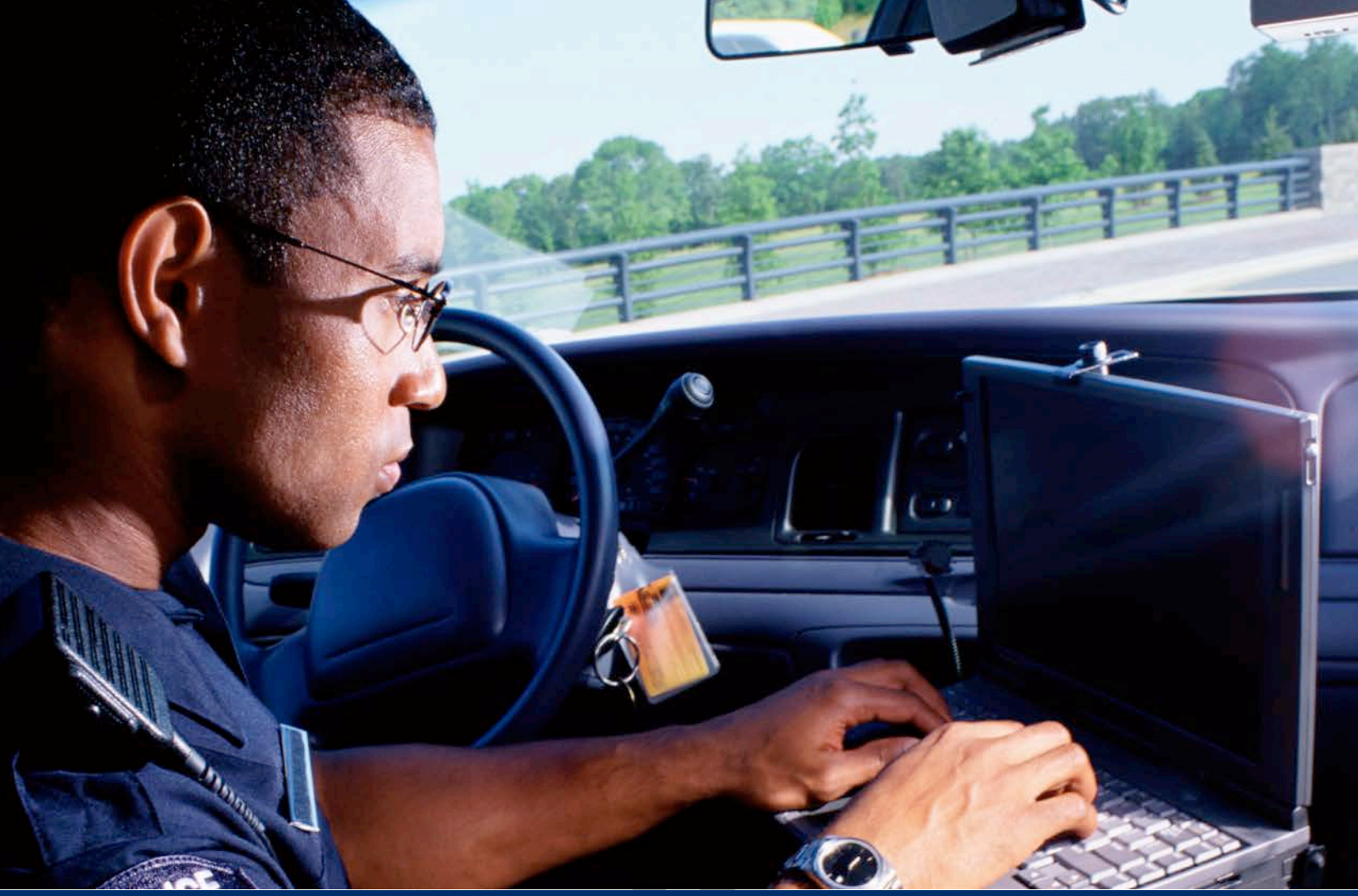

Report on Alerting Tactics

Science and Technology Directorate

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Homeland Security

Science and Technology

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1.0 Introduction

The purpose of this Department of Homeland Security (DHS) Science and Technology Directorate (S&T) Report on Alerting Tactics (Report) is to provide recommendations on effective combinations of alerting tactics for various incident types based upon lessons learned from practitioners. This report examines:

- Nationwide alert originator best practices for reaching communities;
- Effective combinations of current and emerging alerting tools and practices to improve overall public response; and
- Considerations for integrating future technologies (e.g. advanced sensor alerting) and technology platforms (e.g., Next Generation Television (Next Gen TV)) to address current alerting gaps and challenges.

In the fall of 2017, a comprehensive Wireless Emergency Alerts (WEA) landscape assessment was conducted through an extensive literature review and series of interviews with subject matter experts and alert originators. The assessment examined the current WEA landscape, alert originator usage challenges, and the future state of emergency alerting. Initial findings suggested WEA messages based on the Common Alerting Protocol (CAP) provide a mechanism for rapid alerting and warning with significant benefits, including the ability to support immediate situational awareness, geo-target mobile users, and use standardized CAP encoded messages as a universal language. Alert originators consistently voiced that WEA is most effective when paired with other forms of alerting and warnings systems. However, there was not consensus on which combination of tools is generally most effective. The alerting ecosystem consists of multiple systems alert originators can use to reach the public with alert and warning information, "as well as diverse channels of message delivery, distributed sensing devices, and feedback mechanisms."[1] Alerting ecosystem components include:

- Alerts and warnings from Federal, state, and local alerting authorities to the public;
- Coordination between alerting authorities and other governmental entities (e.g., 911);
- Public information sharing to alerting authorities (e.g., social media requests); and
- Public information exchange between community members.

Successful alerting now and in the future hinges upon the effective use and interoperability of the right tactics within an integrated alerts and warnings ecosystem. The result of the assessment includes a recommendation for additional research on effective combinations of alerting tools and tactics to support the future of the alerting ecosystem.

The intended audience of this report includes alert originators and emergency managers (EMs) seeking to adopt alerting best practices and determine the most effective combination of alerting tactics for their community. Eighty experts contributed to this report through a combination of interviews and a Future of Emergency Alerting Workshop (Workshop) held on March 14, 2018. A list of those individuals can be found in Appendix A on page 32. This report

[1] National Academies of Sciences, Engineering, and Medicine. "Emergency Alerts and Warnings Systems: Current Knowledge and Future Research Directions." *The National Academies Press,* 2018. www.nap.edu/read/24935/chapter/4#48. Accessed 21 May 2018.

also draws on multiple data sources including academic papers, federal reports and proceedings, Federal Communications Commission (FCC) filings, legislation, press releases, media coverage, and social media. A list of acronyms used throughout this report can be found in Appendix B on page 35.

2.0 Alerting Best Practices

The alerting ecosystem "is continuing to evolve as new technologies are introduced and new practices and protocols emerge around information sharing during emergency events."[2] An understanding of alerting implementation best practices lays the foundation for alert originators to examine and determine effective combinations of alerting tactics for their own jurisdictions can be found on page 13. This section outlines the following best practices, which alert originators highlighted as improving overall public response, regardless of incident type:

- Clearly define alerting authorities to minimize confusion within an authority and within the community;
- Conduct public education on alerts and warnings to expedite and encourage public protective actions;
- Share and use alerting templates to minimize errors and quickly disseminate alerts;
- Participate in regular trainings and encourage frequent usage of alerting systems;
- Apply lessons learned at regular intervals to maximize alert effectiveness;
- Measure alert effectiveness by engaging partners and the community; and
- Plan for accessibility to better reach populations with access and functional needs (AFN) and limited English proficiency (LEP).

2.1 Clear Delegation of Authority

A challenge frequently voiced by local alert originators is determining who has the authority to send an alert. Currently, there is no clear federal point of contact (POC) or framework that provides governance, best practices or guidance on alerting roles and responsibilities. Alert originators typically use internal, self-created standard operating procedures (SOPs) or other guidance documents to help define alerting authorities and varying levels of administrator rights. Alert originators highlighted that a clear delegation of authority enables quicker and better decision making by streamlining processes and minimizing confusion within an alerting authority. When employees clearly understand what is expected of them, it speeds up the process of sending an accurate alert. SOPs that outline safeguards and chains of command also reduce errors that may cause public confusion, delayed public response, and degraded trust in alerting systems.

For example, in the case of the 2018 Hawaii false missile alert, "a combination of human error and inadequate safeguards contributed to the false alert."[3] On January 13, 2018, a misunderstanding between the Hawaii Emergency Management Agency (HI-EMA) midnight

[2] Ibid.

[3] Public Safety and Homeland Security Bureau. "Report and Recommendations Hawaii Emergency Management Agency January 13, 2018 False Alert." *FCC*, Apr. 2018, https://bit.ly/2vtOT92. Accessed Apr. 2018.

shift supervisor and day shift supervisor led to an unsupervised exercise.[4] An employee sent out the false alert statewide after misunderstanding instructions and confusing the exercise with a real-life event.[5] The HI-EMA employee who sent the alert did so without permission from a direct supervisor. As part of the examination of events, the FCC Public Safety Homeland Security Bureau (PSHSB) released a "report and recommendations" that said emergency management agencies should "limit employee permissions to create or modify" messages to minimize the potential for confusion and avoid sending false alerts.[6] The report and Recommendations also recommended agencies require more than one credentialed originator to validate message content prior to sending an alert.[7]

2.2 Public Education

Public education on alerts and warnings before any incident helps communities nationwide understand the purpose and importance of alerts and to minimize confusion. The public needs to know what to expect from alerting tools and what actions they might need to take for the technology and alert message to be effective. "It is important to remember that the majority of people cannot remember…what a color code may represent, or even the difference between the watches and warnings."[8] Therefore, continuous public education is a critical, ongoing task that expedites and encourages public protective actions.

Public Education Tips

Alert originators and trusted authorities must educate the public ahead of an incident to reduce confusion and increase alert effectiveness. Alert originators successfully educating the public and seeing results identified the following tactics to improve awareness:

- Conduct localized, public tests of alert systems to increase public familiarity;
- Share general information about alerting systems year-round over multiple channels (e.g., events, social media) to increase public awareness and opt-in subscriptions;
- Target specialized education and outreach campaigns ahead of major events (e.g., preparedness week, scheduled test, roll out of a new alerting tool);
- Leverage existing regional and state organizations that support emergency response coordination to conduct education and outreach efforts. For example, the development of coordinated social media kits with resources (e.g. templates, canned language) for recurrent or planned incidents (e.g., hurricanes, major sporting events);
- Partner with trusted community networks (e.g., faith-based institutions, schools, neighborhood associations) to build trust and distribute educational materials. When possible, physically send a representative to attend community meetings; and
- Partner with major businesses in your area to conduct regular education sessions. Businesses often require mandatory or optional emergency planning sessions as part of Human Resources functions.

[4] Ibid.

[5] Ibid.

[6] Ibid.

[7] Ibid.

[8] National Academies of Sciences, Engineering, and Medicine. "Public Response to Alerts and Warnings Using Social Media: Report of a Workshop on Current Knowledge and Research Gaps." *The National Academies Press*, 2013. www.nap.edu/read/15853/chapter/2?term=public+education#3. Accessed 31 May 2018.

2.3 Use Templates and Pre-approved Language

Predesigned alerting templates and pre-approved language minimize the chances for human error and enable alert originators to disseminate important messages quickly. Some of the alert originators interviewed for this report craft pre-scripted "fill in the blank" message templates before an incident for all hazards they face regularly. Additionally, alert originators create templates for other regular protective action advisory messages, such as prepare to evacuate, shelter in place, and hazard awareness.

For example, one alerting authority interviewed provides authorized originators with an alerting matrix. The matrix covers common hazards, explains exactly how to respond when certain incidents or thresholds occur, and what to include in a message or provides pre-approved language. "We would not send anyone out without the matrix now. As a major metro area, the situations are too complex to not be ready or put in that extra planning." The alerting authority developed the matrix tool over the course of seven years by updating hazards and responses as new incidents occurred. All authorized originators are trained on the matrix and use it for day-to-day activities. For templates such as these to be successful, they must be integrated tightly enough into operations to not delay alerts and notifications. By identifying common incidents and encouraging day-to-day use, the originator does not have to rely on one person. "We all know how to use the tools and the matrix. It makes things a lot easier."

2.4 Regular Training and Usage

Training and routine tool usage allows alert originators to practice alerting procedures and gain familiarity with alerting technologies to minimize errors during an incident. Every incident is different with varying factors and decision points that change in the course of seconds. Therefore, it is critical to not only train staff on how an alert is transmitted, but the effects of the alert on the public, to encourage high impact alerting. For example, during the 2018 Hawaii false alert, the HI-EMA alert initiator did not understand the instructions indicating that the exercise was a test, and subsequently transmitted public Emergency Alert System (EAS) and WEA alerts instead of conducting a non-public test.[9] The alert resulted in widespread public panic (Figure 1) and HI-EMA staff were unsure of how to respond due to a lack of regular training and protocols.[10][11][12]

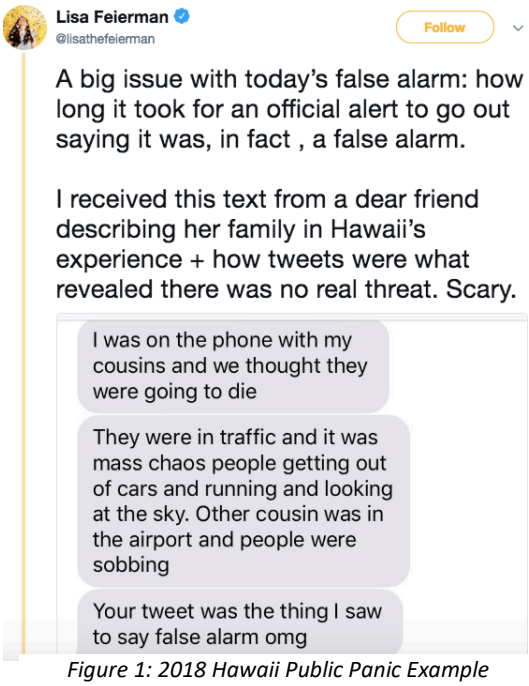

Figure 1: 2018 Hawaii Public Panic Example

[9] Public Safety and Homeland Security Bureau. "Report and Recommendations Hawaii Emergency Management Agency January 13, 2018 False Alert." *FCC*, Apr. 2018, https://bit.ly/2vtOT92. Accessed Apr. 2018.
[10] Mark, Michelle. "38 minutes of panic: Here's how people in Hawaii reacted to a false ballistic missile alert." *Business Insider,* 13 Jan. 2018, read.bi/2tdxZKJ. Accessed 25 June 2018.
[11] Ibid.
[12] Nagourney, Adam, David E. Sanger, Johanna Barr. "Hawaii Panics After Alert About Incoming Missile Is Sent in Error." *The New York Times,* 13 Jan. 2018, www.nytimes.com/2018/01/13/us/hawaii-missile.html. Accessed 25 June 2018.

While alert originators identified regular, localized public tests as the ideal mechanism for increased originator effectiveness and public education, other opportunities exist for regular training and usage. As part of their "report and recommendations," the PSHSB recommended all emergency management agencies "conduct regular internal tests in a controlled and closed environment, such as through the Federal Emergency Management Agency (FEMA) Integrated Public Warnings and Alert System (IPAWS) Test Lab, to maintain proficiency with alerting tools [and] to exercise plans and procedures…"[13] For more information on IPAWS, see Appendix C on page 36.

Additionally, some states are considering setting training standards. A state review following the 2017 California wildfires "found that county officials didn't fully understand the technology, prompting demands for reform."[14] Senator Mike McGuire proposed legislation to "establish [state] guidelines and best practices for public alerts and warnings and the use of mass notification systems."[15] California Senate Bill 833, which the State Senate approved in May 2018, would require county emergency management agency personnel to "undergo annual training on how to best utilize [WEA] software and issue alerts."[16]

2.5 Applying Lessons Learned

Alerting authorities should review and update all alerting practices on a regular basis and not wait for a large incident to occur to identify gaps in alerting systems, platforms, and/or technologies. Additionally, alerting tactics and procedures should be examined together, as opposed to separately, and at regular intervals to maximize effectiveness and overall public reach. For example, one state alert originator interviewed has regularly scheduled monthly calls with their alerting system vendor. Local alert originators are invited to join the call to enhance information sharing, increase coordination, and discuss potential enhancements to operations. "We see it as an opportunity to get feedback on system usage and identify possible improvements." Alerting authorities should also consider ways in which to incorporate feedback and lessons learned from the public.

2.6 Measure Alert Effectiveness

The primary measure for determining if an emergency alert is successful is whether or not the public takes responsive action. In a 2018 National Academies of Sciences, Engineering, and Medicine (NASEM) report on emergency alert and warning systems, NASEM states "feedback is needed during a crisis to immediately understand how the public is responding to the event

[13] Public Safety and Homeland Security Bureau. "Report and Recommendations Hawaii Emergency Management Agency January 13, 2018 False Alert." *Federal Communications Commission*, Apr. 2018, transition.fcc.gov/Daily_Releases/Daily_Business/2018/db0410/DOC-350119A1.pdf. Accessed Apr. 2018.
[14] Alexander, Kurtis. "Wine Country fire: What has changed to reduce risk." *San Francisco Chronicle,* 17 June 2018, www.sfchronicle.com/news/article/Wine-Country-fires-Here-s-what-s-changed-to-12999101.php. Accessed 25 June 2018.
[15] California State, Legislature. Senate Bill 833. *California State Legislature,* 31 May 2018, leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB833. Accessed 20 June 2018.
[16] Squier, Dan. "Bill to upgrade emergency alert system passes state Senate." *Times Standard,* 08 June 2018, www.times-standard.com/article/NJ/20180608/NEWS/180609861. Accessed 25 June 2018.

[and]...for post hoc analysis so that systems can be improved."[17] Current research suggests public feedback on alerts and warnings does not regularly occur in the U.S. To address this challenge, alert originators that regularly and successfully measure alert effectiveness pointed to the methods below to improve public response.

Measurement Tips

Alert originators successfully measuring alert effectiveness identified the following tactics to improve analysis:

- After sending an alert, track media exposure and social media sharing to gauge how quickly an alert is spreading;
- Following major incidents, conduct objective After Action Reports to assess and make recommendations for improvements;
- Review lessons learned from coordination with mutual aid partners;
- Review lessons learned from After Action Reports following major incidents nationwide;
- Use third party software that provide robust data analytics;
- Conduct short, optional surveys following a major incident, training, or systems test to determine effectiveness and seek feedback on improvements; and
- Use mobile applications (apps) for alerting, which collect data and provide back end data analytics (e.g., message click through rates, location heat map).

2.7 Plan for Accessibility

Current assistive alerting capabilities are limited nationwide and should expand in the future. "The population impacted by hazards is incredibly diverse in numerous ways, including differences in languages, abilities, and technology access. An alert and warning system needs to support this diversity and communicate to each impacted subpopulation effectively."[18] While some third-party vendors provide multiple languages, American Sign Language (ASL), and Braille capabilities, it is not standardized.

Considerations must be made to better reach populations with AFN and LEP. In 2013, the Brooklyn Center for Independence of the Disabled (BCID) and Center for Independence of the Disabled, New York (CIDNY) sued Mayor Bloomberg and the City of New York for failing to adequately consider AFN in emergency planning.[19] Plaintiffs argued Mayor Bloomberg violated the Americans with Disabilities Act, the Rehabilitation Act, and the New York City Human Rights Law. A memo from the BCID suggests an effective emergency preparedness and planning program for persons with disabilities includes "providing an accessible public notification and communication plan for notifying persons with sensory disabilities before and during emergencies."[20]

[17] National Academies of Sciences, Engineering, and Medicine. "Public Response to Alerts and Warnings Using Social Media: Report of a Workshop on Current Knowledge and Research Gaps." *The National Academies Press*, 2013. www.nap.edu/read/15853/chapter/2?term=public+education#3. Accessed 31 May 2018.

[18] Ibid.

[19] Brooklyn Center for Independence v. Bloomberg. No. 11 Civ. 6690. United States District Court, S.D. New York. 2013. www.leagle.com/decision/infdco20131112923. Accessed 1 Aug. 2018.

[20] Pinover, Julia. "Mayor Bloomberg Sued for Neglect of Disabled New Yorkers During Emergency Disasters." *Disaster Rights Advocates,* 26 Sept. 2011, dralegal.org/press/mayor-bloomberg-sued-for-neglect-of-disabled-new-yorkers-during-emergency-disasters/. Accessed 1 Aug. 2018.

Many alert originators contributing to this report are able to increase effective engagement with these populations through partnerships. In a report on reaching LEP communities, the U.S. Department of Justice (DOJ) recommends emergency managers and alert originators develop "a Language Access Plan to better serve AFN and LEP populations, as well as partnering with community groups who work closely with LEP individuals and immigrant communities."[21] For example, one alerting authority partners with community groups, faith-based groups, and community leaders across seven languages ahead of incidents to better reach LEP populations. When an incident occurs, the authority relies on their partners to translate and amplify messages to their communities. To better reach ASL communities, the authority partners with Deaf Link to send self-registered individuals' text and email alerts with ASL video. This is a low cost, low effort, and highly effective solution to reaching audiences.

Building upon these best practices, the following sections examine current and emerging alerting tactics, their benefits, and their barriers. Understanding the pros and cons of current and emerging tactics individually will help alert originators examine and determine the right combination of alerting tactics for their jurisdiction. See page 13.

3.0 Current Alerting Tactics

For an alerting program to be successful, alert originators must thoroughly understand and adopt "time tested" existing alerting tactics, in addition to emerging tactics. "During a disaster, one or more alert systems may be degraded or unavailable, making reliance on one or more of the other systems necessary."[22] Mastery and trust of readily available alerting tactics enables alert originators to select the right combination of tactics to best support effective response and recovery within their community. The following table highlights current alerting tactics, their benefits, and their barriers as identified by alert originators, in alphabetical order. The next section of this report examines the benefits and barriers of emerging tactics (e.g., social media, sensor alerting and apps).

[21] U.S. Department of Justice. "Tips and Tools for Reaching Limited English Proficient Communities in Emergency Preparedness, Response, and Recovery." *U.S. Department of Justice*, 2016, www.justice.gov/crt/file/885391/download. Accessed 17 May 2018.

[22] The Communications Security, Reliability, and Interoperability Council VI. "Final Report- Comprehensive Re-imagining of Emergency Alerting." Federal Communications Commission, 29 June 2018, www.fcc.gov/files/csric6wg29junereportcompdocx. Accessed 16 July 2018.

Tactic	Benefits	Barriers
Email	- Reach users on their computers and smart phones - Ability for alert originators to send longer messages - Easy to provide multimedia links, URLs, or additional resources, when appropriate - Users are able to filter the type of information they want to receive, allowing for more personalized alerts - If the email is from an official source, it verifies information and builds trust	- Requires users to sign up and "opt-in" - Must dedicate personnel resources to educate users on availability - User(s) may not receive the email - Potential to lose a user's attention if the message has too much information
EAS	- Reaches users listening to TV or radio - Distinct noise grabs the users' attention - Uses voice technology so people can hear it without looking - Ability for alert originators to send updated alerts and information - Mandatory weekly testing - Verifies information from a trusted source - Uses CAP	- Users are trending away from cable TV and radio in favor of video streaming services - Does not reach users on satellite TV - Multiple alerts can lead to message fatigue - Public and industry complaints for interruption of service - Unable to target alerts with greater accuracy due to media markets
Route Notification (e.g., knocking on doors)	- Information is directly from a trusted source - Higher sense of urgency - Higher rate of responsive action - Reaches isolated communities - Reaches those in need of assistance - Builds trust	- Time consuming tactic - Reaches limited number of individuals - Danger to the alert originator - Does not scale
Reverse 9-1-1 Landline (Voice)	- Ability to target at-risk users through landlines in specific geographic areas - Provides voice alerts on urgent incidents - Easy to provide clear instructions on how to respond	- Fragile infrastructure during natural disasters, which can also be costly - Users are trending away from landline telephone in favor of mobile devices - Once the user hangs up the phone, there is no way to access the alert or information - Individuals tend to be suspicious of automated phone calls - Accessibility issues if language barriers are not addressed

Tactic	Benefits	Barriers
Reverse 9-1-1 Cellular (Voice)	- Ability to target at-risk users through cell phones in specific geographic areas - Provides voice alerts on urgent incidents - Easy to provide clear instructions on how to respond	- Unlisted numbers, cell phones, and numbers on "no-call" lists are not included on call databases unless manually added - Once the user hangs up the phone, there is no way to access the alert or information - Individuals tend to be suspicious of automated phone calls - Accessibility issues if language barriers are not addressed - Currently location services for reverse 9-1-1 are not enabled on cellular devices by policy at the carrier level
Sirens	- Easily gets the attention of affected individuals in the area - Easy to educate communities on the meaning of a siren - Ability to conduct tests and drills of the sirens with the community - Reaches individuals visiting affected areas - Minimal costs for upkeep	- Sirens may mean different things from community to community - Limited time to respond - Limited ability to provide instructions for protective action
Text/SMS	- Short-form messages are easy to send quickly - If a text cannot get through, it keeps trying - Reaches users where they are - Users can easily refer back to messages later - Users are able to filter the type of information they want to receive, allowing for more personalized alerts (e.g., home address, work address, county) - Accessible for the hearing impaired and can use multiple language formats	- Requires users to sign up and "opt-in" - Short messages are limited in effectiveness if they cannot grab a user's attention - Space and character limitations may lead to confusion on actions to take - A lack of sufficient information may result in a longer milling period, the time between receiving an alert and taking action - Must dedicate personnel resources to educate users on availability
Traditional Media (press release, TV or radio broadcast, etc.)	- Easy to tailor content - More detailed information - More time to prep response - Builds trust - Emergency Management controls the information released and shared	- Time consuming process, which sometimes results in information being out of date - Information reaches the public slowly - Public reach is limited - Content tends to be no-nonsense, which feels less personal and engaging - Media desire for breaking news can lead to errors

Tactic	Benefits	Barriers
Website	- Can act as a home base for incident information - Alert originators can update content - Publicly accessible - Allows for long form, short form, and multimedia content - Information comes from a verified source - Integrates well with many alerting tactics	- Public is not automatically notified of updates. Users must seek out information - Requires version control so users read the most up-to-date information - Can be hard to find alert information on more complex websites, not easily accessible
Word of Mouth	- Information is coming from a trusted resource (e.g., family, friends) - Higher sense of urgency - Users are more likely to respond - Reaches isolated communities - Can be amplified through other alerting tactics (social media, text/SMS, email)	- Time consuming tactic - Reaches limited number of individuals

4.0 Emerging Alerting Tactics

While current tactics (e.g., EAS, text/SMS, sirens, and reverse 9-1-1) are integral to the alerting ecosystem's infrastructure, emerging tactics (e.g., social media, sensor alerting and apps) are redefining emergency alerting and how originators share information with their communities. Incorporation of newer tactics could address many shortcomings of current tactics outlined above. The following table highlights emerging alerting tactics, their benefits, and their barriers as identified by alert originators, in alphabetical order.

Tactic	Benefits	Barriers
Apps	- Allows for local originator flexibility to tailor alert functionality to their community - Pushes notifications to alert users - Can target users with location information - Potential to include "filters" for more personalized alerts - If the application is from an official source, it verifies information and builds trust - Collects data analytics to improve alert effectiveness - Easy to provide multimedia links, URLs, or additional resources, when appropriate - Anyone can download an app, including visitors and tourists - Users are able to browse information at their leisure - Could use CAP	- Requires users to download the application and "opt-in" - Potential for additional fiscal resources to create the application - High level of effort to launch and promote the app - Additional resources are required to educate users on application availability and features to make sure they use the app regularly - Every application is built differently and is often dependent on the vendor - Developer buy in - Potential for users to only receive information if they are looking for it - Accessibility challenges
Automotive Infotainment Systems	- Easy to use interface - Can target users with location information - Potential for more personalized alerts via GPS - Potential to carry text, graphics, audio, and other multimedia - Potential for complete automation, which could increase alert distribution speed - Could use CAP	- May increase chances of distracted driving - Public reach is limited to those who are currently driving - Every system is built differently and is often dependent on the vendor - Developer buy in - High level of effort to launch and promote public alert information across systems
Sensors	- Supports early warning - Allows alert originators to detect and distribute alerts more quickly - Can predict impact severity - Potential for complete automation, which could increase alert distribution speeds - Could use CAP	- Cost is dependent upon system needs (earthquake vs. flood) - Removes the human element from alerting - May not provide enough context for the public to take immediate action

Tactic	Benefits	Barriers
Social Media	- Usage is increasing nationwide, increasing potential reach - Supports full alerts and warnings cycle, including preparedness and recovery - Easy to push out information in real-time - Easy to provide multimedia links, URLs, or additional resources, when appropriate - Can supplement traditional alerting tactics to provide more information, reducing milling periods - Monitoring allows for more specific messaging, which can increase protective actions - Easy to share information during non-emergencies to support public education on other alerting tools - Could use CAP	- User will only receive the alert if they are looking for information - Misinformation is difficult to distinguish and combat - Lack of credibility - Depending on the platform, space for content can be limited or constricted by platform requirements - Public expectation of a two-way dialogue may be unrealistic in times of imminent threat, resulting in issues - Legal concerns - Privacy concerns
WEA	- Targets a larger audience via cell phones - Every mobile user with a WEA-capable device will receive an alert broadcast over WEA, unless they "opt out" - AFN communities tend to rely heavily on wireless devices - Reaches tourists and visitors, who are unlikely to have enrolled in a local service - Avoids network congestion issues - Acts like a "siren in your pocket" - Grabs public attention, motivating receivers to seek additional information - Uses CAP	- Imprecise geo-targeting, which can result in over-alerting and message fatigue - Individuals can "opt out" except for Presidential messages - Cell coverage is irregular nationwide, especially in rural areas - Definition of imminent threat is different nationwide - Limited training and exercise opportunities - Limited character message length

In an interconnected world, it is critical for alert originators to integrate both current and emerging tactics into their daily operations today, while also planning for near-future tactics. Combining multiple alerting tactics will best situate originators to meet shifting public expectations, increase capabilities to alert at-risk populations, and increase overall situational awareness of responders.

The following section explores effective combinations of current and emerging alerting tactics that interviewees identified. Alert originators should consider adopting combinations of these tactics that best advance alerts and warnings in their community.

5.0 Effective Combinations of Alerting Tactics

Effective alerting hinges upon the interoperability of multi-modal systems and the coordination of disparate alerting tactics.[23] Alert originators select different tactics depending on the nature of the incident, the locality where the incident is occurring, the incident timeline, and local relationships with other agencies and organizations (e.g., state government, neighboring localities). As incidents change in size, scope, and complexity, alert originators must adapt and use different alerting tactics to share the right information with the public at the right time. This "sliding scale" approach allows originators to:

- Maximize the reach of alerts to disparate populations affected by an incident;
- Increase the number of accurate and timely alert impressions individuals receive; and
- Reduce receiver milling time - the period where a receiver interacts with others, gathers more information, and validates or refutes alert and warning message information.

The following table outlines recommended combinations of alerting tactics by National Incident Management System (NIMS) incident type, which range from Type V (least complex) to Type I (most complex). These recommendations can be modified according to the unique needs and circumstances of a particular agency, jurisdiction, region, state, or territory, as final alerts and warnings determinations are dependent upon incident specifics.

NIMS Incident Type	Type V, IV	Type III	Type II, I
Recommended Combination of Alerting Tactics	- Apps - Email - Sirens - Social Media - Text/SMS - Traditional media - Website - Word of mouth	- All tactics for a Type V, IV Incident - EAS - Reverse 9-1-1 - Route notification - Sensors/Advanced Sensors	- All tactics for a Type III Incident - WEA - Next Gen TV

The following sections outline the above alerting tactic combinations in more detail; note relevant incident criteria; and discuss emerging tactic capabilities, implementation tips, and case studies, where relevant.

5.1 Tactics for Type V/IV Incidents

For typical type V/IV incidents, alert originators address regular life disruptions that do not directly threaten life or property but have the potential to escalate. Type V/IV incidents typically affect a limited area and only a small number of people, therefore, a limited number of agencies are involved in response. Less complex incidents could include traffic or transit disruptions, construction zones, the potential for severe weather, and other day-to-day events that require public monitoring.

[23] "Wireless Emergency Alerting Landscape and Initial Assessment Summary Report." *Corner Alliance, Inc.,* 16 Jan. 2018. Accessed Mar. 2018.

Alert originators identified text/SMS, email, websites, traditional media, sirens, and word of mouth as the most effective combination of current tactics (Figure 2: Black Tactics) to reach the public for less complex incidents. They also pointed to the benefits of integrating emerging tactics (Figure 2: Blue Tactics), such as social media and mobile apps, into alerting operations to inform situational awareness.

Figure 2: Tactics for Type V/IV Incidents

The following sections explore how social media and apps build capacity, in addition to providing tips for integrating tactics into regular operations.

5.1.1 Social Media

Over time, public adoption of social media has increased tremendously, as have public expectations of public safety to use social media to communicate with local communities. "Social media platforms offer new ways [for alert originators] to communicate with the public...including additional official channels, such as government social media accounts...and unofficial channels, such as first-person reports via social media."[24] Social media alerting provides a means of sharing, and receiving, richer content to supplement current tactics (e.g., press releases, broadcast media, email, website) in real-time. For this reason, social media is an important emerging tactic to support response across all incident types.

Key Capabilities

Alert originators identified the following social media capabilities as beneficial to alerting across incident types:

- Enhance the meaning of an alert through multi-modality; and
- Monitor and analyze public response to alerts to enhance alert content.

Multi-modal: Common social media platforms such as Twitter, Facebook, and YouTube are multimodal: combining text, pictures, moving images, and location-based information to

[24] National Academies of Sciences, Engineering, and Medicine. "Public Response to Alerts and Warnings Using Social Media: Report of a Workshop on Current Knowledge and Research Gaps." *The National Academies Press*, 2013. www.nap.edu/read/15853/chapter/2?term=public+education#3. Accessed 31 May 2018.

enhance the meaning of an alert. Additional multimedia capacity and enhanced speeds through multiple systems (e.g., apps, phone banner notifications, text notifications, email notifications, online interfaces) reduce milling and encourage public action. The Federal Communications Commission Public Safety and Homeland Security Bureau (FCC PSHSB) recommends all emergency alerting agencies "have a plan...on how to use social media as a complementary means of communications" for public facing alerts "to use all available communications tools in a coordinated manner to improve public situational awareness and understanding."[25]

Rich media capabilities enabled by social media have proven especially valuable to agencies like the National Center for Missing and Exploited Children (NCMEC), which manages America's Missing: Broadcast Emergency Response (AMBER) Alerts program. NCMEC representatives said, "Social media is a powerful tool and should be used with other alerting tools as standard practice. We push alerts to social media as part of secondary distribution...If you have a smart device in hand, you can be the eyes and ears of law enforcement." NCMEC shares photos and critical information of abducted children over Twitter, Facebook, and Instagram. Facebook even partners with NCMEC to send AMBER Alert notifications to users in the target search area of an abducted child.[26] This is done in tandem with other distribution channels, including lotteries, Department of Transportation (DOT) signs, media broadcasts, and more to increase public awareness of abducted children.

Social Media Monitoring: Social media also allows alert originators to monitor public response to alerts (Figure 2), enabling public safety officials to strategically shape message content as incidents progress. "The advent of social media has transformed emergency public information into a community conversation. If [an authority] is too slow in sharing information, the community will find other sources or provide their own."[27] Targeted alerts over social media quicken the information confirmation process by addressing public concerns directly, reducing the time individuals spend seeking additional information before taking action.[28] While agencies must dedicate time and resources to filtering and verifying information, alert originators identified early warning monitoring to correct and redirect public actions and combat misinformation in real-time as an especially useful tool.[29]

For example, one metropolitan authority "experienced a small fire [downtown] and made the decision not to send a mass alert. The incident was isolated and only affected a small portion of the city. However, people across the river saw the smoke cloud and started posting on Twitter.

[25] Public Safety and Homeland Security Bureau. "Report and Recommendations Hawaii Emergency Management Agency January 13, 2018 False Alert." *Federal Communications Commission*, Apr. 2018, transition.fcc.gov/Daily_Releases/Daily_Business/2018/db0410/DOC-350119A1.pdf. Accessed May 2018.
[26] Vacher, Emily. "Introducing AMBER Alerts on Facebook." *Facebook Newsroom*, 13 Jan. 2015, newsroom.fb.com/news/2015/01/introducing-amber-alerts-on-facebook/. Accessed Jan. 2018.
[27] Godley, Christopher. "County of Sonoma Agenda Item Summary Report." *County of Sonoma,* 11 June 2sonoma-county.granicus.com/MetaViewer.php?view_id=&event_id=945&meta_id=244351. Accessed 26 June 2018.
[28] Kuligowski, Erica D., Jessica Doermann. "A Review of Public Response to Short Message Alerts under Imminent Threat." *U.S. Department of Commerce*, Jan. 2018, nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.1982.pdf. Accessed Feb. 2018.
[29] Ibid.

It looked like a big emergency to them. We decided to send out an alert over our social media accounts telling folks to stay calm and that things were under control. If we had not been monitoring, that situation could have escalated without us knowing." This example highlights how social media can mitigate or eliminate the perpetuation of false information, which can be especially detrimental to public response and public safety during an emergency. With the increased centrality of social media in the everyday life of the public, it is an essential tactic for integration into the emergency alerting ecosystem for all incident types.

Social Media Tips

While some tools exist to help alert originators address social media challenges (e.g., platform analytics, social media management tools), most tools are not designed with public safety in mind or are not readily available to first responders for alerting. In lieu of tools, alert originators successfully leveraging social media as an alerting tactic identified the following tips and tricks:

- On Twitter, target and tag specific individuals (e.g., @username) to direct public action or combat misinformation;
- On Twitter, use a unique hashtag including the location and event (e.g., #townwildfire) to signify incident topics and help users locate additional information faster;
- On Twitter, "pin" important information about an incident to the top of an official page;
- On Twitter, use Twitter Alerts, an opt-in system for high-priority Tweets from select public agencies and public safety organizations;
- On Facebook, use Facebook Live to stream live video updates throughout an incident and directly respond to public inquiries;
- Shorten URLs with a URL shortener (e.g. Google URL Shortener, Bit.ly, or Ow.ly) to keep messages concise and clear;
- Partner with other official channels to amplify messages and spread correct information; and
- Maintain an interactive website that affected individuals on social media can be referred to for additional information on incidents.

5.1.2 Applications

In 2016, people downloaded 149.3 billion mobile apps worldwide.[30] By 2021, research indicates this figure will grow to 352.9 billion.[31] The popularity and growth of the app market has dramatically changed the way people live. Internet-connected mobile devices (e.g., smartphones, tablets, wearables) function as a primary interface through which the public interacts with information at the click of a button. Consequently, the public now expects to receive emergency alerts via various apps. Of the 42 alert originators out of the 80 experts interviewed for this report, 75% currently use mobile apps. To keep up with shifting technology trends and ensure alignment with public expectations, alert originators are integrating ++day-to-day common apps into their regular alerting operations.

Key Capabilities

Alert originators identified the following app capabilities as beneficial to alerting for less complex incidents:

[30] "Number of mobile app downloads worldwide in 2016, 2017 and 2021 (in billions)." *Statista,* May 2018, www.statista.com/statistics/271644/worldwide-free-and-paid-mobile-app-store-downloads/. Accessed May 2018.
[31] Ibid.

- Personalize alerts and warnings to reach targeted portions of the population with compelling messages;
- Push rich multimedia notifications quickly and from any location; and
- Target messages with greater accuracy through Global Positioning System (GPS) features.

Personalized Alerts: Apps provide alert originators with a unique opportunity to personalize alerts and warnings in order to reach at-risk populations while maximizing the probability that people take protective actions.[32] Most emergency alerting apps allow for user personalization, meaning an individual can customize preferences such as location (e.g. home address, location services), language, depth of information (e.g., weather warnings vs. watches), and notification type (e.g., push notification). The integration of apps into operations equips alert originators to obtain and share information to a portion of the population. Messages are more personalized to the consumer through subscriptions to certain alerts or by selecting applicable filters, which further personalize the data they receive. As a result, the receiver may be more convinced the threat will impact them and to take more immediate protective actions.

Push Notifications: Most apps feature rich media push notifications, which users receive whether or not they are using the app or their devices. These notifications deliver a variety of rich media and additional information to supplement other current tactics (e.g., website, email) quickly and from any location. One alert originator said, "It expands our emergency portal. It feels like I have a computer in my pocket, but [users] do not need to go to a website and hit refresh over and over." App notifications can include pictures, videos, URLs, or maps with few of the capacity issues experienced in text/SMS, email, and websites.

Application Tips

Alert originators successfully leveraging apps as an alerting tactic identified the following tips and tricks:

- Work with your developer to build data collection (e.g., click rates, location) into the back end of your app for improved analytics, but avoid collecting personal information to protect citizens' identities;
- Regularly review alert click rates to identify what is working and what is not;
- When possible, use collected data to plan for future incidents. For example, location data could inform evacuation planning in larger cities;
- When using push notifications, make certain information is relevant to the receiver so that users do not ignore or turn off the app; and
- Partner with the following organizations to market the app:
    - Train and bus transit;
    - Highways;
    - Airports; and
    - Frequently visited businesses (e.g., coffee shops, banks, grocery stores).

Location Services: Alerting apps can also overcome geo-targeting issues, increasing originator reach to the right individuals at the right time. Alerting apps with GPS features enable targeted

[32] National Academies of Sciences, Engineering, and Medicine. "Public Response to Alerts and Warnings Using Social Media: Report of a Workshop on Current Knowledge and Research Gaps." *The National Academies Press*, 2013. www.nap.edu/read/15853/chapter/2?term=public+education#3. Accessed 31 May 2018.

messages with greater accuracy. Apps with GPS and location services could be especially valuable for transient populations, like tourists and commuters. One interviewee said, "With traditional alerts like email, you sign up and notifications are only sent for your home address. With the app, you can also select location services. That means if you are downtown, you will get notifications for that area and your home." Regardless of where the user is located, it is possible to personalize the location(s) a user wants to receive alerts about. As a result, messages more effectively communicate a call to action and minimize receiver action delays.

5.2 Tactics for Type III Incidents

For Type III incidents, affected individuals should receive warning from multiple sources, seek additional information, and take protective action within a set time period. This period may span from a few hours to several days. Type III incidents typically happen across multiple sites, require the coordination of two or more agencies or jurisdictions, and affect a sizeable portion of the population. Examples of threats could include severe weather (e.g., flash floods, storms), planned events (e.g., Super Bowl, Presidential Debate), train derailment, or criminal activity.

Alert originators identified EAS, reverse 9-1-1, and route notification apps, in addition to type IV/V incident tactics (e.g., email, traditional media, text/SMS), as the most effective combination of tactics for medium complexity incidents (Figure 3: Black Tactics). They also pointed to the benefits of integrating additional emerging tactics, including sensors, into alerting operations (Figure 3: Blue Tactics).

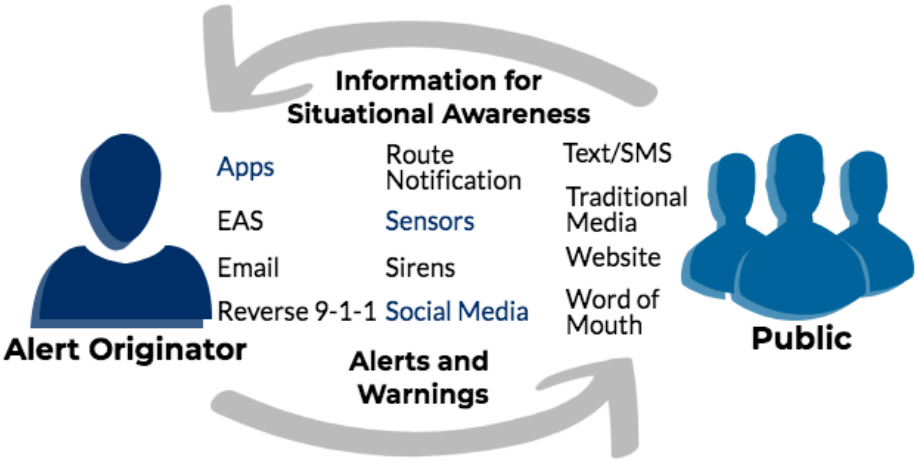

Figure 3: Tactics for Type III Incidents

The following section explores sensor alerting capabilities. Additionally, the report presents a case study on the United States Geological Survey (USGS) earthquake early warning (EEW) system, ShakeAlert, to demonstrate sensor benefits.

5.2.1 Sensor Alerting

From regulating homes to tracking health indicators, sensors are changing conceptions of public life by directly connecting individuals to their personal devices no matter their location. Likewise, sensors are changing how alert originators inform and protect communities. Emerging

networks of sensors, systems, and devices streamline and simplify early warning to the public. Of the alert originators interviewed for this report, 45% currently use sensor alerting to supplement other tactics. For example, Alaska supplements earthquake systems with Deep-ocean Assessment and Reporting of Tsunamis (DART) buoy monitoring systems to track water movement. "As a tsunami moves across the ocean and passes over a DART, the system reports actual tsunami measurements to Tsunami Warning Centers," allowing emergency responders to take more effective actions.[33] When used properly, sensor alerting has the potential to enhance current emergency alerting practices by more expediently detecting threat indicators (e.g., ground shaking, water levels, air quality, and more) and automating alerts.

Key Capabilities

Alert originators identified the following sensor capabilities as beneficial for medium complexity incidents:

- Detect incidents more quickly;
- Trigger alerts and warnings through automation; and
- Increase the time an individual has to take action after receiving an alert.

United States Geological Survey ShakeAlert Case Study:

The USGS and a coalition of state and university partners are currently testing sensor alerting using an EEW system called ShakeAlert (Figure 4). "The purpose of the ShakeAlert system is to identify and characterize an earthquake a few seconds after it begins, calculate the projected intensity of ground shaking that will result, and deliver warnings to people and infrastructure in harm's way."[34] California, Oregon, and Washington have conducted on the ground testing of ShakeAlert since May 2016, and USGS extended testing to the Pacific Northwest in April 2017. The system should provide two to 10 seconds of warning to the public, although the speed of the alert will depend on a user's distance from the earthquake.

Even a few seconds warning would be enough time to duck and take cover, slow trains, stop surgical procedures, or move away from a dangerous work environment. In factories or industrial environments, where production is controlled mainly by machines, EEW responses could be fully automated and require little to no human interaction. "Taking such actions before shaking starts can reduce damage and casualties during an earthquake. It can also prevent cascading failures in the aftermath of an event."[35]

[33] NOAA Center for Tsunami Research. "Deep-ocean Assessment and Reporting of Tsunami. 4th Generation Tsunami Measurement System." *National Oceanic and Atmospheric Administration,* 2013. nctr.pmel.noaa.gov/Pdf/brochures/dart4G_Brochure.pdf. Accessed 1 Aug. 2018.

[34] de Groot, Robert. "ShakeAlert™: An Earthquake Early Warning System for the West Coast of the United States." *ShakeAlert*, www.shakealert.org/. Accessed Mar. 2018.

[35] Ibid.

Figure 4: ShakeAlert User Display[36]

Two forthcoming EEW mobile apps will rely on USGS' ShakeAlert. The Los Angeles City Council Information, Technology, and General Services Committee recently approved funding for the creation and deployment of a city EEW mobile app.[37] Likewise, a Santa Monica-based technology firm called Early Warning Labs (EWL) has partnered with USGS to Beta test the app, QuakeAlert. According to Los Angeles residents, QuakeAlert provided nearly 30 seconds of warning following a 2018 5.3 magnitude earthquake.[38] Both apps are expected to be resident ready by the end of 2018.[39]

While beyond the current scope of ShakeAlert, there is the potential for alert transmission through IPAWS or other alert aggregators. The largest barriers to interoperability with IPAWS or other aggregators are the limitations of systems themselves. According to USGS representatives, "most of today's alerting systems were not designed with the stringent speed requirements of EEW in mind. Current systems cannot send these alerts in a timeframe that would be valuable to the public." As aggregators evolve and move towards cloud-based systems, there is the potential to fast track sensor systems such as ShakeAlert.

ShakeAlert or similar machine originated alerting systems must be paired with other alerting tactics. Social science research shows that message contents are prudent to immediate public action, as further detailed in Appendix D on page 37.[40] ShakeAlert provides a message type

[36] "ShakeAlert—An Earthquake Early Warning System for the United States West Coast." *U.S. Department of the Interior U.S. Geological Survey*, Feb. 2017, pubs.usgs.gov/fs/2014/3083/pdf/fs2014-3083.pdf/. Accessed Feb. 2018.

[37] "Funds for Earthquake Warning App Approved by LA City Council Committee" *CBS Los Angeles,* 19 June 2018, losangeles.cbslocal.com/2018/06/19/earthquake-warning-app-shakealert-la/. Accessed 20 June 2018.

[38] Guzman, Hugo. "L.A.'s earthquake early warning system moves forward." *The Hub,* 19 June 2018, www.hub-la.com/news/earthquake-early-warning-system-moves-forward/. Accessed 3 July 2018.

[39] Ibid.

[40] PREPTalks. "Discussion Guide, Modernizing Public Warning Messaging." *Federal Emergency Management Agency*, bit.ly/2ItkQ5M. Accessed Apr. 2018.

(e.g., earthquake) but does not include detailed message content. Therefore, compelling messages must accompany the basic alarm using other tactics. In the future, advanced sensor alerting could expedite threat detection even further. For more information on near-future advanced sensor alerting capabilities, see page 26.

5.3 Tactics for Type I/II Incidents

The largest, most complex incidents require using every means possible to alert the public to take immediate action. Impact is imminent; therefore, the goal of the emergency response system is to reach the most people as quickly as possible. Threats will impact multiple sites, affecting large areas and immense populations. As a result, multiple agencies and jurisdictions must work together, sometimes with the help of national resources for the safe and effective management of operations. Examples of threats include severe weather (e.g., wildfire, earthquakes), major hazardous materials exposure, and terrorist attacks, among others.

Alert originators identified all current tactics (Figure 5: Black Tactics) and emerging tactics (Figure 5: Blue Tactics), especially WEA, as valuable for complex incidents. More traditional alerting methods (e.g., sirens, route notification and word of mouth) were cited as useful to supplement WEA when infrastructure and technologies fail.

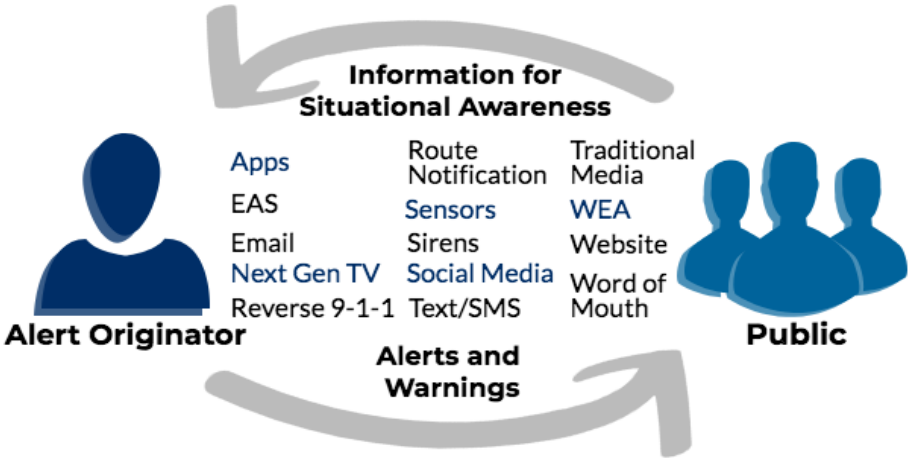

Figure 5: Tactics for Type I/II Incidents

The following section explores how WEA supports response to large-scale incidents and presents a case study on a National Capital Region (NCR) WEA test to demonstrate tactic benefits.

5.3.1 Wireless Emergency Alerts

The WEA system, formerly known as the Commercial Mobile Alert Service (CMAS), transmits three types of messages: Presidential, AMBER, and Imminent Threat alerts. The 2006 WARN Act authorized federal, state, territorial, tribal, and local authorities to use IPAWS to send alerts and warnings within their jurisdictions when the system is not in use by the President. Local and state agencies with alerting authority have discretion over the alerts they send, but all of the

alerts sent via WEA must be considered imminent threat messages.[41] As WEA is meant to reach large populations nearly instantaneously, a complex incident is the only situation where many alert originators feel comfortable authorizing such a powerful tool. One interviewee said, "When there are days until impact [like a hurricane] or a limited number of impacted individuals, we do not need WEA. When impact is imminent, and my entire community is affected, that is when I will use WEA. When I have to reach everyone, not just those who opt-in." If an incident escalates enough to warrant WEA, the alert should be supported by all available incident tactics for the utmost effectiveness.

Key Capabilities

Alert originators identified the following WEA capabilities as beneficial to alerting for complex incidents:

- Support immediate situational awareness; and
- Target mobile users via an opt-out system.

Immediate Situational Awareness: The 2018 Hawaii false missile alert raised concerns across the nation regarding WEA effectiveness and public reaction. Nevertheless, WEA technology worked exactly as it was intended to provide immediate situational awareness. After HI-EMA distributed the initial WEA message, the alert spread quickly across a variety of different platforms (e.g., social media, traditional media coverage). One alert originator said, "The way the message was received and spread across a variety of platforms, WEA did precisely what it should have done. The public received a steady drip of information." The Hawaii incident highlights the power of WEA when used in tandem with other alerting tactics (e.g., sirens, email, social media, reverse 9-1-1, etc.) to ring the alarm to a serious alert, then encourage immediate protective actions by providing information over a variety of other platforms.

Opt-out System: Every mobile user with a WEA-capable device will receive an alert broadcast over WEA unless they have declined receiving messages by "opting-out." Users currently can opt out of AMBER Alerts and Imminent Threat messages, but not Presidential messages (which have never been issued). According to one alert originator, "The strength of WEA is that you do not have to get people to sign up for it...The percentage of the population that chooses to opt-in and register through other systems is very small compared to our total population." For example, Lake County in northern California chose to use all alerting channels, including WEA, to notify the county's 64,000 residents during the October 2017 Sulphur Fire. Many local EMs did not use WEA because they wanted "to avoid mass panic and roads clogged with an unnecessary number of evacuees" and instead relied solely on opt-in systems.[42] Due to the size and severity of the fast-moving wildfire, Lake County Sheriff's Office made the 2AM call to send the WEA. A Lake County EM interviewed for this report said, "It was a personal call, one

[41] Wimberly, Rick. "What's an Imminent Threat Alert via WEA?" *Emergency Management,* 16 Sept. 2013. www.govtech.com/em/emergency-blogs/alerts/-Whats-an-Imminent-Threat-Alert-via-WEA.html. Accessed 11 Apr. 2018.

[42] Lapowsky, Issie. "Inside the Decades-Long Fight for Better Emergency Alerts." *Wired,* 14 Nov. 2017. www.wired.com/story/better-emergency-alerts-fcc/. Accessed Apr. 2018.

informed by years of experience." All 36 Sulphur Fire fatalities occurred in counties that chose not to send wireless alerts, and no deaths were reported in Lake County.[43]

Following the October 2017 California wildfires, the County of Sonoma Fire and Emergency Services Department (FES) Division of Emergency Management and the California Governor's Office of Emergency Services (Cal OES) conducted assessments regarding county alert and warning program capabilities. FES revised existing WEA policies to encourage the use of WEA in life-safety hazard incidents and recommended the county "address standardizing triggers and thresholds for issuing [WEA] messages." Likewise, Cal OES recommended specifying "the use of WEA for all critical public alerts and warnings."[44]

National Capital Region Case Study:

The NCR conducted a WEA test in 2018 to support continued use, training on, and improvements to the WEA system. Despite its many benefits, 60% of alert originators interviewed for the report expressed apprehension in using WEA because there were a number of unknowns regarding WEA effectiveness, real-time use, technology, and public reaction. One EM from the NCR said, "It is very stressful to send a WEA because the incident is always high impact." Alert originators must feel confident they are using reliable alerting tactics to notify the public during a disaster.

For this reason, 13 alerting authorities within the NCR coordinated to simultaneously issue the test, meeting frequently ahead of the test to discuss potential issues. The Metropolitan Washington Council of Governments (COG) also partnered with Everbridge, FEMA, and the FCC to:

- Acquire the necessary FCC waiver to conduct the WEA test;
- Coordinate public outreach on the test across the 20 participating jurisdictions; and
- Collect data via a public survey to assess test effectiveness.

All participating jurisdictions were on call the day of the test to ensure each authority was able to transmit the alert. Due to the complexity of the system, FEMA representatives were also available to assist the alerting authorities should issues arise. For example, originators were unable to transmit the original planned test message, which included an apostrophe. WEA does not recognize apostrophes and would not transmit the alert. According to one NCR EM, "That is the type of thing we would not have known before the test and can now avoid during a real incident in the future."

According to initial data, participating authorities report feeling more confident in WEA following the test because the majority of individuals within jurisdictions received the alert.[45]

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[43] Davis, Aaron C. and Sandhya Somashekhar. "The only California county that sent a warning to residents' cellphones has no reported fatalities." *The Washington Post*, 13 Oct. 2017, wapo.st/2k6Epqk. Accessed May 2018.
[44] Bratton, Sheryl. "Public Alert and Warning Program Assessment for Sonoma County." *CAL OES Governor's Office of Emergency Services,* 26 Feb 2018, assets.documentcloud.org/documents/4388831/Cal-OES-Public-Alert-and-Warning-Program.pdf. Accessed 25 June 2018.
[45] Crane, Thomas. "Takeaways from the DC-area WEA system test." *GCN,* 14 May 2018, gcn.com/articles/2018/05/14/wea-test-lessons-learned.aspx. Accessed 25 June 2018.

WEA does not have reporting capabilities, therefore, data from the optional public survey was the NCR's primary indicator of alert effectiveness. According to one NCR EM, "there is no perfect way to assess WEA effectiveness. If we send one out, the system does not tell us how many people got it, how long it took, etc." Therefore, regular tests and subsequent surveys are critical to help assess WEA operations and identify any improvements.

As part of early outreach efforts, NCR alerting authorities reached out to Community Emergency Response Teams (CERT) and Medical Reserve Corps (MRC) Programs to request participation in the public survey. CERT and MRC volunteers already have a baseline understanding of emergency response, resulting in more contextual feedback on the test. Volunteer participation increased NCR originator confidence in survey findings. "We knew we would have valid feedback on the survey if those folks were involved." The survey was also distributed over social media, websites, and other opt-in subscription systems to encourage public participation. Nearly 15,000 individuals took the survey following the NCR WEA test. Initial findings from the survey indicate issues related to geotargeting (e.g., jurisdiction bleed over); discrepancies between providers and devices (e.g., not all WEA messages triggered a loud noise); and public education on the difference between opt-in and opt-out systems, despite significant coordinated efforts by participating agencies.

Coordinated WEA tests are becoming more frequent across the nation. For example, nine Minnesota counties conducted a WEA EAS test on June 18, 2018. Similar to the NCR, Minnesota counties coordinated with the FCC, conducted extensive pre-test outreach, sought to familiarize the public with Minnesota systems, and helped "ensure WEA and the EAS can be effectively deployed in a coordinated manner during an emergency."[46] Alerting authorities nationwide would benefit from conducting coordinated tests within their jurisdiction, region, or state "to better understand the system's capabilities and verify that [they are] able to communicate with all targeted groups during an emergency."[47]

In the near-future, Next Gen TV could pose a unique opportunity to provide redundancy to WEA should cellular networks or systems fail. The following section evaluates the potential benefits of near-future tactics (e.g., advanced sensor alerting, Next Gen TV) for originator consideration.

6.0 Future Alerting Tactics

In addition to mastering current and emerging alerting tactics, originators must also plan to integrate future tactics to effectively warn populations at risk. Advanced sensors and Next Gen TV are two near-future tactics that, if properly adopted, could positively impact the future of

[46] "FCC Approves Joint EAS-Wireless Alert Test for Minnesota." *InsideRadio*, 21 May 2018, www.insideradio.com/free/fcc-approves-joint-eas-wireless-alert-test-for-minnesota/article_93dd57f2-5cc1-11e8-a2cc-7b70789f2aa0.html. Accessed 25 June 2018.

[47] Crane, Thomas. "Takeaways from the DC-area WEA system test." *GCN,* 14 May 2018, gcn.com/articles/2018/05/14/wea-test-lessons-learned.aspx. Accessed 25 June 2018.

emergency alerting and enhance originator capabilities. The following table highlights the benefits and barriers of future alerting tactics identified as part of research.

Tactic	Benefits	Barriers
Advanced Sensors	- Supports early warning - Allows alert originators to detect and send alerts in near real-time - Potential for complete automation and artificial intelligence (AI), which could increase alert distribution speeds - Could use CAP	- Cost is dependent upon system needs (earthquake vs. flood) - May remove the human element from alerting - May not provide enough context for the public to take immediate action
Next Gen TV	- Allows for more personalized alerts and improved geo-targeting - Bypasses cellular network congestion - Easy to provide multimedia links or additional resources - Encryption enabled - "Wake up" device feature - Increases accessibility through features like text-to-speech, sound alerts, and multilingual support - Could use CAP	- Requires a large market shift for cellular device activation - Requires attachments to adapt legacy TV equipment - Insufficient public safety participation in requirements gathering - Privacy concerns - Potential for public to view as "invasive"

The following sections explore how advanced sensors and Next Gen TV could build capacity and illustrates potential benefits through case studies.

6.1 Advanced Sensor Alerting

As technology evolves, advanced sensors could use connected devices and embedded sensors to "detect, analyze, and categorize potential events, send alerts, and potentially automate certain protective actions."[48] Machine-to-machine communications and advanced sensor capabilities have numerous applications across alerts and warnings. For example, if the National Weather Service (NWS) sent a Hurricane Warning to an at-risk individual while they were out of town, their smart home could receive the alert. The home could be programmed to automatically close the storm shutters and turn the refrigerator to the coldest setting in preparation. The following case study on the Iowa Flood Center (IFC) provides a more detailed example of how advanced sensor alerting capabilities could benefit alert originators in the near-future.

Iowa Flood Center Case Study:

The IFC provides automated, real-time flood forecasting to the state of Iowa through the Iowa Flood Information System (IFIS). IFIS is a "one-stop web-platform to access community-based

[48] National Academies of Sciences, Engineering, and Medicine. "Public Response to Alerts and Warnings Using Social Media: Report of a Workshop on Current Knowledge and Research Gaps." *The National Academies Press*, 2013. www.nap.edu/read/15853/chapter/2?term=public+education#3. Accessed 31 May 2018.

flood conditions; forecasts; visualizations; inundation maps (Figure 6); and flood-related information, visualizations, and applications" based on the IFC's network of sensors across the state of Iowa.[49] IFIS updates automatically every 15 minutes with data from more than 2,000 sensor locations.[50] In addition to the online interface, IFIS users can opt-in to sensor text/SMS alerts, download the IFIS mobile or web app, or follow automated alerts on Twitter. The IFIS mobile app is personalized, allowing users to filter alerts that are relevant to them (e.g., flood thresholds in their neighborhood).

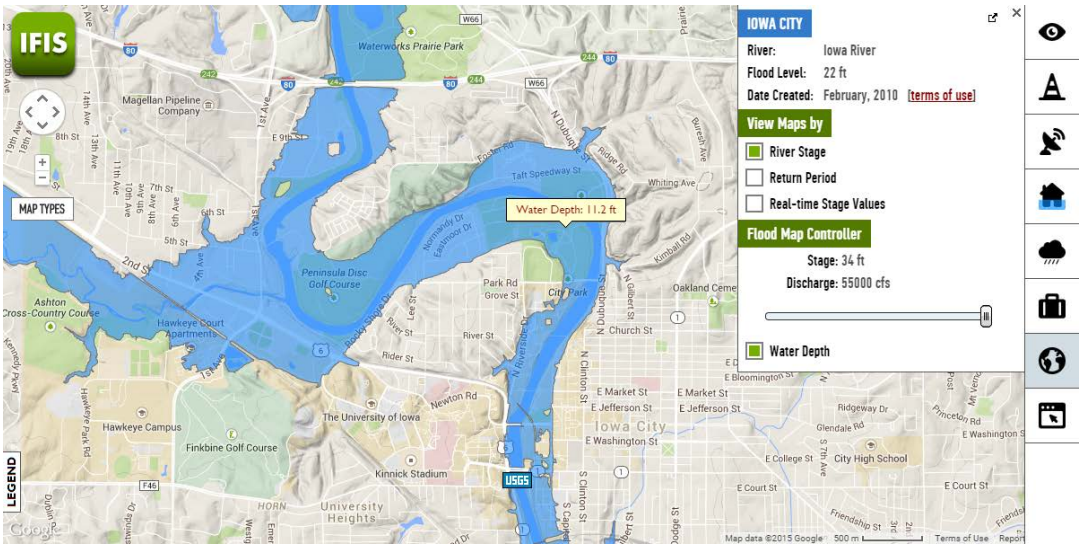

Figure 6: IFIS Flood Inundation Map[51]

The IFC is currently piloting and demonstrating advanced sensor alerting capabilities to supplement IFIS alerting. New capabilities include AI assistant functions (e.g., Siri, Alexa) and holograms (e.g., projected flood maps).

AI assistant functions use voice queries over a mobile phone or other device to attempt to answer sensor related questions and make recommendations. According to IFC representatives, "The goal is for an EM to be in his or her car on the way to an incident and ask Siri or a similar function what the current stream level is in their community. Or anyone in Iowa could ask Siri how much it rained or some other generic question. Everyone would immediately get an answer, rather than having to seek out the information." This feature could decrease public milling by quickly giving individuals the additional information they need. Additionally, originators may be able to access voice query sensor data to determine ways in which to improve alerts in the future by better meeting public information needs.

[49] "Iowa Flood Information System." *Iowa Flood Center*, ifis.iowafloodcenter.org/ifis/en/features.php. Accessed Mar. 2018.
[50] Krajewski, Witold F., Daniel Ceynar, Ibrahim Demir, Radoslaw Goska, et. al. "Real-time Flood Forecasting and Information System for the State of Iowa." *American Meteorological Society,* 14 June 2016, journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-15-00243.1. Accessed Mar. 2018.
[51] Ibid.

IFIS' current hologram prototypes can project maps and flood scenarios for various cities in Iowa. The holograms are interactive, which would allow public safety officials to add layers of data (Figure 7). The brain processes visual information more quickly than text, allowing for swift, more informed decision making and targeted alerting. For example, EMs could choose to project and select buildings for predictions of cost damages and alert individuals in high risk areas to evacuate. AI and hologram functions could result in more valuable early warning systems, better distribution of public safety resources, greater accuracy of alert message content, and reduced milling time as the result of more personalized messages.

Figure 7: IFIS Hologram Projection[52]

6.2 Next Generation Television

Although the long-term viability of Next Gen TV is far from certain, it has capabilities that could be extremely important to alerts and warnings. Next Gen TV aims to enhance and expand the broadcast viewing experience through the Advanced Television Systems Committee (ATSC) 3.0 standard. ATSC 3.0 is "based on an IP (Internet Protocol) backbone and attempts to merge broadcast TV with content from the internet."[53] In November 2017, the FCC voted to allow broadcasters to use the Next Gen TV standard on a voluntary basis.[54] The updated standard offers support for newer technologies and capabilities such as improved picture quality, reception, interactive features that personalize user content, and localized emergency alerts.[55]

[52] Ibid.
[53] Williams, Martyn. "What is Next Gen TV and when will it launch?" *TechHive*, 13 Dec. 2017, www.techhive.com/article/3238869/smart-tv/what-is-next-gen-tv-and-when-will-it-launch.html. Accessed Mar. 2018.
[54] "Unleashing the Next Generation of Broadcast Innovation." *National Association of Broadcasters,* www.nab.org/innovation/nextGenTV.asp. Accessed Mar. 2018.
[55] Ibid.

Advanced Warning and Response Network Case Study:

The Advanced Warning and Response Network (AWARN) is one potential Next Gen TV emergency alerting platform that could enhance originator capabilities and the public's ability to respond to an alert. "AWARN will have the capability to distribute rich media alerts simultaneously to an unlimited number of enabled fixed, mobile, and handheld devices, indoors or outdoors across an entire television broadcast coverage area."[56] Currently, test stations in Cleveland, Ohio and Phoenix, Arizona are piloting ATSC 3.0 and AWARN to identify opportunities for enhancement. In the future, AWARN (Figure 8) could be used in tandem with other tactics to address alerting gaps and requirements such as:

- More personalized alerts and rich media content;
- Improved geo-targeting;
- Better reach to AFN and LEP populations; and
- Alerting system interoperability and redundancy to cellular network dependent tactics.

Initial findings indicate AWARN may provide broader context and more engaging, personalized content to viewers. "AWARN will deliver multimedia alert content, which could include video, radar images and evacuation maps; text, photographic, or pictorial instructions; inundation maps...and shelter locations, treatment protocols, and other recovery information."[57] Research shows the public is more responsive to clear messages that are free of jargon and use plain language. Pairing clear message content with visuals, such as maps or pictures, over TV, mobile, and handheld devices could limit public confusion and action delays. Furthermore, "AWARN provides the technical capability to transmit both multilingual and accessible alerts."

Another major advancement from legacy alerting, which relies on active use of the device in question, is AWARN's ability to deliver an alert regardless of device connectivity. The ability to "wake up" devices would ensure a wider at-risk audience receives important alerts. AWARN is also designed to be CAP compliant, meaning AWARN may be able to broadcast any CAP formatted alerts that are disseminated via IPAWS.

[56] "How It Works." *Advanced Warning and Response Network, 2018,* awarn.org/how-it-works/. Accessed 26 June 2018.
[57] Ibid.

Figure 8: AWARN User Interface[58]

While AWARN poses numerous benefits to originators, the tactic must overcome certain adoption challenges in order for alert originators to use the potential tool. Today's commercially available devices, both TV and mobile, were not designed with tuners that can accept ATSC 3.0 broadcasts. Therefore, public consumers will be required to purchase attachments to adapt legacy equipment, and it is unclear when those will be readily available. Furthermore, even if manufacturers such as LG and Samsung designed smartphone devices with ATSC 3.0 compliant tuners, it is not guaranteed that commercial carriers would install the software to activate the tuners. The big four commercial carriers (e.g., AT&T, Verizon, Sprint, T-Mobile) primarily tier wireless service plans by data usage. AWARN over the air capabilities would allow the public to access local content without using cellular data, affecting commercial earnings.

7.0 The Future of the Alerting Ecosystem

Alert originators should practice a "sliding scale" approach to alerts and warnings, using multiple tactics to maximize alert reach across incident types. This report makes recommendations on effective combinations of tactics across NIMS incident types, which range from Type V (least complex) to Type I (most complex). Originators should use both current and emerging alerting tactics to reach at-risk populations while simultaneously planning for the integration of future systems.

[58] Advanced Warning and Response Network. "In the matter of GN Docket No. 16-142." 9 Nov. 2017, PowerPoint Presentation. Accessed 3 July 2018.

Originators should also coordinate with the following diverse groups of emergency alerting stakeholders to share information, discuss requirements, and formulate strategies for more effective alerting in the future:

- Public safety;
- Federal, state, and local government;
- Researchers and social scientists;
- Engineers and technologists;
- Commercial carriers;
- Vendors;
- Broadcasters;
- Non-government organizations; and
- Industry.

Each perspective brings distinct insights, which result in more innovative ideas to shape the future of alerting and improve effectiveness. Regular engagements are fundamental to supporting current and future system integration, in addition to maintaining alerting capabilities as technology evolves.

8.0 Appendices

Appendix A: Individual Contributors to this Report

The list outlines the individuals and organizations that contributed as part of the Team's data collection. Contributors participated via interviews and the Future of Emergency Alerting Workshop.

State and Local Organization Partners (alphabetical by State)

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4. Dale Carnathan – Lake County, California
5. Hans Ipsen – City of Los Angeles Emergency Management Department, California
6. Gary Singer – City of Los Angeles Emergency Management Department, California
7. Mary Jo Flynn – Sacramento County Office of Emergency Services
8. Rob Barreras – San Diego County, California
9. Alicia Johnson – San Francisco Emergency Management
10. Adair Ravencraft – Metropolitan Washington Council of Governments
11. Charles Guddemi – DC Homeland Security and Emergency Management Agency
12. John Benson – Iowa Homeland Security and Emergency Management
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14. Gary Zamerski – Maryland Emergency Management Agency
15. Russell Strickland – Maryland Emergency Management Agency
16. Randall Cunningham – Harford County Emergency Services, Maryland
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19. Ben Krakauer – New York City Emergency Management
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8. Edward Czarnecki – Monroe Electronics
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Appendix B: Acronyms

The following list outlines acronyms in this report in alphabetical order.

AFN – Access and Functional Needs
AI – Artificial Intelligence
AMBER – America's Missing: Broadcast Emergency Response
Apps – Applications
ASL – American Sign Language
ATSC – Advanced Television Systems Committee
AWARN – Advanced Warning and Response Network
Cal OES – California Governor's Office of Emergency Services
CAP – Common Alerting Protocol
CERT – Community Emergency Response Team
CMAS – Commercial Mobile Alert Service
COG – Council of Governments
DHS – Department of Homeland Security
DOJ – Department of Justice
DOT – Department of Transportation
EAS – Emergency Alert System
EEW – Earthquake Early Warning
EMs – Emergency Managers
EWLs – Early Warning Labs
FCC – Federal Communications Commission
FEMA – Federal Emergency Management Agency
FES – County of Sonoma Fire and Emergency Services Department
GPS – Global Positioning System
HazCollect – NOAA Weather Radio
HI-EMA – Hawaii Emergency Management Agency
IFC – Iowa Flood Center
IFIS – Iowa Flood and Information System
IP – Internet Protocol
IPAWS – Integrated Public Alert and Warning System
IPAWS-OPEN – IPAWS Open Platform for Emergency Networks
LEP – Limited English Proficiency
MRC – Medical Reserve Corp
NASEM – National Academies of Sciences, Engineering, and Medicine
NCMEC – National Center for Missing and Exploited Children
NCR – National Capital Region
NEXT GEN TV – Next Generation Television
NIMS – National Incident Management System
NOAA – National Oceanic and Atmospheric Administration
NWS – National Weather Service
PBS – Public Broadcasting Service
POC – Point of Contact
PSHSB – Public Safety Homeland Security Bureau
S&T – Science and Technology Directorate
SOPs – Standard Operating Procedures
USGS – United States Geological Survey
WEA – Wireless Emergency Alerts

Appendix C: IPAWS Description

FEMA created IPAWS in 2004 in an effort to combine existing alerting systems within the United States under a single platform. IPAWS was established to meet Executive Order 13407, which requires "an effective, reliable, integrated, flexible, and comprehensive system to alert and warn the American people in situations of war, terrorist attack, natural disaster or other hazards to public safety and wellbeing."[59] The IPAWS Open Platform for Emergency Networks (IPAWS-OPEN) is the message aggregator that all alerts must pass through for validation and authentication before being routed to the appropriate public alerting system(s).[60] Those systems could include EAS, WEA, and the National Oceanic and Atmospheric Administration (NOAA) Weather Radio (HazCollect).[61] Public alerting systems, like WEA, act as separate channels for message dissemination. IPAWS-OPEN also transmits to non-federal alerting systems, such as internet web services, emergency telephone networks, siren systems, or digital road signs.[62] Private sector companies (e.g., the Weather Channel, Public Broadcasting Service (PBS), and Facebook) also have agreements in place with FEMA to access, monitor, and retrieve public alerts using the IPAWS All-Hazards Information Feed. These additional dissemination channels contribute to the alerting ecosystem to share as much information with the public as possible so they can actively respond to hazards and threats.

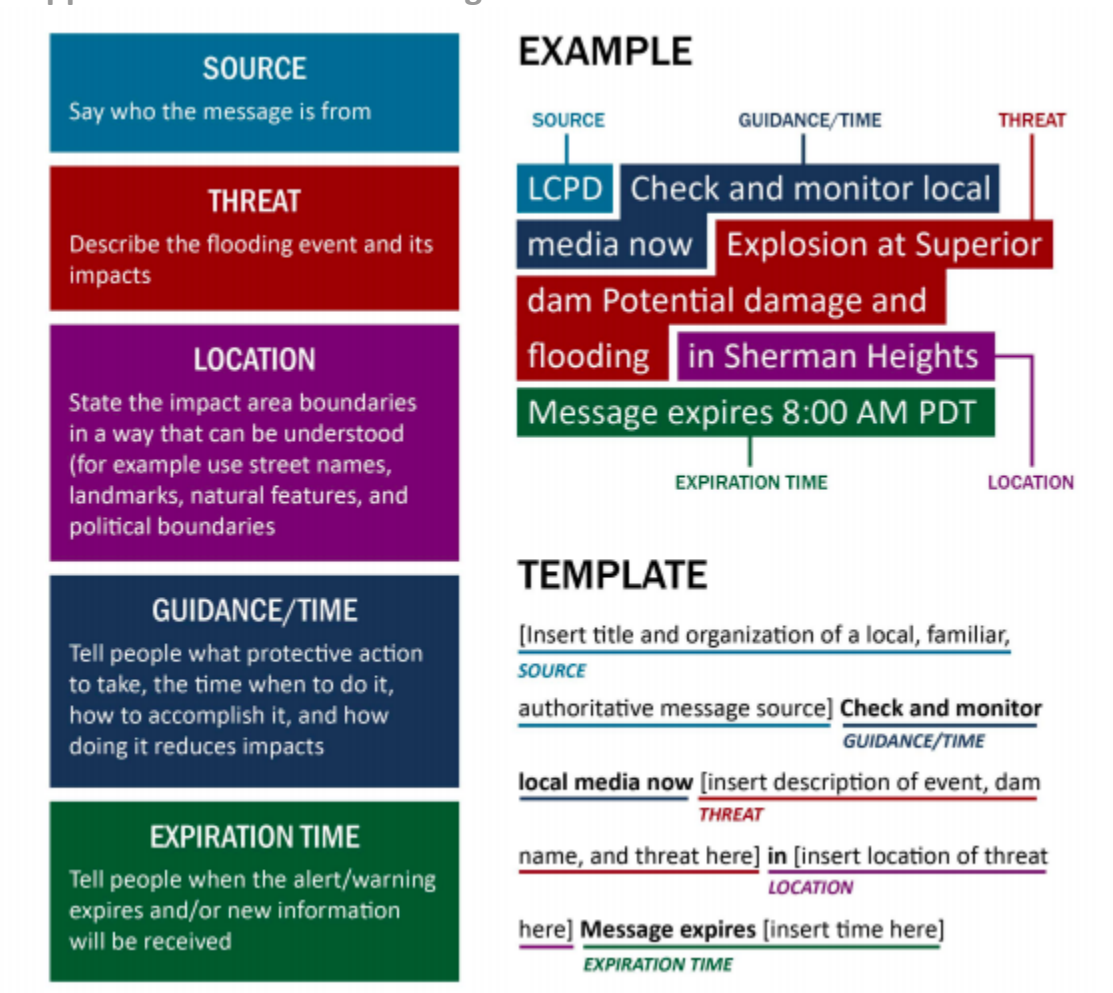
[59] "Federal Emergency Management Agency (FEMA) Integrated Public Alert & Warning System (IPAWS) Common Alerting Protocol (CAP) v1.1 Profile Requirements." *Federal Emergency Management Agency,* 10 Dec. 2008, www.fema.gov/pdf/emergency/ipaws/oasis.pdf. Accessed Feb. 2018.

[60] "Integrated Public Alert & Warning System Open Platform for Emergency Networks." *Federal Emergency Management Agency,* 22 Feb. 2018, www.fema.gov/integrated-public-alert-warning-system-open-platform-emergency-networks. Accessed Apr. 2018.

[61] "Integrated Public Alert & Warning System." *Federal Emergency Management Agency,* 31 Oct. 2017, www.fema.gov/integrated-public-alert-warning-system. Accessed Apr. 2018.

[62] "IPAWS Toolkit for Alerting Authorities." *Federal Emergency Management Agency,* 22 Mar. 2018, www.fema.gov/media-library/assets/documents/86098. Accessed Apr. 2018.

Appendix D: Effective Message Format[63]



[63] PREPTalks. "Discussion Guide, Modernizing Public Warning Messaging." *Federal Emergency Management Agency*, bit.ly/2ItkQ5M. Accessed Apr. 2018.