>SA.47</td>
<td>2.83</td>
<td>The ability to monitor crowd behavior in real time to identify potential changes in sentiment, direction, aggression, etc.</td>
</tr>
<tr>
<td>SA.50</td>
<td>2.83</td>
<td>The ability to obtain accurate jurisdiction-specific data and information on current infection rates, hot spots, recovery rates, death rates, etc. in public health situations</td>
</tr>
<tr>
<td>SA.51</td>
<td>2.78</td>
<td>The ability to obtain consistent and accurate information regarding disease behavior, life span, transmission, epidemiology, positive infection duration, clinical presentations during a public health emergency</td>
</tr>
<tr>
<td>SA.6</td>
<td>2.76</td>
<td>The ability to access and integrate repositories of private UAS data to support incident decision-making and response operations for planning and operations purposes (e.g., realty company videos, hobbyists)</td>
</tr>
<tr>
<td>SA.25</td>
<td>2.75</td>
<td>The ability to create digital or model reconstructions of incident related buildings and/or structures to support decision-making and operations</td>
</tr>
<tr>
<td>SA.24</td>
<td>2.64</td>
<td>The ability to geographically display/map key parameters related a public health incident (e.g., state lock-down status, hospital bed status, stockpile location and status)</td>
</tr>
<tr>
<td>SA.16</td>
<td>2.61</td>
<td>The ability to remotely monitor natural features (e.g., fault lines, hillsides) to obtain advanced knowledge of potential or impending disasters</td>
</tr>
</tbody>
</table>
### APPENDICES

<table>
<thead>
<tr>
<th>SA Number</th>
<th>Rank</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA.39</td>
<td>2.53</td>
<td>The ability to detect the location of illegal narcotics production facilities/fields</td>
</tr>
<tr>
<td>SA.9</td>
<td>2.51</td>
<td>The ability to track the movement of a specific person or persons (non-responders) as they move through buildings or crowds in real time</td>
</tr>
<tr>
<td>SA.36</td>
<td>2.51</td>
<td>The ability to receive advanced and regular notification of hazardous train, trailer, and barge cargo prior to arrival in/through jurisdiction</td>
</tr>
<tr>
<td>SA.17</td>
<td>2.5</td>
<td>The ability to remotely monitor water levels on transportation routes and critical infrastructure</td>
</tr>
<tr>
<td>SA.10</td>
<td>2.47</td>
<td>The ability to maintain sustained surveillance of mobile and stationary protests and civil unrest incidents, including break-off groups, counter-protests, etc.</td>
</tr>
<tr>
<td>SA.42</td>
<td>2.44</td>
<td>The ability to assess homeless encampments for potential threats and hazards (e.g., propane tanks, communicable diseases)</td>
</tr>
<tr>
<td>SA.45</td>
<td>2.41</td>
<td>The ability to remotely distinguish among individuals (e.g., agitators vs. peaceful protestors) within a large group</td>
</tr>
<tr>
<td>SA.4</td>
<td>2.32</td>
<td>The ability to integrate real-time equipment data (e.g., apparatus flow rates) into incident command</td>
</tr>
<tr>
<td>SA.35</td>
<td>2.28</td>
<td>The ability to identify the initiation and location of fires resulting from lightning strikes</td>
</tr>
<tr>
<td>SA.41</td>
<td>2.22</td>
<td>The ability to identify the location of homeless encampments</td>
</tr>
<tr>
<td>SA.37</td>
<td>2.19</td>
<td>The ability to track the arrival and activities of persons suspected of criminal intent into jurisdictions</td>
</tr>
<tr>
<td>SA.34</td>
<td>1.89</td>
<td>The ability to assess water quality for hazards (e.g., algae levels, chemicals) in advance of diving and water-borne operations</td>
</tr>
</tbody>
</table>
Appendix H: Prioritized Communications & Information Sharing Capability Needs

This appendix contains a list of the 37 Communications & Information Sharing capability needs in priority order by mean score.

<table>
<thead>
<tr>
<th>IDENTIFIER</th>
<th>SCORE</th>
<th>CAPABILITY NEED STATEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIS.15</td>
<td>4.06</td>
<td>The ability to maintain communications (voice and data) between units inside and outside of facilities (e.g., shopping malls, office/school buildings, subways)</td>
</tr>
<tr>
<td>CIS.20</td>
<td>3.65</td>
<td>The ability for on-scene responders to receive updated information and data in real time (e.g., optimal navigation routes, situational awareness data) without relying on push-to-talk communications</td>
</tr>
<tr>
<td>CIS.33</td>
<td>3.65</td>
<td>The ability to provide responders with sufficient technology/connectivity to work remotely as needed</td>
</tr>
<tr>
<td>CIS.1</td>
<td>3.63</td>
<td>The ability to provide factual information via social media at sufficient pace to pre-empt or counter misinformation</td>
</tr>
<tr>
<td>CIS.12</td>
<td>3.58</td>
<td>The ability to provide emergency life safety information directly to individual responders (e.g., optimal escape routes)</td>
</tr>
<tr>
<td>CIS.21</td>
<td>3.55</td>
<td>The ability to increase the amount and speed of information from the dispatcher to responders in the field</td>
</tr>
<tr>
<td>CIS.28</td>
<td>3.55</td>
<td>The ability to prevent jamming of or interference with public safety critical transmissions</td>
</tr>
<tr>
<td>CIS.16</td>
<td>3.52</td>
<td>The ability to maintain interoperable communications with commercial, government, public, and private facility security staff</td>
</tr>
<tr>
<td>CIS.14</td>
<td>3.48</td>
<td>The ability to utilize state-of-the-art communications devices (e.g., smartphone vs. LMR) for reliable public safety communications</td>
</tr>
<tr>
<td>CIS.27</td>
<td>3.48</td>
<td>The ability to enhance communications bandwidth during incident response</td>
</tr>
<tr>
<td>CIS.4</td>
<td>3.45</td>
<td>The ability to quickly and consistently communicate accurate and up-to-date incident-related facts and data to the public in all languages and accessible formats</td>
</tr>
<tr>
<td>CIS.11</td>
<td>3.42</td>
<td>The ability to communicate with other members of response team without having to push-to-talk</td>
</tr>
<tr>
<td>CIS.36</td>
<td>3.4</td>
<td>The ability to bi-directionally share current data between all necessary stakeholders (e.g., local health department, hospitals, commercial facility management/staff, government agencies)</td>
</tr>
</tbody>
</table>
### APPENDICES

<table>
<thead>
<tr>
<th>Code</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIS.26</td>
<td>3.35</td>
<td>The ability to distribute information to the public in areas with limited or no internet connectivity</td>
</tr>
<tr>
<td>CIS.30</td>
<td>3.32</td>
<td>The ability to integrate advanced communications and network capability into public safety apparatus and vehicles</td>
</tr>
<tr>
<td>CIS.2</td>
<td>3.29</td>
<td>The ability for public safety agencies to communicate via multiple and emerging social media platforms in a format that can be accessed by all groups (e.g., age demographics, medical/physical impairments, languages/dialects)</td>
</tr>
<tr>
<td>CIS.31</td>
<td>3.26</td>
<td>The ability to ensure connectivity to 9-1-1 systems (e.g., rural/urban, network deserts)</td>
</tr>
<tr>
<td>CIS.17</td>
<td>3.19</td>
<td>The ability to maintain sufficient encrypted communications during operations (e.g., civil unrest incidents)</td>
</tr>
<tr>
<td>CIS.19</td>
<td>3.19</td>
<td>The ability to communicate in loud environments (e.g., ongoing fire alarms)</td>
</tr>
<tr>
<td>CIS.32</td>
<td>3.19</td>
<td>The ability to provide network/digital access across rural, remote, or denied areas</td>
</tr>
<tr>
<td>CIS.34</td>
<td>3.19</td>
<td>The ability to integrate computer-aided dispatch (CAD) functions from multiple jurisdictions</td>
</tr>
<tr>
<td>CIS.22</td>
<td>3.17</td>
<td>The ability to effectively share information among crew/squad/team members during a public health emergency that is impacted by separated locations</td>
</tr>
<tr>
<td>CIS.35</td>
<td>3.17</td>
<td>The ability to integrate discipline data related to calls for service (e.g., homeless-related calls bounce back and forth between EMS/LE/social services)</td>
</tr>
<tr>
<td>CIS.5</td>
<td>3.16</td>
<td>The ability to effectively provide proactive messaging to the public related to potential or occurring incidents (e.g., facility-related risks, inundation information, status of evacuation routes/fuel supplies)</td>
</tr>
<tr>
<td>CIS.9</td>
<td>3.13</td>
<td>The ability to deconflict information derived from disparate sources</td>
</tr>
<tr>
<td>CIS.3</td>
<td>3.1</td>
<td>The ability to increase public following of public safety agencies on social media platforms</td>
</tr>
<tr>
<td>CIS.7</td>
<td>2.87</td>
<td>The ability for the public to provide information directly to public safety agencies about specific incidents in real time</td>
</tr>
<tr>
<td>CIS.37</td>
<td>2.87</td>
<td>The ability to exchange sensitive and protected information across jurisdictions/disciplines/agencies (e.g., civil unrest agitators, BOLO alerts)</td>
</tr>
<tr>
<td>CIS</td>
<td>Score</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
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<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>CIS.29</td>
<td>2.84</td>
<td>The ability to map the effectiveness of communications interoperability within individual jurisdictions or regions (e.g., dead zones, urban canyons, band conflicts)</td>
</tr>
<tr>
<td>CIS.13</td>
<td>2.77</td>
<td>The ability to automatically transcribe emergency 9-1-1 calls in real time (to increase awareness/understanding)</td>
</tr>
<tr>
<td>CIS.23</td>
<td>2.68</td>
<td>The ability to validate, disseminate, and ensure receipt of information and quickly update related policies and procedures (e.g., altered standards of care, PPE requirements)</td>
</tr>
<tr>
<td>CIS.8</td>
<td>2.48</td>
<td>The ability to understand what news sources that members of the public are using to obtain their information</td>
</tr>
<tr>
<td>CIS.18</td>
<td>2.45</td>
<td>The ability to communicate with specific (non-responder) individuals within a crowd</td>
</tr>
<tr>
<td>CIS.6</td>
<td>2.19</td>
<td>The ability to communicate (via audio or video) with patients in advance of responder arrival at call for service</td>
</tr>
<tr>
<td>CIS.24</td>
<td>2.16</td>
<td>The ability to transmit audio, images, and/or video to receiving facilities during treatment or transport of patients</td>
</tr>
<tr>
<td>CIS.25</td>
<td>2.1</td>
<td>The ability to obtain real-time video consult with medical personnel during treatment or transport of patients</td>
</tr>
<tr>
<td>CIS.10</td>
<td>2</td>
<td>The ability to liaison with protest organizers to share information on protest-specific threats or issues</td>
</tr>
</tbody>
</table>
Appendix I: Prioritized Command, Control & Coordination Capability Needs

This appendix contains a list of the 16 Command, Control, & Coordination capability needs in priority order by mean score.

<table>
<thead>
<tr>
<th>IDENTIFIER</th>
<th>SCORE</th>
<th>CAPABILITY NEED STATEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCC.1</td>
<td>UN</td>
<td>The ability to incorporate real-time incident data into decision-making</td>
</tr>
<tr>
<td>CCC.6</td>
<td>4</td>
<td>The ability to maintain sufficient qualified staff for leadership roles during long-duration or simultaneous events</td>
</tr>
<tr>
<td>CCC.12</td>
<td>UN</td>
<td>The ability to efficiently integrate the arrival of additional personnel (e.g., volunteers, mutual aid), including those from non-traditional response agencies</td>
</tr>
<tr>
<td>CCC.8</td>
<td>3.93</td>
<td>The ability to increase cooperation and coordination between agencies and jurisdictions when they are competing for scarce resources</td>
</tr>
<tr>
<td>CCC.4</td>
<td>3.75</td>
<td>The ability to mitigate the introduction of misinformation in decision-making (public safety and public)</td>
</tr>
<tr>
<td>CCC.11</td>
<td>UN</td>
<td>The ability to effectively incorporate non-traditional response agencies into ICS protocols and procedures for collaboration and information sharing (e.g., public health, medical personnel, National Guard)</td>
</tr>
<tr>
<td>CCC.10</td>
<td>UN</td>
<td>The ability to maintain the ICS structure during public health emergencies</td>
</tr>
<tr>
<td>CCC.7</td>
<td>3.45</td>
<td>The ability to develop regional response assets (e.g., HAZMAT, EMS) that provide a higher cumulative level of capability for all participating jurisdictions</td>
</tr>
<tr>
<td>CCC.2</td>
<td>3.42</td>
<td>The ability to efficiently reverse decisions and opinions formed based on outdated/incorrect information</td>
</tr>
<tr>
<td>CCC.3</td>
<td>3.29</td>
<td>The ability to make and execute command decisions that are not in line with political forces</td>
</tr>
<tr>
<td>CCC.9</td>
<td>3.23</td>
<td>The ability to develop consistent guidance among levels of government regarding PPE and altered protocols</td>
</tr>
<tr>
<td>CCC.5</td>
<td>3.06</td>
<td>The ability to assess incident response activities against existing plans, guidance, templates, checklists, etc.</td>
</tr>
</tbody>
</table>
## APPENDICES

<table>
<thead>
<tr>
<th>CCC.15</th>
<th>2.34</th>
<th>The ability to activate and enforce emergency plans and procedures when leadership or staff does not see the event or issue as an emergency</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCC.14</td>
<td>2.13</td>
<td>The ability to obtain user (staff) input regarding proposed protocol changes</td>
</tr>
<tr>
<td>CCC.16</td>
<td>2.03</td>
<td>The ability to coordinate EMS protocols with emergency room protocols (e.g., PPE requirements, transport decisions/expectations)</td>
</tr>
<tr>
<td>CCC.13</td>
<td>1.37</td>
<td>The ability to liaison with foreign law enforcement agencies to mitigate gang/cartel activity</td>
</tr>
</tbody>
</table>
Appendix J: Prioritized Responder Health & Safety Capability Needs

This appendix contains a list of the 27 Responder Health & Safety capability needs in priority order by mean score.

<table>
<thead>
<tr>
<th>IDENTIFIER</th>
<th>SCORE</th>
<th>CAPABILITY NEED STATEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>RHS.2</td>
<td>3.93</td>
<td>The ability to monitor the mental health of traditional and non-traditional responders (e.g., fire, law enforcement, EMS, public safety telecommunicators, front-line medical personnel) during routine and extreme/extended operations</td>
</tr>
<tr>
<td>RHS.23</td>
<td>3.86</td>
<td>The ability to protect the private information of public safety and public health personnel (e.g., address, family information, schools)</td>
</tr>
<tr>
<td>RHS.3</td>
<td>3.83</td>
<td>The ability to monitor and assess the impact of responder mental health during extreme or extended operations (e.g., weather events, wildfire response, civil unrest)</td>
</tr>
<tr>
<td>RHS.6</td>
<td>3.75</td>
<td>The ability to avoid information overload throughout the duration of an incident</td>
</tr>
<tr>
<td>RHS.5</td>
<td>3.54</td>
<td>The ability to provide resources to accommodate responder family responsibilities (e.g., childcare)</td>
</tr>
<tr>
<td>RHS.1</td>
<td>3.5</td>
<td>The ability to regularly institute incident debriefings after traumatic calls for service</td>
</tr>
<tr>
<td>RHS.25</td>
<td>3.34</td>
<td>The ability to assess the physical health effects of multiple and extended operations on responders</td>
</tr>
<tr>
<td>RHS.26</td>
<td>3.33</td>
<td>The ability to test responders (symptomatic and asymptomatic) for infection and antibodies on a recurring basis</td>
</tr>
<tr>
<td>RHS.21</td>
<td>3.3</td>
<td>The ability to provide appropriate PPE to responders in the vicinity of specific hazards (e.g., radiological sources)</td>
</tr>
<tr>
<td>RHS.18</td>
<td>3.26</td>
<td>The ability to integrate protective capabilities into responder duty and base layer garments</td>
</tr>
<tr>
<td>RHS.24</td>
<td>3.25</td>
<td>The ability to monitor physical/life safety status (e.g., vital signs, position, life safety sensor) of all responders</td>
</tr>
<tr>
<td>RHS.4</td>
<td>3.24</td>
<td>The ability to assess the cognitive awareness of responders engaged in operations on scene</td>
</tr>
<tr>
<td>RHS.13</td>
<td>3.14</td>
<td>The ability to protect responders from exposure to communicable conditions</td>
</tr>
</tbody>
</table>

Participants in the PR6 workshop chose to combine two of the capability needs in this domain. RHS.3 was integrated with RHS.2 to create a more comprehensive statement of need.
### APPENDICES

<table>
<thead>
<tr>
<th>RHS</th>
<th>3.11</th>
<th>The ability to protect responder biometric data from private ownership or cyber threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>RHS.17</td>
<td>3.07</td>
<td>The ability to determine potential exposure in the field</td>
</tr>
<tr>
<td>RHS.7</td>
<td>3</td>
<td>The ability to protect responders from hazards related to illicit narcotics or explosives production (e.g., chemical exposure, explosive or flammable materials, respiratory hazards)</td>
</tr>
<tr>
<td>RHS.19</td>
<td>2.93</td>
<td>The ability for responder equipment (e.g., cylinder) to provide a visible alert to display life-saving or other critical status</td>
</tr>
<tr>
<td>RHS.27</td>
<td>2.89</td>
<td>The ability to prevent capture of data derived from responder wearables</td>
</tr>
<tr>
<td>RHS.12</td>
<td>2.83</td>
<td>The ability to maintain focus on protective actions and behaviors during long-duration events (e.g., months or years)</td>
</tr>
<tr>
<td>RHS.9</td>
<td>2.81</td>
<td>The ability to protect responder apparatus, vehicles, and equipment during response operations</td>
</tr>
<tr>
<td>RHS.16</td>
<td>2.77</td>
<td>The ability to safely re-use or decontaminate PPE, equipment, and components</td>
</tr>
<tr>
<td>RHS.11</td>
<td>2.74</td>
<td>The ability for jurisdictions to assess when responders can safely operate during extreme weather events (e.g., high wind speeds)</td>
</tr>
<tr>
<td>RHS.14</td>
<td>2.68</td>
<td>The ability to assess risk of contact with individuals versus risk of exposure (related to change in protocols)</td>
</tr>
<tr>
<td>RHS.8</td>
<td>2.61</td>
<td>The ability to protect responders from threats and hazards commonly encountered during daily operations (e.g., needle-sticks, blood-borne pathogens)</td>
</tr>
<tr>
<td>RHS.20</td>
<td>2.59</td>
<td>The ability to measure equipment data based on individual responder data (e.g., cylinder duration)</td>
</tr>
<tr>
<td>RHS.10</td>
<td>2.48</td>
<td>The ability to protect responder health in lodging situations (e.g., stations, fire camps)</td>
</tr>
<tr>
<td>RHS.15</td>
<td>2.33</td>
<td>The ability to don sufficient and appropriate PPE in a timely manner to ensure patient safety</td>
</tr>
</tbody>
</table>
Appendix K: Prioritized Logistics & Resource Management Capability Needs

This appendix contains a list of the 53 Logistics & Resource Management capability needs in priority order by mean score.

<table>
<thead>
<tr>
<th>IDENTIFIER</th>
<th>SCORE</th>
<th>CAPABILITY NEED STATEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>LRM.38 UN</td>
<td>3.92</td>
<td>The ability to maintain sufficient staffing levels during short-term surge or long-duration events</td>
</tr>
<tr>
<td>LRM.39</td>
<td>3.44</td>
<td>The ability to accurately determine available staffing levels during times of emergency</td>
</tr>
<tr>
<td>LRM.51</td>
<td>3.42</td>
<td>The ability to identify who is authorized to be within the scene perimeter during incident response operations</td>
</tr>
<tr>
<td>LRM.35</td>
<td>3.36</td>
<td>The ability to maintain supply chain for public safety and public health equipment during extended emergencies</td>
</tr>
<tr>
<td>LRM.34</td>
<td>3.33</td>
<td>The ability to maintain sufficient local stockpiles for national-level emergencies</td>
</tr>
<tr>
<td>LRM.19</td>
<td>3.25</td>
<td>The ability to optimally allocate resources based on integrated and real-time data</td>
</tr>
<tr>
<td>LRM.24 UN</td>
<td>3.25</td>
<td>The ability to adequately account for each item that has been used/contaminated/destroyed</td>
</tr>
<tr>
<td>LRM.45</td>
<td>3.21</td>
<td>The ability to identify the credentials and capabilities of affiliated and unaffiliated volunteers</td>
</tr>
<tr>
<td>LRM.17</td>
<td>3.13</td>
<td>The ability to prioritize agencies with urgent need among shared stock</td>
</tr>
<tr>
<td>LRM.40</td>
<td>3.13</td>
<td>The ability to re-allocate staff with compromised health issues (or family) which reduces available resources</td>
</tr>
<tr>
<td>LRM.53</td>
<td>3.13</td>
<td>The ability to present the valid credentials of all persons (responder, private, public) that arrive to support incident response</td>
</tr>
<tr>
<td>LRM.3</td>
<td>3.08</td>
<td>The ability to integrate real-time inundation info into vehicle navigation systems</td>
</tr>
<tr>
<td>LRM.20</td>
<td>3.08</td>
<td>The ability to track consumables during high tempo operations</td>
</tr>
<tr>
<td>LRM.1</td>
<td>3.04</td>
<td>The ability to assess resource needs given known populations remaining in the jurisdiction (e.g., after evacuation)</td>
</tr>
<tr>
<td>LRM</td>
<td>Level</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>LRM.13</td>
<td>3.04</td>
<td>The ability to access and visualize the status of shelters, equipment caches, fuel status, etc.</td>
</tr>
<tr>
<td>LRM.28</td>
<td>3.04</td>
<td>The ability to successfully decontaminate electronic response equipment</td>
</tr>
<tr>
<td>LRM.31</td>
<td>3.04</td>
<td>The ability to quickly decontaminate and turnaround equipment/apparatus for unit availability</td>
</tr>
<tr>
<td>LRM.44</td>
<td>3.04</td>
<td>The ability to visualize the location of resources on the incident scene on top of real-time operations</td>
</tr>
<tr>
<td>LRM.46</td>
<td>3.04</td>
<td>The ability to vet unaffiliated volunteers and non-traditional suppliers for security and validity</td>
</tr>
<tr>
<td>LRM.52</td>
<td>3</td>
<td>The ability to identify real versus printed or counterfeit public safety items (e.g., badges)</td>
</tr>
<tr>
<td>LRM.12</td>
<td>2.96</td>
<td>The ability to know the status of inventory levels of equipment and resources</td>
</tr>
<tr>
<td>LRM.25</td>
<td>2.96</td>
<td>The ability to purchase supplies in the amount needed regardless of previous order quantities</td>
</tr>
<tr>
<td>LRM.5</td>
<td>2.92</td>
<td>The ability to predict future shortages (e.g., water treatment chemicals, CO2, liquid O2)</td>
</tr>
<tr>
<td>LRM.6</td>
<td>2.92</td>
<td>The ability to plan resource requests when call volume varies and future call volume is unknown</td>
</tr>
<tr>
<td>LRM.32</td>
<td>2.92</td>
<td>The ability to ascertain the effectiveness of decontamination procedures</td>
</tr>
<tr>
<td>LRM.4</td>
<td>2.88</td>
<td>The ability to identify where there is redundant dependency on resources (e.g., for evacuation, fatality management) with other jurisdictions</td>
</tr>
<tr>
<td>LRM.21</td>
<td>2.88</td>
<td>The ability to maintain incident resource data in a format that cannot be corrupted or edited</td>
</tr>
<tr>
<td>LRM.23</td>
<td>2.88</td>
<td>The ability to safeguard logistics facilities and staff</td>
</tr>
<tr>
<td>LRM.41</td>
<td>2.84</td>
<td>The ability to recruit staff during a national public health emergency (e.g., social distancing restrictions)</td>
</tr>
<tr>
<td>LRM.2</td>
<td>2.83</td>
<td>The ability to provide specialty transport resources to evacuate populations that have physical health, mental health, and social barriers</td>
</tr>
<tr>
<td>LRM.8</td>
<td>2.8</td>
<td>The ability to convey specific equipment (e.g., donations, resources) and service needs to traditional and non-traditional suppliers and the public</td>
</tr>
<tr>
<td>LRM</td>
<td>Value</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-----------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>16</td>
<td>2.79</td>
<td>The ability to know timelines for delivery of requested resources</td>
</tr>
<tr>
<td>30</td>
<td>2.79</td>
<td>The ability to disinfect/decontaminate large areas (e.g., medical surge sites, PPE storage locations, headquarters buildings, field offices, vehicles/apparatus)</td>
</tr>
<tr>
<td>18</td>
<td>2.75</td>
<td>The ability to automatically order resources based on real-time usage</td>
</tr>
<tr>
<td>9</td>
<td>2.65</td>
<td>The ability to connect solution providers (companies and research centers) who are recipients of federal funding with response agencies in order to refine requirements, priorities, and development pathways</td>
</tr>
<tr>
<td>43</td>
<td>2.58</td>
<td>The ability to visualize health and availability status of staff</td>
</tr>
<tr>
<td>26</td>
<td>2.54</td>
<td>The ability to harness natural or pre-existing on-scene power sources to support response operations</td>
</tr>
<tr>
<td>37</td>
<td>2.52</td>
<td>The ability to trace station, team, and vehicle communicable disease contacts within agencies</td>
</tr>
<tr>
<td>36</td>
<td>2.5</td>
<td>The ability to ensure last-mile delivery and distribution during social distancing regulations</td>
</tr>
<tr>
<td>33</td>
<td>2.48</td>
<td>The ability to track and maintain supplies designated for contagious/contaminated environments</td>
</tr>
<tr>
<td>29</td>
<td>2.46</td>
<td>The ability to protect non-hardened equipment (public and private) from effects of chemicals</td>
</tr>
<tr>
<td>39</td>
<td>2.44</td>
<td>The ability to accurately determine available staffing levels during times of emergency</td>
</tr>
<tr>
<td>10</td>
<td>2.43</td>
<td>The ability to quickly establish purchasing agreements with non-traditional providers due to lack of local or domestic supply</td>
</tr>
<tr>
<td>11</td>
<td>2.39</td>
<td>The ability to validate the claims of potential suppliers (cost, supply levels, quality, delivery timeframe)</td>
</tr>
<tr>
<td>7</td>
<td>2.38</td>
<td>The ability to maintain space for responder equipment (e.g., radio transmission equipment) on commercial buildings, fixtures</td>
</tr>
<tr>
<td>42</td>
<td>2.38</td>
<td>The ability to visualize real-time hospital/medical facility/treatment center resource availability</td>
</tr>
<tr>
<td>48</td>
<td>2.38</td>
<td>The ability to coordinate spontaneous unaffiliated volunteers with emergency management organizations</td>
</tr>
<tr>
<td>22</td>
<td>2.36</td>
<td>The ability to maintain incident financial data in a format that cannot be corrupted or edited</td>
</tr>
</tbody>
</table>
### APPENDICES

<table>
<thead>
<tr>
<th>LRM</th>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LRM.50</td>
<td>2.26</td>
<td>The ability to manage excess donated supplies (e.g., disposal, storage)</td>
</tr>
<tr>
<td>LRM.27</td>
<td>2.25</td>
<td>The ability to utilize energy from responder movement to reduce physiological load</td>
</tr>
<tr>
<td>LRM.47</td>
<td>2.08</td>
<td>The ability to follow-up with volunteers to monitor physical and mental health effects</td>
</tr>
<tr>
<td>LRM.49</td>
<td>2.04</td>
<td>The ability to engage public safety and volunteer organizations in the administration of narcotic countermeasures (e.g., Narcan)</td>
</tr>
<tr>
<td>LRM.15</td>
<td>1.96</td>
<td>The ability to deliver incident related supplies without requiring use of personnel resources (e.g., unmanned vehicle delivery)</td>
</tr>
<tr>
<td>LRM.14</td>
<td>1.83</td>
<td>The ability to deliver supplies to rural or remote incident sites in advance of the arrival of response units</td>
</tr>
</tbody>
</table>
Appendix L: Prioritized Casualty Management Capability Needs

This appendix contains a list of the 31 Casualty Management capability needs in priority order by mean score.

<table>
<thead>
<tr>
<th>IDENTIFIER</th>
<th>SCORE</th>
<th>CAPABILITY NEED STATEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM.1</td>
<td>3.28</td>
<td>The ability to conduct search operations remote from response personnel</td>
</tr>
<tr>
<td>CM.2</td>
<td>2.83</td>
<td>The ability to conduct rescue operations remote from response personnel</td>
</tr>
<tr>
<td>CM.3</td>
<td>2.63</td>
<td>The ability to identify the substances causing overdose in real time</td>
</tr>
<tr>
<td>CM.22</td>
<td>2.58</td>
<td>The ability to monitor the vital signs of trapped or remote patients in real time</td>
</tr>
<tr>
<td>CM.29</td>
<td>2.58</td>
<td>The ability to receive real-time test results for communicable conditions</td>
</tr>
<tr>
<td>CM.6</td>
<td>2.42</td>
<td>The ability to assess persons for mental health characteristics versus drug reactions</td>
</tr>
<tr>
<td>CM.4</td>
<td>2.38</td>
<td>The ability to determine which medications have been previously prescribed for individuals (e.g., anti-psychotic meds)</td>
</tr>
<tr>
<td>CM.7</td>
<td>2.38</td>
<td>The ability to safely restrain patients experiencing excited delirium</td>
</tr>
<tr>
<td>CM.24</td>
<td>2.38</td>
<td>The ability to access patient history and data while rendering care</td>
</tr>
<tr>
<td>CM.27</td>
<td>2.38</td>
<td>The ability to conduct contract tracing of responder exposures or provide information to members of the public who have interacted with infected responders</td>
</tr>
<tr>
<td>CM.14</td>
<td>2.36</td>
<td>The ability to provide weather-appropriate care for homeless persons during temperature extremes</td>
</tr>
<tr>
<td>CM.20</td>
<td>2.29</td>
<td>The ability to ascertain the identity of persons that are unable to coherently speak for themselves</td>
</tr>
<tr>
<td>CM.26</td>
<td>2.29</td>
<td>The ability to screen patients for virus infection or communicable conditions before treatment</td>
</tr>
<tr>
<td>CM.21</td>
<td>2.25</td>
<td>The ability to extract data from citizen/patient wearables to support response operations</td>
</tr>
<tr>
<td>CM.28</td>
<td>2.25</td>
<td>The ability to address issues of under-reporting/over-reporting of symptoms by members of the public in order to receive medical attention and transport</td>
</tr>
<tr>
<td>CM.25</td>
<td>2.21</td>
<td>The ability to ensure patient safety when PPE resources are modified or unavailable</td>
</tr>
<tr>
<td>ID</td>
<td>Score</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>CM.17</td>
<td>2.16</td>
<td>The ability to coordinate with sites of large numbers of potential casualties (e.g., long term care facilities) to determine protocols and response procedures</td>
</tr>
<tr>
<td>CM.23</td>
<td>2.12</td>
<td>The ability to access patient health care data before arrival at call for service</td>
</tr>
<tr>
<td>CM.18</td>
<td>2.08</td>
<td>The ability to track patient outcomes after transport</td>
</tr>
<tr>
<td>CM.30</td>
<td>2</td>
<td>The ability to maintain awareness of vaccine contraindications and side-effects</td>
</tr>
<tr>
<td>CM.11</td>
<td>1.96</td>
<td>The ability to provide sufficient mental health/addiction bed capacity within the jurisdiction for detox or mental health crises</td>
</tr>
<tr>
<td>CM.10</td>
<td>1.92</td>
<td>The ability to communicate where those experiencing the effects of substances of abuse can get initial treatment at time of emergency</td>
</tr>
<tr>
<td>CM.13</td>
<td>1.92</td>
<td>The ability to provide sufficient capacity for women, families, men, children at shelters or treatment facilities</td>
</tr>
<tr>
<td>CM.31</td>
<td>1.92</td>
<td>The ability to reassure patients and the public while wearing a mask</td>
</tr>
<tr>
<td>CM.9</td>
<td>1.88</td>
<td>The ability for responders to analyze paraphernalia/remnants for the ingredients of pills, powders, mixtures, liquids, etc.</td>
</tr>
<tr>
<td>CM.19</td>
<td>1.79</td>
<td>The ability to record/collect data on unidentified casualties (for future identification)</td>
</tr>
<tr>
<td>CM.16</td>
<td>1.76</td>
<td>The ability to conduct remote medical triage or treatment operations (i.e., the patient is not in close vicinity to the responder)</td>
</tr>
<tr>
<td>CM.12</td>
<td>1.64</td>
<td>The ability to identify and visualize the location of closest appropriate facility for treatment/services</td>
</tr>
<tr>
<td>CM.8</td>
<td>1.52</td>
<td>The ability to maintain awareness of criteria for PUI (patient under investigation) to prevent confusion when evaluating a patient</td>
</tr>
<tr>
<td>CM.15</td>
<td>1.52</td>
<td>The ability to effectively allocate patients across approved medical facilities</td>
</tr>
<tr>
<td>CM.5</td>
<td>1.29</td>
<td>The ability to identify when citizens are no longer engaging in court-mandated or voluntary treatment services</td>
</tr>
</tbody>
</table>
Appendix M: Prioritized Training & Exercise Capability Needs

This appendix contains a list of the 26 Training & Exercise capability needs in priority order by mean score.

<table>
<thead>
<tr>
<th>IDENTIFIER</th>
<th>SCORE</th>
<th>CAPABILITY NEED STATEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>TE.20</td>
<td>3.96</td>
<td>The ability to realistically exercise low-frequency, high-consequence incidents</td>
</tr>
<tr>
<td>TE.23</td>
<td>3.55</td>
<td>The ability to provide leadership training to staff during extended response operations</td>
</tr>
<tr>
<td>TE.5</td>
<td>3.46</td>
<td>The ability to exercise operational plans in advance of pre-planned events using immersive capabilities</td>
</tr>
<tr>
<td>TE.17</td>
<td>3.44</td>
<td>The ability to realistically exercise incidents involving critical infrastructure (involving facility staff, buildings, etc.)</td>
</tr>
<tr>
<td>TE.19</td>
<td>3.42</td>
<td>The ability to conduct training and exercise with non-traditional partners (e.g., National Guard) focused on civil unrest response</td>
</tr>
<tr>
<td>TE.18</td>
<td>3.37</td>
<td>The ability to conduct full-scale exercises with realistic numbers of victims</td>
</tr>
<tr>
<td>TE.11</td>
<td>3.27</td>
<td>The ability to update just-in-time training given changing protocols and guidance</td>
</tr>
<tr>
<td>TE.9</td>
<td>3.15</td>
<td>The ability to conduct multi-company, multi-agency, or multi-jurisdictional training while social distancing</td>
</tr>
<tr>
<td>TE.2</td>
<td>3.14</td>
<td>The ability to conduct community-level and national-level after action reports to determine lessons learned and impacts</td>
</tr>
<tr>
<td>TE.7</td>
<td>3.14</td>
<td>The ability to identify hands-on and classroom training that can be conducted remotely (in groups or individually)</td>
</tr>
<tr>
<td>TE.10</td>
<td>3.12</td>
<td>The ability to access training modules from mobile data terminals, laptops, and hand-held devices</td>
</tr>
<tr>
<td>TE.15</td>
<td>3.11</td>
<td>The ability to identify and train public safety staff on de-escalation techniques for individuals and groups</td>
</tr>
<tr>
<td>TE.8</td>
<td>3</td>
<td>The ability to train and exercise non-pandemic operations (e.g., use of force, first aid, crisis intervention) during social distancing restrictions</td>
</tr>
<tr>
<td>TE.16</td>
<td>3</td>
<td>The ability to provide protective and response training to responders in the immediate vicinity of specific threats (e.g., chemical plants, radiological sources)</td>
</tr>
<tr>
<td>TE.13</td>
<td>2.88</td>
<td>The ability to provide sustained hazardous materials training to all responders after awareness level courses</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td>----------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>TE.6</td>
<td>2.86</td>
<td>The ability to integrate PPE and equipment components into advanced training systems</td>
</tr>
<tr>
<td>TE.4</td>
<td>2.83</td>
<td>The ability to customize (per jurisdiction, agency, etc.) training systems</td>
</tr>
<tr>
<td>TE.3</td>
<td>2.78</td>
<td>The ability to integrate audible, visual, and haptic impulses into training systems</td>
</tr>
<tr>
<td>TE.24</td>
<td>2.75</td>
<td>The ability to expand access to affordable social media analysis training courses</td>
</tr>
<tr>
<td>TE.25</td>
<td>2.75</td>
<td>The ability to provide training to responders on effects of implicit bias</td>
</tr>
<tr>
<td>TE.12</td>
<td>2.71</td>
<td>The ability to train and exercise for day-to-day operations in the absence of technology/connectivity</td>
</tr>
<tr>
<td>TE.1</td>
<td>2.6</td>
<td>The ability to ascertain that responders are completing online or distance learning education/training packages</td>
</tr>
<tr>
<td>TE.26</td>
<td>2.59</td>
<td>The ability to obtain training on new equipment and protocols prior to use/dissemination of equipment (e.g., UV disinfecting lamp injuries)</td>
</tr>
<tr>
<td>TE.22</td>
<td>2.56</td>
<td>The ability to provide remote just-in-time training for PPE usage (e.g., donning/doffing, new style) in an infectious disease environment</td>
</tr>
<tr>
<td>TE.21</td>
<td>2.46</td>
<td>The ability to provide medical training to public information officers to relay accurate information</td>
</tr>
<tr>
<td>TE.14</td>
<td>2.31</td>
<td>The ability to provide realistic training on impacts of various levels of flooding for walking, riding, driving</td>
</tr>
</tbody>
</table>
Appendix N: Prioritized Risk Assessment & Planning Capability Needs

This appendix contains a list of the 28 Risk Assessment & Planning capability needs in priority order by mean score.

<table>
<thead>
<tr>
<th>IDENTIFIER</th>
<th>SCORE</th>
<th>CAPABILITY NEED STATEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAP.14</td>
<td>3.44</td>
<td>The ability to capture and assess impacts, smart practices, and lessons learned to inform planning for future pandemic response</td>
</tr>
<tr>
<td>RAP.2</td>
<td>3.15</td>
<td>The ability to identify and track who (specific persons) within a jurisdiction does not have the ability to evacuate</td>
</tr>
<tr>
<td>RAP.3</td>
<td>3.07</td>
<td>The ability to map the location and status of persons that cannot or have not evacuated during a specific incident</td>
</tr>
<tr>
<td>RAP.18</td>
<td>3.07</td>
<td>The ability to assess the extent of potential incidents based on the characteristics of known threats and hazards (e.g., closed chemical facilities, structural stability of dams/levees given seismic hazards)</td>
</tr>
<tr>
<td>RAP.4</td>
<td>3.04</td>
<td>The ability to include public safety personnel in the development of civic planning decisions (e.g., building design, land development)</td>
</tr>
<tr>
<td>RAP.1</td>
<td>3.00</td>
<td>The ability to identify specific jurisdictions that may encounter difficulties with evacuation (e.g., limited traffic routes)</td>
</tr>
<tr>
<td>RAP.10</td>
<td>3.00</td>
<td>The ability to increase public safety infrastructure in correlation with increases in population</td>
</tr>
<tr>
<td>RAP.28</td>
<td>3.00</td>
<td>The ability to plan to conduct mission functions from remote/alternative locations (and switch quickly)</td>
</tr>
<tr>
<td>RAP.27</td>
<td>2.96</td>
<td>The ability to plan for sufficient local revenue to support operations during extended national emergencies</td>
</tr>
<tr>
<td>RAP.26</td>
<td>2.89</td>
<td>The ability to dedicate sufficient personnel to risk assessment and planning due to competing public safety priorities and responsibilities</td>
</tr>
<tr>
<td>RAP.15</td>
<td>2.85</td>
<td>The ability to create a mass fatality plan based on pandemic lessons learned and that is not redundant with resources in other jurisdictions</td>
</tr>
<tr>
<td>RAP.6</td>
<td>2.81</td>
<td>The ability to provide input to commercial facilities on hardening or protection equipment/design (not at public expense) (e.g., as a condition of permitting)</td>
</tr>
<tr>
<td>RAP.11</td>
<td>2.81</td>
<td>The ability to assess public safety capabilities commensurate with existing infrastructure (e.g., transportation routes, water pressure and capacity, age of critical infrastructure)</td>
</tr>
<tr>
<td>RAP.19</td>
<td>2.78</td>
<td>The ability to accurately assess (and reassess) changes in population based on events and seasons</td>
</tr>
<tr>
<td>--------</td>
<td>------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>RAP.16</td>
<td>2.74</td>
<td>The ability to adapt existing pandemic plans and stockpiles to characteristics of current pandemic (differences because of lack of vaccine and treatments)</td>
</tr>
<tr>
<td>RAP.21</td>
<td>2.74</td>
<td>The ability to accurately assess changes in the homeless population within a jurisdiction</td>
</tr>
<tr>
<td>RAP.5</td>
<td>2.67</td>
<td>The ability to re-assess planning/development assumptions based on evolving environmental disasters and incidents</td>
</tr>
<tr>
<td>RAP.12</td>
<td>2.63</td>
<td>The ability to assess the impact of potential jurisdictional water system failures on public safety needs (e.g., fire suppression)</td>
</tr>
<tr>
<td>RAP.17</td>
<td>2.59</td>
<td>The ability to define and approve crisis standards of care in advance of health emergencies</td>
</tr>
<tr>
<td>RAP.7</td>
<td>2.44</td>
<td>The ability for jurisdictions to assess the impact of extreme weather events on planning assumptions (e.g., additional water/energy usage, composition of natural fuel load, tide levels, calls for service)</td>
</tr>
<tr>
<td>RAP.22</td>
<td>2.41</td>
<td>The ability to assess the viability of existing water infrastructure for response-related operations (e.g., hydrant opening effects on pipes)</td>
</tr>
<tr>
<td>RAP.25</td>
<td>2.37</td>
<td>The ability to plan to provide device charging capability for citizens during periods of extended power loss</td>
</tr>
<tr>
<td>RAP.23</td>
<td>2.33</td>
<td>The ability to plan for sufficient extreme weather shelters to protect potentially affected population</td>
</tr>
<tr>
<td>RAP.24</td>
<td>2.3</td>
<td>The ability to plan for sufficient extended shelter-in-place for high-density populations</td>
</tr>
<tr>
<td>RAP.20</td>
<td>2.22</td>
<td>The ability to predict changes in crime patterns during shutdown, national emergency (e.g., rise in domestic violence, decrease in property crimes)</td>
</tr>
<tr>
<td>RAP.13</td>
<td>1.93</td>
<td>The ability to monitor topography and transportation routes to predict the potential location of sink holes</td>
</tr>
<tr>
<td>RAP.9</td>
<td>1.85</td>
<td>The ability to assess the end of eviction moratorium on individual jurisdictions</td>
</tr>
<tr>
<td>RAP.8</td>
<td>1.74</td>
<td>The ability to provide water and wastewater functions to populations downstream from isolated lines, segments, or systems (i.e., re-routing)</td>
</tr>
</tbody>
</table>
Appendix O: Prioritized Investigation & Intelligence Capability Needs

This appendix contains a list of the 39 Investigation & Intelligence Sharing capability needs in priority order by mean score.

<table>
<thead>
<tr>
<th>IDENTIFIER</th>
<th>SCORE</th>
<th>CAPABILITY NEED STATEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>II.31</td>
<td>3.5</td>
<td>The ability to identify specific strategic and operational needs that can benefit from advanced analytics</td>
</tr>
<tr>
<td>II.25</td>
<td>3.38</td>
<td>The ability to integrate data from multiple sources for analysis</td>
</tr>
<tr>
<td>II.32</td>
<td>3.19</td>
<td>The ability to develop a common organization or tagging structure for emergency response data elements</td>
</tr>
<tr>
<td>II.20</td>
<td>3.15</td>
<td>The ability to identify fake tips/calls for service or swatting attempts</td>
</tr>
<tr>
<td>II.28</td>
<td>3.08</td>
<td>The ability to identify and remove inaccurate data in data sets</td>
</tr>
<tr>
<td>II.30</td>
<td>3.04</td>
<td>The ability to compile public safety data sets for advanced analytics</td>
</tr>
<tr>
<td>II.35</td>
<td>3.04</td>
<td>The ability to expand existing public safety databases to include open source publicly available data sources</td>
</tr>
<tr>
<td>II.14</td>
<td>3</td>
<td>The ability to monitor livestreams and social media posts from the incident scene in real time</td>
</tr>
<tr>
<td>II.19</td>
<td>3</td>
<td>The ability for responders to validate the legitimacy of online information sources</td>
</tr>
<tr>
<td>II.11</td>
<td>2.96</td>
<td>The ability to gather data from public and private social media platforms within a set geographic space (e.g., incident scene)</td>
</tr>
<tr>
<td>II.15</td>
<td>2.96</td>
<td>The ability to access and analyze digital data and information related to incidents, investigations, and intelligence</td>
</tr>
<tr>
<td>II.21</td>
<td>2.96</td>
<td>The ability to validate the originating location of social media posts</td>
</tr>
<tr>
<td>II.23</td>
<td>2.88</td>
<td>The ability to quickly identify malicious misinformation contained in social media posts</td>
</tr>
<tr>
<td>II.13</td>
<td>2.85</td>
<td>The ability to monitor what information and misinformation is being disseminated through social media from official and non-official channels</td>
</tr>
<tr>
<td>II.36</td>
<td>2.85</td>
<td>The ability to visualize data and reports derived from intelligence management systems</td>
</tr>
<tr>
<td>II.24</td>
<td>2.81</td>
<td>The ability to ascertain the validity (e.g., not manipulated) of media generated by citizen journalists</td>
</tr>
</tbody>
</table>
## APPENDICES

<table>
<thead>
<tr>
<th>II.29</th>
<th>2.81</th>
<th>The ability to create national-level data analysis capability including data from state and local departments</th>
</tr>
</thead>
<tbody>
<tr>
<td>II.12</td>
<td>2.73</td>
<td>The ability to identify critical data from large volume of information available on social media sites</td>
</tr>
<tr>
<td>II.26</td>
<td>2.73</td>
<td>The ability to provide an intelligence management system to command and investigative personnel</td>
</tr>
<tr>
<td>II.1</td>
<td>2.64</td>
<td>The ability to assess large volume of online threats to identify those most likely to occur</td>
</tr>
<tr>
<td>II.33</td>
<td>2.62</td>
<td>The ability to identify data sources, ownership, and associated legal restrictions for usage</td>
</tr>
<tr>
<td>II.27</td>
<td>2.58</td>
<td>The ability to prevent the degradation of data sets over time</td>
</tr>
<tr>
<td>II.8</td>
<td>2.54</td>
<td>The ability to identify persons with known communicable conditions that are defying public health orders</td>
</tr>
<tr>
<td>II.18</td>
<td>2.5</td>
<td>The ability to protect and legally store data used for digital analysis</td>
</tr>
<tr>
<td>II.4</td>
<td>2.46</td>
<td>The ability to rapidly identify when livestreamed attacks begin</td>
</tr>
<tr>
<td>II.3</td>
<td>2.42</td>
<td>The ability to identify and access threats posted to dark web and private sites</td>
</tr>
<tr>
<td>II.16</td>
<td>2.42</td>
<td>The ability to identify and access emerging social media platforms, threads, hashtags, influencers, etc.</td>
</tr>
<tr>
<td>II.17</td>
<td>2.42</td>
<td>The ability to develop social media analysis credentials commensurate with training/capabilities</td>
</tr>
<tr>
<td>II.22</td>
<td>2.35</td>
<td>The ability to identify non-human users on social media sites (e.g., bots)</td>
</tr>
<tr>
<td>II.2</td>
<td>2.27</td>
<td>The ability to assess the likelihood of violent behavior based on social media posts</td>
</tr>
<tr>
<td>II.7</td>
<td>2.15</td>
<td>The ability to assess online manifestos or posts for indications of impending actions</td>
</tr>
<tr>
<td>II.5</td>
<td>2.12</td>
<td>The ability to identify criminal activities on dark web sites that promote violence or allow illegal commerce transactions</td>
</tr>
<tr>
<td>II.6</td>
<td>2.12</td>
<td>The ability to observe cyber-attack behavior during investigation while preventing malicious effects</td>
</tr>
<tr>
<td>II.9</td>
<td>2.08</td>
<td>The ability to compel/convince infected persons to share information about contacts</td>
</tr>
<tr>
<td>II.10</td>
<td>1.85</td>
<td>The ability to assess the sentiment associated with social media posts</td>
</tr>
</tbody>
</table>
### APPENDICES

<table>
<thead>
<tr>
<th>II.39</th>
<th>1.62</th>
<th>The ability to prevent bias in biometric systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>II.37</td>
<td>1.6</td>
<td>The ability to quickly obtain DNA analysis results</td>
</tr>
<tr>
<td>II.34</td>
<td>1.54</td>
<td>The ability to download and integrate seized phone data</td>
</tr>
<tr>
<td>II.38</td>
<td>1.31</td>
<td>The ability to access publicly-available biometric databases</td>
</tr>
</tbody>
</table>
Appendix P: Prioritized Operations Capability Needs

This appendix contains a list of the 64 Operations capability needs in priority order by mean score.

<table>
<thead>
<tr>
<th>IDENTIFIER</th>
<th>SCORE</th>
<th>CAPABILITY NEED STATEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPS.5</td>
<td>3.86</td>
<td>The ability to safely enter areas of civil unrest to conduct traditional and non-traditional response operations (e.g., law enforcement, emergency medical, fire, public works)</td>
</tr>
<tr>
<td>OPS.29</td>
<td>3.79</td>
<td>The ability to maintain the security and integrity of the public safety answering points (PSAP) and the emergency communications center</td>
</tr>
<tr>
<td>OPS.6</td>
<td>3.75</td>
<td>The ability to extract critically-injured persons from a crowd</td>
</tr>
<tr>
<td>OPS.30</td>
<td>3.64</td>
<td>The ability to maintain the security and integrity of dispatch functions and connectivity</td>
</tr>
<tr>
<td>OPS.25</td>
<td>3.48</td>
<td>The ability for smart buildings to interact with responders who do not have access to smart features (e.g., keyless entry, elevator access)</td>
</tr>
<tr>
<td>OPS.2</td>
<td>3.46</td>
<td>The ability to safely de-escalate tensions/violent actions by a crowd</td>
</tr>
<tr>
<td>OPS.10</td>
<td>3.45</td>
<td>The ability to maintain mission functions during periods of extended budget impacts</td>
</tr>
<tr>
<td>OPS.12</td>
<td>3.45</td>
<td>The ability to effectively and safely conduct response operations during periods of extremely high volume</td>
</tr>
<tr>
<td>OPS.9</td>
<td>3.31</td>
<td>The ability to integrate additional technical professionals (e.g., IT, data visualization, mapping) into response agencies</td>
</tr>
<tr>
<td>OPS.61</td>
<td>3.27</td>
<td>The ability to automatically impact the flow of traffic (vehicles, rail, air) based on current conditions</td>
</tr>
<tr>
<td>OPS.28</td>
<td>3.26</td>
<td>The ability to prevent distributed denial-of-service (DDOS) attacks that impact public safety operations</td>
</tr>
<tr>
<td>OPS.33</td>
<td>3.22</td>
<td>The ability to enhance communications systems in remote or distributed locations</td>
</tr>
<tr>
<td>OPS.37</td>
<td>3.22</td>
<td>The ability to conduct operations in hazardous conditions without the introduction of human responders</td>
</tr>
<tr>
<td>OPS.3</td>
<td>3.21</td>
<td>The ability to mitigate actions of individual actors within a crowd</td>
</tr>
<tr>
<td>OPS.27</td>
<td>3.21</td>
<td>The ability to protect networked sensor systems from cyber threats or hijacking</td>
</tr>
<tr>
<td>OPS.22</td>
<td>3.15</td>
<td>The ability to see through walls</td>
</tr>
</tbody>
</table>
### PROJECT RESPONDER 6
#### APPENDICES

<table>
<thead>
<tr>
<th>OPS.55</th>
<th>3.12</th>
<th>The ability to carry out mission-essential duties when workforce is smaller due to quarantine and illness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OPS.1</strong></td>
<td>3.07</td>
<td>The ability to protect crowds from intentional vehicle attacks (including mobile crowds)</td>
</tr>
<tr>
<td><strong>OPS.36</strong></td>
<td>3.04</td>
<td>The ability for autonomous vehicles to automatically yield to emergency vehicles</td>
</tr>
<tr>
<td><strong>OPS.23</strong></td>
<td>2.96</td>
<td>The ability to keep volunteers/bystanders from incident site due to dangerous conditions (e.g., exposure to toxins, virus, radiation) without endangering responders</td>
</tr>
<tr>
<td><strong>OPS.42</strong></td>
<td>2.96</td>
<td>The ability to enable apparatus and vehicles to operate during precipitation extremes (e.g., extreme snowfall)</td>
</tr>
<tr>
<td><strong>OPS.60</strong></td>
<td>2.93</td>
<td>The ability to route emergency vehicles around stalls in traffic (e.g., holiday traffic near shopping malls) to minimize delays on response time</td>
</tr>
<tr>
<td><strong>OPS.31</strong></td>
<td>2.89</td>
<td>The ability to protect public safety UAS (i.e., from mitigation, hijacking, interrogation)</td>
</tr>
<tr>
<td><strong>OPS.48</strong></td>
<td>2.8</td>
<td>The ability to prevent the public from driving into flooded areas without requiring responder monitoring</td>
</tr>
<tr>
<td><strong>OPS.34</strong></td>
<td>2.75</td>
<td>The ability to safely operate UAS within restricted airspace</td>
</tr>
<tr>
<td><strong>OPS.20</strong></td>
<td>2.67</td>
<td>The ability to augment/support responder physical tasks (e.g., provide mechanical advantage)</td>
</tr>
<tr>
<td><strong>OPS.14</strong></td>
<td>2.66</td>
<td>The ability to retain trained analytical staff at public service salaries</td>
</tr>
<tr>
<td><strong>OPS.4</strong></td>
<td>2.63</td>
<td>The ability to safely move crowds from roadways or bridges</td>
</tr>
<tr>
<td><strong>OPS.53</strong></td>
<td>2.63</td>
<td>The ability to adapt protocols and operations during public health emergency (e.g., high call volume, reduced staff, extended operational periods)</td>
</tr>
<tr>
<td><strong>OPS.13</strong></td>
<td>2.55</td>
<td>The ability to use virtual environments to assess candidates during hiring process</td>
</tr>
<tr>
<td><strong>OPS.38</strong></td>
<td>2.54</td>
<td>The ability to remotely manipulate critical infrastructure components and valves</td>
</tr>
<tr>
<td><strong>OPS.24</strong></td>
<td>2.52</td>
<td>The ability to block live broadcasts of sensitive video streams</td>
</tr>
<tr>
<td><strong>OPS.39</strong></td>
<td>2.52</td>
<td>The ability to conduct remote operations before arrival of response assets (e.g., water delivery, fire retardant application)</td>
</tr>
<tr>
<td><strong>OPS.54</strong></td>
<td>2.52</td>
<td>The ability to satisfy mandated response times during extended operations</td>
</tr>
<tr>
<td>ID</td>
<td>Section</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>---------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>OPS.44</td>
<td>2.44</td>
<td>The ability to rapidly provide PPE, decontamination, antidotes to residents (adults and children) in the vicinity of chemical hazards</td>
</tr>
<tr>
<td>OPS.63</td>
<td>2.44</td>
<td>The ability to assess operational procedures based on higher water levels and flow rates</td>
</tr>
<tr>
<td>OPS.57</td>
<td>2.42</td>
<td>The ability to conduct routine tasks while wearing non-traditional PPE (e.g., gowns, masks)</td>
</tr>
<tr>
<td>OPS.51</td>
<td>2.33</td>
<td>The ability to enforce public health mandates and guidance</td>
</tr>
<tr>
<td>OPS.26</td>
<td>2.26</td>
<td>The ability to maintain equal levels of service to all parts of a jurisdiction (e.g., despite medical deserts)</td>
</tr>
<tr>
<td>OPS.11</td>
<td>2.24</td>
<td>The ability to sustain operations at local agencies while call volume is down</td>
</tr>
<tr>
<td>OPS.45</td>
<td>2.24</td>
<td>The ability to quickly deploy measures to protect commercial facilities from unplanned damage (e.g., from civil unrest)</td>
</tr>
<tr>
<td>OPS.62</td>
<td>2.2</td>
<td>The ability to assess operational procedures based on sustained higher wind speeds</td>
</tr>
<tr>
<td>OPS.19</td>
<td>2.19</td>
<td>The ability to safely clear homeless encampments without injury to responders or public</td>
</tr>
<tr>
<td>OPS.21</td>
<td>2.19</td>
<td>The ability to scan holes, cracks, crevices to manufacture precise-fit plugs or shoring</td>
</tr>
<tr>
<td>OPS.35</td>
<td>2.18</td>
<td>The ability to protect autonomous vehicle systems from malicious hacking</td>
</tr>
<tr>
<td>OPS.41</td>
<td>2.12</td>
<td>The ability to assess the profile/design of stations, vehicles, and apparatus to reflect wind, precipitation, water levels</td>
</tr>
<tr>
<td>OPS.32</td>
<td>2.11</td>
<td>The ability to deliver resources without the need for human responders or animals</td>
</tr>
<tr>
<td>OPS.59</td>
<td>2.08</td>
<td>The ability to harden medical facilities against known hazards in the jurisdiction</td>
</tr>
<tr>
<td>OPS.56</td>
<td>2.04</td>
<td>The ability to assess the impact of ad-hoc public health protection measures (e.g., public propping open fire doors to minimize touching of door handles; use of plastic sheeting to separate individuals) on traditional operations</td>
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<tr>
<td>OPS.17</td>
<td>2</td>
<td>The ability to create digital design drawings for common responder equipment and supplies</td>
</tr>
<tr>
<td>OPS.46</td>
<td>1.96</td>
<td>The ability to safely and environmentally extinguish oil-based fires</td>
</tr>
<tr>
<td>OPS.40</td>
<td>1.88</td>
<td>The ability to conduct patient transport-related missions without personnel resources in a variety of weather conditions</td>
</tr>
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# APPENDICES

<table>
<thead>
<tr>
<th>Code</th>
<th>Value</th>
<th>Description</th>
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<tbody>
<tr>
<td>OPS.47</td>
<td>1.88</td>
<td>The ability to detect wildfires at initial stages</td>
</tr>
<tr>
<td>OPS.50</td>
<td>1.8</td>
<td>The ability to automatically or remotely isolate lines, segments, or systems (e.g., oil/gas, energized)</td>
</tr>
<tr>
<td>OPS.16</td>
<td>1.78</td>
<td>The ability to create a legal (evidentiary) distinction between personal and agency devices</td>
</tr>
<tr>
<td>OPS.18</td>
<td>1.74</td>
<td>The ability to provide further categorization of calls for service related to homelessness (e.g., homeless, from a shelter or hospital, runaway child)</td>
</tr>
<tr>
<td>OPS.64</td>
<td>1.72</td>
<td>The ability to assess operational procedures based on increased wildland fire risk</td>
</tr>
<tr>
<td>OPS.58</td>
<td>1.7</td>
<td>The ability to disguise or camouflage critical infrastructure assets</td>
</tr>
<tr>
<td>OPS.43</td>
<td>1.68</td>
<td>The ability to mitigate down pipeline (e.g., oil/gas) effects during and after incidents</td>
</tr>
<tr>
<td>OPS.7</td>
<td>1.46</td>
<td>The ability to safely destroy non-needed evidence from narcotics or HME production facilities</td>
</tr>
<tr>
<td>OPS.52</td>
<td>1.42</td>
<td>The ability to safely take samples from seized evidence at suspected narcotics or HME production facilities</td>
</tr>
<tr>
<td>OPS.49</td>
<td>1.4</td>
<td>The ability to quickly pull individual tank cars from line of rail cars</td>
</tr>
<tr>
<td>OPS.8</td>
<td>1.18</td>
<td>The ability to store human remains in the absence of jurisdictional capacity</td>
</tr>
<tr>
<td>OPS.15</td>
<td>1.14</td>
<td>The ability for gun holsters to accept a rapid re-holstering</td>
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Appendix Q: Project Responder Priorities Across Time

The image below depicts the highest priority capability needs across all six iterations of project responder. Domain-specific shading and lines illustrate continuity of need across time.

**Figure 78. Project Responder priorities across time**
Appendix R: Acronyms

The table below provides a definition for each acronym used in this study.

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<thead>
<tr>
<th>ACRONYM</th>
<th>DEFINITION</th>
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<td>3D</td>
<td>Three Dimensional</td>
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<tr>
<td>4G</td>
<td>Fourth Generation Technology</td>
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<tr>
<td>5G</td>
<td>Fifth Generation Technology</td>
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<tr>
<td>ACLED</td>
<td>Armed Conflict Location and Event Data</td>
</tr>
<tr>
<td>AFIS</td>
<td>Automated Fingerprint Identification System</td>
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<tr>
<td>AHJ</td>
<td>Authority Having Jurisdiction</td>
</tr>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>API</td>
<td>Application Programming Interface</td>
</tr>
<tr>
<td>AR</td>
<td>Augmented Reality</td>
</tr>
<tr>
<td>ASCE</td>
<td>American Society of Civil Engineers</td>
</tr>
<tr>
<td>ASHER</td>
<td>Active Shooter/Hostile Event Response</td>
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<td>ASPR</td>
<td>Office of the Assistant Secretary for Preparedness and Response</td>
</tr>
<tr>
<td>ATF</td>
<td>Bureau of Alcohol, Tobacco, Firearms and Explosives</td>
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<tr>
<td>AV</td>
<td>Autonomous Vehicle</td>
</tr>
<tr>
<td>BDA</td>
<td>Bi-Directional Amplifier</td>
</tr>
<tr>
<td>BFT-3</td>
<td>Blue Force Tracking (version 3)</td>
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<tr>
<td>BIM</td>
<td>Building Information Modeling</td>
</tr>
<tr>
<td>BLM</td>
<td>Black Lives Matter</td>
</tr>
<tr>
<td>CAC</td>
<td>Common Access Card</td>
</tr>
<tr>
<td>CAD</td>
<td>Computer-Aided Dispatch</td>
</tr>
<tr>
<td>CAD</td>
<td>Computer-aided Design (3D Printing)</td>
</tr>
<tr>
<td>CAGR</td>
<td>Compound Annual Growth Rate</td>
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<tr>
<td>CBRNE</td>
<td>Chemical, Biological, Radiological, Nuclear, and Explosives</td>
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<tr>
<td>CCC</td>
<td>Command, Control &amp; Coordination (Domain)</td>
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<tr>
<td>CDC</td>
<td>Centers for Disease Control and Prevention</td>
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<tr>
<td>CEPA</td>
<td>County Emergency Preparedness Assessments</td>
</tr>
<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
</tr>
<tr>
<td>CHOP</td>
<td>Capitol Hill Occupied Protest</td>
</tr>
<tr>
<td>CIS</td>
<td>Communications &amp; Information Sharing (Domain)</td>
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<td>CISA</td>
<td>Cybersecurity and Infrastructure Security Agency</td>
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### APPENDICES

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<thead>
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<th>Abbreviation</th>
<th>Description</th>
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<td>CM</td>
<td>Casualty Management (Domain)</td>
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<tr>
<td>COMPASS</td>
<td>Collection and Monitoring via Planning for Active Situational Scenarios</td>
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<td>COPS</td>
<td>Community Oriented Policing Service</td>
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<td>COTS</td>
<td>Commercial-Off-the-Shelf</td>
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<td>COVID-19</td>
<td>Coronavirus Disease 2019</td>
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<td>CPR</td>
<td>Cardiopulmonary Resuscitation</td>
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<td>C-UAS</td>
<td>Counter-Unmanned Aircraft Systems</td>
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<td>D2D</td>
<td>Device-to-Device</td>
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<tr>
<td>DARPA</td>
<td>Defense Advanced Research Projects Agency</td>
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<tr>
<td>DAS</td>
<td>Distributed Antenna System</td>
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<tr>
<td>DE</td>
<td>Distribution Element</td>
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<td>DDOS</td>
<td>Distributed Denial-of-Service</td>
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<td>DHS</td>
<td>Department of Homeland Security</td>
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<tr>
<td>DIB</td>
<td>Defense Industrial Base</td>
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<tr>
<td>DLA</td>
<td>Defense Logistics Agency</td>
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<tr>
<td>DMT</td>
<td>N,N-Dimethyltryptamine</td>
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<tr>
<td>DNA</td>
<td>Deoxyribonucleic Acid</td>
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<tr>
<td>DNS</td>
<td>Domain Name Services</td>
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<td>DoD</td>
<td>Department of Defense</td>
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<tr>
<td>DOJ</td>
<td>Department of Justice</td>
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<tr>
<td>DOT</td>
<td>Department of Transportation</td>
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<tr>
<td>DTAC</td>
<td>Disaster Technical Assistance Center</td>
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<td>DVEs</td>
<td>Domestic Violent Extremists</td>
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<td>ECG</td>
<td>Electrocardiogram</td>
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<td>EDGE</td>
<td>Enhanced Dynamic Geo-Social Environment</td>
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<td>EDXL</td>
<td>Emergency Data Exchange Language</td>
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<td>EM</td>
<td>Emergency Management</td>
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<tr>
<td>EMI</td>
<td>Emergency Management Institute</td>
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<td>EMP</td>
<td>Electromagnetic Pulse</td>
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<td>EMS</td>
<td>Emergency Medical Services</td>
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<td>EMT</td>
<td>Emergency Medical Technician</td>
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<td>ESS</td>
<td>Emergency Services Sector</td>
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<td>FAA</td>
<td>Federal Aviation Administration</td>
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<td>Acronym</td>
<td>Full Form</td>
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<tr>
<td>FBI</td>
<td>Federal Bureau of Investigation</td>
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<tr>
<td>FCC</td>
<td>Federal Communications Commission</td>
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<tr>
<td>FDNY</td>
<td>New York City Fire Department</td>
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<td>FEMA</td>
<td>Federal Emergency Management Agency</td>
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<td>FERC</td>
<td>Federal Emergency Regulatory Commission</td>
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<td>FIPS</td>
<td>Federal Information Processing Standards</td>
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<td>FirstNet</td>
<td>First Responder Network Authority</td>
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<td>FOUO</td>
<td>For Official Use Only</td>
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<td>FRRG</td>
<td>First Responder Resource Group</td>
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<td>FY</td>
<td>Fiscal Year</td>
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<td>GFS</td>
<td>Government Facilities Sector</td>
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<td>GIS</td>
<td>Geographic Information System</td>
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<td>GPS</td>
<td>Global Positioning System</td>
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<tr>
<td>GUI</td>
<td>Graphical User Interface</td>
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<td>H1N1</td>
<td>Novel Influenza A virus</td>
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<td>HAZMAT</td>
<td>Hazardous Materials</td>
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<td>HHS</td>
<td>Health and Human Services</td>
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<td>HIPAA</td>
<td>Health Insurance Portability and Accountability Act</td>
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<td>HPH</td>
<td>Healthcare and Public Health Sector</td>
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<td>HPM</td>
<td>High Power Microwave</td>
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<tr>
<td>HUD</td>
<td>Department of Housing and Urban Development</td>
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<td>IACP</td>
<td>International Association of Chiefs of Police</td>
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<td>IAEA</td>
<td>International Atomic Energy Agency</td>
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<tr>
<td>IAFC</td>
<td>International Association of Fire Chiefs</td>
</tr>
<tr>
<td>IAFF</td>
<td>International Association of Firefighters</td>
</tr>
<tr>
<td>IC</td>
<td>Intelligence Community</td>
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<tr>
<td>ICAM</td>
<td>Identity, Credential, and Access Management</td>
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<tr>
<td>ICS</td>
<td>Incident Command System</td>
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<tr>
<td>ICU</td>
<td>Intensive Care Unit</td>
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<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
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<tr>
<td>IFC</td>
<td>International Fire Code</td>
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<tr>
<td>IFF</td>
<td>Identification Friend or Foe</td>
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<td>II</td>
<td>Intelligence &amp; Investigation (Domain)</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>INES</td>
<td>International Nuclear and Radiological Event Scale</td>
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<td>iOS</td>
<td>iPhone Operating System</td>
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<td>IoT</td>
<td>Internet-of-Things</td>
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<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
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<td>ISR</td>
<td>Intelligence, Surveillance, and Reconnaissance</td>
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<td>IT</td>
<td>Information Technology</td>
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<td>JAG</td>
<td>Justice Assistance Grant</td>
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<td>JIT</td>
<td>Just-in-Time (training)</td>
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<td>JPEG</td>
<td>Joint Photographic Experts Group</td>
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<td>LAANC</td>
<td>Low Altitude Authorization and Notification Capability</td>
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<td>LAPD</td>
<td>Los Angeles Police Department</td>
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<tr>
<td>LED</td>
<td>Light-emitting Diode</td>
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<tr>
<td>LEMHWA</td>
<td>Law Enforcement Mental Health and Wellness Act</td>
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<td>LES</td>
<td>Law Enforcement Sensitive</td>
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<tr>
<td>LiDAR</td>
<td>Light Detection and Ranging</td>
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<td>LMR</td>
<td>Land-mobile Radio</td>
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<td>LRM</td>
<td>Logistics &amp; Resource Management (Domain)</td>
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<tr>
<td>LTE</td>
<td>Long-term Evolution</td>
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<td>LVAD</td>
<td>Left Ventricular Assisting Device</td>
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<td>M2E</td>
<td>Mouth-to-Ear</td>
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<td>MCCA</td>
<td>Major Cities Chiefs Association</td>
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<td>MF</td>
<td>Medium Frequency</td>
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<td>MIPT</td>
<td>Memorial Institute for the Prevention of Terrorism</td>
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<tr>
<td>MR</td>
<td>Mixed Reality</td>
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<tr>
<td>mRNA</td>
<td>Messenger Ribonucleic Acid</td>
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<td>MS13</td>
<td>La Mara Salvatrucha</td>
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<td>NAEMT</td>
<td>National Association of Emergency Medical Technicians</td>
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<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
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<td>NBA</td>
<td>National Basketball Association</td>
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<td>NCAA</td>
<td>National Collegiate Athletic Association</td>
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<td>National Defense Industrial Association</td>
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<td>National Electrical Code</td>
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<td>National Fire Protection Association</td>
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**PROJECT RESPONDER 6**

**APPENDICES**

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<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tr>
<td>NGFR</td>
<td>Next Generation First Responder</td>
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<td>NGOs</td>
<td>Non-Governmental Organizations</td>
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<td>NHTSA</td>
<td>National Highway Traffic Safety Administration</td>
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<td>NIEM</td>
<td>National Information Exchange Model</td>
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<td>NJI</td>
<td>National Institute of Justice</td>
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<td>NIMS</td>
<td>National Incident Management System</td>
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<td>Nanometers</td>
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<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
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<td>Nuclear Regulatory Commission</td>
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<td>NTRO</td>
<td>National Terrorism Response Objective</td>
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<td>OBJ</td>
<td>Object</td>
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<td>Office of the Director of National Intelligence</td>
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<td>Operations (Domain)</td>
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<td>Personal Alert Safety System</td>
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<td>PDF</td>
<td>Portable Document Format</td>
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<td>PHMSA</td>
<td>Pipeline and Hazardous Materials Safety Administration</td>
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<td>Personally Identifiable Information</td>
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<td>Personal Identity Verification</td>
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<td>Precision Outdoor and Indoor Navigation and Tracking</td>
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<td>P.L.</td>
<td>Public Law</td>
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<td>Personal Protective Equipment</td>
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<td>Project Responder 6</td>
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<td>PSAP</td>
<td>Public-Safety Answering Point</td>
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<td>PTSD</td>
<td>Post-traumatic Stress Disorder</td>
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<td>QR</td>
<td>Quick Response</td>
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<td>Qubits</td>
<td>Quantum Bits</td>
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<td>R&amp;D</td>
<td>Research and Development</td>
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<td>Radio Detection and Ranging</td>
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<td>Risk Assessment &amp; Planning (Domain)</td>
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<td>RF</td>
<td>Radio Frequency</td>
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<td>RFID</td>
<td>Radio-Frequency Identification</td>
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<td>RHS</td>
<td>Responder Health &amp; Safety (Domain)</td>
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<td>S&amp;T</td>
<td>Science and Technology (Directorate)</td>
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<td>Substance Abuse and Mental Health Services Administration</td>
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<td>SARS-CoV-2</td>
<td>Severe Acute Respiratory Syndrome Coronavirus 2</td>
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<td>SCBA</td>
<td>Self-contained Breathing Apparatus</td>
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<td>Strategic National Stockpile</td>
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<td>SOPs</td>
<td>Standard Operating Procedures</td>
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<td>Stereolithography</td>
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<td>SWAT</td>
<td>Special Weapons and Tactics</td>
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<td>TCO</td>
<td>Transnational Criminal Organization</td>
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<td>TDoS</td>
<td>Telephony Denial of Service</td>
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<td>Training &amp; Exercise (Domain)</td>
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<td>TSA</td>
<td>Transportation Security Administration</td>
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<td>Television</td>
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<td>Unmanned Aircraft Systems</td>
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<td>University of Central Florida</td>
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<td>Ultra-High Frequency</td>
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<td>United States</td>
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<td>U.S. Army Corps of Engineers</td>
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<td>USGS</td>
<td>U.S. Geological Survey</td>
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<tr>
<td>VHF</td>
<td>Very High Frequency</td>
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