Project Responder 3

Toward the First Responder of the Future

March 2012

Homeland Security

Science and Technology

HOMELAND SECURITY® STUDIES & ANALYSIS INSTITUTE
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PROJECT RESPONDER 3: TOWARD THE FIRST RESPONDER OF THE FUTURE

Prepared for
Department of Homeland Security
Science and Technology Directorate, Support to the Homeland Security Enterprise and First Responders Group
and the Federal Emergency Management Agency
National Preparedness Directorate

ACKNOWLEDGEMENTS

Our deep appreciation is extended to the participants in the *Project Responder* focus groups and workshop; their contributions are the foundation of this report. Further, the Institute team offers our gratitude to the emergency responders whose dedication and commitment ensure the safety of our families, our communities, and our nation. This report is a tribute to their service.

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HSSAI Publication Number: RP10-68-04

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EXECUTIVE SUMMARY

Project Responder 3 is the third iteration in a series of studies which endeavor to identify gaps between current emergency response capabilities and those required to respond to a catastrophic event, and subsequently prioritize areas of investment to address or reduce those gaps.

Project Responder 3 used facilitated discussions with responders throughout the United States, including leaders from law enforcement, emergency medical services (EMS), emergency management, and the fire service, to identify existing response capability gaps. Through these discussions, participants identified 40 capabilities that are necessary to fill existing gaps. Among these 40 capabilities, responders identified the following subset of 12 capabilities as those of the highest importance:

- Readily accessible, high-fidelity simulation tools to support training and exercises in incident management and response.
- The ability to know the location of responders and their proximity to risks and hazards in real time.
- The ability to communicate with responders in any environmental conditions (including through barriers, inside buildings, and underground).
- The ability to remotely monitor the tactical actions and progress of all responders involved in the incident in real time.
- Communications systems that are hands-free, ergonomically-optimized, and can be integrated into personal protective equipment.
- Protective clothing and equipment for all first responders that protects against multiple hazards.
- The ability to detect, monitor, and analyze passive and active threats and hazards at incident scenes in real time.
- The ability to identify what resources are available to support a response (including resources not traditionally involved in response), what their capabilities are, and where they are, in real time.
- The ability to identify trends, patterns, and important content from large volumes of information from multiple sources (including non-traditional sources) to support incident decision making.
- The ability to rapidly identify hazardous agents and contaminants.
- The ability to monitor the status of resources and their functionality in current conditions, in real time.
- The ability to remotely scan an incident scene for signs of life and decomposition to identify and locate casualties and fatalities.

In partnership with the InterAgency Board (IAB), *Project Responder 3* participants also provided a compelling vision for potential capabilities that may be required in a future

response environment, unconstrained by present-day resource or technical considerations. While closing all the capability gaps described in *Project Responder 3* will be a long-term and collaborative process, identifying priorities for improved catastrophic incident response can help guide research and development by the federal government, state, local, territorial, and tribal authorities, and the private sector.

FEMA photo by Michael Rieger

I. INTRODUCTION

When a catastrophic incident occurs, the nation calls on its responders to save lives and protect property. Emergency managers, law enforcement officers, firefighters, public health officials, and emergency medical technicians (EMTs) routinely perform their duties with heroism, dedication, and courage. These traits alone, however, cannot guarantee a successful response. To help achieve positive outcomes under extraordinary conditions, responders must have the capabilities to progress from a *willingness to perform* to being *equipped to succeed*.

The response environment is constantly changing and requires an ongoing evaluation of needs, required capabilities, and potential investments or innovations. *Project Responder 3* is an update of the *Project Responder* studies conducted in 2004 and 2008 that identified gaps between current emergency response capabilities and those needed to respond to a catastrophic incident.[1]

Project Responder 3 has a simple goal: to identify the highest priority capabilities to ensure that responders can effectively and safely address catastrophic incidents, now and in the future. These priorities can help guide research and development investment by the federal government, state, local, territorial, and tribal authorities, and the private sector.

The Homeland Security Studies and Analysis Institute (the Institute) was asked to perform this study by the Department of Homeland Security (DHS), through a joint relationship between the Science and Technology Directorate's (S&T) Support to the Homeland Security Enterprise and First Responders Group and the National Preparedness Directorate (NPD) of the Federal Emergency Management Agency (FEMA). This study set out to: 1) identify and prioritize current needs in the context of the evolving response environment; 2) discuss a framework for determining lanes of responsibility between S&T, FEMA, and state/local response agencies for capability investment;[2] and 3) examine long-term capability needs and goals as an initial vision of a "first responder of the future." The InterAgency Board (IAB) provided further guidance, especially regarding the last objective, through discussions to identify characteristics of the future response environment and determine potential advanced capabilities needed to improve efficiency and safety in the long-term.[3]

To achieve these objectives, the Institute primarily sought information from those individuals with the greatest knowledge of existing needs and the highest stake in future capabilities: leaders from relevant response disciplines, representing a broad swath of the responder community. The Institute also reviewed other efforts to identify requirements

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[1] See appendix A for a history of *Project Responder*.

[2] Analysis regarding lanes of responsibility between S&T, FEMA and state/local response agencies was provided to task sponsors under separate cover.

[3] The IAB is a federally chartered advisory group of state and local first responders. Its mission is to "strengthen the nation's ability to prepare for and respond safely and effectively to emergencies." For further information, see https://iab.gov.

for meeting future response challenges, and found those studies largely echo *Project Responder 3* participants' views about the opportunities ahead.[4]

This study was motivated by changes in the response environment since 2008 that suggested a need to reevaluate capability gaps and investment priorities. The methodology section provides an overview of the data-gathering process. The findings section presents analysis of capability gaps and related investment priorities, as well as an initial vision of the "first responder of the future," including transformational innovations that could change response in the long-term.

Motivation—The Changing Response Environment

Capability gaps occur when responders' existing capabilities fall short of meeting the requirements for a successful response. This can be due to shifts in the ability of responders to accomplish their missions, or by changes that alter the response environment (the combination of factors that enable, constrain or otherwise affect the ability of responders to cope with changing hazards, vulnerabilities, and threats). In recent years, economic, technological, infrastructural, and societal developments—as well as a change in the number and type of major incidents facing the nation—have combined to change the response environment. These changes warrant a reevaluation of capability gaps and resulting investment priorities. Such an evaluation should focus on how changes in the response environment have 1) altered requirements in the near- and mid-terms; and 2) affected which long-term investments are needed to close future capability gaps.[5]

Project Responder 3 assessed the response environment on two levels: changes since 2008 (the year of the previous *Project Responder* report), and possible shifts in the future response environment. The changes since 2008 informed the near- and mid-term priorities described in the "Findings" section, while the shifts in the future environment informed the long-term requirements for the "first responder of the future." The following overview provides a brief summary of five change drivers affecting the response environment: economy, technology, major incidents or events, infrastructure, and society.[6]

Economic changes have been significant since 2008, as fiscal constraints caused by slow recovery from the recent recession have led to cuts in government spending at all levels.

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[4] This study focused on catastrophic incident response, that is, response to events that significantly exceed the capabilities of an individual jurisdiction or region.

[5] Any assessment of the future response environment is fraught with uncertainty. It is still useful to understand the *likely* parameters of the future environment, while remaining cognizant that the actual *likelihood* of any particular outcome cannot be defined with certainty.

[6] These change drivers were developed and adopted by DHS for use in several other analyses. This environmental scan has a similar intent as the Strategic Foresight Initiative (SFI), a FEMA project to discuss how important global or national trends may affect the future of emergency management. While *Project Responder 3* reflects a broader scope (representing all emergency response disciplines), this discussion complements the SFI and similar futures analyses.

These cuts have affected emergency responders in many jurisdictions, causing reported declines in baseline capabilities such as staffing and training, as well as a lack of sustainment funding for specialized capabilities needed during a catastrophic incident response. Compounding this situation is a concomitant decline, over the past several years, in federal homeland security grant funding that provided resources to state and local response agencies in the decade after 9/11. This difficult fiscal environment is expected to continue for the immediate future, and while the long-term trajectory is uncertain, capability gaps may continue to be defined as much by responders' scarce resources as by changing response requirements or a lack of innovation.

Shifts in *technology* have also affected the response environment since 2008. The use of social media allows an unprecedented level of communication between response agencies and the public, opening new pathways for situational awareness while simultaneously raising public expectations for responsiveness and technology adoption. Future innovation in areas such as materials science, robotics, and computing could raise public expectations of response capability, leading to a gap between technology available to responders and that which the public anticipates can be leveraged during a response.

Major incidents or events have changed in number and type since 2008. Both 2010 and 2011 were record years for presidentially declared disasters in the United States. Additionally, the past several years saw an increased diversity of incident types, including catastrophic industrial accidents (the Deepwater Horizon oil spill and the natural gas line rupture in San Bruno, CA); severe tornadoes in Joplin, MO, Tuscaloosa, AL, and other states; record floods on the Mississippi River; wildfires in Texas and other states; an earthquake near Washington, DC; and several tragic experiences with “lone wolf” terrorists. The devastating earthquakes in Haiti and Japan also provided lessons for U.S. responders, redefining expectations for the “maximum of maximums,” FEMA’s term of art to describe potential worst-case scenarios.

The increasing vulnerabilities of the nation’s critical *infrastructure* are also changing the response environment, particularly the increased potential for catastrophic infrastructure failure and the possible inability of existing infrastructure to manage the burdens of a major incident response. Infrastructure investment has lagged for years, but since 2008, budget constraints make infrastructure funding an even greater concern. In addition, the increasing interconnectedness and vulnerabilities of cyber-reliant infrastructure implies that these risks will only heighten in future relevance.

Finally, the 2010 census reflects a U.S. *society* that has undergone the initial phases of a fundamental demographic shift toward becoming an older, more multi-lingual country with increasing population centers in the South and Southwest. These trends are expected to continue and may affect workforce and resource allocation requirements in the future response environment. Appendix B contains a more detailed discussion of change drivers in the response environment.

Methodology

The *Project Responder 3* methodology was designed to identify what the response community believes is necessary to efficiently and effectively respond to a catastrophic

event. It is critical to obtain input from this community because of their direct experience responding to large-scale incidents and their first-hand knowledge of capabilities and deficiencies. The Institute gathered input from some of the most well-respected senior leaders in the field and responders from major catastrophic incidents over the past decade. Participants in this project included a cross-section of disciplines, agencies, and jurisdictions (both in size and location, and from rural departments as well as major urban centers). The findings in this report are based on a sampling of the emergency response community; the input from these participants reflects a diversity in perspective that defines the Nation's response community.

This methodology consisted of data gathering and analysis based on in-depth research and structured discussions with the response community through five phases: 1) a literature review focused on existing responder needs and future planning efforts; 2) solicitation of feedback from responders regarding current and future changes to the response environment during a series of focus groups; 3) facilitated discussions of capability needs and gaps during a responder workshop; 4) a prioritization exercise to identify those capabilities of the greatest importance to responder participants; and 5) additional research and outreach by Institute staff to confirm and expound upon participant input.

The Institute conducted a thorough literature review of reports, documents and publications pertaining to emergency response capability needs and gaps, from government sources, academia, response-related organizations and agencies, and private industry. These sources were used to identify existing issues in catastrophic incident response and to support development of a framework for assessing current and future needs. With the exception of previous *Project Responder* reports, the literature search yielded few assessments of cross-cutting requirements or priorities across the emergency response disciplines. The Institute conducted further research on analogous efforts examining long-term requirements and capabilities for individual and system performance enhancements. The military, in particular, has conducted a number of studies focused on the warfighter of the future. These studies helped frame discussions regarding the "first responder of the future." See appendix C for a further discussion of related futures studies.

The initial phase of data gathering from the responder community occurred during the *Project Responder* focus group on May 5, 2011, in Phoenix, AZ. The purpose of this focus group was to identify how the response environment has changed since 2008 (focusing upon changes in technology, the economy, incidents and events, infrastructure, and society), and determine potential capability gaps needing resolution. Participants included responders from law enforcement, fire, emergency management, and emergency medical services (EMS) agencies, along with relevant nongovernmental organizations. The initial focus group provided a baseline for further data gathering and analysis, particularly during the subsequent *Project Responder* workshop, by identifying those changes with significant impacts on responder capabilities.

A second focus group was held in conjunction with an IAB meeting in Seattle, WA, on June 8, 2011. The Strategic Planning SubGroup of the IAB discussed potential

characteristics of the future response environment and potential innovations that could produce significant improvements in the long-term.

The primary data-gathering forum was a three-day workshop, held from August 9-11, 2011, in San Diego, CA. Like the focus groups, the workshop brought together responders from relevant disciplines in local, state, tribal, and federal agencies. The purpose of the workshop was to: 1) identify what responders believe are critical gaps in their ability to respond to catastrophic incidents; 2) prioritize specific capabilities required to close these gaps; and 3) gather input on capabilities needed by future first responders. Workshop attendees participated in a series of facilitated discussions designed to elicit their views about capability needs, followed by an exercise that allowed them to prioritize those needs. To ensure the broadest possible scope of capabilities was discussed, Institute staff organized the discussion around a framework of capability "domains". This framework was derived from the FEMA Core Capabilities List, previous *Project Responder* reports, Presidential Policy Directive–8, and other relevant documents.

This framework provided an organizational construct to allow structured discussion around capabilities instead of disciplines or jurisdictions. It was composed of the following nine capability domains:[7]

> *Situational Awareness:* 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 catastrophic incident response.
>
> *Communications:* The capability to seamlessly and dynamically connect multiple persons/entities and convey meaningful and actionable information to all relevant parties.
>
> *Command, Control, and Coordination (C3):* The ability to identify incident priorities, allocate scarce resources, and exchange relevant information to make effective decisions in a stressful environment.
>
> *Responder Health, Safety, and Performance:* The ability to identify hazards to public safety personnel and develop appropriate mitigations to reduce morbidity and mortality associated with response activities.
>
> *Logistics and Resource Management:* The capability to identify, acquire, track, and distribute available equipment, supplies, and personnel in support of catastrophic incident response.
>
> *Survivor Management:* The capability to provide rapid and effective search and rescue, medical response, prophylaxis, and decontamination for large numbers of incident casualties and identify appropriate sheltering and transportation options.

[7] A tenth capability domain was originally envisioned: *fatality management*. Although invited, responders with special expertise in this area were not able to attend the workshop and participants deferred this discussion.

Risk Assessment and Planning: The capability to identify and manage likely vulnerabilities and threats and develop appropriate responses to potential catastrophic incidents based on identified risk.

Training and Exercise: The ability to provide instruction on necessary skills for catastrophic incident response and coordinate and practice implementation of plans and potential response prior to an incident.

Intelligence and Investigation: The ability to collect, integrate, and assess information to develop conclusions or courses of action prior to a criminal incident or to identify the cause or responsible persons following an event.

Since there are a large number of important capability needs across the domains, and because responders are likely to vary widely in their views of which capabilities are most essential, a survey technique called "Q methodology" was used to prioritize the capability needs arising from the facilitated discussions. Q methodology enables a group of participants to rank order a large number of opinion statements relative to each other. For this study, participants ranked all capability needs from +3 (most strongly agree that this need is a priority) to -3 (most strongly disagree that this need is a priority). The Institute then used factor analysis to discover groups of participants who see the world in the same way with regard to the importance of these capabilities.[8]

At the conclusion of the workshop, participants were divided by discipline in order to envision novel capabilities or developments that could transform how responders work now and in the future.

The final output of the San Diego workshop included: 1) a set of 40 capabilities needed to address existing gaps identified by participants; 2) a subset of 12 capabilities identified as top priorities across domains; and 3) an initial vision of capability requirements for the "first responder of the future."

Local, state, tribal, and federal emergency responders provided input during the data-gathering process. Including a broad spectrum of participants, with diversity in discipline, jurisdiction size and location, and level of government allowed the facilitated discussions to reflect a wide range of viewpoints and experiences. State and local participants represented relevant response disciplines including fire/rescue, law enforcement, EMS, emergency management, non-governmental support organizations, public health, and hospital systems. Federal participants were drawn from response agencies within DHS, the Department of Justice, and the Department of Health and Human Services. Although many of the capabilities discussed were focused on traditional response disciplines, representatives from non-traditional support agencies were included to ensure their invaluable perspectives were also incorporated.

Input from participants in the focus group and workshop was analyzed in the context of additional research and outreach conducted by the Institute. Institute staff attended or

[8] Factor Analysis is a statistical method used to describe variability among observed, correlated variables.

presented at several relevant conferences to gather input and perspective from a wider range of leaders in the response community, including presentations on *Project Responder* at a meeting of the IAB Strategic Planning Subgroup[9] and during a general session of the 2011 Technologies for Critical Incident Preparedness (TCIP)[10] conference.

FEMA photo by Elissa Jun

[9] The IAB Strategic Planning Subgroup "identifies, monitors, evaluates, and coordinates IAB feedback on strategic national plans, programs, and policy initiatives that affect the emergency responder community. This SubGroup informs policymakers about emergency responders' operational outcomes, interprets emerging policies to coordinate IAB position, and maintains a prioritized list of organizations of interest to IAB to develop a strategic engagement plan." InterAgency Board, *FY 2009–2010 Annual Report and 2010 Standardized Equipment List* (Arlington, VA: 2010) p. 23.For further information about the SBSG or the IAB more generally, see https://iab.gov

[10] Technologies for Critical Incident Preparedness Conference. 2011. Presented by the Departments of Defense, Justice, and Homeland Security. http://tcipexpo.com/

FEMA Photo

II. FINDINGS

This section reports on the findings of *Project Responder 3*. It discusses capability gaps and investment priorities as identified through the prioritization process, as well as notional requirements for a "first responder of the future." Many of the needed capabilities are interrelated and addressing one may bring responders closer to addressing others. When determining where to invest time, resources, and money, decision makers may benefit from a holistic view of these 40 identified needs and the flexibility to combine efforts where appropriate.

The facilitated discussion process used during the workshop resulted in the identification of a large number of needs within each domain. Participants were asked to identify the most critical needs at the conclusion of each domain discussion. Participants identified 40 capability statements as the most important; these can be considered priorities for investment.[11] Responders deemed all of these needs to be essential for a successful response to catastrophic incidents. The Institute used the Q methodology to obtain increased granularity into these priorities.

The results from analysis of the Q prioritization process can be divided into two tiers. Tier 1 priorities are a sub-set of 12 capabilities identified as the highest priorities, meaning that there was the greatest level of consensus among participants regarding the importance of these capabilities. Tier 2 priorities are still important, but did not obtain the same level of consensus during the prioritization process. It is important to note that analysis of results from the Q methodology does not generate an overall ranking of the 40 statements; it only allows grouping of statements by level of consensus. See appendix E for more detailed analysis of the results of the prioritization process as used in this study.

Tier 1 Priorities

This set of 12 priorities was assessed by responders to be the most critical. This is reflected in the consensus of scoring by the participants; they garnered the most +3 scores regardless of discipline, jurisdiction, or agency.[12] They represent the most pressing needs. To provide further fidelity based on the analysis of the results, it is possible to further divide these twelve capabilities and to identify notable separations in the rankings of the Tier 1 priorities.

Tier 1A priorities represent capability gaps of the highest importance. These needs garnered the most +3 rankings, the highest raw scores, and the highest factors scores.

- Readily accessible, high-fidelity simulation tools to support training and exercises in incident management and response.

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[11] See appendix E for further discussion of the process used to identify and refine the capability statements.

[12] See appendix E for a thorough discussion of scoring results.

- The ability to know the location of responders and their proximity to risks and hazards in real time.
- The ability to communicate with responders in any environmental conditions (including through barriers, inside buildings, and underground).
- The ability to remotely monitor the tactical actions and progress of all responders involved in the incident in real time.

Just below this top tier of capability priorities, four more needs were identified as very high priorities (Tier 1B):

- Communications systems that are hands-free, ergonomically-optimized, and can be integrated into personal protective equipment.
- Protective clothing and equipment for all first responders that protects against multiple hazards.
- The ability to detect, monitor, and analyze passive and active threats and hazards at incident scenes in real time.
- The ability to identify what resources are available to support a response (including resources not traditionally involved in response), what their capabilities are, and where they are, in real time.

Next, a set of four additional capabilities (Tier 1C) were seen as among the most important of the forty gaps, although ranking below the preceding eight capabilities.

- The ability to identify trends, patterns, and important content from large volumes of information from multiple sources (including non-traditional sources) to support incident decision making.
- The ability to rapidly identify hazardous agents and contaminants.
- The ability to monitor the status of resources and their functionality in current conditions, in real time.
- The ability to remotely scan an incident scene for signs of life and decomposition to identify and locate casualties and fatalities.

The following discussion provides greater detail and explanation regarding the twelve Tier 1 capability gaps.

Tier 1A Priorities

As noted above, Tier 1A priorities were rated as the most important among the capabilities. The very first priority listed, related to simulation tools, was consistently identified as the highest priority by participants.

Readily accessible, high-fidelity simulation tools to support training and exercises in incident management and response.

Responders attributed this need to the burdens imposed by training and exercise requirements. Responders face an array of training and exercise mandates, from certification and recertification in specific skills to on–the-job training courses; technical and managerial training; and exercises for individual, team, and agency proficiency. Although there are many federal, state, and local training mandates, funds to conduct training and exercises are often the first to be cut from budgets in fiscal downturns.

While virtual training cannot replace the interaction involved in live training, there are opportunities to significantly reduce costs while increasing responder proficiency. Workshop participants noted the need for simulation capabilities geared toward each emergency response discipline, and that include realistic missions, tools, and decision points. Such simulations would allow a large number of responders to train repeatedly and frequently, while providing the opportunity to test performance in a wide variety of scenarios. Training could be conducted by a widely varying number of participants, from a single individual to thousands of responders in an agency or region.

Catastrophic incidents require the involvement of multiple disciplines, jurisdictions, and agencies. Exercises for testing response coordination during a catastrophic incident are currently conducted via a progressive HSEEP-compliant exercise series,[13] culminating in a full-scale exercise. These exercises are designed to test the capabilities and coordination of the participating entities, evaluate performance, and identify areas for improvement. Full-scale exercises, however, have several limitations. They are expensive (including personnel overtime, facility costs, etc.); they may not involve all relevant agencies; and they are necessarily built on artificial constraints and assumptions to allow agencies to evaluate multiple factors in a time-controlled (and safe) environment. They can only approximate some of the conditions of a catastrophic incident response and are not repeatable without considerable expense. It is extremely difficult, therefore, to test alternate decision paths in a time-constrained exercise, or during hands-on agency-sponsored training that does not involve all entities that might be affected by those choices. Responders are also limited to learning a specific role in a single exercise, and may not have the opportunity to practice or test different roles and responsibilities that they also may fulfill in a real incident.

Requirements for this priority include high-fidelity virtual simulation tools that would allow responders from multiple agencies, disciplines, and jurisdictions to train for coordinated incident response. Participants defined “high-fidelity” as tools that are as realistic as possible, immersive in the scenario, and potentially include virtual reality capabilities. The technology for these tools currently exists in various forms, from video games to flight simulators, but it needs to incorporate realistic emergency response policies, missions, and equipment. Making realistic simulation tools available to responders on their desktops, laptops, smartphones, or tablet computers holds promise for substantially reducing the cost of providing exercises when weighed against more

[13]The Homeland Security Exercise and Evaluation Program (HSEEP) is a capabilities and performance-based exercise program that provides a standardized methodology and terminology for exercise design, development, conduct, evaluation, and improvement planning.

traditional models. The popularity of massively multiplayer online role-playing games, such as *World of Warcraft*, shows the potential for developing an accessible, immersive, and collaborative exercise environment. Technologies currently used for online video games could support hundreds or thousands of responders training from many different locations. Such tools would allow different jurisdictions to experience and overcome the complications of different missions, incompatible equipment, and communication problems. Virtual exercises could be reenacted repeatedly with different variables. Additionally, high-fidelity simulation tools could capture data to assess operational weaknesses or decision-making flaws, as well as recommend strategies for remediation.

The ability to know the location of responders and their proximity to risks and hazards in real time.

Responders attributed this need to a lack of situational awareness regarding the location and types of hazards present on-scene, whether during a small incident or a large catastrophic event. The military's blue force/red force tracker systems provide a similar capability, but in the case of catastrophic incident response, the system must identify responders and the hazards that they face in greater detail.

Responders generally identify hazards two ways: by noticing a hazard during the course of a response and relaying its presence to other responders and incident commanders, or through pre-incident planning efforts that have proactively identified known hazards or threats. However, pre-incident planning cannot always account for hazards caused or changed by the incident. For example, the presence of a toxic industrial chemical that leaks from its container during an incident could create a hazard well beyond the pre-planned hazardous zone.

Similarly, tracking the location of responders across a wide-area and knowing their proximity to hazards or threats can decrease mortality and morbidity. With this capability in place, a police force facing an armed assault similar to the 2008 Mumbai attack would have a constant stream of real-time information on the location and movement of attackers, and commanders would be able to track and direct the response with full visibility of the location of hostile threats.

During a catastrophic incident, responders may operate over an extensive geographic area and without adequate knowledge of hazards and threats. Remote monitoring of responder location combined with simultaneous awareness of incident hazards could enable proactive protective measures or revised tactics. Further, the capability to identify on-scene hazards in real time, display hazards on a visual interface, and track the location of responders in proximity to those hazards would greatly reduce the likelihood of accidental injury or death.

Requirements for this capability are highly ambitious from both a technology and policy level. While many response agencies currently pre-plan for existing hazards, the location or attributes of these hazards can shift during a major incident, possibly invalidating even the most robust pre-incident plans. Additionally, during a catastrophic incident responders may travel far beyond their jurisdictions and without awareness of potential scene hazards. Existing methods to map pre-identified hazard data on geographic

information systems have greatly increased hazard awareness for daily response. However, in the context of a catastrophic incident, integration of pre-plans from a variety of jurisdictions would be required, entailing the use of a standardized, scalable, and portable format for all incident data. Further, such a capability would require integrating new data identified as the incident progresses. Once pre-existing and novel hazards were integrated into a common data platform, the location of all operating responders could be integrated on the same platform. From a policy standpoint, standards would be necessary to ensure that hazard and responder data could be standardized across users and jurisdictions.

The ability to communicate with responders in any environmental conditions (including through barriers, inside buildings, and underground).

Responders attributed this need to the gap in communications when operational conditions prevent responders from sending or receiving orders, providing tactical updates, requesting help, or receiving warnings about hazardous or changing conditions. Communications are a fundamental enabler for safe and effective catastrophic incident response.

Incident communications, particularly voice communications, depend on two characteristics: the ability to transmit, and the ability to receive and clearly understand the message. In most routine operating conditions, communications systems are generally effective, particularly when using newer digital radio systems. However, message transmission or clarity can be substantially reduced when operating in certain environments, particularly inside buildings, tunnels, underground spaces, or over long distances. Conditions during catastrophic incidents often require communicating urgent information in difficult and changing conditions, often with lives at risk. The *9/11 Commission Report* noted that "the task of accounting for and coordinating the [fire department] units was rendered difficult, if not impossible, by internal communications breakdowns resulting from the limited capabilities of radios in the high-rise environment of the [World Trade Center]."[14]

Communications systems must therefore be able to transmit and receive messages in all potential conditions, particularly those which present the greatest threat to responder safety. Further, a catastrophic incident involving the coordination of numerous responders from diverse jurisdictions creates operational, doctrinal, and technological challenges, especially as the incident scales over a large geographic area or involves numerous responders and response agencies. An additional concern is that while upgrades to radio systems often improve interoperability, different jurisdictions upgrading at different times or to different systems may actually diminish interoperability. Uniform standards can help ensure interoperability across jurisdictions and throughout technology upgrades.

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[14] The National Commission on Terrorist Attacks Upon the United States. *The 9/11 Commission Report*.July 22, 2004, p. 319-320, http://www.911commission.gov/report/911Report.pdf.

There has been significant research and development to improve communications systems that operate effectively under all conditions. This research has focused substantially on the use of repeater stations to increase the range and clarity of radio communications and the dedication of radio frequencies (such as the D-block) to public safety in order to improve interoperability, improvements which have led to increased communications capabilities since 9/11. Further improvement will require technological advances in range, penetration, and clarity to enable effective voice communications in all incident conditions, as well as anticipating other solutions to address communications challenges.

The ability to remotely monitor the tactical actions and progress of all responders involved in the incident in real time.

Responders attributed this gap to unreliable or insufficient technology to monitor tactical actions and progress during an incident. Existing capabilities rely largely upon voice communication between responders and the incident commander, particularly through the transmission of information requests and progress reports. While this practice allows the incident commander to receive on-demand updates, the reliance on voice communication can detract from overall mission success and responder safety. This is due to two main factors: 1) potential unreliability of communications systems in certain situations (such as when operating in a wide geographic area or inside buildings); and 2) continuous changes in the incident scene (potentially limiting the accuracy of transmitted messages). Remotely monitoring actions and progress could resolve these concerns by providing real-time information and increased reliability that improves decision making and allows the recognition of emerging incident requirements.

During a catastrophic incident, the large number of operating responders may overwhelm the capability of incident commanders to effectively monitor tactical actions and identify progress. Response activities may also occur over expansive areas and incorporate responders from disparate jurisdictions, factors which may constrain the usefulness of voice communications systems (particularly portable radios) to provide a consistent source of on-scene information. During the early stages of an incident, management structures may also be insufficient to receive and process tactical updates while simultaneously developing incident response objectives and allocating resources. The sheer volume of incident communications transmitted from the field to an incident command post may exceed capabilities for analysis and, most importantly, timely decision making.

Real time remote monitoring of tactical actions and progress could also free scarce communications bandwidth for critical messages and allow incident commanders to focus on making decisions instead of being occupied by excessive, confusing, and often irrelevant communications. Remote monitoring of tactical actions could also enable better informed resource allocation by proactively identifying delays in anticipated progress and providing additional support. Such decisions would be further improved by an increase in information fidelity; while status updates transmitted by responders are inherently limited by the transmitting individuals' awareness or recognition of their actual progress (as well as their ability to provide accurate information), remote

monitoring helps provide accurate and objective information to enable standardized decision making.

Progress toward a remote monitoring capability depends on three characteristics: 1) tracking responder location across a wide area; 2) providing sufficient detail to reflect tactical progress; and 3) relaying this information to an incident commander in real time in an easily understandable format. While responder tracking has evolved substantially, most applications currently focus on displaying responder location in a geographically confined area (such as a building). Global Positioning System (GPS) technology can be used to display responder locations over a wide area, but may not provide the level of detail needed to indicate tactical progress. For example, even the Precise Positioning Service, the U.S. military's most accurate GPS system, only provides 95 percent location assurance to 22 meters.[15] When assessing tactical progress during an emergency response, tracking at this level can enable an understanding of unit location, but not necessarily the tactical efforts in which responders are engaged. An effective system of remote monitoring would likely involve the integration of multimedia data, such as video and audio streams, along with GPS positioning to allow incident commanders to both map location and view current actions. However, such information must be integrated on a single, intuitive platform to facilitate real-time decision making and ease of use under dynamic conditions; training and exercise programs will be needed to teach incident commanders how to use any such system.

Tier 1B Priorities

Just below the group of Tier 1A capabilities, four more needs were statistically identified as very high priorities. These needs also had several +3 rankings each, high raw scores, and high factors scores.

Protective clothing and equipment for all first responders that protects against multiple hazards.

Responders attributed this gap to the need to protect against all hazards in an unpredictable response environment. Responders face a wide variety of potential hazards during a catastrophic incident. Some of these hazards are typical for a particular discipline; that is, those hazards a given responder is trained to expect and manage (e.g., heat and toxic products of combustion for a firefighter, violent perpetrators for a law enforcement officer). However, responders may also face atypical hazards for which they are ill-prepared and possibly ill-protected. The changing response environment may increase the regularity at which responders face these unusual hazards; for example, EMS personnel may increasingly work in hazard zones alongside police officers or hazardous materials technicians, and law enforcement officers may be asked to neutralize a threat while wearing chemical protective clothing. Currently, personal protective equipment (PPE) is designed to protect against the most likely threats facing a given responder: heat

[15] "USNO NAVSTAR Global Positioning System," Last modified unknown ,http://tycho.usno.navy.mil/gpsinfo.html.

and smoke for a firefighter, blood-borne or airborne pathogens for a paramedic, and projectiles for a law enforcement officer. The scope of a catastrophic incident may require responders to operate in unfamiliar environments where they are less able to anticipate, and therefore less able to mitigate, multiple and concurrent hazards.

Additionally, catastrophic incidents may include entirely unanticipated hazards, such as looters, secondary devices, infrastructure failures, or wide-area chemical, biological, or radiological contamination.[16] Responders may be far from their home jurisdictions and equipped only with the PPE they transported to the incident scene. While a firefighter operating in his/her own jurisdiction may have access to hazardous materials PPE at the station, this gear may be unavailable when responding to remote locations. In such an environment, the availability of a single set of PPE that protects against all likely (or potential) hazards is of increased importance.

PPE manufacturers currently produce ensembles with multi-hazard protection capabilities (one example is the Project Heroes initiative sponsored by the International Association of Fire Fighters (IAFF) and National Institute of Occupation Safety and Health (NIOSH) in conjunction with several manufacturers to develop firefighting PPE with chemical, biological, radiological, and nuclear (CBRN) protection).[17] However, these products are not widely used by response agencies, in part because their cost outweighs their perceived benefit. While prices for multi-hazard PPE may decline in the future, it will likely remain costlier than other equipment. The response community will need to recognize its value to justify the additional costs, particularly in a time of budgetary constraints. Additionally, the precise multi-hazard protection required of many response disciplines may be ill-defined. For example, while law enforcement officers increasingly require some form of respiratory protection to resolve potential incidents involving weapons of mass destruction (WMD), the extent of this protection may be unclear: do officers simply need respirators to avoid inhaling dust and toxic gases, or must they don self-contained breathing apparatus (SCBA)? The development of requirements and standards to justify the purchase of multi-hazard PPE will be a significant incentive toward broader adoption across responder communities.

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

Responders attributed this gap to the need to recognize threats and hazards that rapidly change in size, risk, and location as an incident progresses. Many types of incidents, from high winds to major flooding to an explosive detonation, may lead to unexpected hazards that present unforeseen risks to responder safety. In addition, the relevance of threats and hazards apparent at the onset of an incident may increase or decrease over time, changing

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[16] Secondary devices refers to a terrorism tactic in which an initial attack or incident draws responders to a scene where they are specifically targeted by additional attacks, such as explosive devices. The intent of a secondary (or tertiary, etc.) device is to cause harm to the emergency responders and hamper their efforts.

[17] "IAFF's Project HEROES," last modified November 3, 2011, http://www.iaff.org/hs/Project%20HEROES.htm.

the risk to responders. For example, a hazardous materials release may appear contained during the initial stages of an incident, but could interact with another substance or begin to change form and present a strikingly different hazard. Similarly, after-action reports from the 2011 London riots noted that police initially underestimated the extent of the violence, and had difficulty monitoring the situation in real time to allocate additional resources when required.[18] The capability to continuously detect, monitor, and analyze threats and hazards in real time can enable timely mitigation and protect responders from unwarranted risk. This capability includes systems and tools to gather and assess real-time incident data, as well as the policies required to deploy and operationalize such capabilities.

Requirements for real-time monitoring may involve the forward deployment of data-gathering mechanisms to identify hazards and transmit information for analysis. The objective of such monitoring is to keep responders away from hazard zones prior to full analysis of the specific protective measures required to operate safely. Thus, data-gathering systems will need to either be already in place (i.e., pre-deployed static sensors) or self-deploying (such as robotic or air-dropped cameras and sensors). Either of these options will require significant technological development as well as investment in operational capacity. Once data are gathered from the field, analytic capability must feed decision support systems in real time.

The ability to identify what resources are available to support a response (including resources not traditionally involved in response), what their capabilities are, and where they are, in real time.

Responders attributed this need to the importance of allocating critical resources to the areas of greatest need in a timely manner. Resources required for daily incidents (such as personnel, equipment, vehicles, etc.) are generally visible at the local level. As the scale of an incident escalates, however, and more jurisdictions and agencies become involved, it is increasingly difficult to identify and manage all resources. Additionally, incident managers may have very limited information, if any, regarding non-traditional resources that are available or are operating on-scene. The problem becomes more difficult during catastrophic incidents, where there may be numerous agencies, different areas of responsibility, and competition for available resources. Not only do the demands on those resources increase, but coordination issues become more evident. Significant problems can arise because of lack of interoperability or incident-driven restrictions on availability.

Currently, response agencies use a variety of methods to monitor the status of resources during an event, from paper inventory files and contact lists to more advanced computer-based systems. However, these systems do not aggregate or scale for disasters. Moreover, many of these existing systems are not compatible across jurisdictions and individual agencies may only be aware of those supplies within their immediate control. Advancements in this area require automating capabilities to track inventory levels, available suppliers, qualified response personnel, and transport and distribution

[18] *Cameron Says Police Admit to Wrong Tactics*, BBC, August 11, 2011,http://www.bbc.co.uk/news/uk-14485592.

information in real time. Responders discussed the idea of an Amazon.com©-style of information access, where they could visualize available resources, as well as resource location, status, and estimated time of arrival. Ideally, a sophisticated logistics management system would include the ability to identify and forecast consumption rates, automatically reorder specified items at predefined levels, identify incompatibilities of supply components, and track the use of supplies at the incident scene.[19] This system would need to be fully compatible with other incident-related decision support and management systems and support accounting and financial management requirements or systems. Although such a system would likely not require fundamental changes to response policy or doctrine, significant involvement by responders will be necessary during system development, including training to ensure operational proficiency in all novel systems.

Communications systems that are hands-free, ergonomically-optimized, and can be integrated into personal protective equipment.

Responders attributed this gap to the need for effective communications without limiting operational effectiveness or reducing the safety of the individual responder. Successful incident response relies in significant part upon the ability to transmit and receive mission-critical messages. However, the transmission and receipt of such messages should not detract from tactical operations or place the responder at increased risk. Current communications systems are primarily reliant upon land mobile radio systems which require a push-button to transmit messages and use an attached speaker to broadcast received communications. While these systems may operate capably, their use may be difficult during certain tactical activities. For example, a firefighter operating in full protective gear, including breathing apparatus and heavy gloves, may find it difficult to transmit a message (engaging a transmit button while wearing gloves and dragging a hose line or carrying tools can be annoying at best, impossible at worst) and receive a communication (due to sound dampening from the SCBA mask and loud ambient noise). Similarly, a law enforcement officer may find it difficult, or even dangerous, to broadcast a radio transmission while holding a suspect at gunpoint or chasing a suspect down a street. Communications systems that can be utilized effectively while operating at an incident can contribute to both incident success and viable communications among responders and between responders and incident command. Such scenarios amplify the need for hands-free, integrated communications.

This capability requirement is relatively well developed, as land mobile radio devices currently exist that can be operated using “hands-free” radios (often through voice activation or oversized push-to-talk buttons). There may be opportunities to transfer technology from the military or other professions. Further development of the capability may require full integration with personal protective equipment ensembles, as well as the development of standard specifications to enable adoption across jurisdictions and between various radio systems. Further development will also involve a process to identify the specific ergonomic requirements of different response disciplines to inform

[19] See page 20for a further discussion of *on-scene* resource tracking.

the development of innovative methods of transmitting and receiving voice communications.

Tier 1C Priorities

Participants in the *Project Responder* workshop rated the following four capabilities among the top priorities for emergency response. These capabilities did not score as highly as those groups described above, however.

The ability to monitor the status of resources and their functionality in current conditions, in real time.

Responders attributed this capability gap to the need for an integrated picture of the status of all resources *at the incident scene* regardless of jurisdiction or discipline. In particular, responders noted that incident commanders require the ability to identify the user, location, and status of response assets currently deployed on the incident scene. On scene resources can include supplies, equipment and personnel. There are finite resources on an incident scene and they must be allocated effectively to address the most pressing needs. Equipment and supplies must be assigned to and checked out by individual responders, their status and maintenance needs monitored and logged, and key pieces of equipment need to be locatable at any given time. At the level of a catastrophic incident, tracking these resources in real time becomes problematic, as does the compounding issue of tracking personnel or equipment that arrive to support the response without being officially requested. The ability to monitor the location and use of equipment and supplies would enable more effective allocation and encourage the productive use of scarce resources.

Although there are fundamental differences between incident response and commercial transport or retail requirements, workshop participants cited the capabilities of private-sector firms like FedEx and Wal-Mart for their ability to maintain real-time knowledge of the location and status of very large amounts of packages and merchandise. On an average day, FedEx transports 8.5 million packages of various sizes and can provide real-time tracking information.[20] Using systems such as radio frequency identification (RFID) tags and barcodes, a Wal-Mart warehouse is notified within 14 seconds after purchase that an additional item needs to be replenished to the retail location.[21] Responders stated the need for an automated system that tracks when supplies and equipment have been checked in or out at the incident scene and by whom. Any tag or chip attached to equipment for this purpose must be extremely rugged to withstand the heat, humidity, debris, etc. on an incident scene. If possible, the status and location of equipment should be able to be assessed during the incident. This system could also provide alerts when disposable supplies hit predetermined levels or automatic reordering of supplies given

[20] "FEDEX Corporation History" last modified on September 22, 2011, http://about.van.fedex.com/our_company/company_information/fedex_corporation.

[21] "Accounting Software Research Supply Chain," last modified unknown, http://www.asaresearch.com/ecommerce/supplychain.htm.

preset parameters. In addition, this system should be integrated with a larger logistics management system and needs the ability to quickly integrate with incoming resources.

The ability to identify trends, patterns, and important content from large volumes of information from multiple sources (including non-traditional sources) to support incident decision making.

Responders attributed this need to the challenge of making informed decisions based upon increasingly unmanageable amounts of incident data. Increased use of technology to gather and aggregate incident information has increased the data available to inform incident decision making. Emergency managers and incident commanders must be able to synthesize and analyze this information to make informed operational decisions, such as developing plans, allocating resources, and assigning tasks. These tasks grow more complex as the amount of information increases and as decision makers are held increasingly accountable for the inclusion of all available data. In the case of a large-scale incident the amount of incoming information can easily overwhelm the ability to assess, confirm and operationalize incident data. Additionally, there are often contradictions or areas of insufficient data that complicate decision making. This capability is further complicated by the growth of non-traditional information sources, such as social networking and real-time reporting on events from the general public via mobile devices. Such an unconstrained flow of information, if left in raw form, can contribute to missed opportunities or poor outcomes rather than proactive planning and informed resource allocations. This capability is partially addressed by joint intelligence fusion centers spread throughout the United States. Fusion centers generally develop analytic assessments and products over time, but are increasingly tasked to collect and assess incident-specific intelligence from multiple sources. Concerns about sharing information outside of the relatively small number of responders with appropriate clearances and/or misunderstanding of response agency information needs inhibits distribution of information from these fusion centers.

Resolving this gap requires a capability to synthesize and organize incoming data. This capability will likely entail logical automated analysis that includes trend or pattern identification, as well as the opportunity for analysis and validation by response personnel. While technologies exist to aggregate and analyze vast data streams, building this capability will require adapting those technologies to the emergency response domain and training the appropriate personnel to analyze incident-related data with the support of an automated system.

The ability to rapidly identify hazardous agents and contaminants.

Responders attributed this gap to the inability to quickly and accurately assess incident hazards, in order to utilize appropriate protective measures. While the capability exists to identify the presence of general hazards, it may take a long time to identify the specific hazard and associated health or safety risks. In many cases, responders arrive without any indication of existing threats and immediately begin rescue or response operations, putting themselves at risk. Incidents involving hazardous agents and contaminants can affect thousands or tens of thousands of citizens and require immediate decontamination

or treatment. The rapid identification of such hazards with a high degree of precision can make a significant difference in survival rates.

Workshop participants advocated for the ability to identify and characterize all hazards and contaminants in one device—a version of the "tricorder," the fictional *Star Trek* device capable of scanning and analyzing biological, atmospheric, and other relevant data. Responders would like the device to provide information on the precise threat, appropriate stand-off distances, and decontamination and treatment protocols in real time. Being able to identify threats from one device instead of multiple personal and fixed sensors, with a significant increase in fidelity, would improve responder and public health and safety and facilitate more efficient response. A key to improving capability in this area is developing instrumentation that is extremely sensitive but that can also withstand the rugged environment of the response scene. False positive and negative rates also give cause for concern because incorrect information could have considerable ramifications on survival. A universal device that could be shared across disciplines for a variety of hazards would improve safety in both day-to-day and catastrophic situations.

The ability to remotely scan an incident scene for signs of life and decomposition to identify and locate casualties and fatalities.

Responders attributed this need to the insufficient capability to rapidly locate casualties and fatalities in an unstable rubble pile or across a wide geographic area, as was seen following Hurricane Katrina and in Haiti in the aftermath of the 2010 earthquake. Catastrophic incidents can result in hundreds, thousands, or tens of thousands of casualties. Quickly identifying and locating casualties is extremely difficult; it generally requires tedious ground searches with many responders. Another approach involves using aircraft to conduct flights over disaster zones. Either method takes considerable time and resources. In the law enforcement and emergency management community, similar challenges exist when searching for lost or missing persons over a wide area.

Another associated problem is the difficulty of locating people inside a specific disaster site, such as a collapsed building. Currently, the most effective tool for detecting survivors is search and rescue dogs. Although dogs provide a tremendous capability, there are some restrictions to their use: competing scents are often found at catastrophic incident scenes, layers of rubble may mask scents, or victims may be inaccessible. Other capabilities include microphones or sensors designed to pick up sounds of survivors and infrared cameras that can detect heat signatures. However, the catastrophic incident scene often renders these capabilities less effective due to the sounds and vibrations of other ongoing rescue and response efforts. Workshop participants also discussed the need to detect the position of human remains in order to expedite the identification of incident victims and provide information to family members.

Workshop participants articulated requirements designed to precisely locate incident victims (living and deceased) in three dimensions within the incident scene. Any future tool would have to be hardened to withstand the harsh environment associated with incident response, including water and heat resistance. Responders advocated for a capability (to the extent possible) to conduct the search at a distance, reducing the hazards to response personnel that are engaged in the response.

Tier 2 Priorities

The previous findings represent the 12 capability gaps of the highest priority, as determined by responders participating in the *Project Responder* workshop. However, the discussion during the *Project Responder* workshop also yielded 28 additional priority needs. These additional 28 capabilities are presented in the context of their particular capability domain, reflecting the way discussions were framed during the workshop (as described in the methodology). As discussed above, these are still considered priorities for investment. It is interesting to note 31 of the 40 were ranked +3 (indicating the strongest possible importance) by at least one participant.

Situational Awareness

For the purposes of this study, situational awareness refers to the capability to obtain and distill specific knowledge concerning threats, hazards, and conditions in a timely matter to support incident management decisions across all phases of a catastrophic incident response: "To achieve situational awareness, the right information (without a lot of noise) is needed at the right time, and the right person is prepared to receive it, is capable of analyzing it, and is then able to do something useful with it."[22] While situational awareness is desired in all emergency response situations, it is particularly necessary, and often much more difficult to attain, during a catastrophic incident. These events—whether natural or technological, accidental or intentional—require rapid and complex decision making to address a myriad of disparate and simultaneously occurring problems.

Situational awareness is complicated by the fact that information flows in at a rapid pace from a number of sources. Each source characterizes information based upon its own assessment and based on its own experience. Situational awareness is even further complicated by the different information requirements of emergency response stakeholders. Fire, law enforcement, and medical personnel with different ranks and job responsibilities will need different information to gain situational awareness as it relates to their specific areas of operation.

Participants in the *Project Responder* workshop identified one additional capability related to situational awareness:

A national information sharing system to which all emergency response entities have access that integrates multiple disparate data and intelligence sources.

Responders noted that in order to achieve a credible level of situational awareness, data and information must be collected, aggregated, authenticated, analyzed, and disseminated to the appropriate people in a timely manner. This allows incident commanders to develop a common operating picture of the incident and both current and required

[22] Eric S. Toner, "Creating Situational Awareness: A Systems Approach." white paper prepared for the workshop on medical surge capacity hosted by the Institute of Medicine Forum on Medial and Public Health Preparedness for Catastrophic Events, June 10, 2009, accessed August 26, 2011, www.upmc-biosecurity.org/website/publications/2009/2009-06-10-SituationalAwarenessSystemsApproach.

response activities. It also helps incident commanders and responders forecast the possible and likely progression of the situation as it evolves. Processes, procedures, and technologies need to be refined or established to enable the development of reliable information to support situational awareness. Currently, efforts to share information between response partners are fragmented and often ineffective or even counterproductive. A national information sharing system would enable the free flow of information between relevant parties and promote informed decision making. Participants stipulated that this capability is necessary for preparedness planning and activities as well as incident-specific intelligence and information.

Communications

This study defined communications as the capability to seamlessly and dynamically connect multiple persons or entities and convey meaningful and actionable information to all relevant parties. Effective communications are a critical component of any response effort. The ability to coordinate the efforts of emergency managers, elected officials, responders, and the public depends on timely, reliable, and effective modes of communication. During a catastrophic incident, communications may involve a significantly increased number of responders, jurisdictions, and systems, across a vast geographic area. These requirements may strain or overwhelm steady-state capabilities, due to deficiencies in capacity, interoperability, or compromised infrastructure and capability. The ability for responders on an emergency scene to communicate with one another has a significant impact on operational efficiency and safety. Responders from different areas may utilize different communications technologies, individual responders may be equipped differently, units may use different radio protocols, and the level of training among responders may vary. Interoperable communications is therefore as much of a governance and cultural issue as it is a technological one, perhaps even more so.

Maintaining the ability to communicate with the public is also vitally important in the aftermath of a catastrophic incident. Without clear guidance, the public may fail to take the actions needed to save lives and preserve property. Additionally, incident communications should be multilateral, allowing the general public to provide information to response agencies, informing the development of all-source situational awareness.

Participants in the *Project Responder* workshop identified one additional capability related to communication:

Better-quality voice and data communication systems.

Effective communications require messages to be sent and received with clarity. If the message cannot reach its recipient or the recipient cannot understand the intent of the message, the communications system is ineffective. Responders noted the need for communications systems that can work over long ranges as well as provide clarity. Interoperable communications was also often cited as one of the most important capabilities needed in an emergency response system.

Command, Control, and Coordination (C3)

Command, control, and coordination (C3) is defined here as the ability to identify incident priorities, allocate scarce resources, and exchange relevant information to make effective decisions in a stressful environment.[23]C3 is a broad concept, but can be divided into discrete components that represent how first responders manage catastrophic incidents. Effective C3 involves the capability to develop incident action plans, lead trained and experienced personnel, and gather sufficient incident information to develop incident objectives for an operational period. Once objectives have been developed, C3 requires the identification of existing resources operating during an incident, regardless of geographic scope or agency affiliation, as well as the ability to direct resources to perform required tasks across the incident and in real time.

Once mission assignments have been given, effective C3 involves monitoring progress to identify emerging incident requirements as the situation changes. During a catastrophic incident, C3 inevitably requires coordination between and among agencies and jurisdictions to jointly determine incident objectives, execute decisions collaboratively and effectively, and determine when resources can be reassigned or demobilized.

Participants in the *Project Responder* workshop identified five additional capabilities related to C3:

A system that helps an incident commander recognize when the characteristics and complexity of an incident are different than they appear to be.

Responders noted that incident commanders may be subject to false assumptions or over-reliance on previous experience during a major incident. This concern indicates that incident commanders may require assistance in identifying when initial assumptions may be erroneous, or to test initial impressions to determine if they align with the actual characteristics of the incident. Such a system would need to gather and assess incident information and isolate those variables which determine the characteristics of a particular incident.

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[23] Effective C3 can be measured by the ability of the incident commander to recognize requirements needed to successfully manage an incident response, and to direct adequate resources toward the accomplishment of necessary tasks. The success or failure of C3 can therefore be evaluated on two criteria: the integration of incident data toward the development of strategic objectives and tactical plans, and the direction of appropriate and sufficient resources to achieve said objectives. C3 requires highly scalable processes and systems that can react seamlessly to rapidly expanding incidents. During a catastrophic incident, this requires C3 capabilities to be standardized and integrated between disparate jurisdictions and levels of government; indeed, C3 capabilities should be layered iteratively from a local response to one of national scope. Such capabilities may require particular technology and systems to assess information, transmit directions, and coordinate between geographically dispersed command posts and operations centers, policies to determine mission prioritization and resource allocation, and governance structures to enable seamless collaboration between disciplines, agencies, jurisdictions, levels of government, and nongovernmental partners.

The ability to predict the evolution of an incident, the impacts of decisions, and the results of response actions in real time.

Responders noted that decision-making during an incident is constrained by an inability to accurately predict the trajectory of an incident and how decisions will affect incident outcomes. A predictive model to project how various decisions could influence the course of an incident would allow an informed evaluation of possible choices. The ability to anticipate how decisions and actions impact an incident would require baseline data on the evolution of similar incidents, and the valid information on the implications of various decisions, including those which may be atypical for a given incident.

The ability to prepare future executives to exercise command and control in a multidisciplinary and multi-jurisdictional collaborative setting.

Responders noted that advances in incident command and leadership training primarily require policy and doctrinal shifts to ensure that individuals learn from proficiency-based incident management programs. Rather than participating in static training, as exemplified by one-time online training courses, leaders should be challenged by incident-based, realistic programs that test their proficiency in their specific response roles. Doctrine designed for traditional response capabilities can be broadened to incorporate additional organizations essential to catastrophic incident response.

The ability to identify responders (including volunteers), validate their credentials, and put them to work.

Responders noted that during a major incident it can become difficult to identify available responders and their capabilities. A portion of this capability returns to the oft-discussed need for a universal credentialing system to standardize capabilities across jurisdictions. However, responders noted that the ability to identify responders and their capabilities can also occur on an ad hoc basis, through systems that can aggregate information from responders arriving on-scene, including volunteers, and provide incident commanders with a broad overview of available personnel. Such a system could also validate submitted credentials against national databases, to reduce the likelihood of imposters or insufficiently qualified responders operating on an incident.

Decision support tools that allow incident commanders to vet courses of action and make evidence-driven operational decisions during an incident.

Responders noted the need for decision support tools that truly enhance the incident command process. Data for such tools may exist in disparate forms, and would need to be aggregated into a common format. Additionally, such tools could utilize an algorithm that defines a “good decision” and makes recommendations based upon some empirical outcome. However, in the complex decision-making environment in a catastrophic incident may make this difficult to do reliably.

Responder Health, Safety, and Performance

This study defines responder health, safety, and performance as the ability to identify hazards to public safety personnel and develop appropriate mitigations to reduce morbidity and mortality associated with response activities. It includes activities or

investments designed to reduce risks to responders in a catastrophic response environment, as well as initiatives to improve responder effectiveness in performing key tasks. These capabilities can include both tangible investments, such as personal protective equipment that directly increases responder health and safety, as well as intangible developments such as knowledge products or changes in doctrine, policy, or procedure. Emergency response entails a baseline level of inherent risk. The risk is magnified during catastrophic incident response, due to extended operating periods, potential exposure to hazardous substances, lack of access to incident rehabilitation facilities, and incident actions outside of normal position requirements.[24] Investments in the area of responder health, safety, and performance aim to minimize these risks while maximizing the effectiveness and efficiency of individual responders, response teams, and the overall response effort.

Participants in the *Project Responder* workshop identified three additional capabilities related to responder health, safety, and performance:

The ability for responders to obtain information about the status of their families, and for their families to obtain information about them, in real time.

Responders noted that concern for the safety of one's family can be a significant constraint on mission effectiveness. Capabilities to provide responders with updates on their families' well-being, and vice versa, would benefit the mental well-being of responders operating at a catastrophic incident.

The ability to evaluate the resiliency of individual responders to ensure they will perform effectively in the face of acute and chronic stressors.

Responders noted that resolving existing capability gaps to support responder wellness is largely characterized by a need for improved data and policies. If the unique intersection of risk factors and job stressors that result in negative health outcomes (including behavioral health) can be defined and quantified, effective intervention can be supported with appropriate resources. Without a clear conception of the variables that create a resilient responder, or even a clear definition of health and wellness in general, it will be impossible to propose solutions to identified risks. Additionally, health and wellness requirements can be standardized across jurisdictions and agencies to minimize differentiation between health and wellness outcomes.

The ability to monitor and evaluate the mental and physical status of responders during an incident in real time.

Responders noted that the ability to recognize at-risk responders during an incident would enable proactive interventions and likely improve rates of mortality and morbidity. Systems supporting this capability are under development, including the Physiological Health Assessment System for Emergency Responders (PHASER) sponsored by DHS

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[24] Reissman, D. B., and Howard, J. "Responder safety and health: Preparing for future disasters." *Mount Sinai Journal of Medicine: A Journal of Translational and Personalized Medicine*, March/April 2008, vol. 75, issue 2: 135–141.

S&T. However, existing systems may lack the scientific foundation to inform clear operational decisions; for example, what is the threshold for ordering a firefighter out of a burning building? With the development of such evidence-based thresholds, a system to monitor responder status could reduce avoidable deaths and injuries.

Logistics and Resource Management

Logistics and resource management is defined in this study as the ability to identify, acquire, track, and distribute mission-specific equipment, supplies, and personnel in support of catastrophic incident response. Managing both logistics and resources is a challenge in any incident. This is particularly true during catastrophic incidents, where normal supply chains for may be substantially disrupted. Moreover, catastrophic incidents often require large quantities of resources across wide areas. The inability to provide needed resources is often cited as a significant deficiency after many catastrophic incidents.

Prior to the incident, identification of existing resources, surge capabilities, and transportation capacity is important. During the incident, challenges include determining resource requirements, acquiring needed resources from all potential sources, tracking resources from acquisition through distribution, transporting resources to areas of greatest need (and demobilizing or reallocating them as required), and distributing resources efficiently. An effective logistics and resource management capability requires the integration of systems to aggregate existing resource information, process resource requests, track the logistics process, and record necessary financial information.

Participants in the *Project Responder* workshop identified five additional capabilities related to logistics and resource management:

A "clearing house" that connects those who need resources with those who can fulfill those needs in real time during an incident.

Responders advocated for a platform that would allow suppliers from inside and outside the incident area to communicate with incident managers to offer materials, equipment, and supplies. One responder referred to this as a "disaster craigslist" that would enable improved awareness of available resources and provide multiple options for supplies. Participants cautioned, however, that a process of vetting suppliers would have to be developed to ensure that posted equipment is as described and can be transported to the incident scene in a timely manner.

The ability to predict, assess, and anticipate resource needs and rates of consumption for all types of catastrophic events.

Responders noted that resource management systems must be accessible at all levels of the response—from local governments to federal agency heads—and incorporate the private sector and nongovernmental organizations. These systems should provide logistics managers with a comprehensive picture of what is needed, the priority of the need, the location and cost of resources, a means to request or order resources, and a method to track the status and location of resources once requested.

The need also exists to assist emergency managers with predicting what types of resources will likely be required for a particular event. Information that predicts and suggests future resource needs as the incident continues could assist logistics managers with contingency planning as well as with anticipating needs in a catastrophe.

A financial system that allows incident managers to share and draw on multiple sources of funds to pay for needed assets in advance of reimbursement.

Responders noted that current financial accounting systems and policies are incompatible or inadequate when dealing with the magnitude of a catastrophic incident. Responders cited problems with insufficient funds to pay upfront costs as well as difficulties managing reporting requirements during an event. They noted the need for alternate funding mechanisms, such as innovative insurance programs to provide access to sufficient resources on a timetable that reconciles the need for immediate payment of suppliers and personnel with the approval and reimbursement processes of local, state, and federal agencies. Standard procurement regulations often are inadequate to address crisis acquisition, contracts, and purchasing needed by incident logistics personnel.

The ability to communicate clearly about resources using a common language across disciplines and jurisdictions.

Responders noted that the National Incident Management System's classification of types of resources needs to be expanded to encompass all the physical resources, supplies, and human resources that may be needed to respond and assist in catastrophic incidents. The system should be simple enough to be understood by all stakeholders and sufficient detailed to properly inform the end user of the resource's capabilities.

The ability to evaluate the resource needs and resource management efforts from past incidents, and share lessons about problems and solutions.

Responders noted that an effective and comprehensive system to provide information about lessons learned and disaster management experiences to the emergency management and response community is needed. The system should provide information on recent responses, lessons learned, and best practices. The system should be readily accessible to all stakeholders. The Lessons Learned Information Sharing (LLIS) system currently exists, but responders noted that its content serves more as historical records of incidents and do not lead towards effective systemic improvements.

Survivor Management

Survivor management is defined in this study as the ability to provide rapid and effective search and rescue, medical response, prophylaxis, and decontamination for large numbers of incident casualties and identify appropriate sheltering, transportation, and destination options. A primary focus of response activities in a catastrophic incident is to help people that have been injured or displaced; survivor management encompasses all capabilities that enhance incident survivability.

Participants in the *Project Responder* workshop identified three additional capabilities related to survivor management:

The ability to rapidly determine and disseminate alternate standards of care based on incident conditions.

Responders noted the need to identify necessary standards of care based upon evolving incident requirements, and ensure that those standards are universally applied. This capability includes the ability to deviate from generally accepted standards of care when dictated by incident exigencies.

The ability to communicate information to the families of survivors early, and to reunite survivors and families quickly.

Responders noted the need to communicate patient information, particularly the hospital where the patient has been transported, to the families of survivors, and to distribute identities of survivors to disparate reunification centers. In addition, there may be an opportunity to utilize an online resource where emergency managers, responders, medical providers, and unaffiliated individuals can inquire about the location of an individual possibly impacted by a disaster.

The ability to track the location, condition, and status of patients for the entire time they are in the care of the medical response system.

Responders noted the need to track patients from initial triage to discharge from a hospital. This capability would require the ability to identify patients by unique and anonymous identifiers, aggregate information in a centrally accessible database, and ensure that information is updated at every stage of the medical system. Such a system would increase accountability, provide medical professionals with improved access to necessary records, and allow survivors to immediately determine the location and condition of family members.

Risk Assessment and Planning

Risk assessment and planning is defined in this study as the capability to identify and manage likely threats, vulnerabilities, and consequences from various hazards, and to develop appropriate responses to potential catastrophic incidents based on identified risk. Risk assessment is a systematic approach to identify the specific threats faced by a given jurisdiction or region, determine the vulnerability to those potential threats, and assess the immediate and cascading consequences should the threats become reality. Once identified, emergency managers can identify gaps in their ability to address different risk scenarios, and develop response plans and consequence management strategies to fill the gaps.

Participants in the *Project Responder* workshop identified six additional capabilities related to risk assessment and planning:

The ability to de-conflict many disparate, complex, and varied plans across jurisdictions and levels of government so they can function effectively.

Responders noted that effective risk assessment and integrated planning requires tools which are accessible at all levels of response and standardized nationally. Further,

effective risk assessment tools will need to utilize a common methodology to ensure similar approaches to assessing risk across jurisdictions, to enable regional and national assessments, and generate concrete information applicable to mitigation strategies, response plans, and gap analyses.

The ability to protect and access sensitive and proprietary data required for risk assessments.

Responders noted the need for policies or regulations to incentivize the sharing of data from all sources. Information-sharing agreements may need to be developed to ensure that information flows between public and private entities and among local, state, regional, federal, and tribal partners.

An integrated suite of tools to support risk assessments and risk-based decisions in the planning process.

Responders cited the need to standardize and improve the level of skill and understanding for local officials related to risk assessment and planning. They voiced the need for a training program developed around scientifically based, widely accepted risk assessment and planning methodologies. In addition, subject matter expertise needs to be developed related to the new or improved approaches in order to build a cadre of trained assessors and planners at all levels of government.

The ability to assess infrastructure interdependencies and the impacts of infrastructure loss to support risk assessments.

Responders noted the need for a standardized methodology to acquire relevant information that includes dependencies and interdependencies between critical infrastructure, and the impacts of those dependencies on preparedness and response, as well as systems that can aggregate data from disparate sources in order to provide a more holistic assessment of risk. For example, a power outage may lead to the inability to provide care in a hospital that responders may be relying on for medical care during a catastrophe."

Consistent and coordinated guidelines for use of risk assessment methodologies and development of risk assessments.

Responders noted that resolving gaps in risk assessment and planning methodology development will require more research into elements of risk assessment, as well as the adoption of such elements into a standardized processes. This would entail identifying and defining useful criteria to measure threats, vulnerabilities, and consequences, or perhaps an entirely novel approach for measuring risk.

An integrated suite of tools to facilitate the development of emergency response plans in a standard form.

Responders noted that existing methods of developing emergency response plans are varied and inconsistent. A standardized suite of tools could enable the development and use of response plans that would be inter-operable across jurisdictions, and facilitate

seamless collaboration during major incidents that require the response of multiple jurisdictions.

Training and Exercises

This study defines training and exercise capabilities as the ability to provide instruction on necessary skills for catastrophic incident response and coordinate and practice implementation of plans and potential response prior to an incident. All emergency responses demand a baseline level of training for responders to successfully accomplish mission-critical goals, activities, and tasks. Training programs are primarily concerned with teaching job performance requirements, and with maintaining and updating knowledge, skills, and abilities on an ongoing basis. Although many of the available training courses are not specifically geared toward catastrophic incident response, proficiency in skills used for "routine" responses are essential during a major event. Exercise programs are designed to practice and test the function of a broader response system, evaluate the capability of individual responders and units to operate effectively within that system, and identify areas that need improvement, as demonstrated by lessons learned from an after-action review process.

Investments under the training and exercise capability domain seek to increase the safety, effectiveness, and efficiency of individual responders, units, and agencies. The inherent challenges of responding to any emergency can be magnified during catastrophic incident response due to widespread damage, insufficient resources, lack of situational awareness, extended work cycles, responder fatigue, and other factors. Adequate training and exercise can increase the odds that a response effort can overcome those challenges.

Participants in the *Project Responder* workshop identified one additional capability related to training and exercise:

An effective way to capture, analyze, retain, and share lessons learned and institutional knowledge.

Responders noted that effective training and exercise capabilities require a mechanism to share knowledge and lessons learned on nationwide and international levels. While systems such as the Responder Knowledge Base (RKB) and the Homeland Security Information Network (HSIN) currently provide some capabilities to address this gap, responders felt that these tools were both insufficiently utilized and lacked standardization. Responders further noted that a single system is required with basic, simple, and standard methods of reporting, searching, and assessing lessons learned.

Intelligence and Investigation

Intelligence and investigation is defined in this study as the ability to collect, integrate, and assess information to develop conclusions or courses of action prior to an incident, or to identify the cause or responsible persons following an event. Together, intelligence and investigation provide the capability to proactively prevent a catastrophic incident through the identification and mitigation of emerging risks, as well as the establishment of causality after an incident to inform attribution and corrective action. Intelligence and investigation is often applicable in the context of law enforcement, particularly through

the disruption of criminal or terrorist plots and the post-incident determination of perpetrators. Intelligence and investigation also applies in a more all-hazards context, however, such as the determination of incident origin and the development of prescriptive solutions to prevent future occurrences or reduce incident scope. Such investigations often reach beyond the incident response and recovery, but may begin concurrently with an incident response.

Participants in the *Project Responder* workshop identified three additional capabilities related to intelligence and investigation:

The ability to securely pass intelligence information up, down, and across domestic fusion centers and other organizations that use intelligence.

Responders noted the need for a national information sharing system that integrates multiple intelligence and information sources, and to which all emergency response entities have access. The development, implementation, and ongoing management of this system requires leadership from the federal government; no state or local entity is capable of solving this problem. Users should have the ability to securely share information and with other members of the system. The system should provide "need-to-know" information for individuals with properly validated credentials, as well as information for general distribution to emergency response agencies.

Responders additionally noted that fusion centers, information sharing hubs composed of local, state, tribal, and federal participating agencies that collect, assess, and share threat-related information, may not effectively share incident-state information among and between relevant entities. Without appropriate clearances or a need to have access, some threat information cannot be shared with response personnel, even during response operations. In addition, responders noted that this information is often general threat information or not applicable to specific incident response.

The ability to develop standardized, actionable intelligence products that meet the requirements of the emergency services community.

Responders noted a need for the domestic intelligence community to better understand response agencies' information requirements. The system should also have the ability to incorporate information from response agencies and the public, such as crowd sourcing and social media, while maintaining respect for civil liberties and compliance with applicable laws and regulations. Responders acknowledged the need to compartmentalize information and limit the distribution of pre-event intelligence only to those with a bona fide need to know. However, once an incident occurs, the distribution of potentially actionable intelligence must include a wider base of recipients from response agencies.

The ability to incorporate information from multiple and non-traditional sources (e.g., crowdsourcing and social media) into the intelligence system.

Responders noted the increasing importance of information from non-traditional sources, and acknowledged the need to integrate these information streams into intelligence systems. While responders noted the possible value of systems that could aggregate and mine non-traditional information sources for trends about a particular incident, they also

discussed the need to verify information and to recognize the potential for erroneous or intentionally misleading sources.

Additional Cross-Cutting Themes

During discussions with participating responders, several cross-cutting themes repeatedly emerged that reflect commonalities between many of the capability gaps discussed in this report. These crosscutting themes may constrain the resolution of capability gaps, or multiply their significance.

The first of these themes is the overall decline in baseline resources due to the economic downturn. This decline has occurred despite substantive and successful federal grant programs designed to improve state and local response capability. While grant funding has resulted in improvements in some areas, the economic hardship faced by agencies and jurisdictions has resulted in layoffs and/or lack of funds for other key functions, such as training or maintenance. The end result is that many jurisdictions face a notable reduction in capability despite valuable grant awards. In addition, many jurisdictions have not been able to maintain their equipment and run the risk of losing capabilities they once had. This consideration is evident in several of the capability gaps, such as the need for protective clothing and equipment for all responders that protects against multiple hazards. In a fiscally constrained environment, innovation will need to maximize the effectiveness of existing capabilities rather than focusing solely on potentially unaffordable capability advancement. Two additional considerations derive from this theme. First, capability gaps may exist for daily response as well as during catastrophic incidents (as existing resources may be insufficient to support even basic capabilities for some jurisdictions), meaning that many of the capability gaps outlined above may be equally important for daily response as for a catastrophic incident. Second, capability gaps exist to a vastly different extent across the country, which implies that gap resolution will not increase the capabilities of all response agencies to an equal or even a necessary level.

A second notable theme is the unrealistic expectation among federal policy makers, jurisdictional leadership, and the general public that responders possess futuristic tools, skills, and resources. Some responders call this the "*CSI* effect," reflecting that citizens believe that responders in their community should have access to the same technology seen in movies and on television. This belief may give citizens that false impression that responders have immediate access to all relevant information and data, perfect communications, and clear visibility into incident-specific circumstances (even as they are evolving). Responders are held to this unrealistic standard by leadership, the media, and the public. Participants noted that this effect is already challenging the ability of law enforcement and prosecutors to prosecute crime "beyond a reasonable doubt," as jury members are increasingly expecting perfect DNA-type matching and the ability to reconstruct a crime scene. The public also increasingly expects that the response community will at least have the same technology they have at home, such as the ability to fully leverage smartphones and social networking. This theme serves as an impetus for several priority capability gaps- for example, the need to leverage social media for incident communications is borne from the public's expectation that the response

community is an early adopter of novel technologies. This expectation in some respects represents a failure of the response community to effectively explain to the public the extent of its capabilities, and to manage expectations regarding what can be provided during a resource-constrained response.

A third theme is that the need for non-materiel solutions is equally important as the requirement for new technology and innovation. Indeed, many of the gaps in this report cannot be resolved by technical innovation alone, but require knowledge products or policy guidance to achieve necessary progress. There is an assumption that a new widget will address many of the needs expressed by the response community. However, issues involving policy, doctrine, and culture are essential enablers to many of these capabilities and must be addressed with the same or greater effort. A key benefit of the *Project Responder* methodology is that it reveals both materiel and non-materiel gaps. Indeed, each of the top twelve capability priorities require non-materiel solutions prior to operational adoption, from training standards to safety protocols to decision models. Without these non-material enablers, even the most advanced tool will not effectively address a capability gap.

Another way to assess the findings from *Project Responder 3* is to compare them with the results of past phases of the project. Despite significant changes in mission focus, federal guidance, and operational needs over the past decade, it is interesting to note that a number of capabilities have been consistently rated as high priorities by participants. These include capabilities in the areas of:

- Responder apparel that protects from all hazards
- Three-dimensional location of response personnel on the incident scene
- Interoperable communications and data integration
- Resource management
- Threat and incident data analysis

Substantive research and development programs have been funded in these areas and some advances have occurred. It is not that the development programs in these areas have been lacking in effort or funding; rather, barriers to progress are in many cases organizational, operational, and technical. These are areas where it will be most critical for components within DHS to work together, and with partners at the state and local level and in the private sector, to develop solutions. The following chart shows the continuity of priorities across the three iterations *Project Responder*. Only those priorities that endured across the decade are highlighted, although several others were consistent across two iterations.

Capability Priorities Across Time		
2004 Priorities	2008 Priorities	2011 Priorities
Body Protection from All Hazards	Command & Management	Virtual Simulation Training
On-Scene Detection	Communications (3)	Remote Operational Monitoring
Remote & Standoff Detection	Seamless Data Integration	Responder Location
Point Location & Identification	Full-Body Personal Protection	Communications (2)
Seamless Connectivity & Integration	Logistics Support (2)	Body Protection from All Hazards
Mass Victim Decontamination	Mass Prophylaxis Distribution	Threat & Hazard Identification (2)
Risk Awareness & Assessment	Training & Exercise Programs	Logistics Support (2)
Mass Medical Prophylaxis	Mass Victim Decontamination	Trend & Pattern Analysis
Mass Casualty Medical Care Management	Responder Respiratory Protection	Survivor & Fatality Location
Individual & Collective Protection	Point Location & Identification	
Surveillance & Information Integration	Prioritization & Dissemination of Threat Info	
Logistics Information Systems	Credentialing	
Threat Assessment/Data Collection/Analysis		

Many of the priorities identified in *Project Responder* 3 are consistent with or related to priorities identified in earlier phases. In addition to the five capabilities that have been consistent throughout the effort (noted above), training and exercise needs were addressed in the 2008 report, and capabilities that address threat and hazard identification are similar to the remote and standoff detection requirements described in the 2004 findings. Many of the Tier 2 capability needs are also very similar to older priorities, such as *the ability to rapidly determine and disseminate alternate standards of care based on incident conditions*, which is one of the needs identified as part of *mass casualty medical care management* in 2004. There are a number of capabilities that have emerged with *Project Responder* 3 and several that may have lessened in importance.

There are two new Tier 1 priorities that have emerged with this phase. Remote operational monitoring, found in *the ability to remotely monitor the tactical actions and progress of all responders involved in the incident in real time*, is new to *Project Responder* 3, as is *the ability to remotely scan an incident scene for signs of life and decomposition to identify and locate casualties and fatalities*. The problems encountered by responders following Hurricane Katrina reflect operational needs for both of these priorities. Many of the other *Project Responder* 3 priorities involve the need for improved integration of information and decision-support capabilities. Although this is not a new capability need, a greater proportion of the 2011 priorities address this requirement than in previous *Project Responder* iterations, perhaps due to a significant increase in the amount of data available to support an incident response.

There are several capabilities from earlier phases that were not identified as Tier 1 or Tier 2 priorities in *Project Responder* 3. While the workshop discussion did address issues related to mass decontamination and mass prophylaxis issues, those needs were not among those identified by the majority of the participants among the 40 highest priorities. Perceived capability improvements in these areas may be due to the significant amount of

planning and preparation that accompanied the pandemic planning over the past several years; alternatively, gaps in these areas may remain, but may have been surpassed in importance by the increasing significance of other priorities.

Envisioning the First Responder of the Future

The capabilities described above address near- and mid-term capability gaps. However, responders may face a different set of challenges in the long-term. Proactive planning and investment today can develop the capabilities required for future success. This *Project Responder* study included an effort, initiated by DHS at the request of the IAB, to envision a "first responder of the future". By imagining the first responder of the future, this study sought to identify potential capabilities that may be required in a future response environment, unconstrained by present-day resource or technical considerations.

Past efforts to catalogue capability gaps (as well as the primary data-gathering effort of *Project Responder 3)* have focused on near- and mid-term needs for the first responder community. *Project Responder 3* adapted the *Project Responder* methodology to consider the responders of the future. Specifically, this effort examined potential requirements of future law enforcement officers, paramedics, firefighters, and emergency managers.[25] This approach envisioned these future response disciplines in three different contexts: the individual responder, the responder as a part of a team or unit, and the response system itself (i.e., the interconnected network of responders across disciplines whose capabilities must be brought together to ensure effective response on a daily basis and during catastrophic events). It should be noted that this is an initial vision of potential long-term capability needs conducted within the scope of *Project Responder 3*; indeed, the process for developing this first responder of the future concept was a series of open-ended visioning discussions, designed to evoke novel ideas to define the future response environment and the responder operating within. A more in-depth study and analysis will be needed to develop more detailed projections and requirements.

To begin this effort, the Institute looked at extant futures research, both within the first responder community and from similar external efforts, such as the military (see appendix C). The military's efforts provide a notable point of comparison because several broad efforts in recent decades have matched military capabilities against potential changes to adversaries' capabilities in the future. The team used this research to inform a focus group meeting, held with the IAB's Strategic Planning SubGroup, which took a long-term view of the future response environment and how changes in this environment may affect the future first responder. Subsequently, during the *Project Responder* workshop, participants were divided by discipline in order to envision far-term "game changers"; that is, developments that could transform how responders work now and in the future.

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[25] The Institute study team felt that "support" disciplines, such as public health, and hospital "first-receiver" disciplines where beyond the ability of this limited initial effort. However, ideas for these support disciplines where captured throughout the various meetings, and are also reflected here, including a profile of an emergency manager of the future.

This process identified capabilities specific to future law enforcement officers, paramedics, firefighters, and emergency managers. It also identified cross-disciplinary capabilities that all future first responders may require.

Law Enforcement Officer / Deputy of the Future

Responders noted that the law enforcement officer of the future may operate in a much more technology-driven environment, involving numerous data systems and information management tools. These tools could help officers manage the flow of information, and do so in a context that considers privacy and civil liberties protections. However, responders noted that such a technology-driven environment will require updated policies and doctrine to address new issues that such access to information might raise, such as privacy concerns, the risk of "information overload," and problems with data compatibility. Further, responders noted that changes in technology and society could give rise to new types of crimes that force the law enforcement officer of the future to manage more complex issues. For example, future policing may focus more on crimes involving technology (e.g., identify theft and internet fraud). To manage a changing criminal environment, future law enforcement officers may utilize a vast law enforcement information network, providing real-time data on the people with whom the officer interacts, including behavior modeling tools that will anticipate threats.

Responders discussed game-changing capabilities for law enforcement, unconstrained by financial resources or technology. One such capability would enhance officer safety and performance by providing real-time situational awareness of the response environment,. One participant summed this up as saying, "we need everything TV has," meaning that police need access to information the way it is depicted in television shows such as *CSI* or *24*. Such a "forward information support system," would provide instant notification of threats, better scanning of people, and real-time tracking of resources, all based on up-to-date intelligence. Responders also noted that improvements to the physical and mental readiness of the law enforcement officer could be considered a game changer. Physically, monitoring and improving the health and wellness of officers would enhance police safety. Mental readiness could improve officers' ability to respond to new and more complex challenges. This would require improvements to officer training (especially real-time training related to emerging threats, intelligence, and events) and education (which prepares officers for changing complexity of the job); this is especially important for less-experienced personnel who assume more senior positions as staff turnover takes place. Responders also cited shifts in police doctrine toward a posture of prevention and pre-deployment as a key game changer for the law enforcement *system* of the future. Such a doctrinal shift may include national pre-identified deployment teams of trained personnel, and the ability to move police forces more readily across jurisdictional lines, similar to fire department mutual aid programs. The former is under development but has been limited by fiscal and legal issues. The latter is limited due to legal issues and police cultures that are tied to specific, local, parochial policing patterns and activities.

Paramedic of the Future

Participants noted that the paramedic of the future may have increasing interdependencies with other response disciplines and with the evolving health care field. The individual

paramedic (a term used here to mean all different levels of EMS provision, from first responder through emergency medical technician, paramedic, and other levels of service that may evolve) will be increasingly linked to technology that facilitates diagnosis and patient care. Patients may be involved in their own health care even prior to EMS involvement (as occurs today with Internet-based diagnostic tools). Smartphone applications and patient self-monitoring are emerging now, but their wide-ranging impact on EMS systems in the future could change the nature of EMS delivery, from supporting remote patient self-diagnosis and treatment, to patients who bypass EMS entirely. EMS providers may play a wider role in emerging public health issues, such as bio-events like the recent H1N1 influenza pandemic, especially if budget constraints continue to lead to reductions in public health capability. Responders posited that the paramedic of the future may increasingly use technology as part of administering care, by gathering information for remote evaluation, conducting telemedicine, and even using automated algorithm-driven treatment. Intelligent alerting (from smart-device sensors such as a phone application that would sense a heart attack, for example) that notify an automated response will become more prevalent. General Motors' OnStar system is an incipient example of this concept: detecting vehicle accidents and sending emergency resources. Participants pointed out that as automation increases, contingencies will have to be made for when the algorithms fail. Additionally, responders suggested that electronic reporting will become more prevalent, potentially to the point of tracking everything that occurs in an incident, in the way police cameras now capture the activities of individual law enforcement officers in some jurisdictions. Providers may also have access to a broader scope of patient medical history, requiring better education and policy making to ensure patient privacy is maintained in accordance with evolving legal requirements. Difficult questions will be raised by these changes; for example, will a paramedic have the right to access all of a patient's medical history, or just medical history relevant to the specific emergency?

Responders' discussion of game-changing capabilities focused on breakthroughs in triage and diagnostic technology. These included items such as multifunctional diagnostic instruments (similar to the "tricorder" from *Star Trek*), advanced patient assessment tools (e.g., handheld ultrasound), and field-accessible patient healthcare records. Triage-specific capabilities mentioned by participants included the capability to scan an incident scene to determine potential patients and their condition from a safe standoff position where paramedics will not be at risk of injury, to deploy scalable mass casualty triage systems that are easier to use and tightly integrated, and to remotely scan large areas (such as a building collapse site or even a large geographic area) for signs of life during catastrophic incident response. Responders also discussed game changers in treatment technologies and systems. For example, real-time telemedicine could expand the types of care paramedics provide; easier access to reference materials in the field—perhaps through heads-up displays[26]—with references and patient information could increase situational awareness. Technological advances such as the development of artificial blood

[26] A head-up display or HUD superimposes images on a clear surface, such as a windshield or goggles. It allows users to view information while continuing to look forward.

replacement products could also increase paramedics' ability to provide care. Smaller, lighter, and more portable equipment, such as lighter-weight oxygen cylinders, EMS aid bags, defibrillators, etc. could increase paramedics' mobility. This could even advance to the point of making some patient care equipment wearable (e.g., monitor/defibrillator, pulse oximeter). Responders brought up real-time video links to hospitals or incident command posts as a potential game changer for situational awareness. Another game changer involved safer and easier ways of moving patients, like a robotic cot, robotic stair-chair, or exoskeleton to assist with lifting. Responders also discussed the possibility of ambulances integrated with traffic safety systems, side projection warning devices, physical warning devices, or onboard remote sensors (chemical, biological, radiological).

Firefighter of the Future

Responders noted that the firefighter of the future may face increases in demand load and shifts in types of calls for service. Current urbanization trends suggest cities are increasing in density, but that they are also becoming safer, with wealthier, more educated citizens. Meanwhile, suburban and rural fire departments may see once prosperous middle class communities in the exurbs begin to decline, resulting in less safe properties, and increases in fire incidence. New and dramatically different codes will have only limited effect because many older buildings will still pose "traditional" hazards and response demands for a long time to come. However, new buildings will be smarter, with embedded sensors, evolving fire suppression techniques, and other capabilities that obviate legacy systems. More incidents of failing infrastructure are likely unless national efforts to renew decaying infrastructure, such as bridges, roads, dams, and water mains are initiated. New hazards will also evolve from emerging technologies.

Mega wildfires are predicted to become more prevalent, spurred by changing climates and decades of fire policy that has suppressed the natural fire cycle in the ecosystem. The combined result is a buildup of ladder fuels and a fire season has become a year around event. These problems could become exacerbated as the wildland-urban interface continues to expand due to housing construction in previously rural areas.

Game-changing capabilities discussed by responders included the introduction of lighter, more fully integrated all hazards personal protective ensemble, with integrated sensors, heads-up displays, and access to information and communications that provide the individual and the fire crew with a wide array of information and situational awareness. This equipment would be linked to a command network that tracks responders' movements in real time. The goal of this is an improved safety profile: a firefighter who can see through smoke, is fed data on building conditions and hazards, and is connected to a network of fire crews monitored in real time by an incident command system that proactively (via sensing technology linked to modeling software) alerts when a situation is becoming too hazardous. Responders discussed the potential for incident commanders to view integrated incident video, building schematics, personnel tracking, and real-time condition reporting on an integrated platform. Likewise, they discussed the possibility that firefighters could receive support from an integrated command network that provides real-time information regarding the buildings and hazards to which the firefighters are

responding. Firefighters' work could also be supported by remote sensors and devices and advanced robots that can carry and move heavy loads of equipment.

Other capabilities discussed included the potential for robots to conduct hazardous operations like initial environmental sampling during hazmat incidents, perform primary searches during structural fires (possibly using infrared technology to look for victims), and perform wide-area searches during major incidents. Responders also noted the possibility for technological innovation to modify the incident environment in order to improve responder effectiveness and safety. Particular innovations included the ability to remove products of combustion (smoke and superheated gases) from a structure, reduce the likelihood of flashover (a condition in which the entirety of a room is engulfed in flames), and monitor the condition of the structure to reduce the likelihood of building collapse.

Emergency Manager of the Future

Participants noted that the emergency manager of the future may be required to support and coordinate a wide array of response disciplines, working with numerous, diverse aspects of the community to prepare, mitigate, respond, and recover from incidents. The emergency manager will continue to evolve from a pure planner or civil defense exercise specialist into an operational entity charged with providing total situational awareness to citizens, responders, and decision makers alike. This will require tracking robust resources of all types and projecting incident progression to maximize response interventions. Responders also discussed changes in emergency operations centers (EOC), which could become distributed or virtual networks. Automation may allow EOCs more fully integrate with daily response operations. Automated logistics systems could potentially identify and deploy resources, though this would require a more intelligent system for classifying resources—one that does not rely on a resources name, but on its innate capabilities. Such an integrated system could actually be run by a computer system with modeling, algorithms, and artificial intelligence, similar in computing power to the way automated trading is conducted on the stock exchange. One could envision a disaster occurring, such as an earthquake, in which smart sensors report the status of people and infrastructure, and simultaneously an integrated system assesses available resources and automatically deploys them to the most critical areas. Discussion also included the use of remote assessment to inform dispatchers' decisions or recommendations about what resources to send.

Responders focused on capabilities to automatically vet and manage requests for help coming onto the EOC. The ability to link information from numerous EOCs with public and private sector resources, and to push that information to the right people in the right timeframe would be a game changer. A seamless linkage between dispatch and incident management systems, and the integration of day-to-day data—such as dispatch and 911 system info—into EOC systems on a normal basis would allow emergency managers to become more proficient. Total situational awareness, including real-time situation status and resource status, is the objective. Systems should be automated, as current systems require a large amount of data entry by EOC personnel, resulting in the EOC collecting a partial record of what happened in the past operation period, rather than projecting needs

into the next operational period. Responders also noted the critical need for a rule-based, automated logistics management system.

Cross-Disciplinary Capabilities

Certain capabilities over the long term involve cross-disciplinary advances for future first responders. It is likely that communications, protective equipment, information management, and other technologies could be co-developed. From a non-materiel perspective, the growing complexity of incidents and increased cross-training of responders may become more common, with numerous inter-disciplinary joint teams developing policy, doctrine, and training to respond to incidents together and bring their joint capabilities to stabilize incidents. The future characteristics of the incident response environment have cross-disciplinary implications, such as more mixing of mission spaces across disciplines and more joint and integrated responses.

Future cross-disciplinary issues may include:

- Information overload if growth in feeds and flows is not managed by commensurate decision support. Better ability to process visual information is needed by all responders. Additionally, increasing reliance on technology could jeopardize capabilities due to inherent vulnerabilities in computerized and Internet-based systems. Language skills and cultural competence will be needed to better inform and interact with diverse populations or non-English speakers, regardless of discipline.
- Different educational requirements will be required in the future, as first responders will need more engineers and technologists, just as there is a current need for leaders trained in budgeting and management. Responders on the front lines will be more innately socialized to technology.
- PPE will require some universal applications across disciplines. All responders may need inhalation protection, particularly if there is increased risk from biological or chemical hazards or from industrial toxins. Responders will need PPE that imposes a lower burden and less stress on the individual and less cost to their organization.
- Doctrine and governance for interdisciplinary response across jurisdictions and boundaries must evolve. It must be reinforced by leaders who are trained to understand roles and responsibilities in a networked, distributed response system across jurisdictional boundaries.

This exploration of the first responder of the future is a preliminary effort and is by no means definitive—there is much additional research and study needed to build out this initial vision. However, the discussion above represents a good starting point as federal, state, and local governments and industry begin to identify which capabilities to invest in. The hope is that incremental investment in the short term will lead to systematic improvements in responder capabilities, safety, health, and performance

FEMA photo by Bob McMillan

III. Conclusion: Next Steps toward the First Responder of the Future

Project Responder 3 identified capability priorities of the greatest importance to the future effectiveness and safety of the Nation's emergency responders. The findings discussed in this report represent the consensus of some of the nation's most respected and experienced responders, as developed through the use of facilitated discussion and statistical prioritization.

Participants in this phase were asked to characterize the fundamental capabilities necessary to respond to catastrophic incidents. While the previous *Project Responder* reports contained specific requirements and guidelines for technology developers, this report provides a different perspective on response capabilities, presenting them as systems that include both technology and human factors that could significantly impact catastrophic incident response. This report presents 40 high-priority capability gaps identified by participating responders, with four priorities identified as the most significant by the discussions and prioritization process.

Key Capability Needs

The topmost need identified is for more realistic and accessible training tools, a consideration that has been consistently articulated by participants throughout the decade-long history of *Project Responder*. Participants in *Project Responder* noted that the development of high-fidelity training systems, similar to commercial video games, could enable novel ways to efficiently and effectively train responders, particularly across jurisdictions and regardless of physical location. The use of virtual training systems could result in substantial cost savings to implementing jurisdictions (due to diminished costs for travel and capital investment), as well as facilitate training collaborations between unprecedented numbers of agencies.

The second capability gap highlighted by participants as one of the most critical is the need to track responders in proximity to incident threats. The effective completion of incident tasks is contingent upon the health and undiminished capability of responders, which can be severely diminished by exposure to on-scene hazards. These hazards may be rapidly evolving, they may exist prior to the incident (such as hazardous materials stored in a laboratory), may be created by the incident itself (such as downed power lines), or may change as the incident progresses (such as an active shooter or civil disturbance). Given the fluidity of such hazards, responders need to be able to identify their proximity to danger to enable necessary personal precautions and inform the application of appropriate tactics and incident action plans.

The third capability gap identified as a top priority was the broad ability to monitor the location and progress of personnel. This capability expands upon, and is indeed prerequisite to, determining the proximity to incident hazards (as discussed above). A catastrophic incident response inherently requires participation of a large number of disciplines, agencies and jurisdictions, which are often spread over a wide geographic area. Providing real-time data on the location, actions, and progress of all responders at a

given incident would allow incident commanders to more efficiently and effectively allocate resources toward those areas of greatest need, and anticipate changes in the incident to inform proactive incident planning.

Interoperable communications has long been seen as the "holy grail" of emergency response capabilities; it is essential for many critical response capabilities and yet is often quickly degraded by a catastrophic incident. Communications system failures during the response to the September 11th terrorist attacks, or resulting from destroyed infrastructure during Hurricane Katrina, highlight varying problems that can affect communications systems, with cascading negative impacts on other capabilities such as command and control, situational awareness, and resource management. *Project Responder* participants have identified deficiencies in communications capability since the project was initiated in 2001, particularly highlighting the need for interoperability between responders. Two of the high priority (tier 1) capabilities described in this report focus on communications (specifically, the ability to communicate with responders in any environmental conditions, and the integration of communications equipment into PPE). The ability to transmit and receive information in all operating conditions, and regardless of technology or platform, will improve responder safety and enable unified command and control of all responders operating at an incident.

Relevance of Findings

The findings in this report illustrate priorities identified by front-line emergency responders – the men and women who will be responsible for developing and implementing an effective response to future catastrophic incidents. Participants in this effort were leaders drawn from a cross-section of disciplines, agencies, and jurisdictions (both in size and location, and from rural departments as well as major urban centers) to obtain input from multiple perspectives. This approach has been consistent throughout all three phases of *Project Responder*. The individuals participating in *Project Responder* include some of the most well-known and respected leaders in the field, including responders from major catastrophic incidents over the past decade.

The findings from this report confirm the results from previous phases of *Project Responder*, as well as outside research efforts. In fact, five of the top 12 capabilities ranked highest by participants in the prioritization process were identified as critical during the initial *Project Responder* effort a decade ago. The endurance of these priorities does not detract from the substantial effort dedicated to their resolution; their continued presence merely speaks to the complexity of the problems, the lack of simple solutions, and their critical relevance to catastrophic incident response.

The complexity of these problems reflects the challenge that the capability priorities identified in this report cannot be addressed solely by technological development. Each involves the development and integration of a complex system of operational processes, technology (including, in many cases, both hardware and software), changes in ingrained culture and norms, and overarching policies, governance structures and incentives that affect whether and how these gaps are resolved. For example, advancements in high-fidelity virtual simulation and training, the top priority from *Project Responder* 3, will

require the integration of advanced visualization technology, a standardized set of standard operating procedures and skillsets, a rationalization of overarching (indeed, often conflicting) policies, a realistic depiction of existing tools and equipment, a characterization of valid decision-points and trade-offs, and accurate measures of success and failure. Successful development of this system will involve the input of multiple and diverse stakeholders to identify specific requirements as well as technologists that can translate those needs into a viable product. Implementation will further require the identification and development of protocols and plans for standardization, training, distribution, and operational use, as well as best practices to ensure that virtual training does not supplant the essential and complementary hands-on training that cannot be duplicated by a computer.

Path Forward

The identification of the priorities described in this report is only the first step in providing emergency responders with the capabilities needed to respond effectively to a catastrophic incident. A logical next step is a systematic assessment of existing and emerging enablers (technological or others) against identified gaps to determine the state-of-the-art across different domains, including the private sector, the military, and academia. This assessment would allow DHS to identify a technology baseline, as well as potential areas for rapid transition from commercial or military development to operational use in the response community. DHS could then conduct a strategic planning process, evaluating the identified response priorities against the results of the technology assessment to identify priorities for R&D investment.

For those priorities identified as likely or possible for investment, a full requirements analysis process will be needed to articulate detailed technical specifications. Participation by the emergency response community will be necessary to articulate specific needs and operational realities affecting adoption and implementation. The involvement of technologists will be necessary to translate operational response needs into quantifiable and measurable development requirements. A technology roadmap should be developed for each priority, identifying key milestones and potential costs. The final step in the planning process should be development of a comprehensive Research, Development, Test and Evaluation (RDT&E) plan for capability investments, identifying possible trade-offs and constraints.

The changing response environment demands that responders continually reevaluate their capabilities to meet new threats and hazards. There is no panacea to resolve the gaps identified in this report, nor are they within the purview of any one agency or individual to fix. Moreover, the future response environment may lead to entirely novel capability gaps, ones we cannot conceptualize in the present day. Before those new gaps arise, the response community must resolve the capability gaps of the current day. This report outlines the highest priority capabilities required to minimize the effects of a catastrophic incident while reducing risks to the individual responder and the affected population. This vision, and the supporting input provided by the response community, can help guide research and development investment by the local, state, federal, territorial, and

tribal authorities, and the private sector in taking the next steps toward the needs of the first responder of the future.

FEMA photo by Shannon Arledge

APPENDICES

Appendix A: History of *Project Responder*

It has been more than a decade since the Oklahoma City National Memorial Institute for the Prevention of Terrorism (MIPT) initially commissioned an effort to improve the capabilities of local, state, and federal emergency responders. That effort, called *Project Responder*, was focused on identifying capability needs, shortfalls, and priorities related to response to catastrophic incidents and events. Since its initiation in April of 2001, *Project Responder* has periodically revisited and assessed response capability needs by engaging emergency responders from a diverse set of disciplines and jurisdictions.

The *Project Responder* effort over the past decade can be divided into three distinct phases. The initial effort, from 2001-2004, was funded through a Department of Justice grant to MIPT. The original purpose of *Project Responder* 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 the effort was fundamentally shifted by the terrorist attacks of September 11. During development in the initial phase, emergency responders from multiple disciplines and a wide range of jurisdictions and locations participated in a series of interviews and responder workshops. The output of the data-gathering process was the development of a set of 12 capability areas that, as a whole, 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, a second series of workshops queried technologists from national laboratories, academia, and private industry to inform a national agenda for research and development and a corresponding set of roadmaps detailing new initiatives designed to close gaps in emergency response capability.[27]

The second phase of *Project Responder* was initiated in 2007 by the DHS Science and Technology Directorate. The purpose of the follow-on effort was to examine changes in the emergency response effort since the first report and identify new and enduring capability priorities. Despite the short timeframe between the first and second reports, 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, pandemic influenza, 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. Emergency responders from a wide range of disciplines, jurisdictions, and agencies participated in the effort through a series of interviews and workshops. The findings from the second

[27] For further information, see Thomas Garwin, Neal Pollard, and Robert Tuohy, eds., *National Technology Plan for Emergency Response to Catastrophic Terrorism* (Washington: MIPT and DHS) April 2004.

Project Responder report, released in 2008, included a set of 15 capability priorities and associated challenges in training, technology, management, and policy that responders felt constrained the further development of respective capabilities.

FEMA photo by Robert Rose

Appendix B: Recent and Future Change in the Response Environment

The following discussion presents an assessment of the response environment on two levels: changes since 2008 (the year of the most recent previous *Project Responder* assessment), and a discussion of possible shifts in the future response environment. When these environmental changes are discussed in the context of the capability gaps identified as part of *Project Responder 3,* they help to inform the near-and mid-term priorities described in the "Findings" section as well as the long-term requirements for the "first responder of the future." In order to discuss these changes in a logical and holistic manner, they are organized based upon categorical "change drivers." These drivers are drawn from similar categories used in the FEMA Strategic Foresight Initiative and the National Intelligence Council Global Trends Report.[28]

Change Driver: U.S. Economy

Economic Recession and Prolonged Recovery Have Reduced Baseline Capabilities for Many Response Agencies

The United States has endured a prolonged economic downturn since 2006, characterized by a depressed housing market, constrained access to credit, and reduced consumer demand, with cascading impacts on the employment market. This crisis created a prolonged recession, followed by an enduring decrease in tax revenues, due largely to high unemployment and constrained consumer demand. The economic downturn has had profound impacts emergency response capability. According to the National Homeland Security Consortium, "the devastating impacts [of the global financial crisis] on non-federal budgets and the homeland security capabilities of the private sector … have also degraded the ability to prevent, protect, mitigate, respond, and recover [from an emergency]."[29]

These impacts have led to notable operational deficits for many response agencies. The Insurance Services Office rates the quality of fire protection provided by individual departments to inform property insurance rates. In 2009, it noted that the number of fire departments being audited for potential retrogression (a reduction in rating) had increased by 20 percent over previous years due to "reduction in firefighting personnel available for a response, a reduction in the number and type of responding fire apparatus, gaps in optimal deployment of deficiencies in training programs."[30] Similarly, a report by the

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[28] National Intelligence Council "Global Trends 2025: A Transformed World."Washington, DC:, 2008. www.dni.gov/nic/PDF.../2025_Global_Trends_Final_Report.pdf

[29] National Homeland Security Consortium. *Protecting Americans in the 21st Century: Imperatives for the Homeland: A White Paper by the National Homeland Security Consortium*. October 2010. pg, 2.http://knowledgecenter.csg.org/drupal/content/protecting-americans-21st-century-imperatives-homeland-white-paper-national-homeland-securit. Accessed September 16, 2011.

[30] Waters, Michael. "How the Economy Is Challenging Fire Protection Services." *Insurance Journal*, January 2010.

Police Executive Research Forum noted that the economic downturn has already led to significant cutbacks for many law enforcement agencies. Among other findings, this study noted that 43 percent of surveyed departments had instituted a hiring freeze, 36 percent had reduced overall staffing levels, and 22 percent had actually lain off sworn officers. These studies indicate that many near- and mid-term capability gaps may be caused by a reduction in the basic resources required for daily missions, which are of even greater importance during a catastrophic incident response.

Equally concerning for state and local emergency responders has been the dramatic reduction of federal emergency management grant funding. In 2011, funding for DHS state and local emergency preparedness grants was slashed by approximately $780 million, a nearly 25 percent reduction from the previous year.[31] Although the FY2012 budget is still pending, further cuts to these grant programs are anticipated. As a result, states that are already struggling with budget cuts have been forced to shoulder more of the financial responsibility for entities and programs previously funded by DHS grants, or have eliminated these capabilities altogether (examples include specialized response capabilities such as hazmat response or explosive ordnance disposal).[32, 33] It is important to note that although grant funds can provide significant new capabilities to a jurisdiction or region, there are restrictions associated with how those funds can be spent. Allocation of funds for new equipment is allowed, but ongoing maintenance of that equipment is generally not. Unfortunately for most emergency response agencies, the life cycle costs of grant-funded equipment can be considerable, often exceeding the original purchase price. The combination of reduced operating budgets and cuts to federal grants has impacted many agencies' baseline response capability.

Baseline Response Capabilities May Be Limited in the Long-Term, as State and Local Budgets Remain Constrained

Several economic trends may significantly impact the future response environment. Prolonged high unemployment may continue to affect state and local fiscal solvency,

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[31] Nelson, Rick. "The FY2011 Budget and Homeland Security Grant Funding."Center for International and Strategic Studies. May 19, 2011. http://csis.org/publication/dhs-accelerates-implementation-risk-based-approach-grant-distribution. Accessed September 16, 2011.

[32] In an environment of fiscal austerity, DHS grant funds have been critical in supporting baseline emergency response capabilities otherwise jeopardized by declining budgets (such as staffing levels and new equipment or apparatus). However, it is impossible to determine the extent to which DHS grant funds have prevented a further decline in overall capability (that is, to what extent response capability would have declined in the absence of DHS grants). It is notable, however, that although DHS emergency preparedness grants have broadly penetrated the national response community over the past decade, in any given year only a small fraction of jurisdictions can be recipients. Therefore, the ability of federal grants to defray the impacts of the economic downturn is inherently less than the overall capability loss (further, DHS grants in most cases only support initial investment, not prolonged costs such as sustainment or maintenance).

[33] National Emergency Management Association. State Emergency Management Agency Budgets [webpage].http://www.nemaweb.org/index.php?option=com_content&view=article&id=210&Itemid=382. Accessed September, 16 2011.

significantly constraining budget decisions if government receipts continue to come in below expectations. These reduced revenues may lead to increased budget deficits, requiring painful cuts to municipal services such as public safety. As mentioned above, recent years have seen significant layoffs of firefighters and police officers, and declining resources for emergency management activities, equipment, apparatus and training. While an improved employment climate entails a complex relationship between business investment decisions, consumer demand, and government policies, the future response environment may feature a continued degradation of baseline response capabilities if the employment market remains depressed.

Similarly, the credit rating of the U.S. government could have a notable effect on the ability of states and jurisdictions to finance new construction or investment. The decision by Standard and Poor's to downgrade the U.S. debt rating in 2011, and subsequent downgrades by several ratings agencies of state and local bonds, may indicate future increases in financing costs. This may further constrain the ability of states and municipalities to invest in capital expenditures to support public safety (such as new training facilities, specialized equipment, emergency operations centers, or police and fire stations). Concerns over the federal debt have led to significant cuts in discretionary spending, including preparedness funds for state and local government, a trend that can be anticipated to continue at least in the near term.

Finally, states and jurisdictions across the country face looming crises as a result of maturing and underfunded pension obligations. These obligations, perhaps more than any other factor, jeopardize the long-term economic health of state and local governments and impact their ability to invest in current needs and capabilities.[34] Unless addressed, these funding obligations can lead to fewer response personnel, a decline in capability for daily incident response, older or insufficient equipment, and inadequate training. In the aggregate, these shortfalls have the potential to significantly diminish regional or national capacity to organize and sustain a response to a catastrophic incident.

Change Driver: Technology

Connectivity and Information Accessibility Have Changed Both Citizen Expectations and Available Tools for Response

Technology changes since 2008 have affected both the response environment and the tools utilized to respond. Since 2008, no change has been more pronounced or impactful that the use of social networking for connections and information sharing. Between 2008 and 2009, the amount of time Americans spent on social media sites increased 83 percent.[35] As of 2011, Americans spent more time online viewing social media than

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[34] Hampton, Ted. *Combining Debt and Pension Liabilities of U.S. States Enhances Comparability.* Moody's Investor Service, January 26, 2011.

[35] Nielsen. "Time Spent on Facebook up 700 Percent, but MySpace.com Still Tops for Video, According to Nielsen."June 2, 2009. http://www.nielsen.com/us/en/insights/press-room/2009/time_on_facebook.html. Accessed September 19, 2011.

any other category of online content.[36] The prevalence of social media today offers users the ability to instantly access information from almost anywhere and at any time. The potential homeland security and emergency management implications of social media are vast. Nationally, FEMA has embraced the use of social media for emergency response communication. FEMA Administrator Craig Fugate recently told a Senate hearing, "We must use social media tools to more fully engage the public as a critical partner in our effort."[37] These tools can provide the general public with preparedness information and up-to-the-minute updates during an incident. Efforts are also underway to increase the capability of incident survivors to communicate with emergency response personnel via text messaging.[38]

Similarly, responders now have access to an unprecedented amount of information both prior to and during a response. From mobile computers that provide incident information in the cab of a fire truck or police car to increased use of smartphones and tablet devices to manage resources and develop incident action plans, technology is increasingly leveraged to maximize the capabilities of incident responders and commanders. These innovations have significant implications for the capability gaps discussed in the "Findings" section. Indeed, several noted gaps are due largely to technological innovation, which has been insufficiently transitioned to public safety (for example, virtual training).

Transition of Consumer Technology to Public Safety Applications Will Combine with New Innovations to Enable Novel Response Capabilities

Technological change in the future environment may occur in two forms: incremental change that progresses in a linear process from existing technology to a more advanced future state, and transformational change that involves a "leap ahead" to an entirely new technological paradigm. In the future environment, incremental change will likely consist in large part of expansions in technology access and usage. For example, the use of smartphones with the ability to connect to the Internet and exchange multimedia data across a variety of platforms will increase in the future environment.[39] In 2011, smartphone penetration in the United States was 38 percent, presumably leaving ample

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[36] Elliott, Stuart. "Report Details Rise of Social Media." *New York Times*. September 11, 2011. http://mediadecoder.blogs.nytimes.com/2011/09/11/report-details-rise-of-social-media/. Accessed September 19, 2011.

[37] Fugate, Craig. "Understanding the Power of Social Media as a Communication Tool in the Aftermath of Disasters." Statement before Senate Committee on Homeland Security and Governmental Affairs, Subcommittee on Disaster Recovery and Intergovernmental Affairs[written record]. May 5, 2011. http://www.dhs.gov/ynews/testimony/testimony_1304533264361.shtm. Accessed September 19, 2011.

[38] Ibid.

[39] FEMA. "Strategic Foresight Initiative: Technological Development and Dependency."May 2011. http://www.fema.gov/pdf/about/programs/oppa/technology_dev_%20paper.pdf

room for growth.[40] The increased use of Internet-connected phones could impact the future response environment, as FEMA's Strategic Foresight Initiative notes: "With constant access to information available at people's fingertips, the public will expect that government will be able to provide open and ongoing access to information that society values and responders will use the internet and social media to communicate information to the public in emergency response situations."[41] Although the U.S. growth of social networks such as Facebook and Twitter may be reaching maturity (in 2011, Facebook announced for the first time that its U.S. subscriber base had declined), the use of such platforms in the context of emergency response is still relatively new. As social network participants and the government develop improved methods of collaboration and information exchange, these information sharing mechanisms may be increasingly used as a primary method for response agencies to share information among themselves and with the public.

Other technological changes may be attributable to incremental innovation rather than increased usage or access. Telemedicine is already used to provide access to specialized diagnosis and procedures at remote medical facilities, and technology is quickly approaching the level where ad hoc telemedicine facilities could be leveraged to support mass medical care after a catastrophic incident. Similarly, the move to cloud computing is a growing trend due to cost efficiencies and a globalized business environment, and in the future could enable remote access to incident or risk information from a smartphone or laptop. This shift could allow mission-critical data to be detached from vulnerable facilities, and provide universal access regardless of connectivity to a local network or server. In addition, advances in automation and analytics may facilitate improved information and intelligence fusion, through capabilities such as facial recognition, suspicious behavior identification, automated alert and warning, and pattern recognition.

The explosion of digital data also brings challenges to the response community. The veracity of information exchanges in social media venues needs to be assured prior to its use to drive decisions in a disaster. The ability of smart phones to transmit photos and video in near-real time may also be a tool that can assist with the assessment of the scope of a disaster. The sheer volume of information that is generated can also be a challenge. Sorting out what is valuable from a mass of data is beyond the capability of most public safety and emergency management agencies.

The possibility always exists for "leap-ahead" or "wild card" breakthroughs, such as the next Internet, to fundamentally change the future environment. These occurrences often defy any reasonable prediction. Of particular note are possible transformational advances in the use of robotics for emergency response functions, such as search and rescue or fire suppression, and the potential of wearable computers to provide responders and those who support them with real-time two-way data feeds during an incident. The potential for such transformation changes is a key factor in long-term capability requirements, as the

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[40] "In US, Smartphones Now Majority of New Cellphone Purchases," *neilsenwire*, June 30, 2011.

[41] FEMA. "Strategic Foresight Initiative: Technological Development and Dependency."May 2011. http://www.fema.gov/pdf/about/programs/oppa/technology_dev_%20paper.pdf

"first responder of the future" will be defined in large part by the technologies available. A police officer in the 1970's would have been amazed by the use of vehicle-mounted license plate readers, the tools available to paramedics have evolved greatly, and an earlier generation of firefighters would express surprise at thermal imaging cameras that can read heat signatures through thick smoke. Innovations in the future will appear equally remarkable. It is essential to note that such technologies are invented only because forward-thinking responders and emergency managers see a need and a solution where none currently exists.

Change Driver: Catastrophic Incidents

Increasing Number and Diversity of Catastrophic Incidents has Strained Local and Regional Response Capabilities

Capability requirements and the gaps therein are inherently defined by the type and scale of disasters that necessitate a response. Since 2008, two evident changes have occurred: the number of catastrophic incidents has increased, and the scope of incidents has diversified. Most recently, 2010 and 2011 have been record-setting years for major incidents, with 81 presidentially declared disasters in 2010 alone.[42] By September 2011 this total had already been exceeded, with 83 presidentially declared disasters. These disasters have ranged from hurricanes to floods to wildfires. While it is impossible to correlate or identify causal factors for this recent upsurge in significant incidents, one possible variable is the impact of climate change. Ranging from doomsday to plausible, predictions of the effects of rising temperatures indicate that intense and extreme weather is likely to become more frequent and perhaps more severe. The increased frequency of catastrophic events may greatly strain emergency response systems, introducing significant capability gaps. Recent events such as Hurricane Katrina, as well as the Mississippi River floods and Texas wildfires of 2011, overwhelmed local and, in some cases, state and federal capabilities. Recovery from these events will take years. Additionally, in 2011 Congress appears increasingly reluctant to fully fund disaster relief programs designed to reimburse state and local government for their emergency response expenditures (including overtime pay, lost equipment, and mutual aid obligations). If this trend continues, response agencies may be unable to cover the costs of catastrophic incident response, leaving fewer resources available to maintain existing capabilities. Additionally, recurrent, lengthy, and strenuous deployments to catastrophic incidents may diminish both the mental and physical readiness of responders, particularly groups such as Wildland Type I Incident Management Teams that generally respond to any major disaster in the United States.

Further, recent disasters have highlighted the need for increased focus by the emergency response community on previously underestimated risks. For example, the 2010

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[42] Bell, Beverly. "An Impossible Choice: Reconciling State Budget Cuts and Disasters that Demand Adequate Management," in *The Book of the States 2011*, Council of State Governments, July 1, 2011.http://knowledgecenter.csg.org/drupal/content/impossible-choice-reconciling-state-budget-cuts-and-disasters-demand-adequate-management. Accessed 16 September 2011.

Deepwater Horizon oil spill demonstrated a deficiency in environmental response capabilities. During the response to Deepwater Horizon the U.S. Coast Guard cited a general lack of understanding by state and local officials about their role in response to an oil spill.[43] International disasters have also raised concerns within the domestic response community. The devastating 2011 earthquake in Japan and resulting radiological emergency led to an increase in earthquake preparedness domestically, particularly with concern to nuclear facilities. In addition to natural disasters, the omnipresent threat of terrorism has expanded to include an emphasis on homegrown "lone-wolf" attacks, referring to acts perpetuated by a radicalized individual or small group.[44] This new focus represents a departure from previous efforts to combat potential attacks by large, developed terrorist networks overseas. Since 2008, examples of "lone-wolf" attacks include the 2009 Fort Hood shootings; the 2009 shooting of American servicemen at a recruiting station in Little Rock, Arkansas; and the 2011 shootings and bombings in Norway. Increasing diversity of potential incidents introduces new requirements for response capability; if not proactively addressed, these requirements may lead to widening capability gaps.

Although Unpredictable, Future Catastrophic Incidents May Be Defined by Existing Trends in the Current Threats

While the specific incidents and events that will characterize the future response environment are virtually unknowable, the scope of such incidents may be defined by existing trends. For example, seismologists have noted for some time the likelihood of an earthquake affecting the United States, most likely near the San Andreas fault on the West Coast or the New Madrid fault in the center of the county. Similarly, recent experiences with H5N1 and H1N1 influenza viruses demonstrate the potential threat of such rapidly spreading diseases, particularly more virulent strains. Such a pandemic would require a massive public health, emergency medical, and quarantine/sheltering response. It would have global economic effects.[45] Future trends will likely include terrorism as a continued concern in the future response environment; as noted by FEMA's Strategic Foresight Initiative: "First, the dispersion of technological and scientific knowledge will increase terrorists' access to high consequence weapons …. Second, terrorist organizations are adaptive organizations that are constantly learning and improving their tactics and techniques. Third, there is an increase in self-radicalization of individuals and small groups. Fourth, communications technology continues to support

[43] Final Report of the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling: Chapter 5- Response and Containment. Washington, D.C. 2011.

[44] Jack Cloherty. "9/11 Anniversary: DHS Secretary Napolitano on Guard Against al-Qaeda, Homegrown Terror Threats." ABC News.com. September 07, 2011. http://abcnews.go.com/blogs/politics/2011/09/911-anniversary-dhs-secretary-napolitano-on-guard-against-al-qaeda-homegrown-terror-threats/. Accessed September 16, 2011.

[45] Taisuke Horimoto and Yoshihiro Kawaoka. "Influenza: lessons from past pandemics, warnings from current incidents," *Nature Reviews Microbiology,* 3, 591-600 (August 2005).

recruitment and terrorist messaging."[46] While terrorism will remain a threat, as it has for centuries, it is certainly possible that the past decade saw a historically anomalous surge in terrorist activity, which will decline in the future. However, the trends discussed in the Strategic Foresight Initiative will certainly remain relevant, even increasing enablers of terrorist activity.

The condition of the nation's infrastructure may lead to an increase in human-caused accidental incidents. The next section describes these risks in detail.

Change Driver: Infrastructure

Lack of Infrastructure Investment and Increasing Vulnerabilities Have Led to Risk of Catastrophic Failures and May be a Key Cause of Catastrophic Incidents and Constrained Response

Effective response is enabled by infrastructure such as transportation networks, communications systems, and power distribution. These systems underlie the provision of even basic services. Without this critical infrastructure, the response system would literally grind to a halt. In the United States, aging and ill-maintained infrastructure has reached a point of crisis. After five or six decades, numerous critical infrastructure components have or will soon reach the end of their life expectancy. These antiquated structures may also be ill-equipped to meet the demands of a growing population. A 2009 nationwide survey conducted by the American Society of Civil Engineers gave the nation's overall infrastructure a D rating, with an estimated $2.2 trillion required for necessary improvements. However, the current economic environment makes it unlikely that needed infrastructure investments will be made in the near future. Risks associated with aging infrastructure are twofold. First, aged and poorly maintained infrastructure is at an increased risk of failure, which could ultimately produce large scale catastrophic disasters (such as the I-35 bridge collapse in Minneapolis). Second, aged or inadequate infrastructure can hamper the efforts of emergency responders to respond to or mitigate a catastrophic incident. As infrastructure burdens increase, the interdependencies between them become increasingly critical. Indeed, as the United States grapples with its evolving energy policy, minimal generating capacity has been added to the domestic grid in the past decade. This lack of new construction increases the consequence of loss for any one generating facility, meaning that a facility damaged during a catastrophic incident may cause regional or national cascading effects. Similarly, there may be less spare capacity in the system to support critical dependencies such as the health or emergency services sectors.

Additionally, critical infrastructure has increasingly become the target of outside attacks, raising the potential for catastrophic failure. Nationwide reliance on information and communications technology has exponentially increased potential consequences of a cyber attack. Today, almost all critical functions, from electricity to banking, are reliant upon cyber infrastructure, increasing vulnerabilities of critical systems and sensitive

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[46] FEMA. "Strategic Foresight Initiative: Summary of Findings."May 2011. http://www.fema.gov/pdf/about/programs/oppa/findings_051111.pdf

information such as financial data or medical records. Having one or more of these functions shut down by cyber-terrorists, hostile nation-states or organized criminals has the potential either to create a large scale event (such as a nuclear incident) or severely hamper responder capabilities (through damage to critical assets such as radio communications). Rather than creating immediate gaps, the degraded state of critical infrastructure and the potential for catastrophic failure indicates the need for increased resiliency in response capabilities.

Change Driver: Society

Shifting Migration Patterns and Demographic Changes Have Presented New Challenges

Among the change drivers discussed in this report, social change is perhaps first among equals, as emergency response is defined most of all by the individuals and communities seeking assistance. While changes in society since 2008 have been nuanced, they present practical considerations with implications for existing and emerging capability gaps. Thought to be the result of economic hardship and migration from the North, population demographics have shifted dramatically to the southern and western portions of the country. According to the 2010 census, the South and the West boasted 14.3 percent and 13.8 percent population increases respectively. In comparison, the Northeast grew by only 3.2 percent, while the Midwest had a 3.9 percent increase.[47] Aside from the implications of adapting resources to meet a growing or shrinking population, shifting demographics also affect the amount of federal emergency response funding state and local organizations receive, as those figures are generally based on population data.[48] As a result, many state and local response entities may be required to continue operations with reduced federal financial support.

Future Response Capabilities Will Need to Account for a Gradually Changing Nation

Social and demographic change is perhaps the one area where continuity can be expected in the future response environment. Overall population growth should continue at a steady pace, as the U.S. Census Bureau projects the U.S. population will grow 42 percent between 2010 and 2050. However, it is notable that the population growth rate between 2030 and 2050 is expected to be the slowest in the nation's history.[49] This increase could strain response resources, although the rate of increase should be flat enough to avoid any major discontinuities. As the baby boomer generation enters retirement, the percentage of elderly individuals in the U.S. population may nearly double from 12 percent of the total

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[47] Jones, Tim and John McCormick. *U.S.Population Shift Accelerated to South, West States, 2010 Census Shows*. Bloomberg.com. December 22, 2010. http://www.bloomberg.com/news/2010-12-22/u-s-population-shift-accelerates-to-south-west-states-2010-census-shows.html. Accessed September 16, 2011.

[48] FEMA."Strategic Foresight Initiative: Summary of Findings." pg 6.

[49] Day, Jennifer Cheeseman. "Population Profile of the United States."U.S. Census Bureau. Accessed October 31, 2011. http://www.census.gov/population/www/pop-profile/natproj.html

population in 2000 to 21 percent in 2050.[50] As elderly citizens often require additional medical services and may be less mobile, this increase could imply a heightened burden on responders during a major incident. A significant driver of overall population growth is the increase in the Hispanic population, which is expected to double (from 12 percent to 24 percent) by 2050.[51] The increase could indicate the need for novel communication capabilities during a catastrophic incident response.

Within the United States, population density is expected to continue to shift from rural to metropolitan regions (including urban and suburban areas), and toward coastal regions.[52] This trend may mean increased consequences from incidents affecting metropolitan and coastal regions. It is additionally notable that social preparedness and "community resilience" are a key determinant of incident survivability and consequences, a principle recently codified in FEMA's "Whole Community" initiative. Societal preparedness is unpredictable and difficult to project, and, as FEMA notes, "involves a "philosophical shift in relations between the state and civil society that changes the parameters of how local communities organize and act."[53] Such an intangible trend may not be amenable to prediction, but may be critical in determining the outcome of a catastrophic incident in the future response environment.

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[50] Shrestha, Laura B. and Elayne J. Hesner. *The Changing Demographic Profile of the United States.* Congressional Research Service, 2011.

[51] ESRI. *The U.S. Demographic Landscape is Changing Dramatically.* *http://www.esri.com/news/arcnews/summer07articles/the-us-demographic.html.* Accessed September 1 2011.

[52] Frey, William H. et al. Getting Current: Recent Demographic Trends in Metropolitan America .The Brookings Institution. 2009.

[53] Bach, Robert, et al. *Policy Challenges in Supporting Community Resilience.* FEMA. 2011.

Appendix C: Analogous Efforts to Envision Future First Responder Needs

The research team assessed similar futures efforts in the military, and also surveyed research effort by first responders to envision select futures requirements and capabilities for individual and system performance enhancements. The military efforts provide a similar comparison in that the needs of a soldier, sailor, marine, or airman in conducting military operations in a future operating environment are somewhat analogous to a firefighter, law enforcement officer, or paramedic conducting emergency response operations. The needs to ensure the safety, health, survivability, and performance of both the individual and the team are analogous between the military and first responder communities.

U.S. Military

The military has made numerous efforts in road-mapping needs of future warriors. The U.S. Army's *Soldier as a System* project was started in 2006, endeavoring to provide every soldier with superior capabilities to accomplish assigned tasks and conduct missions against any opponent.[54] The Army's approach stated specifically that, "soldiers remain the centerpiece of our combat systems and formations." The current iteration of the *Soldier as a System* program was to design a "Future Force Warrior" using a two-year subsystem spiral development process leading towards with fully realized product in 2032. The Army's efforts are directed toward near-term improvements that lead toward a long-term system.[55]

The U.S. Marine Corps embarked on its own visioning process through its *Marine Expeditionary Force Development System* (2008). The goal of this effort was to "develop and deliver fully integrated warfighting and associated support and infrastructure non-warfighting capabilities to the operating forces." The process included four phases: a capabilities assessment (functional area analysis and functional needs analysis); a solutions analysis (functional solutions analysis, solutions planning directive, and generating requirements); program development (investment program evaluation inputs); and capabilities implementation and transition (delivering capabilities to operators).

Both the Army and Marine efforts take a systematic approach to viewing individual soldiers or marines within the context of an operating system: the person, uniform, individual equipment, and training that will go in battle; the formations of soldiers or marines and the doctrine, policy, and procedures they use to operate; and the integration of all these different elements into a specific, integrated tool of national power.

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[54] 2008 U.S. Army Purpose Statement: Soldier as a System. 2008. http://www.army.mil/aps/08/information_papers/other/Soldier_as_a_System.html

[55] Commandant of the Marine Corps, "Marine Corps Expeditionary Force Development System," Department of the Navy, Marine Corps Order 3900.15B, March 10, 2008. http://www.marines.mil/news/publications/Documents/MCO%203900.15B.pdf.

The U.S. Air Force embarked on a program specifically designed to focus on one non-materiel element of their future force: the education of its members. The Air Force's Spacecast 2020 project outlines the technologies, processes and policies required to determine educational requirements for the future military, including: who is educated (everyone or a select few); when military members are educated (at specific times for all, or at appropriate times throughout each individual's career); and where military members are educated (in-residence or through virtual residency).[56]

Ultimately, the Army, Marines, Air Force, and Navy must come together with specific capabilities to conduct military operations and ensure national security. For the past 25 years this has been accomplished through what is referred to as "joint" operations. The responsibility for integrating these joint military operational capabilities rests with the Joint Chiefs of Staff, and they have attempted to look at future operations through their *Capstone Concept for Joint Operations* (2010). This report describes in broad terms a vision for how the joint force will operate in response to a wide variety of security challenges from 2016-2028, and outlines the interests, opportunities, challenges, and potential responses required.[57]

The Defense Sciences Board, an advisory group to the Secretary of Defense, released a report, *21st Century Strategic Technology Vectors* (2006), which identified enabling technologies required to meet the challenges of the future military. Highlights included enhanced training, military education, automated language processing, close-in sensor systems, conceiving of the soldier as a network, and the use of social and behavioral sciences to model adversary behavior.[58]

Department of Homeland Security

Within the DHS, there are two notable ongoing efforts exist to envision the future operating environment for responders and inform decision makers of needed capabilities. The first effort is the ongoing U.S. Coast Guard *Evergreen Project*, the most recent iteration of which is *Evergreen II* (2009). Evergreen occurs every four years and uses a four-phase scenario-based strategy development process to develop alternative future scenarios, anticipate future challenges and opportunities, forge strategies, and implement strategies. The program is Coast Guard-centric, but could serve as a model for mapping alternative future scenarios against potential capabilities.[59]

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[56] Air University, U.S. Air Force."SPACECAST 2020." 1994. http://csat.au.af.mil/2020/monographs/exec-sum.pdf

[57] U.S. Department of Defense."Capstone Concept for Joint Operations." 2009. http://www.apc.maxwell.af.mil/l005/pubs/CCJO_2009.pdf

[58] Defense Science Board. "21st Century Strategic Vectors." 2007. http://www.acq.osd.mil/dsb/reports/ADA463361.pdf

[59] U.S. Coast Guard."Evergreen II Project Report. "2009. http://www.uscg.mil/strategy/docs/EVERGREEN%20REPORT%20FINAL.pdf

The other effort within DHS is FEMA's *Strategic Foresight Initiative* (2011) a unique effort to allow the national emergency management community to understand how the world is changing, and how those changes may affect the future of emergency management. Participants in the *Strategic Foresight Initiative* identified nine drivers that are likely to affect the field of emergency management significantly over the next 15 years: the changing role of individual in society, climate change, critical infrastructure, the evolving terrorist threat, global interdependencies, government budgets, technological innovation and dependence, universal access to and use of information, and U.S. demographic shifts. These drivers allow emergency managers at all levels of government and in the private sector to begin the process of building mitigation strategies for threats and hazards posed by the changing world.[60] Prior to this new effort led by FEMA, the emergency management community has lacked an overall national visioning process for its role in the future.

Law Enforcement

The law enforcement community has made a few selected efforts in recent years. The Police Executive Research Forum conducted a *Law Enforcement Technology Needs Assessment* (2009). This project included a survey and workshop to identify, evaluate and prioritize relevant technologies that hold the greatest priority for policing. It identified five priority needs for law enforcement technology, including managing calls for service, crime analysis, database integration, prevention of street crime, and officer hiring and retention.[61]

One unique organization in law enforcement that exists explicitly to look forward is the Police Futurists Society, which in 2009 released *Policing 2020: Exploring the Future of Crime, Communities, and Policing*. Like the *Evergreen* and the *Strategic Foresight Initiative*, its method includes efforts at forecasting alternative future scenarios. *Policing 2020* defines a process to forecast future events (the probable future), identify a range of events and circumstances that could occur (the possible), and to make choices about events that the author hopes will occur (the preferable). It included 16 essays from academic and law enforcement professionals analyzing potential shifts in the law enforcement environment, and effects on policing through 2020. Areas of analysis included demographic shifts, cultural and social change, and the expanded use of information technology and network-centric policing.[62]

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[60] FEMA. "Strategic Foresight Initiative: Summary of Findings," May 2011. http://www.fema.gov/pdf/about/programs/oppa/findings_051111.pdf. Accessed June 27, 2011.Pg 3.

[61] Koper, Christopher S., Bruce G. Taylor and Bruce E. Kubu. "Law Enforcement Technology Needs Assessment."Police Executive Research Forum. 2009. http://www.policeforum.org/library/technology/Lockheed%20Martin%20Report%20Final%203-16-2009.pdf

[62] Schafer, Joseph A. ed. "Policing 2020: Exploring the Future of Crime, Communities and Policing." Police Futurists Society. 2007. www.**police**futurists.org/pdf/**Policing2020**.pdf

Fire Service

The American fire service has done limited futures studies that focused on a comprehensive long-term way to categorize the first responder of the future. The U.S. Fire Administration has conducted several near-term needs assessments; most recently *Four Years Later – A Second Needs Assessment of the U.S. Fire Service* (2006), which surveyed from a random sample of 4,709 departments to update a 2002 assessment that had surveyed over 8,000 of the nation's estimated 31,000 departments. The 2006 survey found a significant number of departments were deficient in staffing, training, and equipment necessary for both daily and major incident response, although to a lesser degree than the 2002 report (and to a far greater extent among small and volunteer departments). The survey did not endeavor to project long-range needs.[63]

Similarly, in 2005 the National Fire Service Research Agenda Symposium at the National Fire Academy conducted a focus group with fire service researchers and leaders to identify and prioritize the areas where research efforts should be directed to support improvements in firefighter life safety. This effort was repeated in 2011, however the report of the meeting has not yet been completed.[64]

Additionally, the fire service has held a series of leadership conferences called the Wingspread Conferences, which have taken place every decade since 1966, most recently in 2006. These tend to capture the evolving role of the fire service in the United States and do not project a roadmap toward firefighter needs in the future.[65]

Emergency Medical Services

The emergency medical services community has made the most wide-reaching efforts in trying to establish a longer-range vision of the EMS worker of the future. The National Highway Traffic Safety Administration has done a series of studies. *The EMS Workforce Agenda for the Future* (2011) looked at the health, safety, wellness, education, certification, data, research, and workforce planning required for building a more effective EMS workforce.[66] The *EMS Education Agenda for the Future: A Systems Approach* (2000) created a vision for an education system to improve efficiency, enhance

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[63] U.S. Fire Administration. "Four Years Later- A Second Needs Assessment of the U.S. Fire Service." 2006. http://www.nfpa.org/assets/files/PDF/NeedsAssessment2NatlReportFA303.pdf

[64] National Fallen Firefighters Foundation."Report of the National Fire Service Research Agenda Symposium." 2005. http://commandsafety.com/tag/2005-national-fire-service-research-agenda-symposium/

[65] International Association of Fire Chiefs Foundation."Wingspread V." Atlanta, GA. 2006. www.nationalfireheritagecenter.org/2006Wingspread.pdf

[66] Chapman, Susan A., Lindler, Vanessa and Kaiser, Jennifer."The Emergency Medical Services Workforce Agenda for the Future."National Highway Traffic Safety Administration.www.ems.gov/pdf/2011/EMS_Workforce_Agenda_052011.pdf

consistency, and lead to greater entry-level competence.[67] The *EMS Agenda for the Future* (1996) provided a plan and needs assessment to guide the development of emergency medical services into the 21st century.[68] The *Agenda* examined what has been learned during the prior three decades and created a vision for the future of EMS. *The Future of Emergency Care in the United States Health System*, conducted by the Institute of Medicine in 2006, looked at the emergency care system in the United States, including strengths, limitations, and future challenges; desired vision of the emergency care system; and recommended strategies needed to achieve that vision.[69]

All these studies, from the military and from the first responder communities, provide examples of different methods for looking at the future needs of first responders and for setting various time horizons, from the near and mid-term to the long term, generally 10-20 years forward, and under various alternative future scenarios.

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[67] National Highway Traffic Safety Administration. "Emergency Medical Services Education Agenda for the Future: A Systems Approach." 2006. http://www.nhtsa.gov/people/injury/ems/FinalEducationAgenda.pdf

[68] National Highway Traffic Safety Administration."EMS Agenda for the Future." 2006. http://nremt.org/nremt/downloads/EMS%20Agenda%20for%20the%20Future.pdf

[69] Institute of Medicine."The Future of Emergency Care in the United States Health System."2007.http://www.iom.edu/Activities/Quality/emergencycare.aspx

FEMA Photo

Appendix D: Q Instrument Methodology and Results

This section briefly explains Q methodology, a statistical technique employed in this study to understand the capability priorities of workshop participants. This methodology was also used during the 2008 *Project Responder* study, and parts of this explanation were provided in the report of the findings from that study.

Q Instrument

Q methodology is an analytical technique credited to Stephenson (1935) that facilitates systematic study of human subjectivity, defined as "a person's communication of his or her point of view" (McKeown and Thomas, 1988: 12). It is used to identify patterns of perceptions about a topic across individuals, and to construct typologies of perspectives based on interpreting these patterns. For a detailed description and technical explanation of the technique, and a comprehensive review of its application, see in particular Brown (1980), McKeown and Thomas (1988), and Brown, Durning, and Selden (1998). The software used for this analysis was PQMethod 2.11.

Q Sample and Sorting Process

The Q technique offers several important advantages to this analysis: First, it allows diverse group of participants to communicate their opinion about a large number of ideas more efficiently and systematically than in open discussion. Second, it permits a more nuanced analysis of priorities than a standard rating or ranking scheme would. Specifically, it facilitates correlation of the responses to see where areas of consensus and disagreement lie, thereby signaling potential opportunities and problems for future policy development efforts, grant funding decisions, and assessment programs. Third, it is non-deterministic—that is, participants are not constrained by some a priori structure or scale of opinion about the topic under investigation (as the sample of statements was derived from the participants themselves and there are approximately 8×10^{47} possible ways of rank ordering the statements). Finally, it promotes much more systematic investigation and characterization of opinions and perspectives than do interviewing or focus group discussions alone.

Thus, following the Q methodology, the 28 participating responders ranked the 40 capability need statements using a specified strategy. The participants sorted the needs based on their opinion of each need's relative importance; these ratings were then compared using common statistical techniques. This analysis yielded a set of eight statistically uncorrelated groups of participants, each of which comprises responders who organized the capability needs similarly. This analysis permits us to do two things: First, we can examine how individual participants sorted the capability needs to determine which of the 40 are the highest priorities. Second, we can examine the eight groups of participants by constructing a "model Q-sort" for each group, which is somewhat akin to a weighted average of their individual responses. These model sorts are shown in appendix H. These model sorts permit the particular capability needs that uniquely define each group of people to be identified. Also, the sorts can be compared to discover areas

of consensus and disagreement about the relative importance of each of the 40 capability needs. This comparison is presented in appendix I.

The application of Q methodology rests fundamentally on the assemblage of communication about a subject, from which is drawn a sample of statements selected to represent the range of opinion. Participants each sort these opinion statements into a forced quasi-normal distribution according to the extent to which they agree or disagree with them. This sorting process produces what is called a "Q-sort," or an individual's set of relative rankings for all statements included in the sample. McKeown and Thomas (1988) explain that the rationale for using the forced quasi-normal structure is to facilitate systematic consideration of the statements in the sample. Respondents retain freedom to locate a statement anywhere in the distribution, and anywhere relative to the other statements, permitting billions of combinations (Brown, Durning, and Selden, 1998). The distribution thus does not have meaning as a conventional attitude index, but as a picture of the relative relationships of the statements for an individual, which might not be revealed if simple scales were used. It has been demonstrated that the shape of the distribution is statistically and substantively inconsequential (Brown, 1971 and 1980, and Cottle and McKeown, 1980). Thus, in Q methodology, the participants are treated as variables, the statements they sort comprise the sample, and the ranks assigned to the sample statements by a participant through the sorting process comprise observations on that participant.

An important objective at hand in this study is to explore how responders perceive capability needs, and to prioritize these needs. While Brown points out that "the selection of statements…for inclusion in a Q sample is of utmost importance but remains more an art than a science" (1980: 186), there are established conventions for generating the sample. Following Brown's (1980) recommendation, this study rests on a naturalistic sample (taken from participants' communications) to maximize the likelihood that the sample captures possible opinions to which the participants can easily attach meaning. It is also structured to promote systematic coverage of the topic of interest. For a detailed explanation of Q sample construction, see Brown (1980:186-191).

For this study, a structured, quasi-naturalistic sample of statements was generated during the workshop discussions. Participants were asked identify their current capability needs in each of nine capability domains. After substantial discussion, participants identified approximately 5 to 15 needs. They were then asked to identify the most pressing among these, to arrive at approximately five top priorities in each domain. This set of priorities was then condensed by eliminating redundancies (including capabilities that were very closely related, though not identical), needs that were characterized too vaguely, and needs for which substantial technology development is known to be underway already.

During a subsequent session at the workshop, the 28 participants were asked to sort the randomly ordered statements into a quasi-normal distribution ranging from -3 (most strongly disagree that this need is an important priority) to +3 (most strongly agree that this need is an important priority). For the statements with which the participants agreed and disagreed most strongly, they were asked to explain why they felt as they did. In addition, participants were asked to provide some basic demographic information, and information about their professional education and experience. It is important to

recognize that all 40 of the capability needs identified are considered important by the participants. The ranking process allows responders to identify which of these important capabilities are most important and which are less important. Thus, a statement ranked -3 (most strongly disagree that this need is an important priority) is not unimportant, but less important than the other capabilities.

Q Factor Analysis and Interpretation

The ways participants rank the statements (captured in the individual sorts) are compared using common factor analytic techniques to arrive at factors that represent groups of people who sorted the statements similarly. Thus, Q methodology effectively reveals different perspectives that exist; the people whose sorts load significantly on a given factor share similar views on the subject under study. Interpretation of the factors is based on the construction of a factor array, or "model Q-sort," for each factor. This is accomplished by merging the sorts that loaded significantly on that factor, weighted according to their loadings, to achieve average scores for each statement, by factor. These model Q-sorts permit the statements that uniquely define each factor—and thus each group of people—to be identified.

Once the factor arrays are constructed, it remains to interpret them. Brown, Durning, and Selden (1998) suggest a three-step approach: First, identify those statements with which each group strongly agreed or disagreed. Next, describe the common theme presented by the array. Finally, compare the groups. Because the Q approach is intensive—Q studies typically involve small numbers of respondents compared to survey techniques—it provides rich, detailed information about how respondents feel about a particular topic. In this sense, the Q technique promotes "situational representativeness" by causing each respondent to address and model the broad array of possible states that arise with respect to the topic under investigation (Brown, Durning, and Selden, 1998: 623). People who sort the sample similarly (and therefore load together) form groups that can be compared using the factors arrays to discover areas of consensus and dissension about the subject in question. Since the participants are not randomly sampled, Q method does not provide insight into how these known "subjectivities" are distributed across a population. Other worldviews may exist that might be revealed if different people were chosen (Selden et al., 1999). It is possible, however, to look for patterns of other attributes across groups, such as variations in demographic characteristics, to lend insight into what might contribute to a person's proclivity to adhere to a certain perspective.

In this study, the Q-sorts of the respondents were correlated to create a 28 by 28 matrix of correlations between the sorters. This matrix was factor-analyzed using the principal components method. Eight factors with eigenvalues greater than unity were rotated using varimax. Eight distinct (weakly correlated) factors emerged for which the loadings of at least three participants' sorts were significant at $p \leq .01$. Thus, these factors each represent a particular perspective on capabilities requirements held by a sub-group of responders. All members who load significantly on a factor have a similar view of these issues. The factor loading for each member represents the correlation of his sort with that factor. Further, as explained above, factors are interpreted according to a factor array. The arrays for each of the eight factors (or groups of responders) that emerged in this

study are presented in appendix I. In other words, appendix I shows how those members that loaded on each factor sorted each statement as a weighted average (i.e., in which column of the distribution shown in appendix I each group of members would have placed each statement).

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Selden, Sally Coleman, Gene A. Brewer, and Jeffrey L. Brudney (1999). "Reconciling Competing Values in Public Administration: Understanding the Administrative Role Concept." Administration and Society 13: 171-204.

Appendix E: Capability Identification and Prioritization Method

The primary purposes of the workshop were threefold: 1) to learn what responders believe to be critical gaps in their ability to respond to catastrophic incidents, 2) to identify specific capabilities required to meet these needs, and 3) to prioritize these capability needs according to how urgent and important they are. To accomplish these objectives, workshop attendees participated in a structured series of facilitated discussions designed to elicit their views about capability needs, followed by an exercise that allowed them to prioritize these needs. This section describes these procedures.

Facilitated Capability Discussions

The workshop was organized around nine domains that represent broad consensus about fundamental dimensions of catastrophic incident response, as described above. Each domain comprises several related response requirements and demands particular capabilities. Thus, over the course of the three-day workshop, facilitators led participants through a systematic discussion of each of these domains. Two facilitators conducted concurrent sessions, so that each attendee participated in four three-hour discussions, each of which addressed one capability domain; except for one pair of sessions that each handled two related capability domains. To assure representation from multiple disciplines and to mitigate biases that might arise from group composition or the influence of a particular facilitator, participants were randomly assigned to each of the focus groups. In addition, a detailed facilitation protocol was used to assure that all sessions met the workshop objectives and produced comparable results. Sessions were staffed by a facilitator who led the discussion, an operator who captured and projected essential elements of the discussion, a note-taker who created a detailed record of the discussion, and a subject matter expert who offered insights and identified important themes from the discussion.

The facilitator opened each session by telling the participants that the objective of the discussion was ultimately to crystallize approximately 10 essential capability needs for response domain at hand. These were to be crucially important needs that, if unmet, the response would fail with respect to the domain. Further, the needs were to be characterized in specific enough terms that their meaning would be clear and DHS would be able to use them to direct research and development programs. The facilitator also reviewed (and in some cases adjusted) the description of the capability domain in question to assure that participants understood and agreed about the nature of the domain and the relevant response requirements.

The facilitator then led the group through a discussion in which they identified and described the capabilities they think must be developed in the near- and mid-term in order to be able to respond to future catastrophic incidents. To help the group in this process, the facilitator began by asking what major challenges currently thwart successful response. Participants were encouraged to think broadly about their own jurisdiction's and discipline's capabilities and the limitations, opportunities, constraints, and internal

and external conditions that either enable or hinder them. The facilitator then asked what capabilities would solve these problems. Participants were asked to nominate and explain candidate capability needs. The facilitator worked with the group to draft a concise statement that articulated each specific capability need the group proposed. Participants commented on each statement, and they were modified until all in the room concurred that the statements accurately represented the need in question. Note, however, that participants could freely agree or disagree with any statement—the point of the exercise was to ensure that the need was characterized in a way that garnered the common understanding of all participants. The facilitator also asked the group to describe the important characteristics of each capability to help form the basis for future requirements specification. Finally, the facilitator conducted a "straw poll" to identify the top few capabilities the group considered to be most important of all of those they had identified.

Prioritization Procedure

The facilitated discussions produced a large number of capability needs across all nine domains. Forty-nine of these were identified by the focus groups as the very highest priorities. After eliminating redundancies and a few needs where substantial capability development is known to be already in progress or that constituted political or policy challenges rather than development challenges, a set of 40 unique priority capability needs were specified.

The central objective of this study is to identify what emergency responders think the current capability priorities are. Since there are a large number of important needs across the capability domains, and since responders are likely to vary widely in their views of which capabilities are most essential, a survey technique called Q methodology was used to fulfill this objective. Q methodology enables a group of participants to rank order a large number of opinion statements relative to each other.

The ways participants sorted the needs were compared using common statistical techniques. This analysis yielded a set of eight statistically uncorrelated groups of participants, each of which comprises responders who organized the capability needs similarly according to their assessment of the relative importance of each need. These groups reveal different perspectives that exist across all participants; in short, the people whose sorts correspond significantly with a given group share similar views of the capability priorities. This analysis permits us to do two things: First, we can examine how individual participants sorted the capability needs to determine which of the forty are the highest priority. Second, we can examine the eight groups of participants by constructing a "model Q-sort" for each group, which is somewhat akin to a weighted average of their individual responses. These model sorts are shown in appendix H. These model sorts permit the particular capability needs that uniquely define each group of people to be identified. Also, the sorts can be compared to discover areas of consensus and disagreement about the relative importance of each of the forty capability needs. This comparison is presented in appendix I.

Findings

This section reports the findings with regard to the capability priorities, including what the top priorities are, what the different perspectives on these priorities are, and where areas of consensus or disagreement about the priorities lie.

Below is a list of the 40 capability needs identified by first responder workshop participants as priorities. Note that the numbers are identifiers only used by the responders as a reference; the numbers do not indicate a priority ranking.

#1 The ability to securely pass intelligence information up, down, and across domestic fusion centers and other organizations that use intelligence.

#2 The ability to de-conflict many disparate, complex, and varied plans across jurisdictions and levels of government so they can function effectively.

#3 Readily accessible, high-fidelity simulation tools to support training and exercises in incident management and response.

#4 Clothing and equipment for all first responders that protects against multiple hazards.

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

#6 An effective way to capture, analyze, retain, and share lessons learned and institutional knowledge.

#7 The ability to monitor the status of resources and their functionality in current conditions, in real time.

#8 A system that helps an incident commander recognize when the characteristics and complexity of an incident are different than they appear to be.

#9 The ability to predict the evolution of an incident, the impacts of decisions, and the results of response actions in real time.

#10 The ability to remotely scan an incident scene for signs of life and decomposition to identify and locate casualties and fatalities.

#11 The ability to identify trends, patterns, and important content from large volumes of information from multiple sources (including non-traditional sources) to support incident decision making.

#12 The ability to assess infrastructure interdependencies and the impacts of infrastructure loss to support risk assessments.

#13 The ability to identify what resources are available to support a response (including resources not traditionally involved in response), what their capabilities are, and where they are, in real time.

#14 An integrated suite of tools to facilitate the development of emergency response plans in a standard form.

#15 The ability to evaluate the resiliency of individual responders so we can assure they will perform effectively in the face of acute and chronic stressors.

#16 The ability to develop standardized, actionable intelligence products that meet the requirements of the emergency services community.

#17 The ability to monitor and evaluate the mental and physical status of responders during an incident in real time.

#18 Better-quality voice and data communication systems.

#19 The ability to evaluate the resource needs and resource management efforts from past incidents, and share lessons about problems and solutions.

#20 A financial system that allows incident managers to share and draw on multiple sources of funds to pay for needed assets in advance of reimbursement.

#21 The ability to rapidly determine and disseminate alternate standards of care based on incident conditions.

#22 A "clearing house" that connects those who need resources with those who can fulfill those needs in real time during an incident.

#23 Consistent and coordinated guidelines for use of risk assessment methodologies and development of risk assessments.

#24 The ability to prepare future executives to exercise command and control in a multidisciplinary and multi-jurisdictional collaborative setting.

#25 The ability to remotely monitor the tactical actions and progress of all responders involved in the incident in real time.

#26 The ability to predict, assess, and anticipate resource needs and rates of consumption for all types of catastrophic events.

#27 Communications systems that are hands-free, are ergonomic, and can be integrated into personal protective equipment.

#28 The ability to communicate clearly about resources using common terminology across disciplines and jurisdictions.

#29 The ability to track the location, condition, and status of patients for the entire time they are in the care of the medical response system.

#30 The ability to identify responders (including volunteers), validate their credentials, and put them to work.

#31 The ability for responders to obtain information about the status of their families, and for their families to obtain information about them, in real time.

#32 The ability to protect and access sensitive and proprietary data required for risk assessments.

#33 The ability to know the location of responders and their proximity to risks and hazards in real time.

#34 The ability to incorporate information from multiple and non-traditional sources (e.g., crowdsourcing and social media) into the intelligence system.

#35 Decision support tools that allow incident commanders to vet courses of action and make evidence-driven operational decisions during an incident.

#36 The ability to rapidly identify hazardous agents and contaminants.

#37 An integrated suite of tools to support risk assessments and risk-based decisions in the planning process.

#38 The ability to communicate information to the families of survivors early, and to reunite survivors and families quickly.

#39 A national information sharing system to which all emergency response entities have access that integrates multiple disparate data and intelligence sources.

#40 The ability to communicate with responders in any environmental conditions (including through barriers, inside buildings, and underground).

The ability to communicate with responders in any environmental conditions (including through barriers, inside buildings, and underground).

Top Priorities

The workshop participants identified 40 critical capability needs. Responders deemed all 40 of these needs to be essential to successful response to catastrophic incidents. To help prioritize efforts to address these needs, the sorting process described above can be used to determine which of these critical needs are the very highest priorities. Specifically, the results of the sorting process offer three ways to examine the capability needs: First, it is possible to calculate a raw score for each statement as an aggregate of each individual's ranking of each need. Second, it is possible to tally the number of times each need received the highest possible ranking (+3). Third, it is possible to calculate a weighted average score for each need by reference to the groups of participants revealed by the Q analysis. In this case, the score for each need is based on the score each participant in a given group gave each need, weighted by the participant's correlation with the group.

When the 40 critical capability needs are examined from these perspectives, 4 needs rise to the top as the very highest priorities. These needs garnered the most +3 rankings, the highest raw scores, and the highest factors scores. They are:

#33: The ability to know the location of responders and their proximity to risks and hazards in real time.

#40: The ability to communicate with responders in any environmental conditions (including through barriers, inside buildings, and underground).

#25: The ability to remotely monitor the tactical actions and progress of all responders involved in the incident in real time.

#3: Readily accessible, high-fidelity simulation tools to support training and exercises in incident management and response.

Just below this top tier of capability priorities, four more needs were identified as very high priorities. These needs also had several +3 rankings each, high raw scores, and high factors scores. These are:

#27: Communications systems that are hands-free, ergonomically-optimized, and can be integrated into personal protective equipment.

#4: Protective clothing and equipment for all first responders that protects against multiple hazards.

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

#13: The ability to identify what resources are available to support a response (including resources not traditionally involved in response), what their capabilities are, and where they are, in real time.

Next, a set of four additional capabilities were seen as among the most important of the 40 needs. These also garnered high scores, though not quite as high as the two tiers identified above. These are:

#11: The ability to identify trends, patterns, and important content from large volumes of information from multiple sources (including non-traditional sources) to support incident decision making.

#36: The ability to rapidly identify hazardous agents and contaminants.

#7: The ability to monitor the status of resources and their functionality in current conditions, in real time.

#10: The ability to remotely scan an incident scene for signs of life and decomposition to identify and locate casualties and fatalities.

In light of the process used to derive them, the balance of the 40 needs were all considered to be critical. In fact, 31 of the 40 were ranked +3 (indicating strongest agreement) by at least one participant. While still viewed as important, some needs did not rise to the top of any participant's ranking and received lower scores relative to the others. Those needs that were generally considered relatively less important compared to the others are:

#19: The ability to evaluate the resource needs and performance of the resource management system on past incidents, and share lessons about problems and solutions.

#14: An integrated suite of tools to facilitate the development of emergency response plans in a standard form.

#2: The ability to de-conflict many disparate, complex, and varied plans across jurisdictions and levels of government so they can function effectively.

#32: The ability to protect and access sensitive and proprietary data required for risk assessments.

#20: A financial system that allows us to share and draw on multiple sources of funds to pay for needed assets in advance of reimbursement.

In cases where participants indicated less urgency about a capability need, they often cited the impression that either the capability was already in development or existence (even if not broadly available or fully employed). In some cases, participants were less supportive of capabilities that do not pertain as directly or immediately to catastrophic incident response, putting their emphasis instead on capabilities that had obvious life safety implications. Some participants saw these capabilities as important, but dependent on policy and management changes, rather than on development investments. Finally, some argued that there are solutions in other domains and disciplines that could be brought to bear in the field of emergency response to address these needs.

Dominant Perspectives

In this section, the views different groups of responders have of the capability priorities are described based on the model sorts (appendix H). Overall, eight groups emerged for which at least three participants' sorts were statistically significant. In other words, eight different perspectives are evident among the participants. While these groups are certainly distinct (the correlations between these groups are 0.39 or less), these groups are not entirely independent. Ten participants fell into more than one group. The eight groups of participants that emerged from the analysis do, however, vary in terms of which issues were most important (i.e., in terms of the strength of their agreement that each need is an important priority). In fact, there are no capability needs about which there is clear consensus across all groups. (That is, there are no needs for which the specific ranking is statistically indistinguishable across all eight groups.)

The model sorts for the eight groups were first interpreted by examining those capability needs with which each group strongly agreed or disagreed (i.e., ranked as ± 3 or ± 2). Then, the groups' differences were identified by examining those needs that distinguished each group. (Refer to appendix I to see the extent to which each group of participants agreed or disagreed with the cited needs on average, and relative to other participants.) Also, participants were asked to explain in writing why they agreed or disagreed with those needs that they sorted at the extreme ends of the distribution (that is, those they felt most strongly about). Their comments help to illuminate those issues that garnered the strongest opinions.

Group 1. Eight of the 28 participants (29 percent) form this group. Generally these participants targeted a variety of communications-related requirements as the very most important priorities, including hands-free systems (need #15), communication through

barriers (need #40), and reporting the location of responders relative to hazards (need #33). Notably, this group is very similar to the first and largest group that emerged during the last project responder prioritization analysis in 2008. These participants describe communications as the "key element" for successful incident response from which all else follows. They point out the crucial relationship between communications and responder safety, but also note that cumbersome communications reduces effectiveness and undermines response outcomes. Many participants in several groups emphasized the need for capabilities that can help protect responders from hazards with the clear message that responder life safety is of premier importance. What distinguishes this group is its interest in situational awareness on the part of incident commanders, particularly insight into the status of their responders (need #17) and the nature of the event itself (need #8). As compared to these priorities, this group is less concerned about planning and financial management capabilities.

Group 2. Eight of 28 participants (29 percent) comprise this group. These participants place an emphasis on remote monitoring of responders (needs #25 and #33) and hazards (need #5). Yet this group is distinguished by the fact that it considers the need to evaluate the resiliency of responders ahead of an incident as less important than other groups do (need #15). Some participants indicated that they thought this was important, but already possible and not related to response directly.

Group 3. Six of 28 participants (21 percent) were included in this group. Distinct from group 2, this group strongly agrees that the ability to evaluate the resiliency of responders (need #15) is an important capability priority. This group also places a premium on decision making, and sees decision support tools (need #35) as a higher priority than other groups do. As one group member noted, "Resources won't be used wisely or efficiently if the incident commander is overwhelmed." On the other hand, this group finds the need for a lessons learning capability (need #6) to be less important than other groups do. Some members of this group commented that the essential elements of this capability exist, but that there is a lack of will to overcome the bureaucratic barriers that prevent responders in the field from enacting the capability in a meaningful way. This group is also distinguished by less urgency about the need to be able to identify hazardous agents (need #36).

Group 4. Five of 28 participants (18 percent) make up this group. This group emphasized the need for simulation tools (need #3) because the infrequency of events means that competency degrades and because simulations offer responders the opportunity to learn about complex and dangerous environments in a safe setting. They also see an urgent need for detection tools (need #5) and a credentialing system (need #30). One participant pointed out that all of these are tools that could be implemented at all levels of government and across all sectors (public, private, and non-profit/voluntary).

Group 5. Four of the 28 participants (14 percent) form this group. Like group 4, this group sees credentialing as important, and like group 1 is concerned about communications. This group's distinct concern, however, is the need for robust risk assessment methods (need #23). Other participants argue that risk assessment is not directly relevant to response and that standardization stifles creative thinking, but this group sees it as fundamental to response planning and decision making. This group also

sees the ability to incorporate information from multiple and non-traditional sources into the intelligence system (need #34) as less important than others do. One participant indicated the concern that without companion capabilities to protect and vet information reliability, this capability cannot be robust.

Group 6. Four of the 28 participants (14 percent) make up this group. This group's priorities have to do with resources, including the ability to identify what resources are available (needs #13 and #30) and to predict resource needs (need #26). As one participant explained, "If we are unable to anticipate interdependencies … we will quickly lose control of an already bad situation." On the other hand, this group is distinguished by the fact that it sees the need for better intelligence sharing (need #1) as less important. One participant argued, "Security classification, credentialing, and standardization are relied upon too heavily to achieve and maintain control. These tools and techniques rely too much on reducing uncertainties and not enough on resolving ambiguity or complexity." This group also sees the need for information about the location of responders with respect to hazards (need #33) as less important than other groups do. One participant argued that remote monitoring of responders may tempt incident commanders to become more involved in line operations than they should. Another thought that a sense of being monitored might make line responders fear being second-guessed and cause them to hesitate in the face of time-critical tactical decisions.

Group 7. Three of the 28 participants (11 percent) constitute this group. These responders value the ability to communicate clearly about resources using common terminology (need #28) more than the other groups do, viewing "non-standard communication, terminology, and processes [as a] major obstacle." On the other hand, one member of another group argues that this is already under way, but "it's just taking too long." This group also thinks hands-free communications systems (need #27) are less important than other groups do. One participant asserted that we've already wasted too much federal money on "hands free ergonomic toys."

Group 8. Three of the 28 participants (11 percent) form this group. Unlike other groups, these responders strongly support the ability to incorporate information from multiple and non-traditional sources into the intelligence system (need #34). Participants in other groups are more skeptical, wondering if this information and the sources that generate it are mature enough. This group also sees tools to help generate emergency response plans in a standard form as important (need #14), while others think this can already be done. On the other hand, this group values decision support tools for incident commanders (need #35) less than other groups do.

The distinctions between these groups highlight the fact that while some capability priorities garnered broad support across a majority of participants, there are also some areas where participants disagreed about how urgent and important a particular need is. Areas where the groups differ can also be identified by measuring the degree of statistical dissimilarity across groups for each of the 40 needs (see appendix I). To summarize, participants diverged most in their opinions about the importance of these capability needs:

#35: Decision support tools that allow incident commanders to vet courses of action and make evidence-driven operational decisions during an incident.

#20: A financial system that allows us to share and draw on multiple sources of funds to pay for needed assets in advance of reimbursement.

#39: A national information sharing system to which all emergency response entities have access that integrates multiple disparate data and intelligence sources.

For each of these capability needs some participants expressed very strong agreement that these are important priorities, while others were less supportive of these needs than of any others.

Appendix F: Capability Priority Statement Rankings

This table shows all 40 capability priorities, and rankings that represent the score each group of participants would have given each priority. The size of each group is in parentheses. The priorities are sorted according to their average ranking weighted by the size of the group.

Statement	Group 1 (8)	Group 2 (8)	Group 3 (6)	Group 4 (5)	Group 5 (4)	Group 6 (4)	Group 7 (3)	Group 8 (3)	Weighted average ranking
The ability to know the location of responders and their proximity to risks and hazards in real time.	3	3	3	1	2	-2	0	1	1.84
The ability to remotely monitor the tactical actions and progress of all responders involved in the incident in real time.	1	3	2	0	0	-1	3	2	1.35
The ability to detect, monitor, and analyze passive and active threats and hazards at incident scenes in real-time.	2	3	1	3	-1	-1	1	-1	1.31
The ability to communicate with responders in any environmental conditions (including through barriers, inside buildings, and underground).	3	0	2	0	3	2	-2	-1	1.19

Statement	Group 1 (8)	Group 2 (8)	Group 3 (6)	Group 4 (5)	Group 5 (4)	Group 6 (4)	Group 7 (3)	Group 8 (3)	Weighted average ranking
Readily accessible, high-fidelity simulation tools to support training and exercises in incident management and response.	0	0	3	3	2	0	0	1	1.08
The ability to identify what resources are available to support a response (including resources not traditionally involved in response), what their capabilities are, and where they are, in real time.	0	2	1	-1	1	3	1	2	1.04
The ability to monitor the status of resources and their functionality in current conditions, in real time.	0	2	0	0	1	1	2	3	0.95
Communications systems that are hands-free, ergonomically-optimized, and can be integrated into personal protective equipment.	3	1	0	0	1	0	-3	1	0.76
The ability to rapidly identify hazardous agents and contaminants.	2	2	-2	1	1	0	0	0	0.72

Statement	Group 1 (8)	Group 2 (8)	Group 3 (6)	Group 4 (5)	Group 5 (4)	Group 6 (4)	Group 7 (3)	Group 8 (3)	Weighted average ranking
The ability to identify trends, patterns, and important content from large volumes of information from multiple sources (including non-traditional sources) to support incident decision-making.	1	2	2	-1	-2	2	-2	1	0.71
Protective clothing and equipment for all first responders that protects against multiple hazards.	1	2	-2	2	1	2	-3	-2	0.49
The ability to identify responders (including volunteers), validate their credentials, and put them to work.	-1	-1	0	3	3	3	1	-2	0.49
The ability to track the location, condition, and status of patients for the entire time they are in the care of the medical response system.	0	0	0	2	2	1	-2	-1	0.33
The ability to rapidly determine and disseminate alternate standards of care based on incident conditions.	1	-1	2	0	0	0	-1	0	0.23

Statement	Group 1 (8)	Group 2 (8)	Group 3 (6)	Group 4 (5)	Group 5 (4)	Group 6 (4)	Group 7 (3)	Group 8 (3)	Weighted average ranking
Decision support tools that allow incident commanders to vet courses of action and make evidence-driven operational decisions during an incident.	-1	1	3	1	-1	-2	2	-3	0.20
The ability to predict, assess, and anticipate resource needs and rates of consumption for all types of catastrophic events.	-2	1	1	-1	-1	3	3	-1	0.17
The ability to remotely scan an incident scene for signs of life and decomposition to identify and locate casualties and fatalities.	1	1	-2	2	0	-1	0	-2	0.10
To understand how to prepare future executives to exercise command and control in a multi-disciplinary and multi-jurisdictional collaborative setting.	0	0	1	1	-2	0	1	-1	0.07

Statement	Group 1 (8)	Group 2 (8)	Group 3 (6)	Group 4 (5)	Group 5 (4)	Group 6 (4)	Group 7 (3)	Group 8 (3)	Weighted average ranking
The ability for responders to obtain information about the status of their families, and for their families to obtain information about them, in real time.	1	-1	-2	1	0	1	2	0	0.06
Much better-quality voice and data communication systems.	2	-1	-2	1	0	1	1	-2	0.05
The ability to monitor and evaluate the mental and physical status of responders during an incident in real-time.	2	-2	1	0	0	-1	0	0	0.05
The ability to securely pass intelligence information up, down, and across domestic fusion centers and other organizations that use intelligence.	0	0	-1	0	2	-3	2	2	0.03
A “clearing-house” that connects those who need resources with those who can fulfill those needs in real time during an incident.	-2	1	-1	-1	1	2	0	0	-0.17

Statement	Group 1 (8)	Group 2 (8)	Group 3 (6)	Group 4 (5)	Group 5 (4)	Group 6 (4)	Group 7 (3)	Group 8 (3)	Weighted average ranking
The ability to incorporate information from multiple and non-traditional sources (e.g. crowd sourcing and social media) into the intelligence system.	0	0	-1	1	-3	0	-1	3	-0.19
The ability to evaluate the resiliency of individual responders so we can assure they will perform effectively in the face of acute and chronic stressors.	1	-3	2	0	0	-1	-1	0	-0.27
The ability to communicate information to the families of survivors early, and to reunite survivors and families quickly.	0	-2	0	0	-1	1	1	0	-0.33
A system that helps an incident commander recognize when the characteristics and complexity of an incident are different than they appear to be.	2	0	0	-2	-2	-1	0	-3	-0.35

Statement	Group 1 (8)	Group 2 (8)	Group 3 (6)	Group 4 (5)	Group 5 (4)	Group 6 (4)	Group 7 (3)	Group 8 (3)	Weighted average ranking
Consistent and coordinated guidelines for use of risk assessment methodologies and development of risk assessments.	-2	-1	1	-2	3	0	-1	0	-0.46
An effective way to capture, analyze, retain, and share lessons learned and institutional knowledge.	-1	1	-3	-1	2	0	-2	-1	-0.58
The ability to develop standardized, actionable intelligence products that meet the requirements of the emergency services community.	-1	-1	0	-1	0	-2	0	1	-0.65
The ability to communicate clearly about resources using a common language across disciplines and jurisdictions.	0	-3	0	-2	0	-1	3	1	-0.66
The ability to predict the evolution of an incident, the impacts of decisions, and the results of response actions in real time.	0	0	-1	-2	-2	0	1	-2	-0.66

Statement	Group 1 (8)	Group 2 (8)	Group 3 (6)	Group 4 (5)	Group 5 (4)	Group 6 (4)	Group 7 (3)	Group 8 (3)	Weighted average ranking
A national information sharing system to which all emergency response entities have access that integrates multiple disparate data and intelligence sources.	-1	-2	0	2	-3	-2	-1	3	-0.72
The ability to evaluate the resource needs and performance of the resource management system on past incidents, and share lessons about problems and solutions.	-3	1	-3	0	1	2	-3	0	-0.76
The ability to de-conflict many disparate, complex, and varied plans across jurisdictions and levels of government so they can function effectively.	-1	-1	0	-3	-2	1	-2	2	-0.86
The ability to assess infrastructure interdependencies and the impacts of infrastructure loss to support risk assessments.	-2	0	1	-3	-1	-3	-1	-1	-1.15

Statement	Group 1 (8)	Group 2 (8)	Group 3 (6)	Group 4 (5)	Group 5 (4)	Group 6 (4)	Group 7 (3)	Group 8 (3)	Weighted average ranking
An integrated suite of tools to support risk assessment and risk-based decisions in the planning process.	-1	0	-1	-3	-1	-3	-1	0	-1.18
An integrated suite of tools to facilitate the development of emergency response plans in a standard form.	-3	-2	-1	-1	-1	0	0	2	-1.23
The ability to protect and access sensitive and proprietary data required for risk assessments.	-2	-2	-1	-2	0	-2	0	1	-1.32
A financial system that allows us to share and draw on multiple sources of funds to pay for needed assets in advance of reimbursement.	-3	-3	-3	2	-3	1	2	-3	-1.68

Appendix G: Model Q Sorts

Statement	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
The ability to rapidly determine and disseminate alternate standards of care based on incident conditions.	1	-1	2	0	0	0	-1	0
The ability to communicate information to the families of survivors early, and to reunite survivors and families quickly.	0	-2	0	0	-1	1	1	0
The ability to develop standardized, actionable intelligence products that meet the requirements of the emergency services community.	-1	-1	0	-1	0	-2	0	1
To understand how to prepare future executives to exercise command and control in a multi-disciplinary and multi-jurisdictional collaborative setting.	0	0	1	1	-2	0	1	-1
The ability to monitor the status of resources and their functionality in current conditions, in real time.	0	2	0	0	1	1	2	3
A “clearing-house” that connects those who need resources with those who can fulfill those needs in real time during an incident.	-2	1	-1	-1	1	2	0	0
The ability for responders to obtain information about the status of their families, and for their families to obtain information about them, in real time.	1	-1	-2	1	0	1	2	0
The ability to monitor and evaluate the mental and physical status of responders during an incident in real-time.	2	-2	1	0	0	-1	0	0

Statement	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
The ability to assess infrastructure interdependencies and the impacts of infrastructure loss to support risk assessments.	-2	0	1	-3	-1	-3	-1	-1
The ability to predict the evolution of an incident, the impacts of decisions, and the results of response actions in real time.	0	0	-1	-2	-2	0	1	-2
The ability to identify what resources are available to support a response (including resources not traditionally involved in response), what their capabilities are, and where they are, in real time.	0	2	1	-1	1	3	1	2
An integrated suite of tools to facilitate the development of emergency response plans in a standard form.	-3	-2	-1	-1	-1	0	0	2
An integrated suite of tools to support risk assessment and risk-based decisions in the planning process.	-1	0	-1	-3	-1	-3	-1	0
Readily accessible, high-fidelity simulation tools to support training and exercises in incident management and response.	0	0	3	3	2	0	0	1
The ability to protect and access sensitive and proprietary data required for risk assessments.	-2	-2	-1	-2	0	-2	0	1
The ability to remotely monitor the tactical actions and progress of all responders involved in the incident in real time.	1	3	2	0	0	-1	3	2
The ability to track the location, condition, and status of patients for the entire time they are in the care of the medical response system.	0	0	0	2	2	1	-2	-1

Statement	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
Much better-quality voice and data communication systems.	2	-1	-2	1	0	1	1	-2
A system that helps an incident commander recognize when the characteristics and complexity of an incident are different than they appear to be.	2	0	0	-2	-2	-1	0	-3
The ability to de-conflict many disparate, complex, and varied plans across jurisdictions and levels of government so they can function effectively.	-1	-1	0	-3	-2	1	-2	2
The ability to rapidly determine and disseminate alternate standards of care based on incident conditions.	1	-1	2	0	0	0	-1	0
Consistent and coordinated guidelines for use of risk assessment methodologies and development of risk assessments.	-2	-1	1	-2	3	0	-1	0
The ability to rapidly identify hazardous agents and contaminants.	2	2	-2	1	1	0	0	0
The ability to remotely scan an incident scene for signs of life and decomposition to identify and locate casualties and fatalities.	1	1	-2	2	0	-1	0	-2
The ability to identify trends, patterns, and important content from large volumes of information from multiple sources (including non-traditional sources) to support incident decision-making.	1	2	2	-1	-2	2	-2	1
The ability to securely pass intelligence information up, down, and across domestic fusion centers and other organizations.	0	0	-1	0	2	-3	2	2

Statement	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
The ability to evaluate the resiliency of individual responders so we can assure they will perform effectively in the face of acute and chronic stressors.	1	-3	2	0	0	-1	-1	0
The ability to predict, assess, and anticipate resource needs and rates of consumption for all types of catastrophic events.	-2	1	1	-1	-1	3	3	-1
The ability to identify responders (including volunteers), validate their credentials, and put them to work.	-1	-1	0	3	3	3	1	-2
An effective way to capture, analyze, retain, and share lessons learned and institutional knowledge.	-1	1	-3	-1	2	0	-2	-1
Communications systems that are hands-free, ergonomically-optimized, and can be integrated into personal protective equipment.	3	1	0	0	1	0	-3	1
The ability to communicate with responders in any environmental conditions (including through barriers, inside buildings, and underground).	3	0	2	0	3	2	-2	-1
The ability to detect, monitor, and analyze passive and active threats and hazards at incident scenes in real-time.	2	3	1	3	-1	-1	1	-1
The ability to know the location of responders and their proximity to risks and hazards in real time.	3	3	3	1	2	-2	0	1
The ability to communicate clearly about resources using a common language across disciplines and jurisdictions.	0	-3	0	-2	0	-1	3	1

Statement	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
The ability to evaluate the resource needs and performance of the resource management system on past incidents, and share lessons about problems and solutions.	-3	1	-3	0	1	2	-3	0
Protective clothing and equipment for all first responders that protects against multiple hazards.	1	2	-2	2	1	2	-3	-2
The ability to incorporate information from multiple and non-traditional sources (e.g. crowd sourcing and social media) into the intelligence system.	0	0	-1	1	-3	0	-1	3
A national information sharing system to which all emergency response entities have access that integrates multiple disparate data and intelligence sources.	-1	-2	0	2	-3	-2	-1	3
A financial system that allows us to share and draw on multiple sources of funds to pay for needed assets in advance of reimbursement.	-3	-3	-3	2	-3	1	2	-3
Decision support tools that allow incident commanders to vet courses of action and make evidence-driven operational decisions during an incident.	-1	1	3	1	-1	-2	2	-3

Appendix H: Capability Priority Statement Rankings by Group Sorted by the Degree of Statistical Consensus or Dissent

Group 1
8 of 28 (28.6%) respondents loaded significantly

-3 Most strongly disagree	-2 Strongly disagree	-1 Disagree	0 Neutral	+1 Agree	+2 Strongly agree	+3 Most strongly agree
14	12	2	1	4	5	**27**
19	22	6	3	10	**8**	33
20	23	16	7	11	**17**	40
	26	30	9	15	18	
	32	35	13	21	36	
		37	24	25		
		39	28	31		
			29			
			34			
			38			

Note: Bold numbers indicate priorities that distinguish this group by how they are ranked within the sort framework (statistically significant at $p < .01$).

*Most strongly **agree** that the following capabilities are priorities:*

- Communications systems that are hands-free, ergonomically-optimized, and can be integrated into personal protective equipment.
- The ability to know the location of responders and their proximity to risks and hazards in real time.
- The ability to communicate with responders in any environmental conditions (including through barriers, inside buildings, and underground).

*Most strongly **disagree** that the following capabilities are priorities :*

- An integrated suite of tools to facilitate the development of emergency response plans in a standard form.
- The ability to evaluate the resource needs and performance of the resource management system on past incidents, and share lessons about problems and solutions.
- A financial system that allows us to share and draw on multiple sources of funds to pay for needed assets in advance of reimbursement.

Group 2
8 of 28 (28.6%) respondents loaded significantly

-3 Most strongly disagree	-2 Strongly disagree	-1 Disagree	0 Neutral	+1 Agree	+2 Strongly agree	+3 Most strongly agree
15	14	2	1	6	4	5
20	17	16	3	10	7	25
28	32	18	8	19	11	33
	38	21	9	22	13	
	39	23	12	26	36	
		30	24	27		
		31	29	35		
			34			
			37			
			40			

Note: Bold numbers indicate priorities that distinguish this group from the other groups by how they are ranked within the sort framework (statistically significant at $p < .01$).

*Most strongly **agree** that the following capabilities are priorities:*

- The ability to detect, monitor, and analyze passive and active threats and hazards at incident scenes in real-time.
- The ability to remotely monitor the tactical actions and progress of all responders involved in the incident in real time.
- The ability to know the location of responders and their proximity to risks and hazards in real time.

*Most strongly **disagree** that the following capabilities are priorities:*

- The ability to evaluate the resiliency of individual responders so we can assure they will perform effectively in the face of acute and chronic stressors.
- A financial system that allows us to share and draw on multiple sources of funds to pay for needed assets in advance of reimbursement.
- The ability to communicate clearly about resources using a common language across disciplines and jurisdictions.

Group 3
6 of 28 (21.4%) respondents loaded significantly

-3 Most strongly disagree	-2 Strongly disagree	-1 Disagree	0 Neutral	+1 Agree	+2 Strongly agree	+3 Most strongly agree
6	4	1	2	5	11	3
19	10	9	7	12	15	33
20	18	14	8	13	21	35
	31	22	16	17	25	
	36	32	27	23	40	
		34	28	24		
		37	29	26		
			30			
			38			
			39			

Note: Bold numbers indicate priorities that distinguish this group by how they are ranked within the sort framework (statistically significant at $p < .01$).

*Most strongly **agree** that the following capabilities are priorities:*

- Readily accessible, high-fidelity simulation tools to support training and exercises in incident management and response.
- The ability to know the location of responders and their proximity to risks and hazards in real time.
- Decision support tools that allow incident commanders to vet courses of action and make evidence-driven operational decisions during an incident.

Group 4
5 of 28 (17.9%) respondents loaded significantly

-3 Most strongly disagree	-2 Strongly disagree	-1 Disagree	0 Neutral	+1 Agree	+2 Strongly agree	+3 Most strongly agree
2	8	6	1	18	4	3
12	9	11	7	24	10	5
37	23	13	15	31	20	30
	28	14	17	33	29	
	32	16	19	34	39	
		22	21	35		
		26	25	36		
			27			
			38			
			40			

Note: Bold numbers indicate priorities that distinguish this group by how they are ranked within the sort framework (statistically significant at $p < .01$).

*Most strongly **agree** that the following capabilities are priorities:*

- Readily accessible, high-fidelity simulation tools to support training and exercises in incident management and response.
- The ability to detect, monitor, and analyze passive and active threats and hazards at incident scenes in real time.
- The ability to identify responders (including volunteers), validate their credentials, and put them to work.

*Most strongly **disagree** that the following capabilities are priorities:*

- The ability to de-conflict many disparate, complex, and varied plans across jurisdictions and levels of government so they can function effectively.
- The ability to assess infrastructure interdependencies and the impacts of infrastructure loss to support risk assessments.
- An integrated suite of tools to support risk assessment and risk-based decisions in the planning process.

Group 5
4 of 28 (14.3%) respondents loaded significantly

-3 Most strongly disagree	-2 Strongly disagree	-1 Disagree	0 Neutral	+1 Agree	+2 Strongly agree	+3 Most strongly agree
20	2	5	10	4	1	**23**
34	8	12	15	7	3	30
39	9	14	16	13	6	40
	11	26	17	19	29	
	24	35	18	22	33	
		37	21	27		
		38	25	36		
			28			
			31			
			32			

Note: Bold numbers indicate priorities that distinguish this group by how they are ranked within the sort framework (statistically significant at $p < .01$).

*Most strongly **agree** that the following capabilities are priorities:*

- Consistent and coordinated guidelines for use of risk assessment methodologies and development of risk assessments.
- The ability to identify responders (including volunteers), validate their credentials, and put them to work.
- The ability to communicate with responders in any environmental conditions (including through barriers, inside buildings, and underground).

*Most strongly **disagree** that the following capabilities are priorities:*

- A financial system that allows us to share and draw on multiple sources of funds to pay for needed assets in advance of reimbursement.
- The ability to incorporate information from multiple and non-traditional sources (e.g. crowd sourcing and social media) into the intelligence system.
- A national information sharing system to which all emergency response entities have access that integrates multiple disparate data and intelligence sources.

Group 6
4 of 28 (14.3%) respondents loaded significantly

-3 Most strongly disagree	-2 Strongly disagree	-1 Disagree	0 Neutral	+1 Agree	+2 Strongly agree	+3 Most strongly agree
1	16	5	3	2	4	13
12	32	8	6	7	11	26
37	33	10	9	18	19	30
	35	15	14	20	22	
	39	17	21	29	40	
		25	23	31		
		28	24	38		
			27			
			34			
			36			

Note: Bold numbers indicate priorities that distinguish this group by how they are ranked within the sort framework (statistically significant at $p < .01$).

*Most strongly **agree** that the following capabilities are priorities:*

- The ability to identify what resources are available to support a response (including resources not traditionally involved in response), what their capabilities are, and where they are, in real time.
- The ability to predict, assess, and anticipate resource needs and rates of consumption for all types of catastrophic events.
- The ability to identify responders (including volunteers), validate their credentials, and put them to work.

*Most strongly **disagree** that the following capabilities are priorities:*

- The ability to securely pass intelligence information up, down, and across domestic fusion centers and other organizations that use intelligence.
- The ability to assess infrastructure interdependencies and the impacts of infrastructure loss to support risk assessments.
- An integrated suite of tools to support risk assessment and risk-based decisions in the planning process.

Group 7
3 of 28 (10.7%) respondents loaded significantly

-3 Most strongly disagree	-2 Strongly disagree	-1 Disagree	0 Neutral	+1 Agree	+2 Strongly agree	+3 Most strongly agree
4	2	12	3	5	1	25
19	6	15	8	9	7	26
27	11	21	10	13	20	**28**
	29	23	14	18	31	
	40	34	16	24	35	
		37	17	30		
		39	22	38		
			32			
			33			
			36			

Note: Bold numbers indicate priorities that distinguish this group by how they are ranked within the sort framework (statistically significant at $p < .01$).

*Most strongly **agree** that the following capabilities are priorities:*

- The ability to remotely monitor the tactical actions and progress of all responders involved in the incident in real time.
- The ability to predict, assess, and anticipate resource needs and rates of consumption for all types of catastrophic events.
- The ability to communicate clearly about resources using a common language across disciplines and jurisdictions.

*Most strongly **disagree** that this is an important capability priority:*

- Clothing and equipment for all first responders that protects against multiple hazards.
- The ability to evaluate the resource needs and performance of the resource management system on past incidents, and share lessons about problems and solutions.
- Communications systems that are hands-free, ergonomically-optimized, and can be integrated into personal protective equipment.

Group 8
3 of 28 (10.7%) respondents loaded significantly

-3 Most strongly disagree	-2 Strongly disagree	-1 Disagree	0 Neutral	+1 Agree	+2 Strongly agree	+3 Most strongly agree
8	4	5	15	3	1	7
20	9	6	17	11	2	**34**
35	10	12	19	16	13	39
	18	24	21	27	**14**	
	30	26	22	28	25	
		29	23	32		
		40	31	33		
			36			
			37			
			38			

Note: Bold numbers indicate priorities that distinguish this group by how they are ranked within the sort framework (statistically significant at $p < .01$).

*Most strongly **agree** that the following capabilities are priorities:*

- The ability to monitor the status of resources and their functionality in current conditions, in real time.
- The ability to incorporate information from multiple and non-traditional sources (e.g., crowd-sourcing and social media) into the intelligence system.
- A national information sharing system to which all emergency response entities have access that integrates multiple disparate data and intelligence sources.

*Most strongly **disagree** that the following capabilities are priorities:*

- A system that helps an incident commander recognize when the characteristics and complexity of an incident are different than they appear to be.
- A financial system that allows us to share and draw on multiple sources of funds to pay for needed assets in advance of reimbursement.
- Decision support tools that allow incident commanders to vet courses of action and make evidence-driven operational decisions during an incident.

Appendix I: Participants

The following individuals participated in *Project Responder* 3 focus groups, workshops, interviews, and research:

Sgt. Mike Abdeen: Los Angeles County Sheriff's Department (Los Angeles, CA)

Asst. Chief Hassan Aden: City of Alexandria Police Department (Alexandria, VA)

Mark Anderson: Strategic Planning Sub-Group, Inter-Agency Board; City of Bellevue Fire Department (Bellevue, WA)

Capt. Brett Bailey: City of Tulsa Police Department (Tulsa, OK)

CDR Jason Barrett: U.S. Coast Guard (San Diego Sector)

Commander Geary Brase: City of Phoenix Police Department (Phoenix, AZ)

Special Agent Jeff Cassett: Federal Bureau of Investigation (Washington, DC)

Chief Diane Cavaleri: City of Boston Emergency Medical Services (Boston, MA)

Chief Mark Chubb: City of Woodinville Fire Department (Woodinville, WA)

Director Kelly Deal: Oolaga-Talala Emergency Medical Services (Talala, OK)

Captain John Delaney: Inter-Agency Board; City of Arlington Fire Department (Arlington, VA)

Assistant Chief Jeff Dulin: Inter-Agency Board; City of Charlotte Fire Department (Charlotte, NC)

Col. Terry Ebbert: City of New Orleans Office of Homeland Security and Emergency Management (New Orleans, LA)

Lieutenant Scott Eckels: City of Castle Rock Fire Rescue Department (Castle Rock, CO)

Deputy Chief James Esposito: City of New York Fire Department (New York, NY)

Alicia Etgen: City of Tulsa Public Health Department (Tulsa, OK)

Director of Operations Rob Freeman: City of Los Angeles Office of Emergency Management (Los Angeles, CA)

Cheryl Gauthier: Inter-Agency Board; Massachusetts Department of Public Health (State of Massachusetts)

John Gibb: Inter-Agency Board; New York Office of Emergency Management (State of New York)

Assistant Port Director Beverly Good: Customs and Borders Protection (San Diego Sector)

Lieutenant Randy Griffin: City of Dewitt Fire Department (Dewitt, NY)

Lieutenant Raymond Guidetti: New Jersey State Police Department (State of New Jersey)

Battalion Chief Jay Hagen: Inter-Agency Board; City of Seattle Fire Department (Seattle, WA)

Mike Harryman: Inter-Agency Board; Oregon Department Public Health (State of Oregon)

Regional Director Richard Hinrichs: American Red Cross (San Diego Region)

Operations Chief Cheryl Horvath: Northwest Fire District, AZ (Phoenix, AZ)

Sergeant Martin Hutching: Sacramento County Sheriff's Department (Sacramento, CA)

WMD Branch Chief Robert Ingram: Inter-Agency Board; City of New York Fire Department (New York, NY)

Robert Johns: Inter-Agency Board; Department of Homeland Security Domestic Nuclear Detection Office

Director Scott Krushak: City of Phoenix Department Emergency Management (Phoenix, AZ)

John Koerner: Inter-Agency Board; Department of Homeland Security Office of Infrastructure Protection

Major Clay McGuyer: Inter-Agency Board; National Guard Bureau

Director Carolyn Levering: City of Las Vegas Office of Emergency Management (Las Vegas, NV)

Operations Director Mike Marsh: American Medical Response (San Mateo, CA)

Detective Arturo Mendez: City of New York Police Department (New York, NY)

Ray Mollers: Inter-Agency Board; Department of Homeland Security Office of Infrastructure Protection

Assistant to the General President Lori Moore-Merrill, Ph.D.: International Association of Fire Fighters

Assistant Chief Greg Morrison: City of Breckenridge Police Department (Breckenridge, CO)

Capt. Ruth Nelson: Los Angeles County Sheriff's Department (Los Angeles, CA)

District Chief Dan O'Connell: Inter-Agency Board; City of Chicago Fire Department (Chicago, IL)

Director Jim Page: Illinois Law Enforcement Aid System (Chicago, IL)

Regional Director Jim Puza: Salvation Army (Phoenix Region)

Special Agent Angel Ramos-Rojas: Immigration and Customs Enforcement (San Diego Sector)

Assistant Chief Michael Sanford: Inter-Agency Board; City of Seattle Police Department (Seattle, WA)

Chief James Schwartz: Arlington County Fire Department (Arlington, VA)

Sergeant Thomas Sharkey: Inter-Agency Board; Washington Metropolitan Area Transit Authority Police (Washington, DC)

Dr. Reed Smith, M.D.: Committee for Tactical Emergency Casualty Care (C-TECC); Arlington County Fire Department (Arlington, VA)

Director Victor Stagnaro: National Fallen Firefighters Foundation (Emmitsburg, MD)

Elaine Stewart-Craig: Inter-Agency Board; Department of Defense

Director Lawrence Trevino: City of San Antonio Office of Emergency Management (San Antonio, TX)

Director Pete Weaver: Maricopa County Department of Emergency Management (Phoenix, AZ)

Operations Coordinator Scott Wollek: American Red Cross (National Capital Region)

Agent John Woo: California Bureau of Narcotics Enforcement

Appendix J: Slides to Accompany Final Report

UNCLASSIFIED

HOMELAND SECURITY STUDIES & ANALYSIS INSTITUTE

An FFRDC operated by Analytic Services Inc. on behalf of DHS

Project Responder 3: Toward the First Responder of the Future

Slides to Accompany Final Report

16 December 2011

Homeland Security Science and Technology

FEMA

UNCLASSIFIED

Sponsorship

Project Responder 3: Toward the First Responder of the Future

- Prepared for:
  - DHS Science and Technology Directorate, Support to the Homeland Security Enterprise and First Responders Group
  - Federal Emergency Management Agency National Preparedness Directorate
- Supported by:
  - InterAgency Board (IAB) Strategic Planning SubGroup

2

Final Report Overview

I. **Introduction**
- Motivation
- Methodology

II. **Findings**
- Tier 1 Priorities
- Tier 2 Priorities
- Cross-cutting Themes
- "First Responder of the Future"

III. **Conclusion**

IV. **Appendices**

3

Introduction

Project Responder Overview:
- Initially funded in 2001.
- A systematic effort aimed at identifying gaps between current emergency response capabilities and those capabilities required to respond to a catastrophic incident.
- Emergency responders from a broad spectrum of both traditional response agencies and non-traditional partners have participated in three phases of *Project Responder* over the last decade.

4

Introduction

Project Responder 3:

- Goal: identify the highest priority capabilities for ensuring that responders can effectively and safely address catastrophic incidents, now and in the future.
- Objectives:
  1. Identify and prioritize current needs in the context of the evolving response environment;
  2. Discuss a framework for determining lanes of responsibility between S&T, FEMA, and state/local response agencies for capability investment; and
  3. Examine long-term capability needs and goals as an initial vision of a "first responder of the future."

5

Motivation

- Study was motivated by changes in the response environment that suggested a need to re-evaluate capability gaps and investment priorities.
- *Project Responder 3* assessed the response environment on two levels:
  - Changes since 2008 (the year of the previous *Project Responder* report)
  - Possible shifts in the future response environment
- Analyzed five *change drivers* that affect the response environment: economy, technology, major incidents or events, infrastructure, and society.

6

Project Responder 3 Methodology

Methodology consisted of data gathering and analysis based on in-depth research and structured discussions with the response community, including:

1. A literature review focused on existing responder needs and future planning efforts;
2. Solicitation of feedback from responders regarding current and future changes to the response environment during a series of focus groups;
3. Facilitated discussions of capability needs and gaps during a responder workshop;
4. A prioritization exercise to identify those capabilities of the greatest importance to responder participants; and
5. Additional research and outreach conducted by Institute staff to validate and expound upon participant input.

7

Focus Groups

- Initial focus group held May 5, 2011 in Phoenix, AZ.
  - Focus Group had the following objectives:
    - Identify how the response environment has changed since 2008 (focusing upon changes in technology, the economy, incidents and events, infrastructure, and society)
    - Discuss priorities for intervention and investment to address capability gaps
- Second focus group was held in conjunction with an IAB meeting in Seattle, WA, on June 8, 2011.
  - Strategic Planning SubGroup of the IAB discussed:
    - Characteristics of the future response environment
    - Potential innovations that could produce significant improvements in the long-term

8

Workshop

- Held from 9-11 August 2011 in San Diego, CA.
- Purpose:
  - Identify what responders believe are critical gaps in their ability to respond to catastrophic incidents.
  - Prioritize specific capabilities required to close these gaps.
  - Gather input on capabilities needed by future first responders.
- Participants represented response disciplines included Fire/Rescue, Law Enforcement, EMS, Emergency Management, NGO, Public Health, and Hospitals, as well as federal agencies including FBI, ICE, CBP, and USCG.

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Methodology (cont)

- Organized workshop discussions around a framework of capability “domains”.
- Framework was derived from the FEMA Core Capabilities List, previous *Project Responder* reports, Presidential Policy Directive–8, and other relevant documents.
- Provided an organizational construct to allow structured discussion around capabilities instead of disciplines or jurisdictions.
  - Composed of nine capability domains.

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Methodology - Capability Domains

- Situational Awareness
- Communications
- Command, Control, and Coordination (C3)
- Responder Health, Safety, and Performance
- Logistics and Resource Management
- Survivor Management
- Risk Assessment and Planning
- Training and Exercise
- Intelligence and Investigation

11

Methodology (cont)

- The facilitated discussion process used during the workshop resulted in the identification of a large number of needs within each domain. Participants were asked to identify the most critical needs at the conclusion of each domain discussion.
- Analysis of participants' input identified 40 capabilities that are necessary to fill existing gaps; these can be considered priorities for investment.

12

Methodology: Q Prioritization

- Used to prioritize the capability needs arising from the facilitated discussions.
- Enables a group of participants to rank order a large number of opinion statements relative to each other.
- Process:
  - A set of capability statements was derived from the participants during workshop discussions
  - Participants ranked all capability statements from +3 (most strongly agree that this need is a priority) to -3 (most strongly disagree that this need is a priority)
  - Factor analysis was then used to identify patterns of viewpoints across individuals and high priority capability needs
- Prioritization results do not produce a rank order

13

Findings

- Findings section addresses:
  - Capability gaps and investment priorities as identified through the prioritization process.
  - Cross-cutting themes.
  - Notional capabilities for a “first responder of the future.”
- Results from analysis of the Q prioritization process can be divided into two tiers:
  - Tier 1 priorities are a sub-set of 12 capabilities identified as the highest priorities, meaning that there was the greatest level of consensus among participants regarding the importance of these capabilities.
  - Tier 2 priorities are still important, but did not obtain the same level of consensus during the prioritization process.

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Tier 1 Priorities

- The top 12 priorities can be grouped into three levels:
  - Tier 1A priorities represents those capability gaps of the *highest* importance.
    - These needs garnered the most +3 rankings, the highest raw scores, and the highest factors scores.
    - The very first priority listed, related to simulation tools, was statistically significant as the highest priority most often identified by participants.
  - Just below this top tier of capability priorities, four more needs were identified as very high priority gaps (Tier 1B).
  - Next, a set of four additional capabilities (Tier 1C) were seen as among the most important of the forty gaps (although ranking below the preceding eight capabilities).

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Capability Priorities– Tier 1A*

- Readily accessible, high-fidelity simulation tools to support training in incident management and response.
- The ability to know the location of responders and their proximity to risks and hazards in real time.
- The ability to communicate with responders in any environmental conditions (including through barriers, inside buildings, and underground).
- The ability to remotely monitor the tactical actions and progress of all responders involved in the incident in real time.

* Note: List is not in rank order

16

Capability Priorities– Tier 1B*

- Protective clothing and equipment for all first responders that protects against multiple hazards.
- The ability to detect, monitor, and analyze passive and active threats and hazards at incident scenes in real-time.
- The ability to identify what resources are available to support a response (including resources not traditionally involved in response), what their capabilities are, and where they are, in real time.
- Communications systems that are hands-free, ergonomically-optimized, and can be integrated into personal protective equipment.

* Note: List is not in rank order

17

Capability Priorities– Tier 1C*

- The ability to monitor the status of resources and their functionality in current conditions, in real time.
- The ability to rapidly identify hazardous agents and contaminants.
- The ability to identify trends, patterns, and important content from large volumes of information from multiple sources (including non-traditional sources) to support incident decision-making.
- The ability to remotely scan an incident scene for signs of life and decomposition to identify and locate casualties and fatalities.

* Note: List is not in rank order

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Capability Priorities – Tier 1A

Capability Priority: Readily accessible, high-fidelity simulation tools to support training in incident management and response.

- Responders attributed this need to the burdens imposed by training and exercise requirements.
- Virtual training provides opportunities to significantly reduce training costs while increasing responder proficiency.
- High-fidelity virtual simulation tools would allow responders from multiple agencies, disciplines, and jurisdictions to train for coordinated incident response.
- Technology for these tools currently exists in various forms but needs to incorporate realistic emergency response policies, missions, and equipment.

19

Capability Priorities – Tier 1A

Capability Priority: The ability to know the location of responders and their proximity to risks and hazards in real time.

- Responders attributed this need to a lack of situational awareness regarding the location and types of hazards present on-scene.
- Pre-incident planning cannot always account for hazards caused or changed by the incident.
- Tracking the location of responders across a wide-area and knowing their proximity to hazards or threats can decrease mortality and morbidity.
- Remote monitoring of responder location combined with simultaneous awareness of incident hazards could enable proactive protective measures or revised tactics.

20

Capability Priorities – Tier 1A

Capability Priority: The ability to communicate with responders in any environmental conditions (including through barriers, inside buildings, and underground).

- Responders attributed this need to the gap in communications when operational environments prevent responders from sending or receiving orders, providing tactical updates, requesting help, or receiving warnings about hazardous or changing conditions.
- Catastrophic incidents often require communicating urgent information in difficult and changing conditions, often with lives at risk.
- Further improvements in communications capability will require technological advances in range, penetration, and clarity to enable effective voice communications in all incident conditions.

21

Capability Priorities – Tier 1A

Capability Priority: The ability to remotely monitor the tactical actions and progress of all responders involved in the incident in real time.

- Responders attributed this gap to unreliable or insufficient technology to monitor tactical actions and progress during an incident.
- During a catastrophic incident, the large number of operating responders may overwhelm the capability of incident commanders to effectively monitor tactical actions and identify progress.
- Remotely monitoring actions and progress would provide real-time information and increased reliability that improves decision making and allows the recognition of emerging incident requirements.

22

Capability Priorities – Tier 1B

Capability Priority: Protective clothing and equipment for all first responders that protects against multiple hazards.

- Responders attributed this gap to the need to protect against all hazards in an unpredictable response environment.
- The scope of a catastrophic incident may require responders to operate in unfamiliar environments where they are less able to anticipate, and therefore less able to mitigate, multiple and concurrent hazards.
- PPE manufacturers currently produce ensembles with multi-hazard protection capabilities, however, these products are not widely used by response agencies, in part because their significant cost outweighs their perceived benefit.

23

Capability Priorities – Tier 1B

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

- Responders attributed this gap to the need to recognize threats and hazards that rapidly change in size, risk, and location as an incident progresses.
- Many types of incidents may lead to unexpected hazards that present unforeseen risks to responder safety.
- The capability to continuously detect, monitor, and analyze threats and hazards in real time can enable timely mitigation and protect responders from unwarranted risk.

24

Capability Priorities – Tier 1B

Capability Priority: The ability to identify what resources are available to support a response (including resources not traditionally involved in response), what their capabilities are, and where they are, in real time.

- Responders attributed this need to the importance of allocating critical resources to the areas of greatest need in a timely manner.
- As the scale of an incident escalates, and more jurisdictions and agencies become involved, it is increasingly difficult to identify and manage all resources.
- Advancements in this area require automating capabilities to track inventory levels, available suppliers, qualified response personnel, and transport and distribution information in real time.

25

Capability Priorities – Tier 1B

Capability Priority: We need communications systems that are hands-free, ergonomically-optimized, and can be integrated into personal protective equipment.

- Responders attributed this gap to the need for effective communications without limiting operational effectiveness or reducing the safety of the individual responder.
- Current communications systems are primarily reliant upon radios which require a push-button to transmit messages and use an attached speaker to broadcast received communications.
- While these systems may operate capably, their use may be difficult during certain tactical activities.
- Communications systems that can be utilized effectively while operating at an incident can contribute to both incident success and viable communications among responders and between responders and incident command.

26

Capability Priorities – Tier 1C

Capability Priority: The ability to monitor the status of resources and their functionality in current conditions, in real time.

- Responders attributed this capability gap to the need for an integrated picture of the status of all resources *at the incident scene* regardless of jurisdiction or discipline.
- The ability to monitor the location and use of equipment and supplies would enable more effective allocation and encourage the productive use of scarce resources.
- Responders stated the need for an automated system that tracks when supplies and equipment have been checked in or out at the incident scene and by whom, as well as monitors the status and location of those supplies.

27

Capability Priorities – Tier 1C

Capability Priority: The ability to identify trends, patterns, and important content from large volumes of information from multiple sources (including non-traditional sources) to support incident decision-making.

- Responders attributed this need to the challenge of making informed decisions based upon increasingly unmanageable amounts of incident data.
- Increased use of technology to gather and aggregate incident information has increased the data available to inform incident decision making.
- In a large-scale incident the amount of incoming information can easily overwhelm the ability to assess, validate and operationalize incident data.
- This capability is further complicated by the growth of non-traditional information sources, such as social networking and incident-state input from the general public via mobile devices.

28

Capability Priorities – Tier 1C

Capability Priority: The ability to rapidly identify hazardous agents and contaminants.

- Responders attributed this gap to the inability to quickly and accurately assess incident hazards, in order to utilize appropriate protective measures.
- The rapid identification of hazards with a high degree of precision can make a significant difference in survival rates for emergency responders and victims.
- Being able to identify threats from one device instead of multiple personal and fixed sensors, with a significant increase in fidelity, would improve responder and public health and safety and facilitate more efficient response.

29

Capability Priorities – Tier 1C

Capability Priority: The ability to remotely scan an incident scene for signs of life and decomposition to identify and locate casualties and fatalities.

- Responders attributed this need to the insufficient capability to rapidly locate casualties and fatalities across a wide geographic area.
- Catastrophic incidents can result in hundreds, thousands, or tens of thousands of casualties, and quickly identifying and locating casualties is extremely difficult.
- Responders articulated requirements designed to precisely locate incident victims (living and deceased) in three dimensions within the incident scene.

30

Tier 2 Priorities

- Discussions during the *Project Responder* workshop also yielded 28 additional priority needs.
- Additional capabilities are presented in the context of their particular capability domain, reflecting the way discussions were framed during the workshop.
- These are still considered priorities for investment.

31

Capability Domain: Situational Awareness

Capability Domain Definition: 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 a catastrophic incident response.

Situational Awareness Capability Priorities:

- A national information sharing system to which all emergency response entities have access that integrates multiple disparate data and intelligence sources.

32

Capability Domain: Communications

Capability Domain Definition: The capability to seamlessly and dynamically connect multiple persons/entities and convey meaningful and actionable information to all relevant parties.

Communications Capability Priorities:

- Better-quality voice and data communication systems.

33

Capability Domain: Command, Control and Coordination (C3)

Capability Domain Definition: The ability to identify incident priorities, allocate scarce resources, and exchange relevant information to make effective decisions in a stressful environments.

Command, Control, & Coordination Capability Priorities

- The ability to understand how to prepare future executives to exercise command and control in a multi-disciplinary and multi-jurisdictional collaborative setting.
- Systems that helps an incident commander recognize when the characteristics and complexity of an incident are different than they appear to be.
- The ability to predict the evolution of an incident, the impacts of decisions, and the results of response actions in real time.
- The ability to identify responders (including volunteers), validate their credentials, and put them to work.
- Decision support tools that allow incident commanders to vet courses of action and make evidence-driven operational decisions during an incident.

34

Capability Domain: Responder Health, Safety and Performance

Capability Domain Definition: The ability to identify hazards to public safety personnel and develop appropriate mitigations to reduce morbidity and mortality associated with response activities.

Responder Health, Safety, & Performance Capability Priorities:

- The ability for responders to obtain information about the status of their families, and for their families to obtain information about them, in real time.
- The ability to evaluate the resiliency of individual responders so we can assure they will perform effectively in the face of acute and chronic stressors.
- The ability to monitor and evaluate the mental and physical status of responders during an incident in real-time.

35

Capability Domain: Logistics and Resource Management

Capability Domain Definition: The capability to identify, acquire, track and distribute available equipment, supplies and personnel in support of catastrophic incident response.

Logistics & Resource Management Capability Priorities

- A “clearing-house” that connects those who need resources with those who can fulfill those needs in real time during an incident.
- The ability to evaluate the resource needs and performance of the resource management system on past incidents, and share lessons about problems and solutions.
- A financial system that allows us to share and draw on multiple sources of funds to pay for needed assets in advance of reimbursement.
- The ability to predict, assess, and anticipate resource needs and rates of consumption for all types of catastrophic events.
- The ability to communicate clearly about resources using a common language across disciplines and jurisdictions.

36

Capability Domain: Survivor Management

Capability Domain Definition: The capability to provide rapid and effective search and rescue, medical response, prophylaxis, and decontamination for large numbers of incident casualties and identify appropriate sheltering and transportation options.

Survivor Management Capability Priorities:

- The ability to rapidly determine and disseminate alternate standards of care based on incident conditions.
- The ability to communicate information to the families of survivors early, and to reunite survivors and families quickly.
- The ability to track the location, condition, and status of patients for the entire time they are in the care of the medical response system.

37

Capability Domain: Risk Assessment and Planning

Capability Domain Definition: The capability to identify and manage likely vulnerabilities and threats and develop appropriate responses to potential catastrophic incidents based on those threats.

Risk Assessment & Planning Capability Priorities:

- The ability to de-conflict many disparate, complex, and varied plans across jurisdictions and levels of government so they can function effectively.
- The ability to protect and access sensitive and proprietary data required for risk assessments.
- An integrated suite of tools to support risk assessment and risk-based decisions in the planning process.
- The ability to assess infrastructure interdependencies and the impacts of infrastructure loss to support risk assessments.
- Consistent and coordinated guidelines for use of risk assessment methodologies and development of risk assessments.
- An integrated suite of tools to facilitate the development of emergency response plans in a standard form.

38

Capability Domain: Training and Exercise

Capability Domain Definition: The ability to provide instruction on necessary skills for catastrophic incident response and coordinate and practice implementation of plans and potential response prior to an incident.

Training & Exercise Capability Priorities:

- An effective way to capture, analyze, retain, and share lessons learned and institutional knowledge.

39

Capability Domain: Intelligence and Investigation

Capability Domain Definition: The ability to collect information, and integrate and assess that information to develop conclusions or courses of action prior to a criminal incident or to identify the cause or responsible persons following an event.

Intelligence & Investigation Capability Priorities:

- The ability to securely pass intelligence information up, down, and across domestic fusion centers and other organizations that use intelligence.
- The ability to develop standardized, actionable intelligence products that meet the requirements of the emergency services community.
- The ability to incorporate information from multiple and non-traditional sources (e.g. crowd sourcing and social media) into the intelligence system.

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Cross-Cutting Themes

Several cross-cutting themes repeatedly emerged that reflect commonalities between many of the capability gaps or multiply their significance:

1. The overall decline in baseline resources due to the economic downturn despite substantive and successful federal grant programs designed to improve state and local response capability.
2. The unrealistic expectation among federal policy makers, jurisdictional leadership, and the general public that responders possess futuristic tools, skills, and resources.
3. The need for non-materiel solutions is as important as the requirement for new technology and innovation.

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Priorities Across Project Responder

- Another way to assess the findings from Project Responder 3 is to compare them with the results of past phases of the project.
- Despite significant changes in mission focus, federal guidance, and operational needs over the past decade, it is interesting to note that a number of capabilities have been consistently rated as high priorities by participants.
  - Responder apparel that protects from all hazards
  - Three-dimensional location of response personnel on the incident scene
  - Interoperable communications and data integration
  - Resource management
  - Threat and incident data analysis

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First Responder of the Future

- Project Responder 3 included an effort, initiated by DHS at the request of the IAB, to envision a “first responder of the future”.
- Purpose: to identify potential capabilities that may be required in a future response environment, unconstrained by present-day resource or technical considerations.
- Participants gathered in discipline-specific groups to conduct a visioning exercise for potentially transformational innovations that could fundamentally change how they respond.

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First Responder of the Future Law Enforcement

- Participants noted that the Law Enforcement officer of the future may:
  - Operate in a much more technology-driven environment, involving numerous data systems and information management tools.
  - Focus more on crimes involving technology (e.g. identity theft, internet fraud).
  - Have real time situational awareness of the environment and people they interact with, which would enhance officer safety and performance.
  - Experience shifts in police doctrine toward a posture of prevention and pre-deployment as a key game changer for the law enforcement *system of the future.*

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First Responder of the Future Paramedic

- Participants noted that the Paramedic of the future may:
  - Be increasingly linked to technology that facilitates diagnosis and patient care.
  - Play a wider role in emerging public health issues, such as bio-events like the recent H1N1 influenza pandemic.
  - Use technology as part of administering care, by gathering information for remote evaluation, conducting telemedicine, and even using automated algorithm-driven treatment.
  - Have access to tools such as multifunctional diagnostic instruments (similar to the "tricorder" from *Star Trek),* advanced patient assessment tools (e.g., handheld ultrasound), and field-accessible patient healthcare records.

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First Responder of the Future Firefighter

- Participants noted that the Firefighter of the future may:
  - Face increases in demand load and shifts in types of calls for service.
  - Have access to lighter, more fully integrated all hazards personal protective ensemble, with integrated sensors, heads-up displays, and access to information and communications
  - Receive support from an integrated command network that provides real-time information regarding the buildings and hazards to which the firefighters are responding.
  - Receive support from robots to conduct hazardous operations like initial environmental sampling during hazmat incidents, perform primary searches during structural fires (possibly using infrared technology to look for victims)
  - Modify the incident environment in order to improve responder effectiveness and safety.

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First Responder of the Future Emergency Manager

- Participants noted that the Emergency Manager of the future may:
  - Be required to support and coordinate a wide array of response disciplines, working with numerous, diverse aspects of the community to prepare, mitigate, respond, and recover from incidents.
  - Automatically vet and manage requests for help coming into the EOC.
  - Link information from numerous EOCs with public and private sector resources, and to push that information to the right people in the right time.
  - Track robust resources of all types and project incident progression to maximize response interventions.

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First Responder of the Future Cross-Cutting Needs

- Participants noted several cross-cutting trends or needs that may impact the First Responder of the Future:
  - Information overload if growth in feeds and flows is not managed by commensurate decision support.
  - Increasing reliance on technology could jeopardize capabilities due to inherent vulnerabilities in computerized and internet-based systems.
  - Language skills and cultural competence will be needed to better inform and interact with diverse populations or non-English speakers, regardless of discipline.
  - Responders on the front lines will be more innately socialized to technology.
  - PPE will require some universal applications across disciplines.
  - Responders will need PPE that imposes a lower burden and less stress on the individual and less cost to their organization.
  - Doctrine and governance for interdisciplinary response across jurisdictions and boundaries must evolve.

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Conclusion

- *Project Responder* 3 identified capability priorities of the greatest importance to the future effectiveness and safety of the Nation's emergency responders.
- The findings discussed in this report represent the consensus of some of the nation's most respected and experienced responders, as developed through the use of facilitated discussion and statistical prioritization.
- The changing response environment requires that responders continually reevaluate their capabilities to meet new threats and hazards. The future environment may lead to entirely novel capability gaps, ones which we cannot conceptualize in the present day.
- This report outlines the tangible and intangible capabilities of the highest priority required to minimize the effects of a catastrophic incident while reducing its risk to the individual responder.
- This vision can help guide R&D investment by the federal government, state, local, territorial, and tribal authorities, and the private sector in taking the next steps toward the first responder of the future.

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Key Capability Needs

- This report presents 40 high-priority capability gaps identified by participating responders, with four priorities identified as the most significant by the discussions and prioritization process.
  - Readily accessible, high-fidelity simulation tools to support training in incident management and response.
  - The ability to know the location of responders and their proximity to risks and hazards in real time.
  - The ability to communicate with responders in any environmental conditions (including through barriers, inside buildings, and underground).
  - The ability to remotely monitor the tactical actions and progress of all responders involved in the incident in real time.

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Relevance of Findings

- The findings in this report illustrate priorities identified by front-line emergency responders – the men and women who will be responsible for developing and implementing an effective response to future catastrophic incidents.
- The findings confirm the results from previous phases of Project Responder, as well as outside research efforts.
- The capability priorities identified in this report cannot be addressed solely by technological development.
- Each involves the development and integration of a complex system of operational processes, technology (including, in many cases, both hardware and software), changes in ingrained culture and norms, and overarching policies, governance structures and incentives that affect whether and how these gaps are resolved.

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Path Forward

- The identification of the priorities described in this report is only the first step in providing emergency responders with the capabilities needed to respond effectively to a catastrophic incident.
- Logical next steps:
  - A systematic assessment of existing and emerging enablers (technological or others) against identified gaps to determine the state-of-the-art across different domains.
  - Evaluation of identified response priorities against the results of the technology assessment to identify priorities for R&D investment.
  - A full requirements analysis process to articulate detailed technical specifications.
  - Development of a comprehensive RDT&E plan for capability investments, identifying possible trade-offs and constraints.

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Publication Number: RP10-68-04

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