Public Response to Alerts and Warnings on Mobile Devices: Summary of a Workshop on Current Knowledge and Research Gaps

ISBN
978-0-309-18513-4

102 pages
6 x 9
PAPERBACK (2011)

Committee on Public Response to Alerts and Warnings on Mobile Devices: Current Knowledge and Research Gaps; National Research Council

PUBLIC RESPONSE TO ALERTS AND WARNINGS ON MOBILE DEVICES

SUMMARY OF A WORKSHOP ON CURRENT KNOWLEDGE AND RESEARCH GAPS

Committee on Public Response to Alerts and Warnings on Mobile Devices:
Current Knowledge and Research Gaps

Computer Science and Telecommunications Board

Division on Engineering and Physical Sciences

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

THE NATIONAL ACADEMIES PRESS
Washington, D.C.
www.nap.edu

THE NATIONAL ACADEMIES PRESS 500 Fifth Street, N.W. Washington, DC 20001

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Support for this project was provided by the Department of Homeland Security with assistance from the National Science Foundation under award number IIS-095654. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the organizations that provided support for the project.

International Standard Book Number-13: 978-0-309-18513-4
International Standard Book Number-10: 0-309-18513-0

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This report is available from:

Computer Science and Telecommunications Board
National Research Council
500 Fifth Street, N.W.
Washington, DC 20001

Additional copies of this report are available from:

The National Academies Press
500 Fifth Street, N.W., Lockbox 285
Washington, DC 20055
(800) 624-6242
(202) 334-3313 (in the Washington metropolitan area)
Internet: http://www.nap.edu

Printed in the United States of America

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Preface

This report presents a summary of the Workshop on Public Response to Alerts and Warnings on Mobile Devices: Current Knowledge and Research Gaps, held April 13 and 14, 2010, in Washington, D.C., under the auspices of the National Research Council's (NRC's) Committee on Public Response to Alerts and Warnings on Mobile Devices: Current Knowledge and Research Gaps. The complete statement of task for the committee is provided in Box P.1.

The workshop was structured to gather inputs and insights from social science researchers, technologists, emergency management professionals, and other experts knowledgeable about how the public responds to alerts and warnings, focusing specifically on how the public responds to mobile alerting.

Although this document was prepared by the above-named committee on the basis of the workshop presentations and discussions, it does not, in keeping with NRC guidelines for developing report summaries, necessarily reflect a consensus view of the committee. Additionally, these summaries should not be taken as remarks made solely by the scheduled session speakers, because the discussions included remarks offered by others in attendance, and the summaries of the workshop sessions provided in the chapters of this report are a digest both of the presentations and of the subsequent discussion. In keeping with the workshop's purpose of exploring an emerging topic, this summary does not contain findings or recommendations.

BOX P.1
Statement of Task

The Department of Homeland Security's (DHS's) Commercial Mobile Alert Service (CMAS) program is intended to provide alerts and warnings to over 80% of the American population on mobile devices (cell phones and pagers). An ad hoc committee will plan and conduct a public workshop to examine current knowledge and research on how the public responds to alerts and warnings with a specific focus on mobile alerting, examine related work on mobile and text messaging, and identify research gaps relevant to the CMAS program. The workshop will feature invited presentations and discussion. An unedited transcript of the event will be provided to DHS and placed in the project's public access file. A workshop report will be issued.

This workshop report reveals (1) the extensive body of knowledge regarding alerts and warnings and the public response and action before, during, and after emergency situations; and (2) the many questions that arise when considering how to apply this knowledge to the Commercial Mobile Alert Service (CMAS), which is currently under development—and more generally to the use of mobile and other new information and communications technologies for alerts and warnings.

Chapter 1, which covers the first two sessions of the workshop, provides a brief overview of the CMAS program and its objectives, as well as background information on the alerting process and public response. Chapters 2 through 5 provide integrated summaries of the session presentations and the discussion that followed, organized by topic. Chapter 6 summarizes the research questions identified during the breakout sessions and subsequent plenary discussion. Appendix A presents the workshop agenda, and speaker biosketches are provided in Appendix B. Appendix C provides the biosketches of the committee and staff.

Ellis Stanley and Jeannette N.R. Sutton,
Co-Chairs
Committee on Public Response to
Alerts and Warnings on Mobile Devices:
Current Knowledge and Research Gaps

Acknowledgment of Reviewers

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

Robert Kraut, Carnegie Mellon University,
Leslie Luke, San Diego County Office of Emergency Management,
Dennis Mileti, University of Colorado, Boulder,
Helena Mitchell, Georgia Institute of Technology,
George Percivall, Open Geospatial Consortium, Inc.,
Ramesh Rao, University of California, San Diego, and
Michelle Wood, California State University, Fullerton.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the contents, nor did they see the final draft of the report before its release. The review of this report was overseen by David Mendonça, Rensselaer Polytechnic Institute. Appointed by the National Research Council, he was

responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

Contents

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Overview and Context: The Commercial Mobile Alert Service, the Warning Process, and Public Response

This report presents a summary of the Workshop on Public Response to Alerts and Warnings on Mobile Devices: Current Knowledge and Research Gaps, held in April 2010 in Washington, D.C., under the auspices of the National Research Council's (NRC's) Committee on Public Response to Alerts and Warnings on Mobile Devices: Current Knowledge and Research Gaps. The workshop explored what is known about how the public responds to alerts (an *alert* indicates that something significant has happened or may happen) and warnings (a *warning* typically follows an alert and provides more detailed information indicating what protective action should be taken) and the implications of what is known about such public responses with regard to the U.S. Department of Homeland Security's (DHS's) Commercial Mobile Alert Service (CMAS).[1] CMAS is currently being developed to provide a national capability to deliver brief text alerts to cellular telephone subscribers.

After the welcome and opening comments, the first session of the workshop introduced CMAS, and the second session provided an overview of what is known about how people respond to alerts and warnings.

In the first session, Denis Gusty, DHS, discussed the origins and current status of CMAS and the program's requirements. In the second session, Peter White, AT&T, discussed the use of text messages for alerting and the technical and operational considerations that factored into

[1] The Commercial Mobile Alert Service is sometimes defined as the Commercial Mobile Alert System.

planning for CMAS. Michael Lindell, Texas A&M University, provided an overview of what is known from past research about the process of sending alerts and warnings and how people respond to them, and Joseph Trainor, University of Delaware, went on to debunk key misconceptions about the public response to alerts and warnings and about other behavior during a disaster. Garry Briese, Briese and Associates, moderated the second session and commented on the use of CMAS to deliver alerts. This chapter provides an integrated summary of these presentations and the discussions that followed, organized by topic.

COMMERCIAL MOBILE ALERT SERVICE (CMAS)

Why CMAS?

Regarding the wide use of cellular telephones and other mobile wireless devices in the United States, CTIA—The Wireless Association® reported more than 290 million U.S. subscribers by mid-2010, a greater than 90 percent penetration rate.[2] Cellular networks thus provide an attractive opportunity for delivering alerts and warnings, complementing the mechanisms used today—broadcast radio and television, cable television, National Oceanic and Atmospheric Administration (NOAA) weather radio, reverse-911 (which allows jurisdictions to dial a list of telephone numbers and play recorded messages), and sirens. Cell phones are generally kept close at hand in a variety of settings; their users can be reached on the street, in automobiles, and at home or at work, and audio alerts can even awaken people when they are sleeping. Also, the ability to target messages to a cell phone's actual location makes it possible to target more precisely those individuals who would be most at risk in a crisis situation. Cell phones thus seem well positioned to fill gaps in message-receipt coverage by traditional systems—as well as additional gaps that may open up as the reach of traditional broadcast media diminishes.

Establishment of CMAS

The Warning, Alert, and Response Network (WARN) Act of 2006,[3] which establishes a national all-hazards alert system and calls for the use of multiple technologies, including wireless telecommunications, was

[2] Statistics from CTIA Semi-Annual Wireless Industry Survey, available at http://www.ctia.org/advocacy/research/index.cfm/AID/10316; and CTIA Wireless Quickfacts, available at http://www.ctia.org/advocacy/research/index.cfm/aid/10323. Note that a penetration rate calculated, as here, by dividing subscribers by the U.S. population is likely to be an overestimate, because some individuals may have multiple subscriptions.

[3] Public Law 109-347.

motivated in part by a desire to leverage new technologies to increase the reach of alerts and warnings.[4] As required under the WARN Act, the Commercial Mobile Service Alert Advisory Committee (CMSAAC) was established in late 2006 by the Federal Communications Commission (FCC) to engage stakeholders in the development of initial policy and procedures for one component of that national system—the use of cellular telephones for alerts. CMSAAC, composed of representatives from service providers, handset vendors, emergency personnel, and industry groups, issued its first report in 2007, defining CMAS's basic system architecture and establishing technical standards and operating procedures.[5]

Following the issuance of the CMSAAC report, the CMAS program was established within the Department of Homeland Security. The task of validating the CMSAAC recommendations was assigned to DHS's Science and Technology Directorate, along with an examination of related issues such as the state of knowledge about the likely public response to alerts and warnings on mobile devices. The workshop summarized in this report was convened as one element of DHS's examination of public response (see the statement of task for this study in Box P.1 in the Preface of this report).

Overview of CMAS

Three types of alerts were defined by the WARN Act of 2006 for issuance by CMAS:

1. *Presidential alerts,* to be issued by the president when there is a national emergency or threat (note that a presidential alert, for which the Emergency Alert System [EAS] and its predecessors for communicating with the public in a national emergency were originally implemented, has never been issued);
2. *Imminent threat alerts,* to be issued when there is an immediate threat to people or property, such as a tornado; and

[4] The use of multiple new technologies for alerts and warnings was initiated under Executive Order 13407: "Public Alert and Warning System," issued June 26, 2006. This executive order established the Integrated Public Alert and Warning System (IPAWS), which will serve as a modernization and integration of the nation's alert and warning infrastructure, of which CMAS will be one component.

[5] The recommendations of the CMSAAC appear in its draft report: Commercial Mobile Service Alert Advisory Committee, Federal Communications Commission (FCC), *Commercial Mobile Alert Service Architecture and Requirements,* PMG-0035, FCC, Washington, D.C., 2007; and in FCC, "Notice of Proposed Rule Making on the Matter of Commercial Mobile Alert System," Public Safety Docket No. 07-287, 2008.

3. Child abduction emergency alerts (also known as AMBER Alerts), to be issued in the case of a child who has been abducted or who has run away.

Alert system subscriptions can either be opt-in (one must register to receive messages) or opt-out (one must take action to not be registered automatically). CMAS will be an opt-out system; cellular customers would receive imminent threat alerts and AMBER Alerts unless they opted out. It will not be possible to opt out of receiving presidential alerts. Carrier participation is voluntary; to date the major cellular carriers have signed on to the program.

The deployment of CMAS requires new cellular telephone software, which in most cases means the purchase of new handsets, although some phones may be field-upgradable. Once the service is deployed, carriers will be required to notify subscribers if their handsets are CMAS-compatible and to place labels on new handsets indicating whether they support CMAS or not.

CMAS-compatible handsets will use a special alert tone for CMAS messages—to draw attention to the messages and to distinguish them from other messages. This tone will override the normal ringer-volume settings. A unique vibration cadence will also be used to reach hearing-impaired users.

The CMAS architecture (Figure 1.1) provides for alerts to be issued at the federal, state, tribal, and local levels. Alerts are to be transmitted by the originating entities to a Federal Emergency Management Agency (FEMA)-administrated gateway for approval, formatting, and transmission to participating cellular service providers—which will then transmit the alert over their networks.

The message format defined for CMAS was based on prior work to define a standard alert-message format, the Common Alerting Protocol. This format, which specifies the geographical area affected, the recommended action, an expiration time, and the sending agency, is designed to allow messages to increase interoperability with other alert systems. Additionally, the text of the CMAS itself (i.e., not including the header) is limited to 90 characters.

CMAS will use a cell broadcast technology known as short message service-cell broadcast (SMS-CB) to transmit messages. This technology is different from the more familiar short message service (SMS) used to exchange text messages between subscribers. (SMS is also used for alerts and warnings; these opt-in text alert systems have been introduced by a number of organizations and jurisdictions.) Cellular broadcast offers two principal advantages over SMS. First, a single broadcast message can reach each active cell phone within range of a given cellular tower, reducing the network capacity required for message delivery compared to

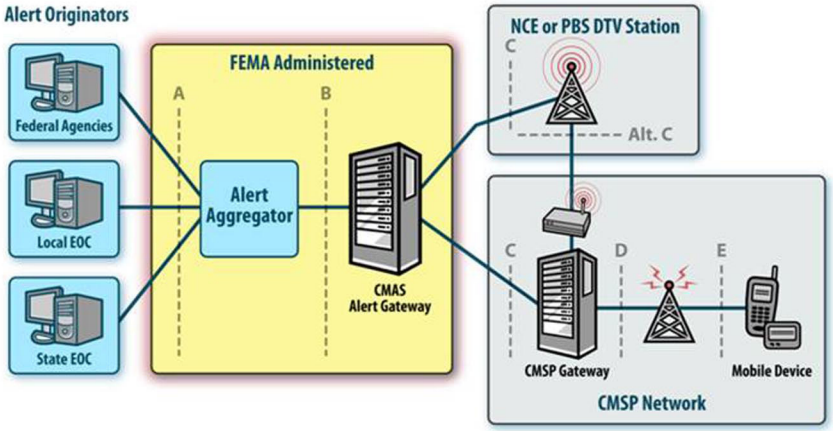

FIGURE 1.1 Commercial Mobile Alert System (CMAS) reference architecture. NOTE: EOC, Emergency Operations Center; FEMA, Federal Emergency Management Agency; NCE, non-commercial educational; PBS, Public Broadcasting Service; DTV, digital television; CMSP, commercial mobile service provider.

that required for sending messages to each subscriber. Moreover, because cellular broadcast uses a data channel separate from that used for other messages and calls, it is unaffected by network congestion. This is important because cellular networks can become damaged or overloaded in the very crisis situations in which alerts are most needed. The second principal advantage of cellular broadcast over SMS is that, because messages can be localized to cellular towers, alerts can be geographically targeted, and targeted by actual subscriber location rather than by telephone area code or home service area. In the case of CMAS, this capability is to be used to localize messages by county or equivalent jurisdiction.[6]

The CMSAAC report[7] referred to above recommends the use of cellular broadcast technology because of its immunity to network congestion. The same report also cautions about the potential for overloading the network if broadcast messages are allowed to include links (i.e., Web uniform resource locators [URLs]) to more detailed information. Including such links would, of course, be an obvious way to provide more information than can be contained in a CMAS message. However, this

[6] The localization is based on standardized codes for county and equivalent geographical entities previously defined in the now-withdrawn Federal Information Processing Standards (FIPS) 6-4 standard and now defined by the American National Standards Institute INCITS 31:200x standard.

[7] CMSAAC, PMG-0035, 2007; and FCC, Public Safety Docket No. 07-287, 2008.

approach was rejected by the CMSAAC out of concern that the practice could quickly lead to network overload.

The implications of this recommendation in light of what is known about the public response to alerts were discussed at the workshop. Several participants observed that it is well known that people often seek to confirm alerts before taking action. It seems likely that people receiving an alert on a cell phone would seek additional information by texting or placing telephone calls to family or friends, using social networks, browsing news Web sites, or searching online—activities that might end up using more capacity than would be needed if people followed a link to official information. It was further observed that the contrast might be even starker if the official information were especially designed to spare network capacity, such as through little or no use of images and other multimedia content. The cumulative effect on network capacity depends on multiple factors, including the relative likelihood of people's using the network either to download official supplemental information or to seek additional information independently, and the respective network capacity consumed by each activity.

The CMAS program is envisioned by DHS and CMSAAC to be rolled out in flexible iterations, allowing for fuller testing of the system and also for the incorporation of new technologies or other enhancements. The initial phase will use English only, potentially creating challenges for those with limited proficiency in the English language. The sending of messages in non-English languages is being evaluated by DHS's Science and Technology Directorate and CMSAAC for future iterations of CMAS.

RESEARCH ON EFFECTIVE ALERTS AND WARNINGS AND IMPLICATIONS OF THE RESEARCH FOR CMAS

Conceptually, alerts and warnings are generally viewed as distinct.[8] *Alerts* are designed to indicate that something significant has happened or may happen. *Warnings,* which typically follow alerts, provide more detailed information, indicating who is at risk, where the risk resides, who is sending the warning message, and what protective actions need to be taken. The distinction is also useful because some technologies are better suited for the delivery of alerts (e.g., sirens or CMAS) whereas others (e.g., broadcast radio and television) are better able to deliver the more detailed messages needed to provide warnings. However, from the standpoint of an individual receiving a message, the distinction may not always be apparent or even relevant.

[8] The focus of this report is on alerts and warnings. Similar terms are used in related contexts, such as the watches and warnings that are issued by the National Weather Service.

The Warning Process

People receive alerts and warnings about emergencies in a variety of ways, including print and electronic media and face-to-face communication. Each of these channels of communication has distinct characteristics—such as the rate and precision of dissemination, penetration into normal activities, specificity and distortion, and feedback—that dictate how effective they will be in particular circumstances or in reaching particular segments of the population.

Sirens, for example, provide a very limited amount of information but can be effective at getting people's attention and have broad reach, notably to people who are outdoors or who otherwise do not have access to broadcast media or telephones. Weather radios provide much more detailed information than sirens can, for example, but the message delivery depends both on people's owning specialized equipment and on that equipment's being switched on. Citizens often relay information received on their own alert systems, which frequently leads to a distortion of the initial message. Face-to-face communication does have the advantage, however, of allowing the sender (e.g., a neighbor, coworker, or friend) to verify immediately that the message was received.

Public officials often use multiple outlets to ensure wide dissemination of messages. One reason for doing so relates to the different characteristics of the different communication channels. For example, because weather forecasts allow alerts and warnings to be issued days in advance, many information outlets, including print media, are useful for carrying messages about hurricanes or winter storms. By contrast, tornado warnings are very time-sensitive, and so sirens and other immediate alerting systems are required for these hazards. Not everyone has access to a particular single information source; for example, not everyone happens to be watching television when alerting messages are shown, and not everyone can hear sirens. Finally, people have individual preferences about how they want to receive information.

A model for an alert and warning system includes event detection, message dissemination (alerts and warnings), message receipt, and response. (Box 1.1 focuses on the last two of these elements—message receipt and public response.[9]) This model takes into account a number of factors associated with the alert or warning, including the source, access to and preferences about communications channels, the message, sender and receiver characteristics, and social and environmental cues, each of which affects how people receive, process, and act on the information.

[9] The issuance of an "all-clear" message is sometimes considered the final stage of the warning process.

BOX 1.1
The Warning Process: Message Receipt and Response by the Public

Below is a list of steps that the affected population takes during a crisis or emergency following the receipt of an alert and/or warning message.

- *Receive the warning*—People must physically receive a warning.
- *Understand the warning*—Once people receive a warning they must be able to process the message and understand what it means.
- *Believe the warning is credible*—People must believe that the source of the warning is reliable and the threat could materialize.
- *Confirm the threat*—People must take steps in order to verify that the threat described in the warning is real.
- *Personalize the threat*—People must believe that the threat is something that can potentially affect them.
- *Determine whether or not protective action is needed*—People need to decide if they need to take action.
- *Determine whether protective action is feasible*—People need to decide if they are able to take action.
- *Decide if you have the resources to take protective action*—Finally people need to have the resources to actually do what is required.

SOURCE: Reprinted with permission from Joseph Trainer. 2010. Myths and Misconceptions Surrounding People, Alerts, and Warnings. Presentation at Workshop on Public Response to Alerts and Warnings on Mobile Devices, Washington, DC, April 13; based on earlier work in D. Mileti and J. Sorensen, *Communication of Emergency Public Warnings,* Oak Ridge National Laboratory, ORNL-6609, 1990.

Consider, for example, the process of delivering tsunami warnings: (1) a warning center detects an earthquake with the potential to generate a tsunami; (2) the warning center transmits this information to a variety of receivers, including government agencies and the media; (3) some, but not all, of these entities receive the message; and (4) of those that receive the message, not all transmit it to members of the public. Ultimately, some citizens will receive the message from multiple sources, but some will not receive the message at all—and only some recipients of the message will take prompt action. Flash floods exemplify events with such rapid onset that there may not be time for an official warning message to be formulated and sent. In such cases, it may be individuals in a community who successfully deliver timely messages and prompt appropriate action.

People interact and make decisions during various points in the warning process. They must be exposed to the message, comprehend the message, and then make a decision about what protective action to take. People's decisions about protective action are often influenced by

situational factors—for example, do they have the appropriate supplies for sheltering in place or evacuating? However, most often people's first action is to search for additional information to confirm the alert or warning. In such situations, people also consider social cues such as whether their neighbors are evacuating or whether local businesses are closing, and environmental cues such as whether they can see evidence of the reported hazard. They may also turn to other warning sources such as radio, print, or online information for confirmation.

The source of an alert or warning has a marked influence on people's perception of its validity and thus on their decisions regarding what protective action, if any, they will take. If the information source is not identified in the message, the message is unlikely to be deemed as trustworthy. Several factors affect the public's view of trustworthiness—for example, does the source have appropriate expertise and does the source have a protective responsibility? Therefore, it is important to recognize that the public will rely on different information sources in different types of emergency situations. For example, in an incident involving water-supply contamination, the public may respond most effectively to warnings from the water utility. Similarly, a weather alert issued by the National Weather Service is generally viewed by the public as having a high degree of credibility. In other situations, such as those for less familiar hazards (e.g., water contamination), the responsible party may not be the most trusted source, and the public will rely chiefly on local and state government information sources.

Effective Warning Messages

For warnings, there is a sizable body of social science research[10] on what constitutes effective warning messages, which include the essential elements listed in Box 1.2.[11] Other relevant information in addition to the essential elements includes the official actions that have been taken or are in progress, sources of official assistance, and sources for further official information.

In contrast, much less is known about effective content for alerts because traditional alert technologies—such as sirens and weather radio

[10] The extensive "Annotated Bibliography for Public Risk Communication on Warnings for Public Protective Actions Response and Public Education" was compiled by Dennis Mileti, Rachel Bandy, Linda B. Bourque, Aaron Johnson, Megumi Kano, Lori Peck, Jeannette Sutton, and Michele Wood and is available at www.colorado.edu/hazards/publications/informer/infrmr2/pubhazbibann.pdf.

[11] Much of this section, including the information in Box 1.2, draws on the work of Dennis Mileti and his colleagues, which was provided to committee members as background information leading up to the workshop.

BOX 1.2
Essential Elements of Effective Warnings

For warnings, there is a sizable body of social science research on what constitutes effective warning messages. These key elements are listed below.

The message should be—

- Clear, with no jargon;
- Specific in its instructions;
- Accurate and truthful;
- Certain, using authoritative language; and
- Consistent, also explaining any changes from past messages.

The message should contain the following information:

- What exact action should be taken;
- When to take action, including when action should start and when it should be completed;
- Where the hazard is taking place, in order to define clearly to whom the message is directed;
- Why protective action is necessary, including consequences if action is not taken; and
- Who is sending the message.

The message should be confirmed as follows:

- Through frequent repetition, and
- Through issuance over multiple communication paths.

SOURCE: Drawn from the work of Dennis Mileti and colleagues provided to committee members as background information prior to the workshop.

alerts—are only able to convey a very small amount of information. Such alerts require significant public education prior to a hazardous event so that populations at risk can translate tonal alerts to protective actions. Some recent alerting systems, such as the SMS text messages being provided today by many local jurisdictions, are able to provide added content, but because they are new and subscribed to by only a limited subset of the population, there has been relatively little experience with their use in disasters and thus fairly little is actually known about how to formulate effective messages.

As a result, past research and lessons learned are not fully translatable to the question of what would constitute effective content for CMAS alerts,

because CMAS messages will contain more information than conventional alerts provide but much less information than conventional warnings offer. Moreover, CMAS raises novel issues such as the potential advantages as well as drawbacks in providing links (URLs) to associated warnings and other information. Chapter 6 discusses these issues in more detail.

MISCONCEPTIONS ABOUT RESPONSES TO ALERTS AND WARNINGS

Classic examples of misconceptions about people's behavior following disasters include the idea that there is looting, price gouging, panic, and role abandonment. Such common assumptions about people's behavior are often at odds with what has been learned from post-disaster research about how people actually behave.

Following is a non-exhaustive sampling of misconceptions relevant to alerts and warnings:

- *Misconception: Alerts cause mass panic.* As a result of this misconception, warnings are often delayed until they have become absolutely necessary, in order to avoid panic. In fact, research has shown that what sociologists call *normalcy bias*—that is, the underestimation of the possibility of the disaster occurring and of its possible effects—is a greater risk. For example, consider the last time that you heard a fire alarm sound—most likely people did not immediately evacuate the building in which the alarm rang.
- *Misconception: People who do not comply with alerts are either irrational or stupid.* Research shows that alerting messages received by the public are just one type of input important to decision-making processes. Messages are not directives, and they are normally not immediately complied with. The warning process (Box 1.1) includes physically receiving the warning, understanding the warning, believing its credibility, confirming and personalizing it, and determining what action to take.
- *Misconception: Technical terms are intuitive.* Terms that an emergency manager may believe to be intuitive may not be understood by a significant portion of the public. Consider, for example, the difference between a *tornado warning* (which means that there is imminent danger and one should take shelter immediately) and a *tornado watch* (which means that conditions for a tornado are favorable and one should prepare to take shelter).
- *Misconception: Response to alerts is binary; either compliance or noncompliance occurs*. The reality is that people may take many different actions in response to alerts, actions that are shaped by the steps outlined in Box 1.1.

- *Misconception: Individual messages constitute the complete "system."* Each individual alert or warning should actually be thought of as contributing to a larger, integrated context. It is important to understand not only the meaning of a particular message but also how it relates to earlier alerts and warnings and to information available from other sources.
- *Misconception: Technology delivery systems are neutral or value-free.* It is important to recognize that there are distinct characteristics and differences between population groups that own and use particular technologies and population groups that do not own and use those technologies. The characteristics and differences among groups include such factors as income and age.
- *Misconception: One-size-fits-all solutions.* No single system will reach the entire population or be suited for all circumstances. Technology, language, type of hazard, and regional subculture are among the many factors that should be taken into consideration.

Note that the identification of the statements above as misconceptions does not mean that they never occur. For example, contrary to the common misconception, looting after disasters rarely happens; however, there are exceptions, such as the pervasive looting that took place after Hurricane Hugo severely damaged St. Croix in 1989. The exceptions are associated with special circumstances—in this case to extreme differences in economic and political status and the release of years of political and social tension following the disaster.

OBSERVATIONS OF WORKSHOP PARTICIPANTS

In the discussion following the panel presentations at the workshop, participants offered a number of observations about the role of CMAS in a national all-hazards warning system, including the following:

- Alerts and warnings systems are sociotechnical systems that require a thorough understanding not only of the technology but also of the interactions among detection, dissemination, and public response.
- CMAS will be only one of many sources of alerts and warnings and should be thought of as a new and useful component of what must be an integrated system.
- Like other capabilities for delivering alerts and warnings, CMAS will have both advantages and limitations. CMAS will allow messages to be geographically targeted with some precision, and it will provide a specific message directly to the public without opportunities for distortion. It also has a potentially wide reach, given that many people keep wireless devices within 3 feet of them all the times—and will be especially

important for reaching households that do not have conventional landline telephone service. Among the limitations of CMAS are the brevity of the message content and the fact that there is no provision for receipt verification.

- Localization of CMAS messages by county or equivalent jurisdiction might be too coarse-grained, especially in the case of large counties and highly localized events. Some tighter localization may be possible, but this would be constrained by the size of the regions potentially served by individual cellular towers and their overlapping coverage.[12]
- The cellular networks on which CMAS will depend are susceptible to damage in certain types of disasters, and the message length of CMAS is limited. Thus it will be important to educate people to use older technologies such as broadcast radio and television in addition to mobile devices in order to obtain additional information if needed, or as primary sources of information if cellular networks are not available.
- Further examination of the CMSAAC recommendation[13] not to include URLs in CMAS messages is warranted. CMSAAC rightly cautions about the potential for network overload in emergencies. However, if a CMAS message does not point people to an authoritative source of additional information, it is possible that the network will be overloaded as people place calls, browse news Web sites, or search for information to confirm an alert or warning and obtain additional information. In particular, it is worth considering whether a link to a site carefully designed to minimize network traffic might cause less congestion than the information seeking and resulting demands on network capacity that would take place without such a link.

[12] Tests conducted in 2010 by the County of San Diego, State of California, and Sprint, for example, found that localization was more difficult along the coast where the density of cellular towers was highest and there was considerable overlap in the areas that they served. Personal communication with workshop participants Leslie Luke and Stephen Rae, County of San Diego.

[13] CMSAAC, PMG-0035, 2007; and FCC, Public Safety Docket No. 07-287, 2008.

2

Current Use of Text Messages for Alerts and Warnings: Experiences and Lessons Learned

Many communities, universities, and other organizations have deployed text alerting systems using short message service (SMS) and/or e-mail to supplement other avenues for conveying alerting messages to the public. Many of the lessons learned from these systems may be applicable to the Commercial Mobile Alert Service (CMAS) program, although CMAS will have some distinct features not found in the other systems: (1) CMAS will use cellular broadcast rather than SMS or e-mail, (2) all cellular subscribers of participating carriers who use CMAS-compliant telephones will receive alerts unless they opt out, and (3) CMAS will use the cellular network to target messages geographically based on the actual location of the recipient.

The District of Columbia established a text alerting system, DC Alerts, to deal not only with typical severe-weather warnings but also with road closings and other security measures that are frequently in force in the nation's capital. Considerable effort was made in planning for the service's rollout—an effort that included in-depth training, exercises, and pilots, and the involvement of community organizations for obtaining initial and ongoing feedback.

Exemplifying another emergency notification system—in the wake of the crisis that occurred on the campus of the Virginia Polytechnic Institute and State University (Virginia Tech) on April 16, 2007, when a student opened fire, the establishment by Virginia Tech of a robust emergency notification system became a high priority. Indeed, spurred by this incident and as mandated by the Higher Education Opportunity Act of 2008—

which requires the immediate notification to campus communities upon confirmation of significant emergencies or dangerous situations[1]—alerting systems have been instituted at colleges and universities nationwide. The Virginia Tech Emergency Notification System (ENS) delivers text messages by way of SMS and e-mail and delivers voice messages by way of cellular and landline telephones. It also provides information on a Web site.[2]

In the workshop session on the current use of text messages for alerts and warnings, Barbara Childs-Pair, BDR, Inc. (and former director of the D.C. Emergency Management Agency), gave a presentation on lessons learned during the rollout of the District of Columbia's alerting system, and Michael Mulhare, Virginia Tech, discussed Virginia Tech's experience with its campus alerting system. Darrell Darnell, White House Office for Critical Infrastructure Protection and Resilience Policy and Strategy, served as the session moderator. The sections that follow provide an integrated summary of these presentations and the discussions that followed, organized by topic. They draw on the Virginia Tech and District of Columbia examples to examine design, implementation, messaging, and operational aspects of alerting systems as they relate to the public response.

SUBSCRIPTION

Virginia Tech's system is opt-out—that is, employees are automatically enrolled, and students are enrolled when they register for classes unless they actively opt out of the system. Registrants can also provide up to three different telephone numbers at which they may be contacted. The system has approximately 55,000 subscribers, or about 85 percent of the student, faculty, and staff population.

DC Alerts is an opt-in system, with registration offered through a Web site. The system allows registrants to choose what types of alerts they want to receive—those involving severe weather, transportation disruptions, interruptions of utility services, government or school closings, AMBER Alerts, or other breaking news and information—and to limit alerts according to the time of day or neighborhood in which situations occur. Registrants can also sign up to see information for particular communities and districts regarding crime. (During registration, users can also ask to receive messages in Spanish.)

Characteristically for this system, DC Alerts registration can spike before major events. For example, in December 2008, the month before the presidential inauguration, there had been 30,000 subscribers; but just

[1] Public Law 110-315.

[2] The ENS is described in detail in Virginia Polytechnic Institute and State University, *Emergency Notification System Protocols,* January 2010. Blacksburg, Va.

prior to the inauguration, on January 14, 2009, there were about 70,000 subscribers. Within a month that number dropped to 40,000, only to start climbing again as the Cherry Blossom Festival approached in the spring.

Two educational issues related to subscription were noted as being important to communicate to the public. First, events can occur at any time, and alert services are important all the time, not just during large events. Second, it is important for individuals to subscribe to an appropriate set of alerts to ensure that they receive messages that are important for them to have but avoid receiving messages that they do not need. During registration for the alerts, people often sign up for all possible categories, but it is possible to tailor one's registration for alerts to meet individual needs. For example, a person who commutes into the District of Columbia but lives in Virginia might want to register for severe-weather alerts only during work hours, which the system allows.

Subscription management is a challenge in both opt-in and opt-out systems. For example, in addition to delivering messages to people's contact telephone numbers, Virginia Tech also delivers alerts to an employee's or a student's university-issued e-mail address. This provides for a redundant communications channel that helps ensure message receipt if the student or staff member is away from the telephone or has failed to keep their registered telephone number current.

A related issue is the ability to remove inactive names from the system, which both reduces the load on the system and prevents people from receiving alerts that no longer apply to them. At Virginia Tech, anyone not associated with the university for two consecutive semesters is automatically removed from the system. In the District of Columbia, the frequency of events encourages registrants to keep their information updated. However, the DC Alerts system also has numerous registrants who no longer live in the area—for example, interns or contractors who may reside in the city only for a short period of time often fail to remove their names from the system.

MESSAGE CONTENT

Virginia Tech alerts are focused on three key pieces of information: (1) the nature of the incident, (2) the location where the incident has occurred, and (3) the action to be taken. Often the action to be taken is simple, such as "Stay away" or "Stay indoors." Virginia Tech uses subsequent messages to provide additional information and to point to other sources of information. Developing the content of these messages is complicated, and it can be difficult to satisfy those receiving messages.

The specific language used in an alert can matter greatly. For example, the use of the word "shooting" in the alert sent about the 2007 incident

at Virginia Tech would come under criticism later for having been too vague—that is, had someone been shot accidentally or had a violent crime occurred?[3] In another incident, an alert about an escaped convict believed to be on campus referred to the escapee as a "murderer"—language that some criticized as being too inflammatory.

At Virginia Tech, a set of message templates has been developed to improve the understandability of messages and to reduce the time needed for agreement to be reached on their formulation. These templates take into account 18 possible events, with two different categories of emergencies. The two categories are "Urgent" (for situations that may pose a threat) and "Immediate" (for situations confirmed to pose an immediate threat). The predetermined messages include the number of characters used by each template so that one can quickly see how much additional information can be included in the message. (Message length is limited by the maximum of 160 characters allowed in an SMS message.) Also, great emphasis is placed on avoiding jargon in the messages so that they can be readily understood.

USE OF MULTIPLE METHODS TO ENSURE RECEIPT AND TO COPE WITH NETWORK CONGESTION

The Virginia Tech alerting system can activate several alerting methods simultaneously. Subscribers can designate up to three different communication methods—including as many as three telephone numbers—to receive voice messages, text alerts, and e-mail. (Allowing for three telephone numbers permits students to direct that alerts be sent to their parents as well.) Users are asked to confirm their receipt of messages; if a message is not confirmed, the system will attempt to reach the other registered numbers. A third-party vendor coordinates the receipt of the message by cellular providers.

Several technologies are used to extend the Virginia Tech system—e-mails are used to send longer, more detailed messages, and displays that show the messages also sent by SMS are present in most classrooms. Other traditional alert and warning capabilities are also used, including a hotline number that provides recorded information, sirens, loudspeakers, and alerts to local media. Virginia Tech also provides desktop software that receives messages by means of an Internet connection and notifies the user with audio and a message window.

A final element of the Virginia Tech system is the university Web site.

[3] Virginia Tech Review Panel. *Mass Shooting at Virginia Tech: Report of the Review Panel.* Richmond, Va. August 2007. Available at http://www.governor.virginia.gov/tempcontent/techpanelreport.cfm. Accessed April 13, 2010.

Because the university Web site had crashed on the day of the shooting in 2007, considerable effort was made subsequently to ensure that the site could withstand large amounts of traffic. For example, during emergencies the content is stripped down to only essential elements in order to reduce server load and network bandwidth.[4] This capability is especially important because once an initial alert is sent, telephone systems can become saturated (as people seek additional information or attempt to ascertain the well-being of others). Through the inclusion in initial messages of a pointer to the Web site for additional information and updates, users know where to continue to go to get information as a situation develops.

OPERATIONAL ISSUES

Protocol

An important element of any alerting system is the establishment of a protocol that formalizes decisions made about what events the emergency notification system will be used for and about who makes the decision to notify the public (or other agencies or organizations). The protocol also establishes a standard that can be consulted in case, in the aftermath of an event, questions arise regarding why a message was or was not sent.

Especially when dealing with particularly dangerous or threatening events, it is important to be able to issue alerts promptly. One possible source of delay is the time that it can take on-duty personnel to contact and gain the approval of the officials with the authority to issue an alert. To avoid such a potential delay, the Virginia Tech protocol gives explicit authority to whichever senior police officers (those with a rank of sergeant or corporal) are on duty and also gives authority to other (nonpolice) campus officials. The intent is to provide the officials on duty with confidence that they have the authority to issue alerts when needed.

Testing

Virginia Tech tests all the notification channels of its system each semester. Additional, limited tests are periodically conducted with smaller test populations. Such tests are mandated by both federal law (the Higher Education Opportunity Act of 2008) and Virginia law. Although these

[4] See National Research Council, *The Internet Under Crisis Conditions: Learning from September 11*, The National Academies Press, Washington, D.C., 2003, p. 42, for a discussion of the implications of "flash crowd" events for Internet services and strategies for coping with them.

tests are expensive (a full functional test at Virginia Tech costs roughly $150,000), they not only verify that the system operates correctly, but they help educate the target population about the service and provide confidence to decision makers that the capability will work when needed.

Location

The geographical area covered by both the Virginia Tech alerting system and DC Alerts overlaps with that covered by other alerting systems and provided by other universities or local jurisdictions. DC Alerts has developed partnerships with the multiple universities in the District of Columbia. Its initial agreement was with the George Washington University, to ensure that students would receive alerts and be notified of any recommended protective action. Virginia Tech has several campuses in the greater Washington, D.C., metropolitan area not covered by the campus alerting system; furthermore, alerts regarding the Blacksburg, Virginia, main campus might not be relevant for those on campuses in the Washington, D.C., area. Virginia Tech encourages those students to register with DC Alerts to ensure they have access to alerts and warnings information.

DC Alerts has the additional challenge of reaching commuters and tourists who do not reside in the city. Tourists are unlikely to have registered for alerts, and commuters will primarily be interested in alerts and warnings only while they are working in the city. Although the registration system allows people to sign up for some alerts to be sent only during work hours, people still need to register for multiple systems—one for their home and one for work—if they are to receive all relevant alerts and warnings.

EDUCATION OF THE PUBLIC

Community organizations and leadership play an important educational role with respect to DC Alerts. The District of Columbia received Federal Emergency Management Agency (FEMA) and Department of Homeland Security (DHS) funds that supported extensive training and drills for citizens, including staff and students in the local schools. The District of Columbia initiated 36 community and neighborhood programs. The District's Homeland Security and Emergency Management Agency spent about 6 months working in the neighborhoods educating the community and working with community leadership. A program manager and program monitors were identified not only to work within the community to ensure that alerts and warnings were disseminated but also to provide feedback to emergency responders during an actual emergency

or crisis on how the community was being affected, what the current response in the community was, and what additional information might be helpful.

At Virginia Tech, with its steady flow of new students arriving each year, there is need for a continuous process of educating new members of the community. Virginia Tech is currently developing a training program for students, faculty, and staff to ensure that the population is aware of emergency preparedness and its importance.

OBSERVATIONS OF WORKSHOP PARTICIPANTS

In the discussion following the panel presentations, a number of observations were offered regarding how information from SMS messaging might be applied to the Commercial Mobile Alert Service (CMAS). The observations included the following:

- Community engagement can be an important part of any system. Community organizations can assist in educating the public about emergency preparedness, can assist in the dissemination of information during major events, and also can provide emergency managers with feedback on the public response. Although CMAS does not have a built-in capability to verify that messages are received, community organizations can provide that information during and after an event.
- Coordination among geographically overlapping emergency notification systems can help ensure that affected populations receive alerts and warnings.
- Alerting systems operated by local jurisdictions and other organizations can supplement and complement the information delivered by CMAS.
- Multiple alerting tools using distinct communications channels are invaluable in maximizing the population reached during an emergency.
- Approaches such as CMAS's use of a separate delivery channel or the use of low-bandwidth Web sites can ease the stress placed on networks and increase the likelihood that affected populations are able to receive messages.
- Although higher precision of geographical targeting is desirable in order to provide people with the most relevant information, this can be difficult to achieve in practice. CMAS only localizes by county or equivalent jurisdiction, and alerts sent by individual jurisdictions are based on telephone numbers or e-mail addresses and thus cannot target people moving among multiple jurisdictions.

3

Communicating During a Crisis

The Commercial Mobile Alert Service (CMAS) is currently being developed to leverage communications technology for communicating with the public in a crisis. In the workshop session on messaging, risk communications, and risk perception, Timothy Sellnow, University of Kentucky, and Matthew Seeger, Wayne State University, examined what is known about communicating risk and the relationship between message content and public response. They also considered what the implications might be of using as brief a message as a 90-character text message—the maximum allowed for a CMAS message.

In the next workshop session, Technologies for Alerts and Warnings: Past, Present, and Future, Robert Dudgeon, San Francisco Department of Emergency Management; Jennifer Preece, University of Maryland; and David Waldrop, Microsoft, Inc., considered the role of social networks in alerting and warning. Nalini Venkatasubramanian, University of California, Irvine, then discussed future alerting technologies.

The two sessions were moderated by Brett Hansard, Argonne National Laboratory, and John Sorensen, Oak Ridge National Laboratory, respectively. This chapter provides an integrated summary of the presentations and the discussions that followed, organized by topic.

CRISIS COMMUNICATION VERSUS RISK COMMUNICATION

In a simplified model, there are three stages in a crisis event—the stages (1) before the crisis, (2) during the crisis, and (3) after the crisis.

Risk communication, which centers on what is known about potential risks and possible responses, functions primarily in the stages before and after a crisis. Before a crisis, the goal is to educate and engage with the public and just before the crisis to issue warnings. After the crisis, the goals shift to applying lessons learned during the crisis and to building resilience from future events.

Crisis communication, by contrast, occurs in stage 2, during the crisis, and has very specific communications demands. Crisis communication inherently involves many acknowledged unknowns in the context of a particular event. Thus, an approach that is successful for risk communication may not succeed during a crisis.

During a crisis situation, communication with the public shifts from a dialogue about potential risks to instructional messages focused on the steps that members of the public should take to protect themselves (for example, evacuating or sheltering in place). Another aspect of response management involves connecting with others—individuals trying to connect with one another, such as families seeking to reunite, and emergency responders from a variety of agencies needing to connect with others in order to coordinate response efforts.

OLD MEDIA VERSUS NEW MEDIA

The traditional view of information dissemination centers on the command post. Alerts and warnings are prepared by public officials, media receive their information from briefings by public information officers (PIOs), and the public receives its information from the media. According to the traditional view, the perception of the crisis is tightly controlled by the context of the briefing room and the information that the PIO chooses to provide. Likewise, information is mediated, the timing of the information is very controlled, and direct access to the crisis zone is controlled. Regardless of which news source people turn to, they receive much the same information.

Today's media can provide unfiltered, more-immediate information. Long before an alert is delivered by CMAS or another official source, information about the event will most likely already be available on social media sites, such as Twitter or Facebook, that support online social interaction, including the widespread sharing of people's observations about current events. Information shared using these tools, or even information simply exchanged among individuals, includes not only text but images and video, which are readily captured using mobile telephones. As a result, those directly affected by a disaster can also become key sources of information about the event. These tools also change conventional news gathering—reporters can use cell phones

to interview people at the scene of an event or to gather both still images and video quickly.

One potential consequence of the use of these new tools is that the personal experience of those caught up in a disaster, who may be experiencing psychological trauma and stress, can now be shared widely. Even those not physically present can vicariously experience the traumatic nature of disasters.

In contrast to conventional mass media that reach mass audiences, the new media tend to reach audiences that are more selective or limited, in the sense that the messages that these media convey are targeted to particular groups. For example, in Facebook, people see information provided by individuals or organizations that they have designated as "friends," and in Twitter people see information provided by individuals or organizations that they "follow" (although it is also possible to search all Twitter messages based on keywords). Recipients of information may in turn re-post the information (in Twitter parlance, "retweeting") and may provide additional information that they think will be of interest to their connections. Social media can also broaden the reach of conventional media; people commonly redistribute links to news reports about disasters.

Social media also allow a community to leverage the trust that people place in their connections. Information provided by colleagues, friends, and family may be viewed as more credible than a mass alert or a news report. Similarly, local media may have more credibility than national media do if the local media are seen as being more interested in service to their communities than in wide audience appeal.

Old and new media may also differ in their resilience in a disaster. For example, although their ability to provide mobile communications can be invaluable in a disaster, cellular networks are subject to overload, their infrastructure is subject to damage, and keeping both the infrastructure and the individual phones powered can be a challenge. Older technologies have often proven to be resilient—for example, during Hurricane Charley in 2004, a local radio station's building was destroyed, and yet the station was operating again within 5 hours.

Finally, disasters and people's natural desire to feel connected during such crises may prompt them to adopt additional media, both new and old. Individuals in the elderly population who may not currently have cellular telephones may come to recognize their value during a disaster, and younger people who may not currently have battery-powered radios may purchase them when they realize the potential shortcomings of the cellular network during a disaster.

USE OF SOCIAL MEDIA TO FILL COMMUNCIATIONS GAPS

In November 2007, a freighter hit the San Francisco-Oakland Bay Bridge, dumping 55,000 gallons of bunker fuel into the San Francisco Bay. Although the event was very visible and might have appeared to be a serious incident, bunker fuel floats and is relatively easy to clean up. However, because official information was not made available to the public promptly, emergency management officials quickly "lost the public information battle." Blogs and other media began reporting inaccurate information—but these media were not being tracked by officials. Soon the reports led to unsanctioned cleanup efforts and the formation of protest rallies. Further complicating the situation, the San Francisco city government lacked the authority to close the city's beaches even though the bunker fuel was toxic. The upshot of the situation was that the San Francisco Department of Emergency Management found itself dealing with the repercussions of a nondisaster that, despite a very successful cleanup effort, was being viewed as a disaster by the public.

This event highlights the challenges of traditional crisis communications capabilities. Traditional tools such as the Emergency Alert System, which provide for notification of emergencies via broadcast radio and television, as well as newer technologies such as satellite radio and cable television, do not appear to be useful during such events because the events themselves are generally viewed as not being serious enough to warrant the use of the traditional alert and warning tools. As far as working through the media, it can take PIOs a long time to prepare, get approval for, and deliver news releases and briefings. The city of San Francisco did have a short message service (SMS)-based alerting tool available, but here too, it would have taken a while to get a message composed and approved. More-rapid dissemination tools, including the use of social media, are being looked to as additional tools for providing more timely information in future events.

SYNERGISTIC USE OF MULTIPLE MEDIA

Events during the wildfires in San Diego County, California, in October 2007 provide an interesting example of how different types of media can be used synergistically. A primary driver of information during the disaster was local radio station KPBS. To complement KPBS broadcasts during the fires, station staff used a Twitter account and a Google map to provide updated information. Box 3.1 shows the Twitter stream, and Figure 3.1 shows the Google map. As the wildfires progressed, this ad hoc system emerged, providing focused information and addressing specific areas where information was missing. The Twitter content was varied—ranging from links to official government information sites to transporta-

BOX 3.1
Examples of Twitter Messages

Following is a sample of Twitter messages sent by public radio and television broadcaster KBPS (@kpbs) during the wildfires in San Diego County, California, in 2007.

- "To get a list of local assistance centers in Southern California visit http://tinyurl.com/ywejgn."
- "The CA Department of Insurance is sending fraud investigators to assistance centers and neighborhoods to reduce the chance of scam artists."
- "Fire victims can register with FEMA [Federal Emergency Management Agency] online by visiting http://tinyurl.com/yolpfj."
- "Santa Clarita area update: Buckweed Fire now joins the Magic Fire in being 100 percent contained."
- "Resource: people suffering with stress following the wildfires can contact the Orange Co Emergency Op Center hotline at (714) 628-7085."
- "The Malibu fire has been fully contained."
- "Caltrans [California Department of Transportation] says Route 74 will remain open in both directions tonight."

SOURCE: KPBS Public Radio @kpbs [Twitter]. Available at http://twitter.com/kpbs.

tion information. The Google map integrated several different pieces of information into a single visual cue. The interactive map not only showed the locations of the fires but also where to find shelters, where evacuation centers were, and even where evacuees could take their animals.

INFORMATION SHARING AND GATHERING

A recent study that examined people's use of social media in responding to the 2009-2010 H1N1 influenza outbreak found that people used social media not only to forward the official messages but also to add pointers to additional information that might or might not have been deemed reliable by health care authorities. During the initial H1N1 outbreak, the Centers for Disease Control and Prevention (CDC) made a concerted effort not only to use multiple outlets to maximize the reach of the CDC message but also to try to ensure that CDC messages were the public's primary source of information on the subject. To that end, CDC also used Facebook, Twitter, and other social media tools to monitor public opinion and to correct rumors. A lesson to be drawn from this experience is that although one cannot determine what information people

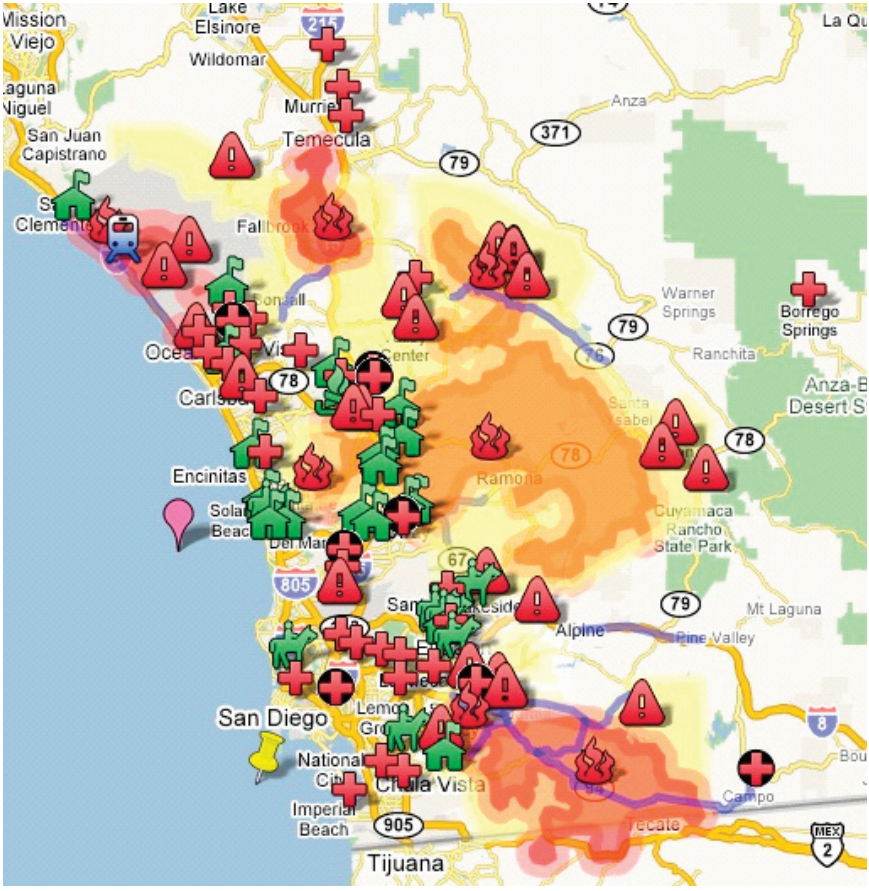

FIGURE 3.1 During the wildfires in San Diego County, California, in 2007, an interactive Google map provided interactive information that could be updated, on wildfire location, shelters, transportation disruptions, and other useful locations. SOURCE: Fire information posted by KPBS. © 2010 Google; Map data © 2010 Google, INEGI.

receive, it is possible to monitor the information that is being seen by the public and to reiterate key points if necessary.

A flash flood that occurred in March 2010 in San Francisco illustrates the potential for using social media to gather information about an incident. During the course of that event, emergency managers had received word from 911 telephone reports of a sinkhole at a downtown intersection. However, the severity of the event did not become fully apparent until pictures and video were posted on social media sites—in fact there

turned out to be a 20-foot geyser gushing from a manhole. Twitter and Facebook proved important sources of information on other problems such as the flooding of some San Francisco Municipal Railway (Muni) stations. Such reports can complement information provided by officials on the scene, who may not be able to provide reports because they are overburdened with responding to events.

Another lesson learned from the San Francisco flash flood incident is that people on the ground may be the source of both the first reports and the most detailed reports (including pictures and video)—and can make such information widely available to the public using social media. On the one hand, there are potentially significant benefits to people's receiving such prompt and detailed information. On the other hand, there are risks that false information will be reported and spread. The net result is that social media communiqués on such incidents can both aid and complicate the task of emergency managers.

MICROBLOGGING

Users of Twitter during crises are re-posting information from traditional media, providing commentary on the event and on the public and government response, and informing their connections as to how they are themselves being affected by the event. A 2009 study of Twitter content during a crisis found that message content could be categorized as follows: 37 percent of the messages provided information (warnings, updates, answers); 34 percent were commentary; 26 percent dealt with personal impact or requests for information; and 4 percent were promotions of available media coverage or products and services.[1] In addition to individuals sending messages, public officials can also make use of Twitter to reach portions of the public. Indeed, a recent study suggests that brief messages can be communicated during disasters in a highly effective manner.[2]

The demographics of Twitter usage differ from those for mobile phones, with a penetration rate significantly lower than the 85 percent who subscribe to cellular telephone service. Also, Twitter users tend to be younger and richer, and more of them are in nonminority populations. According to data collected in March 2010, the majority of Twitter users

[1] F. Vultee and D.M. Vultee. "What We Tweet About When We Tweet About Disasters: The Nature and Sources of Microblog Comments During Emergencies." Paper presented at the 93rd National Communication Association Annual Convention, Chicago, Ill., November 12-15, 2009.

[2] S.R. Veil, T. Buehner, and M. Palenchar. "Increasing Dialogue in Disasters: Incorporating Social Media in Risk and Crisis Communication." Paper presented at the National Communication Association Conference, San Francisco, Calif., November 2010.

are female (55 percent), between the ages of 18 and 34 (45 percent), and Caucasian (69 percent), with an income above $100,000 (30 percent).[3] As a result, one would not expect Twitter to be the most effective way of reaching many of the populations known to be at most risk in a crisis.

OTHER NEXT-GENERATION CRISIS COMMUNICATION TOOLS

A number of organizations have been experimenting with a variety of new tools for emergency management. For example, Microsoft developed a prototype social network (called Vine, released as a beta in 2009, and discontinued in late 2010) especially targeted toward supporting the needs of families, other small groups, and small organizations.

One rationale behind the creation of Vine was that there are many types of disasters, on many different scales and of many different descriptions, local and global, human-made and natural, personal and societal, and only some of these emergencies require an alert to be sent by federal, state, or local governmental authorities. Events of interest only to families or other small groups can still find tools that support alerts and warnings to be useful. Another rationale behind the creation of Vine was the need for tools that support the variety of roles that individuals may play in an emergency—for example, father, husband, Red Cross volunteer, and Little League coach. Flexible tools that support each of these roles could be of considerable value.

Several years ago, researchers at the University of Maryland began designing and developing a prototype of another sort of tool, 911.gov.[4] This tool was designed both to allow the public to use mobile phones and to enable the Web population to report a wide variety of incidents.[5] The Web-based tools allowed users to upload photographs and videos so that emergency responders had a better understanding of what was happening at the site of a disaster. Over time, a number of cities and counties have embraced the use of mobile and Web technologies to augment traditional 911 systems.

Looking ahead, workshop participants suggested several directions for next-generation tools. These include building alerting tools that employ multiple communications channels (e.g., e-mail, Web, social networks, and mobile) and support bidirectional communications (so that recipients can send information back to emergency managers). Future tools might

[3] Data available at www.quantcast.com/twitter.com. Accessed March 28, 2010.

[4] Additional information can be found at the project's Web site, http://www.cs.umd.edu/hcil/911gov/.

[5] Ben Shneiderman and Jennifer Preece. "911.gov: Community Response Grids." *Science* 315:944 (2007). Available at http://www.sciencemag.org/cgi/content/summary/315/5814/944. Accessed August 23, 2010.

be better integrated with a user's existing social networking tools (so that a different, unfamiliar tool need not be used in a disaster) and leveraging users' existing social networks (e.g., also alerting, where appropriate, one's friends or family). Such tools would reach people more effectively, provide them with more targeted information, provide emergency managers with the ability to gather and aggregate information that is relevant to the communities that they serve, and open up opportunities for the public to be more involved with their communities and government.

OBSERVATIONS OF WORKSHOP PARTICIPANTS

During the presentations and in the discussion following the panel presentations, a number of observations drew on recent experiences with using social media and other communications tools:

- Integrated systems that can easily span traditional and new communications systems will be needed to maximize the reach of alerts and warnings. For example, although cellular technology is widely used, it reaches neither everyone nor everywhere.
- The available technologies for delivering alerts and warnings will change over time. Emergency managers will need to adapt when users shift to new tools.
- Although social media play a growing role in disaster and crisis communications, they are not yet primary or major sources of information during a disaster; instead they serve as emerging tools that may play an increasingly important role in the future.[6]
- Messages that come from local entities are generally viewed as more credible than those coming from national sources. This suggests that although CMAS messages will be routed through a national gateway, it will be useful to include the responsible local agency as part of the message.
- Trust and credibility are affected by timing. If a CMAS alert is one of the first pieces of information received, its credibility will be higher.
- Alerts and warnings have to be actionable and should include context—for example, why one should take this particular action.
- Those receiving a message will first try to verify the information. Additional information sources need to be provided. If people do not

[6] Studies following the San Diego wildfires found that only 0.2 percent of the population received their first evacuation notification through the Internet, and 4.9 percent subsequently used the Internet for follow-on information. See John Sorensen, Barbara Vogt Sorensen, Allen Smith, and Zachary Williams. *Results of an Investigation of the Effectiveness of Using Reverse Telephone Emergency Warning Systems in October 2007 San Diego Wildfires.* ORNL/TM-2009/1254. Oak Ridge National Laboratory: Oak Ridge, Tenn.

have the ability to obtain additional information, the effectiveness of the message will be limited. Although a "clickable" link to additional information may not be feasible (and indeed is not permitted in the initial release of CMAS), it still may be possible to reference secondary sources such as broadcast radio and television or Web sites.

- Message testing and audience analysis will play an important role in CMAS. Post-event analysis can provide some of the best information regarding public response and the effectiveness of the messages that were sent.
- Emergency managers or public information officers may encounter difficulties when they experiment with using social media. First, the managers' or PIOs' leadership may be uncomfortable with the relative loss of control with respect to how an alerting message is distributed, compared to traditional dissemination methods. Second, the information technology systems in the agency may block access to social media Web sites and services. Addressing both of these issues will require new policies that support the use of social media.
- Communication during a crisis has benefits beyond public response. Communicating with others during crisis can be cathartic; reconstituting a sense of community is a critical function of communication systems.

4

Public Education and Training

Public education and outreach not only can help people understand the purpose and capabilities of an alerting or warning system but also can prepare and motivate them to take appropriate action when alerts or warnings are received. In the workshop session on public education and training, Mark Benthien, Southern California Earthquake Center, discussed his experience with education initiatives pertaining to earthquakes. Michele Wood, California State University, Fullerton, discussed current research on public education campaigns, and Daryl Rand, Harrison Advertising/The Rand Group, examined the education question from a marketing perspective. Inés Pearce, Pearce Global Partners, Inc., was moderator for the panel. This chapter provides an integrated summary of these presentations and the discussions that followed, organized by topic.

AN EXAMPLE: THE GREAT CALIFORNIA SHAKEOUT

Earthquakes are typically "no-notice" events, which means that the first alert that a person generally receives of an earthquake is the feeling of the ground shaking. (Today it is possible to provide very limited advance alerts to those sufficiently far from the epicenter of an earthquake; see Box 4.1 for a description of earthquake detection and alerting systems.) Those affected by an earthquake do not have the opportunity that those receiving a hurricane alert might, to take time gathering information about the hazard and to decide what actions to take; nor is there an opportunity (or need), as there might be with severe weather, for people

BOX 4.1
Early Earthquake Warning Systems

Early Earthquake Warning Systems (EEWSs) exploit the limited window afforded between the time that earthquake energy propagates from the epicenter of an earthquake to the time that it reaches an affected population. Numerous locales are developing tools such as EEWSs, but only two have a public message component—those of Mexico and Japan. EEWSs can be used, for example, to tell people to take shelter and to tell drivers to pull over to the side of the road. They can also be used to automatically secure transportation and industrial systems. For example, the Japanese EEWS is used to stop trains automatically.

Mexico City is especially well suited to the EEWS approach because earthquakes generally occur on the coast and then propagate to the lake-bed deposit under Mexico City, which amplifies the shaking. Mexico City's system provides a public alert when shaking first occurs at the coast. The Japanese system delivers both Emergency Alert System (EAS)-like television and radio alerts and alerts resembling the National Oceanic and Atmospheric Administration (NOAA) weather radio that makes use of dedicated receivers.

California is also developing an EEWS. The first phase of development, from 2006 to 2009, involved developing and testing detection algorithms. Work has now progressed into a prototyping phase. The development and deployment of the system are being conducted with caution so as to avoid false alarms, which might undermine the credibility of the system. An existing system, the California Integrated Seismic Network, does send out a notice of the location of the epicenter and the magnitude of an earthquake within 5 seconds after the earthquake. These notices are sent only to official emergency managers, but they could possibly be used to issue public alerts as well. The Department of Homeland Security's Science and Technology Directorate is also examining sensor technologies and automation and sensor data that could be used to trigger alerts or warnings.

The EEWS program has raised a number of challenging technical and social questions associated with the time sensitivity of alerts, including the following:

- To ensure the timely detection of an earthquake, sensors must be densely distributed in potential fault areas, and communications with the sensors must be rapid and reliable. No matter how extensive the sensor network, there will be "blind spots" if an earthquake epicenter is directly below the population.
- In addition to the need for communications with sensors to be fast and reliable, detection algorithms must also be fast and reliable, able to detect within seconds whether a significant event has occurred.
- To issue timely alerts, the communications channels for notifying the public must be low-latency and reliable. For example, e-mail, short message service, and reverse-911 are too slow. The EAS or sirens could be fast enough, as could the cellular broadcast technology to be used for the Commercial Mobile Alert Service.
- The briefness of the advance warning time for earthquakes means that people will need to be well educated with respect to what particular messages mean and what steps should be taken.

to personally confirm the event. As a result, it is especially important to provide the public with advance education and training about earthquake risks and proper protective action.

The Earthquake Country Alliance (ECA) is a statewide coalition of California organizations and individuals who are developing materials and activities with consistent messaging. The goal is twofold: to educate people about preparedness and to educate people about protective actions. The ECA focuses on practicing simple protective action, such as that recommended in the easily remembered phrase "Drop, cover, and hold on." The goal is that, through drills, not only will people learn appropriate protective behavior, but they would practice it instinctively when they received an alert. Annually the ECA coordinates a statewide drill called the Great California ShakeOut. The ECA provides manuals to participating organizations on how to perform an earthquake drill, as most organizations have not held such drills before. At the appointed time, the ECA also issues the test alert.

In addition to teaching people the simple actions advocated in "Drop, cover, and hold on," the ShakeOut also provides an opportunity to educate participants on preparedness practices. Educating those living in earthquake country about preparedness is extremely important. To be properly prepared before an earthquake occurs, the ECA asks that people do the following: secure their living space, ensuring that top-heavy furniture, water heaters, television sets, and other heavy objects will not fall during an earthquake; store water, 1 gallon per person per day for at least 3 days, but ideally up to 2 weeks; and have a fire extinguisher and ensure that family members know how to use it properly. The ShakeOut is having an impact, as the state of California sees an increase in the purchase of preparedness products at the time of the drill.

The ShakeOut started in 2008 with the Great Southern California ShakeOut. November 12-16, 2008, was a week of special events to educate and encourage Southern Californians to be prepared; a regional drill was held November 13, 2008. There were 5.57 million participants—chiefly schools but also businesses, communities, governments, and families. In 2009 the event went statewide, with 6.9 million participants. The ShakeOut is now an annual event for which the ECA partners with state agencies and the Federal Emergency Management Agency (FEMA). Although the ECA has been successful in recruiting businesses, schools, and organizations as participants, individual registrations are quite low. The ECA is using social media to encourage people to participate and also to count people who may not be registering.

Starting in 2011, participation in the drills will be extended to states in the central United States, coinciding with the bicentennial of large earthquakes which struck that region in 1811 and 1812. Similar drills are being

planned or are under consideration in other regions that have historically experienced severe earthquakes, including the Pacific Northwest, Utah, and Alaska.

BUILDING AN EDUCATIONAL CAMPAIGN

Much time and money have been spent educating the public in the areas of preparedness and emergency management. However, such educational campaigns often have not proven very fruitful for three key reasons: (1) The time or space allocated for public service announcements is limited, and many pro bono commercials run late at night. (2) Emergency management professionals may not be familiar with marketing. Indeed, few undergraduate or graduate programs provide courses in public education, outreach, or marketing. (3) Professionals with marketing expertise tend not to be involved in emergency planning and preparation activities.

Several organizations have aimed to close the gaps listed above by creating guidelines for public awareness. Two of them, the Emergency Management Accreditation Program (EMAP), a nonprofit organization that provides assessment and accreditation of emergency management programs and personnel, and CBS Outdoor, a for-profit advertisement managing firm, have developed a set of blueprints for creating public awareness plans and educational initiatives. EMAP's public awareness program guideline, *Assessing Your Disaster Public Awareness Program,* was issued in 2006.[1] In formulating its guidelines, EMAP convened experts from a wide variety of disciplines. The contribution of CBS Outdoor was *An Approach to Preparedness,* a blueprint for emergency managers to use in creating a public education and outreach plan.[2]

The blueprints from EMAP and CBS Outdoor, along with an extensive body of earlier work,[3] lay out guidelines for the development of success-

[1] Emergency Management Accreditation Program (EMAP). *Assessing Your Disaster Public Awareness Program.* EMAP, Washington, D.C., October 2006.

[2] CBS Outdoor. *An Approach to Preparedness.* CBS Outdoor, New York, N.Y. 2007.

[3] E.g., Dennis Mileti, Sarah Nathe, Paula Gori, Marjorie Greene, and Elizabeth Lemersal, *Public Hazards Communication and Education: The State of the Art,* Natural Hazards Research and Applications Information Center, Boulder, Colo., 2004; Dennis S. Mileti and John H. Sorensen, *Communication of Emergency Public Warnings: A Social Science Perspective and State-of-the-Art Assessment* (Report ORNL-6609 for the Federal Emergency Management Agency), Oak Ridge National Laboratory, Oak Ridge, Tenn., 1990; Michael K. Lindell and Ronald W. Perry, *Behavioral Foundations of Community Emergency Planning,* Hemisphere Publishing, Washington, D.C., 1992; Dennis S. Mileti and Colleen Fitzpatrick, "Communication of Public Risk: Its Theory and Its Application," *Sociological Practice Review* 2(1):20-28 (1991); and Dennis S. Mileti, Colleen Fitzpatrick, and Barbara C. Farhar, "Fostering Public Preparations for Natural Hazards," *Environment* 34(3):16-20, 6-39 (1992).

ful public education campaigns. They draw on the social psychology of hazard education and on extensive investigations into the public response to past campaigns to set out principles for effective public education campaigns and other lessons learned.

OBSERVATIONS OF WORKSHOP PARTICIPANTS

In the discussion following the panel presentations, workshop participants made the following observations regarding planning and implementing effective educational campaigns:

- *Do not use fear to engage the public.* Fear is not an effective tactic for engaging the public and should not be used as the primary tactic for this purpose. Although such tactics may be effective in increasing people's perception of risk, this perception does not necessarily translate into desired behavioral changes.
- *Make use of multiple sources of information.* For example, local fire departments are considered by the American public to provide the most honest and complete information about emergency situations, but only about a third of the U.S. population has access to such information. Local fire departments are thus a very effective source of information, but not for everyone. Rather than identifying and relying on a single credible source, use a panel of sources to reach the broadest audience possible. Ensure that messages are consistent across information sources.
- *Understand community demographics and media cover.* Geodemographic mapping allows demographic variables that correlate with risk to be overlaid with the areas covered by various media.
- *Make public education interactive and experiential.* People benefit from experiencing what warning messages and alerts will look like. It is essential to build in feedback for the system in order to collect evaluation data from those experimenting with the system.
- *Encourage information seeking.* Encourage people to talk with one another about emergency preparedness. People who start communicating with one another are more likely to take appropriate action. People are seeking information in new ways using social media and other communications technology, and it is important to embrace the new opportunities that this use presents.
- *Partner with businesses.* Businesses have a responsibility to their employees to provide emergency planning. Businesses have specific needs, and it is important to coordinate with them during their emergency planning to ensure that there is not conflicting information and that there is planned action between the business and emergency management officials.

- *Partner with school groups.* Students typically absorb new information readily and can become conduits for such information to their families.
- *Educate those responsible for preparing messages.* Credibility is important and will be diminished if a message contains incorrect information, unclear information, or even typographical errors.
- *Put the information on the table and include the elected officials.* Conflicts can arise between governments—for example, between city and county governments. Although emergency managers may have conflicts, they can usually work together and generally already are doing so. The challenge comes with public information officers who are managing information for elected officials. The elected officials often engage in extensive battles in terms of getting information out.
- *Have a simple message.* Regardless of what type of disaster a geographic area may face—hurricane, tornado, earthquake, or flood—the recommended preparatory actions are often very similar even if the priorities are different. These preparatory actions include telling people to have food and water on hand, to have a battery-powered radio, and to be prepared to evacuate if necessary. If these basic "calls to action" can be conveyed to and acted on by even a significant fraction of the population, much progress will have been made.
- *Engage various funding sources and partnerships.* Professional marketing campaigns can be costly. Building public education campaign funds into grants can be helpful, but private-public partnerships can also be helpful. Emergency managers can also reach out to local marketing or public relations professional associations.

5

Communicating with At-Risk Populations

Although the Commercial Mobile Alert Service (CMAS) will send alerts to people's cellular telephones and thus reach a large fraction of the population, this approach will also present special challenges for certain at-risk segments of the population. In the workshop session on communicating with at-risk populations, Judy Harkins, Gallaudet University, discussed research performed at Gallaudet University on how best to provide alerts to people who are deaf and hard of hearing. Ed Price, Georgia Institute of Technology, discussed research completed at the Georgia Institute of Technology's Rehabilitation Engineering Research Center for Wireless Technologies (Wireless RERC) on how people with hearing, sight, physical, and cognitive disabilities interact with cellular telephones and alerts. Chris Mayhorn, North Carolina State University, shared insights on reaching older adults. Brenda Phillips, Oklahoma State University, served as moderator and highlighted the interactions of gender and ethnicity on emergency preparation, education, and response. The rest of this chapter provides an integrated summary of these presentations and the discussions that followed, organized by topic.

USE OF WIRELESS DEVICES BY PEOPLE WITH DISABILITIES

The Wireless RERC uses ongoing surveys, which have over the past few years involved more than 1,600 people with disabilities, to collect data on use trends and user needs. People with disabilities have important communications needs, often using mobile devices as a lifeline, not

only during medical emergencies but also daily to further independence and access to services. For people with disabilities who are unable to drive themselves, mobile devices can be imperative in arranging for transportation. Indeed, the penetration of wireless devices in communities of people who have disabilities is the same, if not slightly higher, than in the community at large.

This finding, and the observation that text messages are increasingly used to deliver alerts and warnings, prompted the Wireless RERC to conduct a series of field trials, focus groups, and simulations to investigate a variety of approaches to delivering text alerts. The study population was primarily individuals who are blind or have low vision, or who are deaf or hard of hearing, along with a few participants with cognitive disabilities; the study population included people with varying levels of technical savvy. The tests used two different devices: (1) a Windows mobile device with custom software to provide a tone alert similar to that used in the Emergency Alert System (EAS), other customized attention signals, and text-to-speech processing; and (2) standard BlackBerry devices that support text messaging and are commonly used in the community of people who are deaf and hard of hearing.

The Wireless RERC studies were completed before an initial set of requirements for the CMAS program was set forth by the 2007 Commercial Mobile Service Alert Advisory Committee (CMSAAC) report.[1] The studies used a standard short message service (SMS) text message and a Web page, putting essential information in the SMS body and including a hyperlink to the full alert on the Web page. The first test group, composed of people who are blind and vision-impaired, used the custom device. These test subjects found that the tone alerts and speech synthesis were a significant improvement over the phones that they normally used. The second test group, composed primarily of people who are deaf and hard of hearing, used the BlackBerries. They found the text message alerts to be useful but not a big improvement over the systems that they normally used. For example, many in this group already subscribed to alerts from third-party providers such as the Weather Channel. For them, the EAS-like alert was slightly preferred because it provided somewhat more detailed information and did not contain advertisements. Notably, in post–field surveys, 83 percent of people with sensory limitations said that receiving emergency alerts by way of wireless devices was highly desirable.

After the 2008 adoption of the CMSAAC recommendations by the FCC, Wireless RERC conducted a second series of tests using CMAS-like messages (90-character messages that did not contain links to second-

[1] CMSAAC, PMG-0035, 2007; and FCC, Public Safety Docket No. 07-287.

ary sources) and alerting by means of a distinctive tone and vibration cadence. About three-quarters of those who had participated in previous tests thought that this CMAS-like alert was an improvement over the third-party alerts with which they were familiar. They observed that CMAS-like messages were simple and that they clearly indicated what action to take, but these people suggested that it would be useful if links to supplemental information were included.

SPECIAL CONSIDERATIONS FOR PEOPLE WHO ARE BLIND OR HAVE LOW VISION

Text alerts are inherently ill suited for people who are blind unless the telephone that they are using has the ability to read the text—that is, has text-to-speech capabilities. Without the inclusion of text-to-speech capabilities, CMAS-like messages simply cannot be used by those who are blind. Moreover, there are questions about the more general usability of cell phones by people who are blind—the phones that they commonly employ fall into two categories. The first category consists of much older telephones with fewer features and settings and thus very simple interfaces that can readily be memorized. However, these older phones cannot receive CMAS messages, and it is unclear whether new phones that do support CMAS will be simple enough to be used by those who are blind. The second category consists of new smartphones that have built-in voice commands and voice menus. Today, these capabilities are only found on high-end smartphones, which may be too expensive for many.

SPECIAL CONSIDERATIONS FOR THOSE WITH IMPAIRED HEARING

Fortunately, there are several resources for emergency alerting that already exist for those who have a hearing impairment. E-mail and SMS alerting systems are already understood to work well. Television coverage of emergencies provides a great deal of text and visual graphics, so that even those who cannot hear what is being said can glean at least some of the needed information from the media coverage. There are National Oceanic and Atmospheric Administration (NOAA) weather radios with text displays, flashing lights to garner attention, and vibration functions to awaken a person. However, the content of the text component is much more limited than the audio (speech) information that is broadcast to the radios. Telephone emergency notification systems are not particularly useful for those with impaired hearing, as fewer people with impaired hearing have a land line, and most telephone alerting systems do not provide a TTY option, which would allow a person who is deaf to receive the calls

as text. One of the greatest challenges is the "eye-busy" situation in which the attention of a person with impaired hearing is focused elsewhere. The attention-getting mechanism must be disruptive enough to cause the user to change focus immediately.

Once the existence of an emergency is known by a person who has a hearing impairment, the Web is extremely useful for that person. As discussed previously, social and new video can play an important role. However, any video posted by emergency response or management needs to be captioned or it is not particularly useful for those with a hearing impairment. During the San Diego wildfires, a local organization posted video communicating in American Sign Language (ASL) for those with deafness, indicating that there were resources as well interpreters at a local shelter.

When people who are deaf are not at home, it becomes even more difficult to alert them to potential crises and disasters. Conventional sources of emergency warnings—car radios, sirens, and public-address systems—are inaccessible to them. Communication with bystanders and often even communication with responders are not possible. CMAS will play an important role in reaching people who have impaired hearing when they are not at home.

Gallaudet University's experience with opt-in emergency notification highlights the importance of CMAS participation's being opt-out. Gallaudet had an opt-in e-mail and mobile alerting system; however, only 15 percent of those under the age of 25 registered. The university has since moved to an opt-out e-mail alert. Students have their phones with them constantly, but if they cannot be induced to opt in, the system is useless. Students claim that they choose not to participate because too-frequent alerts would be annoying.

Tone and Vibration

An important component of CMAS is the unique tone to alert cellular telephone users that the message being received is different from other messages. The current specified tone is the EAS two-tone signal at 960 and 853 hertz. The cell phone industry supported these tones because most ring tones are in the high range. However, these frequencies can be difficult for those who are hearing-impaired, as their hearing capability usually resides in the lower frequencies. This challenge will need to be considered during future iterations of CMSAAC recommendations.

CMAS will also provide a distinct vibration cadence for people with impaired hearing. A recent study of a small sample of Gallaudet students and staff was done to determine what the best vibration cadence might

be.[2] Participants rated the following four vibratory temporal patterns presented on a mobile: (1) no pattern/constant, (2) even on-off, (3) long and short pattern similar to the one selected by CMAS, and (4) long and buzzy short pulses. Three different durations of each pattern were tried: 4 seconds, 8 seconds, and 12 seconds. Participants evaluated the effectiveness of the patterns and the similarity to their own devices' default tone, responding to the question of whether the patterns would be sufficiently distinguishable to get their attention in an emergency. Based on the results of this study, the signal needs to be long. The best ratings were for single signals at about 12.5 seconds. The even-on-off pattern, which is currently specified by CMAS, was somewhat more preferred. Although a temporal and unique pattern is important, the nature of the specific pattern is secondary to length in importance, according to the study.

The study at Gallaudet University did not examine the strength of the vibration, as that cannot be changed on current mobile devices. However, it is important to note that as devices become smaller, vibrations are becoming weaker. This could pose a challenge for future generations of alerting systems.

American Sign Language

Wireless RERC completed some research with people who are deaf who use American Sign Language (ASL) as their primary language. For most people who are born with deafness or who are early deafened, ASL, not English, is likely to be their primary language, and some may have very limited proficiency in English. (ASL and English are distinct languages, with quite different grammatical structures.) Wireless RERC simulated ASL alerts on smartphones. Test subjects received a CMAS-type 90-character message followed by a video of someone signing the alert. Most people thought that the combination of text and ASL was better than either one alone, suggesting that ASL may be a desirable capability in future iterations of CMAS.

The research conducted by Wireless RERC also found that the common terminology used in the National Weather Service alerts, such as "Take cover" or "Low-lying area," do not translate well into ASL and that not all people understood those terms. People in different parts of the country may use different ASL terms, but the advantage here at least is that National Weather Service alerts are also regionalized. The

[2] J. Harkins, P. Tucker, N. Williams, and J. Sauro. "Vibration Signaling in Mobile Devices for Emergency Alerting: A Study with Deaf Evaluators." *Journal of Deaf Studies and Deaf Education* (in press).

National Weather Service should work more closely with the community of people who are deaf to identify more easily understood words and descriptions.

SPECIAL CONSIDERATIONS WITH RESPECT TO DISABILITIES IN THE ELDERLY POPULATION

The overall population of the world is aging. Based on projections, by 2050 at least a full 20 percent of the U.S. population, or 70 million people, will be 65 years of age or older.[3] During disasters or crises, older adults are vulnerable for several reasons. They are much more likely to become casualties during a disaster, to suffer long-term psychological distress, and to recover economically more slowly.

Every sensory channel can become less sensitive as individuals age. For example, reduced fine motor control makes cellular telephone buttons and keys difficult to manipulate, a problem that is compounded for those with arthritis of the fingers. Research looking at the usability of several alternatives—touch screens, larger keyboards, and voice input—has found that touch screens are the easiest for elderly persons to use and can enable older adults to achieve performance comparable to that of younger adults. However, these solutions can present their own challenges, including accidental activation and arm fatigue.

Declines in vision can also impair effective response to warnings and alerts in older adults. Older adults generally have greater susceptibility to glare and difficulty distinguishing between certain colors, for example, blue and green. For CMAS and mobile devices, text for older persons needs to be made more readable through the use of 12- or 14-point, sans serif fonts and the avoidance of colors that are difficult to distinguish between. Older adults also tend to have difficulty hearing higher frequencies. As discussed earlier, most ring tones are in the higher frequencies, and this could prevent older adults from hearing the alerts. The preference of a particular vibratory cadence may differ by age.

In addition to an increase in visual and auditory disabilities or impairments that often occurs in older persons, there are comorbidities associated with age. Older adults thus often face multiple hindrances in receiving and responding to alerts and warnings delivered by mobile devices.

There are also significant challenges for those with diminished cognitive abilities. Steps such as comprehending an alert, seeking additional information, and deciding on an appropriate decision to take protective action rely heavily on cognitive abilities such as attention and memory.

[3] U.S. Census Bureau, "U.S. Interim Projections by Age, Sex, Race, and Hispanic Origin." Washington, D.C., 2004.

As people age, these abilities may diminish as a result of changes in perception, motor abilities, and cognition as well as changes in memory and reading comprehension skills. Research on cognitive aging indicates that there are often deficits in the selective attention of older adults, meaning that they may have difficulty identifying what information is important. To alleviate such limitations caused by cognitive challenges, it is useful to direct attention to the specific parts of a message that are the most important. Older adults may also experience memory deficit and may have problems simultaneously processing information while reading text. Cognitive overload or information overload can tax working memory, which suggests the importance of not sending multiple messages in rapid succession and of avoiding overly complex instructions and jargon.

All of the factors described above can decrease the usability of cellular telephones by older people, which is a major factor in reducing the adoption of cell phones by this group. Fifteen percent of Americans do not access the Internet on a regular basis; most of these are older adults. Only 25 percent of adults 65 years of age or older have cell phones. Furthermore, owning a cell phone does not necessarily mean the owner can use the device. Older adults are not generally viewed as early adopters of new technologies, but it is a misconception that they are technophobes. Their choice of whether or not to use cell phones or other information technology depends on the technology's utility and ease of use. Persons who are elderly will probably need to be trained not only to use the mobile devices but also educated about how useful the alerts and warnings system would be.

GENDER-BASED CONSIDERATIONS

The importance that gender can have in people's behavior during disasters was underscored by the 2004 Indian Ocean tsunami, in which a large majority of fatalities in some communities were women and children.[4] Many women drowned because they had not been taught to swim, in part because their customary role in the culture is to bring fish caught by the men to market. Another cultural factor involved in these drownings was the clothing customarily worn by women, in which they became entangled as they tried to escape the flood waters or search for their children. Children, who were most likely to be looked after by women, were also placed at higher risk.

In the United States, an important gender-based social pattern is that women are more likely than men to be the caregivers for children and elderly relatives, who are more likely to be at risk in a disaster. When

[4] BBC News, "Most Tsunami Dead Female—Oxfam," March 26, 2005.

issuing messages, consideration needs to be given to the recipients of the message and also to those who surround the people at risk. Another significant gender-based factor is that women tend to act sooner than men when a warning or alert is issued, which places men at greater risk. During Hurricane Mitch in 1998, a greater number of men than of women died.[5] This is generally attributed to the desire of men to protect their resources and family homes. Coinciding with studies highlighting the isolation of older populations, particularly of older males, data on Hurricane Katrina show that older African-American men tended to die disproportionately compared to other populations.[6]

CONSIDERATIONS RELATED TO RACE AND ETHNICITY

As discussed in Chapter 4, educational initiatives need to take into account an ethnic community's usual information channel. This information should inform the development of public education campaigns.

Preferred information sources (television, radio, or online) can vary across racial and ethnic lines. For example, it has been reported that many Mexican-Americans prefer to get information on community initiatives and programs at neighborhood meetings. Race and ethnicity also play a role in the public's response to alerts.[7] It is important to identify where credibility and trust lie and to use those avenues. Furthermore, racial and ethnic minorities are more likely to seek multiple confirmations from informal sources and to delay taking protective action. This was particularly apparent during Hurricane Katrina, when affected populations first gathered multiple generations living within the area before making a decision on protective action.

Language can also create a challenge in receiving messages among populations with limited proficiency in English. A tornado hit Saragosa, Texas, in 1987. Unfortunately an English-language warning was translated incorrectly, and Spanish-speaking people thought that they were getting

[5] The World Bank. "Hurricane Mitch—The Gender Effects of Coping and Crises." *PREMnotes,* No. 57, August 2001. Available at http://www1.worldbank.org/prem/PREMNotes/premnote57.pdf. Accessed December 21, 2010.

[6] Sebastian N. Jonkman, Bob Maaskant, Ezra Boyd, and Marc Loyd Levitan. "Loss of Life Caused by the Flooding of New Orleans After Hurricane Katrina: Analysis of the Relationship Between Flood Characteristics and Mortality." *Risk Analysis* 29:676-698 (2009).

[7] For additional information, see Ronald W. Perry and Lisa S. Nelson, "Ethnicity and Hazard Information Dissemination," *Environmental Management* 15(4):581-587 (1991); Ronald Perry and A. Mushkatel, *Minority Citizens in Disasters,* University of Georgia Press, Athens, Ga., 1996; Ronald Perry and M. Lindell, *Communicating Environmental Risk in Multiethnic Communities,* Sage, Thousand Oaks, Calif., 2004; or A. Fothergill, E.G.M. Maestas, and J.D. Darlington, "Race, Ethnicity and Disasters in the United States: A Review of the Literature," *Disasters* 23:156-173 (1999).

news of a tornado, not a *warning* of a tornado. People were gathered at community centers, and so they did not have access to radio. Others were home watching Spanish-language television, which was not broadcasting the message. These gaps in message receipt led to a large number of people not taking the appropriate protective action.

OBSERVATIONS OF WORKSHOP PARTICIPANTS

The panelists and participants in the discussion following the panel offered the following observations regarding communicating with at-risk populations:

- Affordability and accessibility have to be considered in developing warning systems and designing new technologies. A technology that is out of reach for a large segment of the population loses a great deal of its usefulness.
- Poor literacy is another challenge, which suggests that message testing needs to be done with a diverse set of test users.
- In addition to taking into account the challenges faced by elderly persons, it is also important to consider the use of alerts and warnings by children. For example, how will a child who is home alone respond to an alert?
- Credibility of the person or system conveying an alert or warning message is critical to ensuring that people take appropriate action, and people tend to trust "people like themselves." This suggests the need for attention to diversity in educational campaigns and message formulation.

6

Research Gaps

The Workshop on Public Response to Alerts and Warnings on Mobile Devices: Current Knowledge and Research Gaps had two principal goals: (1) to present what is known about the public response to alerts and warnings and how what is known about that response relates to the design, operation, and future development of the Commercial Mobile Alert Service (CMAS) program; and (2) to identify gaps in that research. The following sections present research opportunities identified by the committee and drawn from plenary presentations and discussions in breakout sessions of the workshop, along with associated implementation challenges, and a list of new technologies for alerts and warnings that are likely to raise additional research questions.

RESEARCH OPPORTUNITIES

Message Content

The CMAS specification provides for 90-character messages and prohibits the inclusion of uniform resource locators (URLs) that link to additional sources of information. Workshop participants indicated that relatively little is known empirically about how people will respond to such short alerts. Following is a list of research topics in the areas of message content and length identified by workshop participants:

- How does a 90-character limit for alerts constrain the ability to

provide the public with alerts? What implications does the 90-character limit have for public response?

- Can such a short message provide enough information to let individuals know that a significant event has taken place? Does it provide enough information for individuals to obtain additional information and take appropriate action to protect themselves?
- What are the message characteristics that lead to effective instruction in crisis situations?
- What does the public want the alert or warning message to say? What do they need to hear?
- To what extent will CMAS alerts trigger information-seeking behaviors, and what forms will such behavior take? Might that information-seeking behavior end up leading to the network overloads that the Commercial Mobile Service Alert Advisory Committee (CMSAAC) voiced concern about?

Message Dissemination

Segments of the population are becoming increasingly accustomed to receiving mobile text messages, including alerts and warnings, from other individuals, from businesses, and from government agencies. Indeed, there has been some experience with the use of text alerts in municipal and countywide systems as well as some research looking at the effectiveness of these systems, but there has been no experience with national-scale systems. Moreover, the user bases for the systems in place today are small, and participation is entirely on an opt-in basis—so these systems only reach users who are most interested in receiving such alerting information. Where opt-out systems have been established, such as at the Virginia Polytechnic Institute and State University, the populations have been relatively small and centered around a particular institution. In contrast, CMAS will establish a large-scale opt-out system that covers much of the general population. Following is a list of unanswered questions about how the general public might respond to CMAS messages:

- What are the consequences of too many messages (e.g., if the threshold for events which trigger alerts is set too low, if alerts cover too large a geographical area, if messages are repeated too often, or if there are too many false alarms)? Is there a threshold level that would cause people to ignore the messages or opt out from participating?
- What are the consequences of too few messages (e.g., if the threshold for alerts is set too high or messages are repeated too infrequently)?
- How does an alerts and warnings system generate the *credibility* needed to garner attention and guide the public's response?

- What level of geographical targeting is needed to make messages relevant? Is the targeting by county or equivalent entities sufficiently precise?
- Will the distinctive alert tone and other special features be sufficient to distinguish CMAS alerts from other text messages, including spam?

Information-Seeking Behavior

Given the limited information that can be provided in a CMAS alert, gaining an understanding of what people will do in response to alerts is a central question. Past research has shown that people respond to alerts and warnings by seeking additional information to confirm the event, determine their risk, and decide on their next action. Following is a list of research questions in the area of information-seeking behavior:

- Can the information-seeking behavior of people who receive CMAS alerts be predicted? What are the mechanisms for obtaining information and the sources of information that various subgroups use, and what information are they likely to seek?
- Will a CMAS alert create a demand for cell-phone-delivered information that could overwhelm bandwidth-limited communications channels such as the cellular networks over which people receive the alerts? For example, when they have received an alert, will people place phone calls to friends or relatives, search for Internet information, or browse news and information Web sites?
- How do individuals determine what are credible sources of information, and how does that determination differ by group?
- Would a pointer (URL) to a bandwidth-conserving official source of additional information actually reduce network congestion compared to the bandwidth used by individuals seeking information on their own? (That is, might some people be satisfied with that additional information, which could be specially tailored to reduce the bandwidth required to deliver it?)
- How could authoritative secondary sources best be incorporated into the CMAS program?

Social Media

New and social media such as Facebook and Twitter are being used both by professionals and by citizens to disseminate information in emergency situations. These tools may be used as a second and confirming source during an alert or warning. Additionally, social media tools are often designed and used to provide short pieces of information, which

may provide insight on the best use and content for CMAS messages. The following research topics with respect to social media tools for alerts and warnings were identified at the workshop:

- To what extent can results of research on social media be applied to gaining an understanding of what the public response to CMAS alerts might be?
- What roles will social media play in emergency communications? Will the social media be among the important secondary sources that people turn to for information? Will these media ever play a primary or major role in initial alerts? How do they relate to, or complement, CMAS?
- How might social media factor into CMAS and other official message dissemination?
- How will public education initiatives need to be designed to help the public understand and evaluate the usefulness of unofficial information sources?

Demographics and Access

Although the use of cellular telephones is widespread, not everyone owns, carries, or uses a cell phone, and cell phone service is not available in some sparsely populated areas. The following questions on these topics need further research:

- What is the current demographic profile of use of mobile devices in the United States?
- How does this use vary demographically (i.e., by age, income, ethnicity, gender)?
- How does this use of mobile devices vary with populations that have sensory or cognitive impairments?
- How do cell phones and text alerts fit into the broader set of communications sources (including interactions with other individuals and community institutions) that communities use to convey information about emergencies?
- What are the implications of supporting messages using text messages in only the Roman alphabet, which the initial rollout of CMAS supports? How can multiple languages best be incorporated into the subsequent phases of CMAS?

Context

The very nature of mobile devices means that people will receive CMAS messages in a wide variety of settings—including classrooms,

highways, public trains and buses, and innumerable other places. Additionally, travelers who are away from home will receive alerts for hazards with which they may not be familiar. Following are questions needing further research that are related to the context in which people will receive alerts and warnings:

- How will an individual's location affect his or her response to an alert or warning? (For example, what might be the response of a person who is driving compared with that of a person traveling on public transportation?)
- How will people deal with messages about which they have not been educated? (For example, how might someone respond who lives on the West Coast and who then travels to "Tornado Alley" in the midsection of the United States and is not familiar with the meaning of "tornado warning" or does not know what the appropriate protective action is in the case of a tornado?)

IMPLEMENTATION CHALLENGES

The following sections describe challenges ahead for CMAS with respect to public education, the incorporation of CMAS efforts into a broader context of other alerting systems, and testing, piloting, and research with respect to CMAS messaging.

Public Education

Workshop participants emphasized that an effective educational component is a key to introducing new alert technologies and methods. They cited past research showing that educating the public in advance about what actions to take under particular circumstances is key to effective public response. The constrained message context of CMAS places an even greater premium on educating the population in advance about the steps to take to protect themselves, the best places to go for additional information, and ways in which they might assist others.

The size and diversity of the populations that will receive CMAS alerts and the diversity of the hazards about which alerts may need to be sent indicate the challenges of developing educational programs with sufficient breadth. These programs will need to explain not only CMAS but also the necessary public responses associated with different types of alerts.

Incorporation into the Broader Context

Workshop participants observed that CMAS will need to be effectively incorporated into the broader context that includes other alerts and warnings systems, broadcast media, social media, and so forth. CMAS will have the greatest effect if messaging is consistent across these sources (because inconsistent messages will hamper an effective public response) and if their use is coordinated. (For example, if a CMAS message says to tune to a local broadcast channel for further information, it is important for local emergency management officials to have forged good relationships with those broadcasters so that the information will in fact be available.)

Testing, Piloting and Ongoing Research

The brevity of CMAS messages and the new contexts in which they will be used point to the importance of testing and research. It will be helpful to test the effectiveness of the wording of particular messages with test subjects. Before the CMAS program is introduced nationally, pilot programs can be used to determine what messaging is most effective, how CMAS messages can best be coordinated with other alerts and warnings, and so forth. Finally, ongoing research that gathers lessons learned from the early use of CMAS can be used to improve future generations of the program and to inform local, state, and federal officials on best practices for using the system.

FUTURE TOOLS FOR ALERTS

Advances in information and communications technologies are creating new opportunities for disseminating alerts and warnings. Several of these were discussed throughout the workshop, including the following:

- *Ad hoc wireless networks.* Most mobile devices have the capability to access wireless hot spots such as those found in coffee shops, bookstores, and public buildings. These semi-public wireless networks have much more capacity than that of cellular wireless networks. Can these networks be quickly and easily accessed during emergencies to disseminate information? Could they be useful as a redundant way of reaching mobile device users?
- *Mobile devices and social media as information sources for emergency managers.* Cell phones can be used by the public to report information from a disaster site. Social media and microblogging sites will continue to be used by those affected by a disaster or crisis. How can emergency managers best accumulate and access the information posted to social

media sites to respond to emergencies more efficiently? What are the privacy implications of doing so?

- *Location-based services for geographical targeting.* Geographic codes used in CMAS to localize messages by county or equivalent jurisdiction will provide a fair approximation of the geographic area and population affected by an emergency. However, much more precise alerting could be provided by attaching more precise geographic information to alerts and making use of the location capability built into cell phones. In what scenarios might such precision be useful? What are potential drawbacks, such as concerns about privacy?
- *Automation.* How could automation be used to provide more timely alerts for highly time-sensitive messages, such as those from Early Earthquake Warning Systems? Do technical or procedural factors make it difficult to deliver alerts sufficiently rapidly? Might automated systems lead to an undesirable level of false alarms?
- *Distributed sensing using mobile devices.* What is the potential for incorporating sensor devices in widely distributed devices such as cell phones to detect and provide more detailed information on events?

Appendixes

Appendix A

Workshop Agenda

APRIL 13-14, 2010
NATIONAL ACADEMY OF SCIENCES
WASHINGTON, D.C.

Tuesday, April 13, 2010

8:30 a.m. Welcome and Opening Comments
Jon Eisenberg, Director, Computer Science and Telecommunications Board (CSTB)
Ellis Stanley and Jeannette N.R. Sutton, Committee Co-Chairs
David Boyd, Program Manager, First Responder Group, Science and Technology Directorate, Department of Homeland Security (DHS)

9:00 Overview of CMAS
Denis Gusty, Branch Chief, Knowledge Management Tools, Science and Technology Directorate, U.S. Department of Homeland Security

9:45 Overview of Alerts and Warnings, the Alerts and Warnings System, and How People Respond

- What do we already know about processes by which individuals and organizations respond to hazards?
Michael Lindell, Texas A&M University

- What are the myths and realities surrounding public response?
  Joseph Trainor, University of Delaware

- How are text messaging and its use for alerts and warnings evolving?
  Peter White, AT&T Wireless

Moderator:
Garry L. Briese, Briese and Associates/Center for New Media and Resiliency

11:15 Current Use of Text Messages for Alerts and Warnings: Experiences and Lessons Learned

- Counties
  Barbara Childs-Pair, former Director, District of Columbia Homeland Security and Emergency Management Agency

- Universities
  Michael Mulhare, Virginia Polytechnic Institute and State University

Moderator:
Darrell Darnell, Office on Critical Infrastructure Protection and Resilience Policy and Strategy, White House National Security Staff

1:30 p.m. Messaging, Risk Communications, and Risk Perception

- What is known about communicating risk and messaging? How does this apply to CMAS, which will deliver 90-character text messages to cell phones?

Participants:
Timothy Sellnow, University of Kentucky
Matthew Seeger, Wayne State University

Moderator:
Brett Hansard, Argonne National Laboratory

3:15 Technologies for Alerts and Warnings: Past, Present, and Future

- What technologies are currently being used or developed to provide alerts and warnings? How will the public use these technologies, and what are the implications for CMAS today and in the future?

Participants:
Nalini Venkatasubramanian, University of California, Irvine
Robert Dudgeon, City of San Francisco's Department of Emergency Management
David Waldrop, Microsoft Corporation
Jennifer Preece, University of Maryland, College Park

Moderator:
John H. Sorensen, Oak Ridge National Laboratory

4:30 Breakout Sessions

- What are key research results and lessons learned related to public response?
- What are the implications of these results for current, planned, and future alert and warning systems that use mobile devices?
- What gaps exist in our understanding?
- What additional research might improve our understanding of public responses to alerts?

Wednesday, April 14, 2010

8:30 a.m. Breakout Report Back

9:00 Public Education and Training

- How do public education and training activities affect the public response to alerts? What can we learn from past and current public education campaigns?
- What are the implications for CMAS?

Participants:
Mark Benthien, Southern California Earthquake Center
Michele Wood, California State University, Fullerton
Daryl Rand, Harrison Advertising/The Rand Group

Moderator:
Inés Pearce, Pearce Global Partners, Inc.

10:30 Communicating with At-Risk Populations

- What are the challenges in reaching at-risk populations? What is known about these challenges, and where are the gaps in our understanding? What are the implications for CMAS?

- An Aging Population
Christopher B. Mayhorn, North Carolina State University

- People with Disabilities
Ed Price, Georgia Institute of Technology

- The Hearing Impaired
Judy Harkins, Gallaudet University

- Minorities (and Moderator)
Brenda Phillips, Oklahoma State University

12:00 noon Closing Session and Conclusions

Ellis Stanley and Jeannette N.R. Sutton, Committee Co-Chairs
Denis Gusty, Program Manager, First Responder Group, Science and Technology Directorate, U.S. Department of Homeland Security

Appendix B

Biosketches of Workshop Speakers

Mark Benthien is the director for Communication, Education and Outreach for the Southern California Earthquake Center (SCEC), headquartered at the University of Southern California (USC). Mr. Benthien received a Bachelor of Science degree in geophysics from the University of California at Los Angeles in 1995 and a Master of Public Policy degree from USC in 2003. He communicates earthquake knowledge to end users and the general public in order to increase earthquake awareness, reduce economic losses, and save lives. Components of his work include the following: (1) coordinating productive interactions among SCEC scientists and with partners in science, engineering, risk management, government, business, and education; (2) managing activities that increase earthquake knowledge and science literacy at all educational levels; (3) leading efforts to improve earthquake hazard and risk assessments; and (4) promoting earthquake preparedness, mitigation, and planning for response and recovery. Many of these efforts are in coordination with members of the Earthquake Country Alliance, a private-public partnership of organizations that provide earthquake information and services, for which Mr. Benthien serves as the executive director. In this role he is the lead organizer of the Great California ShakeOut, a new annual earthquake drill with millions of participants throughout the state.

David G. Boyd is the director of the Command, Control and Interoperability Division at the Department of Homeland Security (DHS) and is responsible for research and development (R&D) programs that support

command and control, communications, computing, intelligence, surveillance, reconnaissance, cybersecurity, and interoperability. Before joining DHS, Dr. Boyd served as the director of science and technology for the National Institute of Justice, where he managed R&D programs in every facet of technology affecting law enforcement and corrections, including the forensic sciences, less-than-lethal technologies, information and communications technologies, and concealed weapons and contraband detection, among others. Dr. Boyd is a retired U.S. Army Officer and a recipient of the 2005 Presidential Rank Award, the highest recognition available in the Federal Civil Service. With graduate degrees in management and public policy analysis as well as a doctorate in decision sciences, he has also published extensively in military, law enforcement, technical, and general-circulation publications.

Garry L. Briese is a co-founder of the Center for New Media and Resiliency and a principal in the professional services and consulting company Briese and Associates. In April 2008, he was appointed by the Secretary of the Department of Homeland Security (DHS) as the Federal Emergency Management Agency's (FEMA's) regional administrator for DHS/FEMA Region 8, for Utah, Colorado, Wyoming, Montana, North Dakota, and South Dakota. Mr. Briese served until January 2009 in this position, as the senior DHS/FEMA official in the region. During that time, the 2008 Democratic National Convention was held in Denver, Colorado, and FEMA Region 8 was the lead agency for federal consequence management response preparations and response. Prior to coming to DHS/FEMA, he served as vice president, Emergency Management and Homeland Security, for ICF International, a NASDAQ-listed professional services corporation based in Fairfax County, Virginia. Mr. Briese served as the executive director of the 12,000 member International Association of Fire Chiefs (IAFC) from 1985 to 2007. Previously he had served as the executive director of the Florida College of Emergency Physicians, and he has more than 36 years' experience in all levels of emergency services, including local, state, national, and international. He is a well-known author and lecturer on leadership and on the future challenges for the fire and emergency services community and has coauthored two first-responder emergency medical textbooks as well as an innovative textbook for the basic training of firefighters. He developed several innovative programs such as the Fire Service Leadership Partnership Program, an internationally recognized labor-management relations program, and the National Fire Service Near Miss Reporting System. Mr. Briese has served as a career and volunteer firefighter as well as the publicly elected chair of the Board of Fire Commissioners of a fire protection district in Orange County, Florida. He is a member of the advisory committee to the Board of the

National Fallen Firefighters Foundation and is a member of the board of directors of the IAFC Foundation. Mr. Briese received his B.A. in international relations from the University of South Florida and his master's degree in public administration from Nova Southeastern University. He is an adjunct faculty member in the Center for Trauma at the University of Colorado at Colorado Springs.

Barbara Childs-Pair is the former director of the District of Columbia Homeland Security and Emergency Management Agency and the homeland security adviser for the National Capital Region. In that role, she developed play books and protective action guides for the mayor of the District of Columbia, cabinet officials, and elected officials. She also assisted with the development of the first-hour checklist and play books for the National Capital Regional after September 11. Ms. Childs-Pair had extensive experience with briefing mayors, governors, and White House officials during her more-than-30-year career with the District of Columbia.

Darrell Darnell is the director, Critical Infrastructure Protection and Resilience Policy, National Security Staff in the newly created White House Office on Resilience. He assumed this position on October 26, 2009. Prior to joining the National Security Staff, Mr. Darnell was the director of the District of Columbia Homeland Security and Emergency Management Agency, from March 2007 to October 2009. As director, he led the development of an overall public safety strategy to ensure the readiness and operational capability of the District of Columbia to prevent, or respond to and recover from, natural hazards, intentional acts of destruction, or accidental emergencies. He established a Homeland Security Program for the District of Columbia and directed the planning and interagency coordination of District of Columbia support to special events and National Security Special Events such as the visit of Pope Benedict XVI to the United States and the inauguration of President Obama. Mr. Darnell served as the director, Preparedness Division, Department of Homeland Security Headquarters Operational Integration Staff (I-Staff), where he oversaw DHS and interagency operational planning and the execution of national exercise, evaluation, and preparedness assessment programs. Prior to his assignment to the I-Staff, Mr. Darnell served as the director of the Local Programs Division within the State and Local Program Management Division at Office of State and Local Government Coordination and Preparedness where he oversaw the development and implementation of antiterrorism and counterterrorism preparedness programs for the Urban Areas Security Initiative. Mr. Darnell was a special assistant to the director of the Office of Community Oriented Policing Services (COPS), and

he assisted the Office of the Director in the administration and management of the COPS Office, as well as serving as a liaison for the director to state and local law enforcement officials. Mr. Darnell has served as an adjunct professor at Prince George's Community College in Maryland and at the University of Maryland, University College-Asian Division. He served honorably as a member of the United States Air Force, retiring in November 1997. Mr. Darnell is a senior fellow at the George Washington University Homeland Security Policy Institute and the first recipient of the Founder's Award from the Naval Postgraduate School's Center for Homeland Defense and Security. He is a graduate of the Harvard School of Public Health and Kennedy School of Government's National Preparedness Leadership Initiative.

Robert Dudgeon is a deputy director in the City of San Francisco's Department of Emergency Management and is responsible for the Division of Emergency Services. The division is responsible for coordinating the city's multidisciplinary response to emergencies, developing emergency plans, managing the city's exercise program and public preparedness programs. The Emergency Medical Services Agency, also housed in the division, is responsible for regulatory oversight of the city's Emergency Medical Services System and medical planning for disasters. In addition, the division is responsible for managing homeland security and other related preparedness grants for the city. As an adjunct assignment, Mr. Dudgeon serves as a senior adviser to Mayor Gavin Newsom on matters of disaster preparedness and emergency management. Mr. Dudgeon holds a B.A. in management and has more than 20 years of experience ranging from first responder/paramedic to managing the San Francisco's emergency operations center.

Denis Gusty serves as the Program Manager, First Responder Group, Science and Technology Directorate, U.S. Department of Homeland Security. In addition, he leads the data interoperability programs of the Office of Interoperability and Compatability, which aim to improve incident response and recovery by developing tools that include the Federal Emergency Management Agency (FEMA) Integrated Public Alert and Warning System (IPAWS) and the Commercial Mobile Alert Service (CMAS) and the EDXL messaging standards that help emergency responders manage incidents and exchange information in real time. Mr. Gusty came to Command, Control, and Interoperability from the U.S. General Services Administration (GSA), where he served as director of GSA's Office of Intergovernmental Solutions. Prior to joining GSA, Mr. Gusty served as a program manager at the U.S. Department of Labor. In that role, he was responsible for helping to implement the President's Management Agenda

by managing the e-Government initiative, GovBenefits.gov. Mr. Gusty has more than 7 years of experience in developing intergovernmental partnerships and information technology policy and practices.

Brett Hansard is the manager of the Argonne National Laboratory (ANL) Risk Communication and Management program, which provides public affairs training, product development, and exercise support to government, nonprofit, private-sector, and international organizations of all types. He has been with ANL since 1999. He has a deep and varied background in emergency public information, having served as spokesperson on stories of local, national, and international significance. As a Federal Emergency Management Agency (FEMA) public affairs officer, he has worked on more than 24 presidentially declared disasters, including the floods in the Midwest in 1993; the Northridge earthquake in California in 1994; the flood in Grand Forks, North Dakota, in 1997; Hurricane Floyd in 1999; the Colorado wildfires in 2002; and Hurricane Katrina in 2005. In September 2001, Mr. Hansard served as lead public affairs officer in support of FEMA Urban Search and Rescue efforts at the World Trade Center. In February 2002, he helped coordinate FEMA external affairs operations at the 2002 Olympic Winter Games in Salt Lake City, Utah, and in August 2008 he oversaw the FEMA media monitoring and analysis program at the Democratic National Convention in Denver, Colorado. Mr. Hansard has performed a variety of roles within a Joint Information System/Joint Information Center, including serving as external affairs lead and public affairs lead, performing research and writing, and working on the news desk and on rapid response. He is also a certified fire information officer. Previously Mr. Hansard served as press secretary and research assistant for the Senate Veterans' Affairs Committee and as a staff member for U.S. Senator Alan Cranston. He has worked as campaign coordinator and spokesperson for a California State Senate campaign in Los Angeles. He has written numerous articles, speeches, and op-ed articles for political candidates, senior public officials, and chief executive officers. He has an M.P.P. from the Harvard University Kennedy School of Government and a B.A. in journalism from California State University, Northridge.

Judy Harkins is a professor in Gallaudet University's Department of Communication Studies. She is the founding director of the Technology Access Program at the university and a principal investigator of the Rehabilitation Engineering Research Center on Telecommunications Access in cooperation with the Trace Center, University of Wisconsin. Her research bears both directly and indirectly on the accessibility of emergency communications to people with disabilities. At Gallaudet she has developed a course on communication accessibility for deaf under-

graduates. Dr. Harkins served in an advisory capacity to the Federal Communications Commission (FCC) in the User Needs Group of the Commercial Mobile Service Alert Advisory Committee (CMSAAC), as an alternate on Network Reliability and Interoperability Council VII, and on two other FCC Federal Advisory Committees related to consumer issues and telecommunications accessibility. She comments frequently in FCC proceedings concerning public safety and people with disabilities, and she has participated actively in industry forums established within the Alliance for Telecommunication Industry Solutions to produce solutions to accessibility problems. In 2009-2010, she was honored with the Lifetime Achievement Award of Telecommunications for the Deaf, Inc., the Chairman's award of the Institute of Electrical and Electronics Engineers/Communications Quality and Reliability Technical Committee, the Susan B. Hadden award for pioneering work in telecommunications by the Alliance for Public Technology, and a certificate of appreciation for contributions to the accessibility committee of the National Emergency Number Association.

Michael Lindell is the director of the Hazard Reduction and Recovery Center at Texas A&M University. He has a graduate degree in social psychology from the University of Colorado (1975), with a specialty in disaster research, and has completed hazardous materials emergency responder training through the Hazardous Materials Specialist level. Dr. Lindell has more than 25 years of experience in the field of emergency management, during which time he has conducted a program of research on the processes by which individuals and organizations respond to natural and technological hazards. In addition, he has had extensive experience in providing technical assistance to government agencies, industry groups, and private corporations in the development of emergency plans and procedures. Dr. Lindell has written extensively on emergency management and is the author of more than 60 technical reports, 60 journal articles and book chapters, and 5 books and monographs. Much of his research, especially that supported by the National Science Foundation (NSF), has examined the processes by which affected populations respond to warnings of the imminent threat of a natural or technological hazard. His organizational research, also supported by NSF, has looked at the effects of disaster experience and the community planning process on the development of adaptive strategies for promoting emergency preparedness. Dr. Lindell has served as an adjunct faculty member for the Federal Emergency Management Agency's National Emergency Training Center, lecturing on disaster psychology and public response to warning. He also has been an instructor in other workshops that federal agencies have sponsored for state and local emergency planners throughout the

country, and he has appeared as a panelist in conferences on protective actions in hazardous materials emergencies. In addition, he has been a consultant to five of the Department of Energy national laboratories on a variety of topics in the area of emergency preparedness and response.

Christopher B. Mayhorn, an associate professor and program coordinator of the Human Factors and Ergonomics Psychology program, joined the faculty at North Carolina State University in 2002. He earned a B.A. from the Citadel (1992) and an M.S. (1995), a graduate certificate in gerontology (1995), and a Ph.D. (1999) from the University of Georgia. He also completed a postdoctoral fellowship at the Georgia Institute of Technology. His teaching duties include courses in research methodology, human factors, and cognition. Dr. Mayhorn's current research interests include everyday memory, decision making, human-computer interaction, and safety and risk communication, as well as the design of home medical devices for older adult populations. Dr. Mayhorn has more than 30 peer-reviewed publications, and his research has been funded by government agencies such as the National Science Foundation. Currently, Dr. Mayhorn is serving on the Human Factors and Ergonomics Society (HFES) Government Relations Committee and as the president of the Carolina Chapter of HFES.

Michael Mulhare was appointed director of emergency management at Virginia Polytechnic Institute and State University (Virginia Tech) in November 2008. The university's Office of Emergency Management is a new office, reporting to the vice president of administrative services, which oversees emergency planning and preparedness and response. Mr. Mulhare is responsible for developing and maintaining a comprehensive and integrated emergency management program utilizing an all-hazard approach to the coordination and management of risk assessment, emergency management, disaster planning, and continuity of operations planning and response activities. He had previously, since 1985, served the Rhode Island Department of Environmental Management in a variety of capacities: from 2001 to 2008 as the department's emergency response administrator in the Office of the Director, and in 2006 he took on the added duties of chief of the new Office of Emergency Response. Mr. Mulhare is a registered professional engineer, with more than 25 years of practical experience as an emergency manager, first responder, and scientist and engineer.

Inés Pearce is the chief executive of Pearce Global Partners, Inc. (PGP), addressing the needs of government, business, nonprofit organizations, and communities to reduce the potential for loss of life and property from

natural and human-caused disasters. Ms. Pearce is a business continuity and emergency management expert with 17 years of professional experience, including 12 years specializing in public-private partnerships. She serves as the senior adviser for the Business Civic Leadership Center (BCLC) of the U.S. Chamber of Commerce, where she is the BCLC's primary point of contact for community-level disaster preparedness, recovery, and partnership coordination. She has also serves as the BCLC's liaison during disasters, for the facilitation of long-term recovery, such as after the earthquakes in Chile and Haiti in 2010, the American Samoa tsunami in 2009, and, in 2008 the flooding in Iowa, storms in Florida, and hurricanes in Texas and Louisiana. In 2009, Ms. Pearce was selected to the National Research Council's Committee on Private-Public Sector Collaboration to Enhance Community Disaster Resilience. Before launching PGP, Ms. Pearce was appointed director of Seattle Project Impact for the City of Seattle Office of Emergency Management, managing four mitigation programs that provided resources for safer schools, homes, and businesses, as well as better hazard maps. During her tenure, Seattle Project Impact received numerous national excellence awards. As an expert in public-private partnerships, Ms. Pearce has represented the World Economic Forum at the United Nations' (UN) Global Platform for Disaster Risk Reduction in Geneva, Switzerland, and has addressed the UN regarding public-private partnerships at the World Conference for Disaster Reduction in Kobe, Japan. In 2003, Ms. Pearce was inducted into the Contingency Planning and Management (CPM) Hall of Fame in the Public Servant category. She has also received two National Excellence Awards from the Western States Seismic Policy Council; in 2009, she received an Award of Recognition from the City of Los Angeles for the successful planning of the Great Southern California ShakeOut, the largest earthquake drill in U.S. history, with 5.5 million participants, surpassed in 2009 with 6.9 million registrants statewide; and in 2010, she received the U.S. Geological Survey's Shoemaker Award for Communications Excellence. Ms. Pearce is the president of the Disaster Resistant Business Toolkit (DRB Toolkit®) Workgroup, a 501c-3 public charity that provides a comprehensive software tool facilitating the process for small businesses and nonprofit organizations to create and then implement improved disaster readiness plans; the president of the Contingency Planning and Recovery Management group; and a member of the board of the Cascadia Regional Earthquake Workgroup. She received her B.A. degree in political science from Gonzaga University.

Brenda Phillips teaches emergency management and research methods courses, with particular expertise in disaster recovery and high-risk popu-

lations at Oklahoma State University. She is a researcher with the Center for the Study of Disasters and Extreme Events and a faculty member in the Fire and Emergency Management Program. Her research has been funded by the National Science Foundation, the U.S. Geological Survey, and the Natural Hazards Center. She taught in Costa Rica through a Rotary Foundation International Grant, received a Fulbright-Hays Award to Pakistan, and participated in a National Science Foundation Researcher Exchange with the People's Republic of China. She has given invited presentations in New Zealand, Australia, Germany, Costa Rica, and India, and at the U.S. National Academies, Church World Services, the National Weather Service Training Center, and various state offices of emergency management. Her work has been published in the *Journal of Emergency Management*, *Disaster Management*, *Disasters*, *International Journal of Mass Emergencies and Disasters*, *Sociological Focus*, and *Humanity and Society*.

Jennifer Preece is a professor in and dean of the College of Information Studies—Maryland's iSchool—at the University of Maryland. Her research focuses on the intersection of information, community, and technology. She is particularly interested in community participation on- and off-line. Dr. Preece is the author of eight books and numerous research articles. Two of her books are *Online Communities: Designing Usability, Supporting Sociability* (Wiley, 2000) and a coauthored best-selling text entitled *Interaction Design: Beyond Human-Computer Interaction* (Wiley, 1st ed., 2002; 2nd ed., 2007; 3rd ed., 2011).

Ed Price is the research director of the Interactive Media Technology Center at the Georgia Institute of Technology. He is one of the founders of the center, starting there as a student at its inception in 1989. He has led many research efforts, including the award-winning Odyssey Online educational program, which teaches cultural history through archeological artifacts. Dr. Price holds two worldwide patents in telemedicine and has filed additional patents on audio searching and eCommerce networks. He is past chair of the international Video Development Initiative (ViDe), which is the lead organization behind the proposed International Telecommunication Union H.350 standard for videoconferencing directories. Dr. Price is also a project director in the Rehabilitation Engineering Research Center on Mobile Wireless Technology for Persons with Disabilities, leading the development efforts in universal control and multimodal interfaces as well as research into emerging wireless technologies. He is also a primary representative to the INCITS V2 standards committee developing the Alternative Interface Access Protocol, an emerging standard which will ensure that mobile devices will be able to interact with their surrounding environments.

Daryl Rand, currently with Harrison Advertising and The Rand Group, has had a 35-year career marked by long-term assignments in advertising, public relations, and media management. For the past 5 years, Ms. Rand has spearheaded an initiative focused on launching public education/awareness outreach campaigns for many of the nation's major cities, including New York and San Francisco, and the State of New Jersey. She participated in crafting the Emergency Management Accreditation Program's Guidelines for Public Awareness Programs to strengthen public education. Her focus on the need to implement sustained readiness education was instrumental in forming a coalition of the country's top emergency managers, now known as the Top Eight. Her emergency management and homeland security perspectives have been broadened as a result of her membership in the Washington-based organization Business Executives for National Security. Ms. Rand has been a consultant to CBS Outdoor, the global leader in Out-of-Home Media, and its predecessors for the past 25 years. In that capacity, she helped negotiate the transit advertising franchise and subsequent extensions with New Jersey Transit for advertising rights on 3,000 buses managed by the only state authority operated by CBS Outdoor. Ms. Rand also supervised all statewide transit advertising operations and sales for their New Jersey market. She is the founder and president of Harrison Advertising, Inc., a Women's Business Enterprise Corporation, fully certified by the State of New Jersey, New Jersey Transit, the Port Authority of New York and New Jersey, the Metropolitan Transit Authority, Washington Metropolitan Area Transit Authority, and Southeastern Pennsylvania Transit Authority. In addition, she and her father before her have served the Provident Bank as advertising and public relations counsel for five decades. Eight years ago, Ms. Rand founded the partnership of RM International with Alan Marcus to continue to serve the bank in that capacity.

Matthew Seeger is currently a professor and chair in the Department of Communication at Wayne State University, Detroit, Michigan. His teaching and research are in communication ethics, crisis and emergency risk communication, organizational responses to crisis and disaster, interagency coordination, and informational needs. Dr. Seeger also served as associate dean of the Graduate School at Wayne State. He has advised 35 doctoral dissertations in the areas of organizational communication, crisis communication, and related topics. He has served as a consultant to AT&T, DaimlerChrysler, Blue-Cross/Blue-Shield, General Motors, K-Mart Corporation, and the State of Michigan, among other organizations. He has worked with the Centers for Disease Control and Prevention (CDC) and the State of Michigan on issues of crisis communication and the public health, cross-border coordination, and crisis leadership. He participated in

the CDC's debriefing and critique of its response to the 2001-2010 anthrax episode and in developing the CDC's crisis communication protocols. He has worked very closely with the CDC on issues of pandemic influenza preparedness. Dr. Seeger also worked with the U.S. Department of Agriculture on issues of risk communication. In 2002, he participated in a U.S. Department of State grant to train Russian government officials in effective crisis communication. His work on communication risk and crisis management has appeared in the *Handbook of Crisis and Risk Communication, International Encyclopedia of Communication, Journal of Health Communication Research, Communication Yearbook, Handbook of Public Relations, Public Relations Review, Communication Studies, Journal of Business Communication, Journal of Change Management, Management Communication Quarterly, Southern Communication Journal, Journal of Business Ethics, Journal of Applied Communication Research, Journal of Health Care for the Poor and Underserved, Health Promotion and Practice,* and *Communication Research Reports* and in several edited collections and proceedings. His books include *Effective Crisis Communication* (Sage, 2007); *Crisis Communication and the Public Health* (Hampton, 2008); *Communication and Organization Crisis* (Praeger, 2003); and *Risk Communication: A Message Centered Approach* (Science Press, forthcoming). He also wrote *Ethics in Organizational Communication* (Hampton, 1998), a comprehensive treatment of ethical issues of communication faced by organizations. Dr. Seeger has received research support from CDC, the National Science Foundation, the National Center for Food Protection and Defense, and the State of Michigan. His current research interests focus on informational needs during crisis, crisis and public health, communication and natural disasters, crisis discourse, and the application of chaos theory and learning theory to crisis. He recently completed *Communication, Organization and Crisis* for Quorum Press and is working on a book dealing with crisis communication for Sage and editing *Crisis Communication and the Public Health* for Hampton Press.

Timothy Sellnow is a professor of communication at the University of Kentucky where he teaches courses in research methods, organizational communication, and risk and crisis communication. Dr. Sellnow's research focuses on bioterrorism, pre-crisis planning, and communication strategies for crisis management and mitigation. He has conducted funded research for the Department of Homeland Security, the U.S. Department of Agriculture, and the Centers for Disease Control and Prevention. He has published numerous articles on risk and crisis communication and has coauthored four books. His most recent book is entitled *Risk Communication: A Message-Centered Approach* (Springer, 2008). Dr. Sellnow is the former editor of the National Communication Association's *Journal of Applied Communication Research.*

John H. Sorensen—See biosketch in Appendix C, "Committee and Staff Biosketches."

Joseph Trainor is a research assistant professor at the Disaster Research Center, University of Delaware, with joint appointments in the Department of Sociology and Criminal Justice and the School of Urban Affairs and Public Policy. He is a member of the University of Delaware Research Council and an active participant in the International Research Committee on Disasters. His primary research interests include international aspects of disasters, social networks, disaster researcher and practitioner integration, warnings and protective action, human behavioral response to disasters, effects of organizational design, and patterns of association in multi-organizational networks. Dr. Trainor has significant research experience and has been involved in a number of funded research projects, both in the United States and internationally. He has authored or coauthored more than 12 articles and book chapters on disaster-related topics. He was the principal network analyst in a study of multi-organizational coordination after the World Trade Center attacks on September 11; the lead graduate researcher on a project to examine the organizational and institutional development and operation of Emergency Support FuctionESF#9/Search and Rescue in the United States; and he conducted an analysis of the perspective of FEMA employees on the impacts organizational design. In addition to more traditional quantitative and qualitative research, he also has engaged in a number of field research projects. He was a member of a research reconnaissance team that traveled to India and Sri Lanka immediately following the December 2004 Indian Ocean tsunami, and later he served as the lead field researcher for the Disaster Research Center's effort to examine the social aspects of Hurricane Katrina. Dr. Trainor has also recently been working to develop a number of disaster planning and outreach services. The goal of this effort is to provide state and local communities with assistance as they engage in the disaster planning process and at the same time to provide emergency management students with real-life experience. In addition to other efforts in this area, he assisted in the development of an approach to writing Emergency Operations Plans (EOP), a planning process for small communities, and has been involved in writing a number of research summaries for state, federal, and international governments that summarize different aspects of key social science research on disasters. Finally, Dr. Trainor has been actively participating in the establishment of the University of Delaware's new degree program in disaster science and management.

Nalini Venkatasubramanian is currently a professor in the Department of Computer Science at the University of California, Irvine. She has had

extensive research and industry experience in the areas of distributed systems, adaptive middleware, and distributed multimedia systems and mobile applications. Her experience in crisis alerting systems has been in the context of developing fast, reliable, and customized alerts to large populations in the presence of surge demands and infrastructure failures—in particular through the RESCUE project and the CrisisAlert System. Professor Venkatasubramanian has published more than 150 papers and is a recipient of several awards, including the NSF Career Award and Teaching Excellence Awards. She has served on the program committee and organizing committee of a variety of conferences on middleware, distributed systems, and mobile applications.

Dave Waldrop served as the architect of Microsoft's Vine, a location-aware social networking application focused on keeping family and friends in contact during emergencies. Prior to joining Microsoft, he served as the vice president of Netserv as well as the vice president of sales for Centennial Computer Systems. Mr. Waldrop has extensive experience in senior leadership in sales, customer and product marketing, and business development, and a distinguished track record of driving innovation through start-up business models, establishing, negotiating, and driving large strategic partnerships, and developing and leading high-performance teams.

Peter White began his professional career as an assistant district attorney in the New York County District Attorney's Office, where he tried felony cases and later specialized in complex criminal investigations using eavesdropping and other electronic surveillance. He joined the wireless industry in 1995 as a director with AT&T Wireless Services and has held numerous legal and external affairs positions since that time. In 2003, Mr. White joined the International Division of AT&T Wireless, where he was responsible for all company relationships with governments from Bermuda, to the Cayman Islands, to Trinidad and Tobago. He returned to domestic matters in 2005, where he currently is responsible for enhanced-911 and other emergency communications, roaming, and related policy issues.

Michele Wood received a doctorate in public health from the Department of Community Health Sciences at the University of California, Los Angeles (UCLA); she also holds a master's degree in community psychology. Dr. Wood is an assistant professor in the Health Science Department at the California State University, Fullerton, where she teaches courses in statistics and program design and evaluation. She has 20 years' experience designing, implementing, and evaluating interventions. Through

her affiliation with the Southern California Injury Prevention Center in the UCLA School of Public Health, she managed a national household preparedness survey, conducted as part of the National Center for the Study of Terrorism and Responses to Terrorism (START) program through the University of Maryland's Center of Excellence, as well as a California household telephone survey on earthquake preparedness.

Appendix C

Committee and Staff Biosketches

Ellis Stanley (*Co-Chair*), director of Western Emergency Services, has more than 32 years of work experience in emergency management, beginning as the director of emergency management for Brunswick County, North Carolina, in 1975. While in Brunswick County, he was selected as the first fire marshal for the jurisdiction and also served as fire and rescue commissioner. There Mr. Stanley was very involved with hurricane planning and response as well as having developed one of the first fixed-nuclear-facility plans in the nation following the accident in 1979 at the Three Mile Island Nuclear Generating Station. In 1982 Mr. Stanley was appointed director of the Durham-Durham County Emergency Management Agency, where he worked very closely with the world's largest research park in the North Carolina Triangle area and was heavily involved with hazardous materials planning. In 1987 he was appointed director of the Atlanta-Fulton County Emergency Management Agency by the governor of Georgia. While in Atlanta, Mr. Stanley had extensive experience in major event planning (the 1988 Democratic National Convention, the visit of Nelson Mandela in 1995, and the 2006 International Olympic Games). Mr. Stanley was appointed in 1997 as assistant city administrative officer for the City of Los Angeles and in 2000 as the general manager of the Emergency Preparedness Department for the City of Los Angeles until his retirement in 2007. Mr. Stanley joined Dewberry, LLC, in November 2007 as the director of Western Emergency Management Services. In March 2008, he was chosen to be the director of DNC Planning for the city and county of Denver, Colorado. Because of the success of the Democratic National

Convention, the date August 29, 2008, was proclaimed "The Ellis Stanley Day in Denver."

Jeannette N.R. Sutton (*Co-Chair*) is a senior research scientist at the Trauma Health and Hazards Center at the University of Colorado at Colorado Springs, National Institute for Space, Science, and Security Centers. Dr. Sutton most recently worked as a research faculty member at the Natural Hazards Center at the University of Colorado, Boulder, where she coordinated a number of research projects on community preparedness, regional collaboration and the Urban Areas Security Initiative, warning systems for extreme events, and, most recently, the uses of social media during disasters and crisis events. Dr. Sutton is currently the principal investigator (PI) on two separate 3-year National Science Foundation-funded projects. The first, Disaster Resilient Rural Communities, focuses on the effects of information access on perceptions of collective efficacy in rural communities affected by seasonal hazards (with co-PI Charles Benight). The second project, Informal Online Communication in Crises and Disaster Events, is a comparative examination of online social networks that emerge in response to hazardous events (with co-PI Carter Butts). Dr. Sutton is also affiliated with the Argonne National Laboratory, where she conducts research on social media policy for emergency management and response. In addition, she serves as an academic adviser to Crisis Commons and the volunteer technical community responding to disasters. Dr. Sutton's research has been featured in *Nature*, *Reason*, and *Emergency Management Magazine*. She received her Ph.D. in sociology from the University of Colorado at Boulder, and a Master of Divinity from Princeton Theological Seminary. She served as a victim services coordinator following the Columbine High School shooting in 1999.

Louise Comfort is a professor of public and international affairs and the director of the Center for Disaster Management at the University of Pittsburgh's Graduate School of Public and International Affairs. She teaches in the field of public policy analysis, information policy, organizational theory, and sociotechnical systems. She holds degrees in political science from Macalester College (B.A.); the University of California, Berkeley (M.A.); and Yale University (Ph.D.). She has been the principal investigator of the Interactive, Intelligent, Spatial Information System (IISIS) Project, from 1994 to the present (http://www.cdm.pitt.edu). Her recent publications related to disaster management include the following: *Designing Resilience: Preparedness for Extreme Events* (University of Pittsburgh Press, 2010); "Retrospectives and Prospectives on Hurricane Katrina: Five Years and Counting" (*Public Administration Review*, 2010); "Transition from Response to Recovery: The January 12, 2010 Haiti Earth-

quake" (*Earthquake Spectra*, 2010); "The Dynamics of Disaster Recovery: Resilience and Entropy in Hurricane Response Systems 2005–2008" (*Public Organization Review,* 2009*);* and "Crisis Management in Hindsight: Cognition, Communication, Coordination and Control" (*Public Administration Review*, 2007). Dr. Comfort is currently engaged in three large-scale research projects on crisis management. In August 2009 she concluded a 5-year National Science Foundation (NSF)-funded research project on Secure CITI: A Critical Information Technology Infrastructure, in which she served as a co-PI with two computer scientists. The project examined the design of networks of information infrastructure for urban regions. Dr. Comfort is currently the PI on a 3-year NSF-funded project on Designing Resilience for Communities at Risk: Improving Decision Making to Support Collective Action Under Stress. This project focuses on the design and development of a computational model for an early tsunami detection system for a test bed off the coast of Padang, Sumatra, Indonesia. Further, she is engaged in the development of a test bed for information systems to be implemented with the collaboration of practicing agencies in the Pittsburgh metropolitan region, Pennsylvania. She is also a project lead investigator on a research arm to develop an electronic dashboard for a large research project, Public Health Adaptive Systems, that is examining the adaptive capacity of the public health system. This project, conducted jointly with three other research arms, is directed by Margaret Potter, Graduate School of Public Health, University of Pittsburgh, and funded by the Centers for Disease Control and Prevention. In her research, Dr. Comfort has focused on the design, development, and integration of information processes to support decision making in urgent, uncertain environments.

John Harrald is a professor at the Center for Technology, Security, and Policy at Virginia Polytechnic Institute and State University. He previously served as the director of the George Washington University (GWU) Institute for Crisis, Disaster, and Risk Management (www.gwu.edu/~icdrm) and is a professor emeritus of Engineering Management and Systems Engineering in the GWU School of Engineering and Applied Science. He was the founding executive editor of the *Journal of Homeland Security and Emergency Management* (www.bepress.org/jhsem) and is a member of the National Research Council's Disaster Roundtable Advisory Committee. Dr. Harrald has been actively engaged in the fields of emergency and crisis management and maritime safety and port security and as a researcher in his academic career and as a practitioner during his 22-year career as a U.S. Coast Guard officer; he retired from the Coast Guard in the grade of captain. Dr. Harrald received his B.S. in engineering from the U.S. Coast Guard Academy, an M.S. from the Massachusetts Institute of Technology

where he was an Alfred P. Sloan Fellow, and an M.B.A. and Ph.D. from Rensselaer Polytechnic Institute.

Richard G. Muth was appointed executive director of the Maryland Emergency Management Agency (MEMA) by Governor Martin O'Malley on June 1, 2008. Director Muth has devoted his entire professional career to safeguarding the lives of Maryland citizens by improving public safety and emergency management practices at the federal, state, and local levels. He is a 33-year career and volunteer veteran of the Baltimore County Fire Department. He has previously chaired the Governor's Emergency Management Advisory Council (GEMAC), served as a two-term president of the Maryland Emergency Management Association, and was a committee member and subsequent chair of the State Emergency Response Commission (SERC). In 1993, Mr. Muth was appointed director of the Office of Emergency Preparedness in Baltimore County. In 1998, he served as the on-scene coordinator of Maryland resources while battling massive wildfires in the state of Florida; he was awarded a governor's citation for his efforts. That same year, he was honored by the American Red Cross for establishing new protocols between Baltimore County and the Red Cross. In 1999, he was chosen to chair the Baltimore Metro Council Y2K Contingency Planning Group. In 2003, Mr. Muth was appointed by Governor Robert Ehrlich to serve as Baltimore County's Director of Homeland Security and Emergency Management; in that capacity he oversaw the county's Hazardous Materials Program, Advanced Tactical Rescue, Fire Department Communications, and the Chemical Stockpile Program. He has chaired the U.S. Defense Department's Weapons of Mass Destruction Program—Domestic Preparedness Chemical team and has been recognized for his leadership roles in the aftermath of Hurricane Isabel and as Maryland's Emergency Resource Coordinator following Hurricane Katrina. As MEMA's executive director, he oversees a staff of 75 people who work closely with state agencies and Maryland's local jurisdictions, coordinating and planning the state's response to any disaster. When a disaster occurs, whether it is human-made or natural, Mr. Muth becomes the lead person having the primary responsibility of managing the emergency event and closely advising the governor on preparedness and response strategies.

David Ropeik is an author and a consultant on risk perception and risk communication to government, business, health care organizations, trade and professional organizations, consumer groups, and educational institutions. He is a former instructor of risk communication at the Harvard School of Public Health and was co-director of the school's professional education course "The Risk Communication Challenge." He is the author

of *How Risky Is It, Really? Why Our Fears Don't Always Match the Facts* (McGraw-Hill, March 2010). He is a coauthor of *RISK, A Practical Guide for Deciding What's Really Safe and What's Really Dangerous in the World Around You* (Houghton Mifflin, 2002). He is the creator and director of the program "Improving Media Coverage of Risk," a training program for journalists. Mr. Ropeik was a television reporter for WCVB-TV in Boston from 1978 to 2000; in that role he specialized in reporting on environment and science issues. He twice won the DuPont-Columbia Award (often cited as the television equivalent of the Pulitzer Prize), and seven regional Emmy awards. He was a Knight Science Journalism Fellow at the Massachusetts Institute of Technology (MIT), 1994-1995, and a member of the board of directors of the Society of Environmental Journalists, 1991-2000. He has taught journalism at Boston University, Tufts University, and MIT.

John H. Sorensen is a distinguished research staff member at the Oak Ridge National Laboratory (ORNL). He has been involved with research on emergency planning and disaster response for more than 30 years. He has been the principal investigator (PI) on more than 40 major projects for federal agencies, including the Federal Emergency Management Agency (FEMA), the Department of Energy, the Environmental Protection Agency, the Nuclear Regulatory Commission, the Department of Defense, and the Chemical Safety and Hazard Investigation Board. Dr. Sorensen has participated in research including the Three Mile Island Public Health Fund Emergency Planning Project on Three Mile Island and the Second Assessment of Research on Natural Hazards, for which he served as the subgroup leader for Prediction, Forecast Warning and Emergency Planning. He has worked closely with the Chemical Stockpile Emergency Preparedness program and consults for the nuclear power industry. Dr. Sorensen has authored more than 140 professional publications, including *Impacts of Hazardous Technology: The Psycho-Social Effects of Restarting TMI-1* (State University of New York Press, 1987). He has published extensively on response to emergency warnings, risk communications, organizational effectiveness in disasters, emergency evacuation, decontamination, and protective actions for chemical emergencies. Dr. Sorensen has led the development of emergency management information systems, simulation models, conventional and interactive training courses, and educational videos. He has served on many advisory committees, including the Natural Hazard Research and Applications Center at the University of Colorado, the Atomic Industrial Forum's National Environmental Studies Task Force on Emergency Evacuation, and FEMA's Emergency Management Technology Steering Group. He was a member of the National Research Council's Subcommittee on Earthquake Research and the Committee for Social Science Research on Disaster. Dr. Sorensen has a Ph.D.

in geography from the University of Colorado at Boulder and was an assistant professor at the University of Hawaii before going to ORNL.

Staff

Jon Eisenberg is the director of the Computer Science and Telecommunications Board of the National Research Council. He has also been the study director for a diverse body of work, including a series of studies exploring Internet and broadband policy and networking and communications technologies. In 1995-1997 he was an American Association for the Advancement of Science (AAAS) Science, Engineering, and Diplomacy Fellow at the U.S. Agency for International Development, where he worked on technology transfer and information and telecommunications policy issues. Dr. Eisenberg received his Ph.D. in physics from the University of Washington in 1996 and a B.S. in physics with honors from the University of Massachusetts at Amherst in 1988.

Virginia Bacon Talati is an associate program officer for the Computer Science and Telecommunications Board of the National Research Council. She formerly served as a program associate with the Frontiers of Engineering program at the National Academy of Engineering. Prior to her work at the National Academies, she served as a senior project assistant in education technology at the National School Boards Association. She has a B.S. in science, technology, and culture from the Georgia Institute of Technology and an M.P.P. from George Mason University, with a focus in science and technology policy.

Shenae Bradley is a senior program assistant at the Computer Science and Telecommunications Board of the National Research Council. She currently provides support for the Committee on Sustaining Growth in Computing Performance, the Committee on Wireless Technology Prospects and Policy Options, and the Computational Thinking for Everyone: A Workshop Series Planning Committee, among other projects. She formerly served as an administrative assistant for the Ironworker Management Progressive Action Cooperative Trust and managed a number of apartment rental communities for Edgewood Management Corporation in the Maryland/D.C./Delaware metropolitan areas. She is in the process of earning her B.S. in family studies from the University of Maryland at College Park.