Emergency Alert and Warning Systems

Current Knowledge and Future Research Directions

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Agenda and Speakers

I. Introduction
Jon Eisenberg, National Academies

II. Remarks from the Sponsor
Denis Gusty

III. Report Briefing
Ramesh Rao

IV. Q&A
Ramesh Rao
Denis Gusty
Eve Gruntfest
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Remarks from the Sponsor

Committee

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- ROOP DAVE, Information Technology Research Academy, New Delhi
- EVE GRUNTFEST, California Polytechnic State University
- BROOKE LIU, University of Maryland
- LESLIE LUKE, Los Angeles County Office of Emergency Management
- DENNIS MILETI, University of Colorado, Boulder
- NAMBIRAJAN SESHADRI, Broadcom Corporation (retired)
- DOUGLAS SICKER, Carnegie Mellon University
- KATE STARBIRD, University of Washington
- CHARLES L. WERNER, ParadeRest and Commonwealth of Virginia

Statement of Task

- **Review current knowledge** about how to effectively deploy and use emergency alert and warning systems and explore related future computing, engineering, and social science research needs
- **Convene workshop** to capture results of DHS S&T-sponsored and other recent research and foster dialog among technologists, social science researchers, and emergency managers
- **Summarize** results of DHS-sponsored research
- Provide an **overview of current knowledge** about emergency alerts and warnings and their relationship to citizen interactions and information needs
- **Set forth an interdisciplinary research agenda** that highlights gaps and future needs

Defining Alerts and Warnings

- Purpose of alerts
  - **To deliver** messages to warn populations at risk of **imminent threats** with the goal of **maximizing the probability** that people take protective actions and **minimizing their delay** in taking those actions

- Why are they important?
  - **To alert the public about natural hazards** such as severe weather and **manmade events** such as terrorist attacks or chem/bio threats



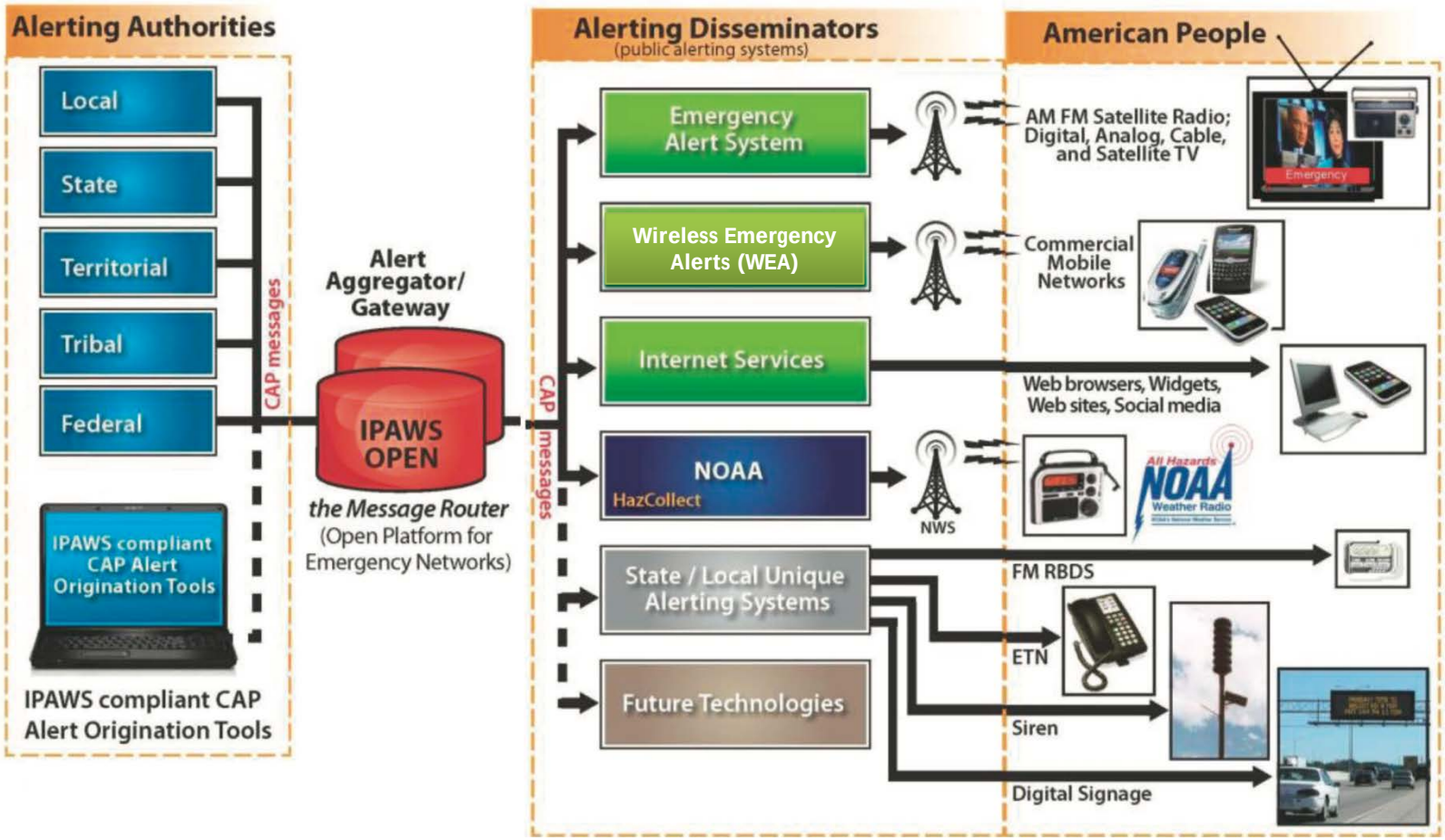


Recent Events



- Hurricanes Harvey, Irma, and Maria
- The October 1, 2017, shootings on the Las Vegas Strip
- 2017 California wildfires

Alerting System Today



Recent DHS-Supported Research

- Public Response
  - E.g., public perception of various hazards, public reactions to messages of various character lengths (140, 280, 1380) and psychophysiological, emotional, cognitive, and behavioral responses to a simulated WEA message
- Geotargeting
  - E.g., new geotargeting mechanisms, diffusion behavior of messages, and public benefit and performance tradeoffs of geo-targeted WEA messages.
- Technologies
  - E.g., integration strategies to aid alert originators adopt and utilize WEA and cybersecurity guidelines for cell carriers

Desired Properties of an Alert System

- **Only reach people at risk** from (or have other interests in) the hazard.
- **Communicate impact and recommend protective actions** that people can understand and can reasonably take, with guidance **tailored to the circumstances** of each alert recipient.
- **Reflect changing information needs** as an event unfolds
- **Be respected and trusted** by the public, emergency mangers, other public officials, and the media.
- Be **suitable for all hazards** and effective in reaching **all at-risk populations**.
- Work well **alongside other government and private information sources**.
- Allow for **collecting feedback** from the alerted population to **determine the effectiveness** of an alert and give emergency managers better **situational awareness** during an event.

Evolving the Nation's Alert and Warning System

- Goal: Take advantage of new technologies and reflect new knowledge gleaned from events and research

- Near-term goals
  - Increase adoption of WEA and other existing alert and warning systems
  - Exploit current knowledge about public response to craft more effective alert messages
  - Use location information currently available on cell phones to improve geotargeting precision
  - Exploit other comms: 4G/LTE, WiFi, Bluetooth, …
  - Add capabilities for performance monitoring and user feedback

Evolving the Nation's Alert and Warning System (cont'd)

- Long-term goals
  - Assure end-to-end service availability and message validity and integrity.
  - Provide users with more granular control of when and how they're alerted.
  - Consider further opening IPAWS data feeds for third-party apps.
  - Better inform emergency managers by rapidly analyzing social media data.
  - Use IoT to detect and analyze events and send alerts.
  - Leverage backup comms such mesh networking and FM broadcast.

Socio-Technical Research Agenda

- Knowledge needed to fully realize near-term and long-term goals
- Public Response
  - More effective messages
  - Better meeting needs of subpopulations
  - More precise geotargeting
  - Better education and enhanced community engagement
- Technical Challenges
  - More robust/reliable message delivery
  - Leveraging wider range of connected devices
  - Protecting security and privacy and increasing trust
- Post-Alert Feedback and Monitoring

Crafting More Efficient Messages

- **Including protective guidance in links to enhanced media**
  - What information is best included in a message and what information is best included in linked content?
- **Expressing time until hazard impact**
  - What is the best lead time to ensure appropriate action is taken?
- **Opt-in versus Opt-out**
  - Past research suggests that alerts and warnings should be sent through as many channels as possible, but over alerting is a known problem. What drives opt-in and opt-out behaviors?
- **Message length**
  - How can longer (360 characters) WEA best be used? What are the optimal message lengths for different hazards and different delivery mechanisms?

Meeting the Needs of Subpopulations

- **Language and dialects**
  - In what cases will templates and machine translation be "good enough"?
- **Differing abilities**
  - How can messages be best presented to physically and cognitively challenged individuals?
- **"Digital divide"**
  - How do we take advantage of new technologies while also ensuring those with less access receive timely alerts?

Geotargeting

- **Determining locations of interest**
  - How can locations of interest be dynamically updated rather than manually specified by users?
- **Location-based protective action**
  - What are the opportunities for more precisely specifying protective action based on location? How can such capabilities be realized?
- **In-building location**
  - Such information can be used to determine evacuation routes to advise on evacuation versus sheltering in place. For example, it is currently hard to determine on what floor a user is located.
- **Communicating location**
  - How to best communicate, possibly through visualizations, about the location of the message recipient versus the area of impact?

Community Engagement & Education

- How can emergency managers make effective use of community-oriented tools such as NextDoor?
- How can we leverage social media to enhance community engagement and promote disaster education?
- What methods are effective in motivating behavior change?
- What other factors contribute to successful public disaster education campaigns? How important is in-person training? What role can new techniques such as gamification play?

Post-Alert Feedback

- What information would be most helpful to emergency mangers before, during, and after an event?
- What information would be helpful to hazards researchers?
- What is the best way to collect the information, taking into account technical constraints and privacy concerns?

WEA Delivery Technology

- What would the impact of including a URL be on network capacity?
- What is causing failures to deliver WEA messages as evidenced by recent testing?
- Can we move beyond 90 characters and take advantage of the longer message lengths offered by 3/4/5G networks while providing backward compatibility?
- Is it feasible to combine multiple cell broadcast messages into a single, longer alert message?
- How to complement WEA with other modalities including third-party apps and services to reach more recipients and increase the likelihood of delivery?

Enhancing Alert Delivery

- **Bypassing network failure**
  - Can we exploit alternative ways to deliver information to phones such as mesh networks, peer-to-peer communication, and FM radio?
  - Can we use peer-to-peer communications techniques, such as those used by FireChat, to relay messages to people without a direct network connection?
  - How do we validate the efficacy of these technologies?
- **Battery life management**
  - How do we reserve power on cell phones and other devices so alerts can continue to be received during an event?
  - Can we provide feedback to alert originators on whether future messages will be delivered given current device battery levels in the target audience?

Role of Connected Devices

- **Automated alerts based on aggregated data**
  - Faster event detection and alerting for very fast moving hazards such as active shooters
  - Need to aggregate enough data so that machine learning can be used in a robust fashion to reliably detect events and gain sufficient situational awareness to determine the best protective action
- **Best devices for alerting**
  - Which devices should be used to issue alerts for which hazards?
  - Are there opportunities to customize where alerts are sent to better communicate appropriate protective action? For example, under a boil water order, could an alert be presented on a smart refrigerator when the water dispenser is used?
- **Reducing milling with virtual assistants**
  - What role can devices such as Alexa or Google Home play in answering questions to reduce milling behavior or to learn about protective actions?

Trust, Security, and Privacy

- How can we issue the necessary credentials to state and local emergency managers nationwide and provide necessary training?
  - For example, could we simplify by issuing jurisdiction-wide rather than individual credentials?

- How can emergency managers quickly detect and effectively respond to the spread of false or misleading information?

- How can personal information be used to provide geographically relevant information while protecting individual privacy?

Challenges to Building a Better Alerting System

- **Slow adoption of new systems** by alert originators
- **Limitations of weather forecasts** and other information about hazards
- **Ever-changing technology**
- Difficulty of **interdisciplinary research** and **translating research results to practice**
- **Incentivizing relevant stakeholders to participate**

Summary

- A more cohesive and all-encompassing alert and warning system is needed that can:
  - Better integrate public and private communications mechanisms and sources of information
  - Continue to provide the necessary information for the purpose of preserving the health and safety of people
  - Employ a technology-agnostic architecture that allows new technologies for delivering alerts be adopted quickly.
- The nation's alerting capabilities, such as WEA and IPAWS, will need to evolve and progress as the capabilities of smart phones and other mobile broadband devices improve and newer technologies become available.
- This evolution will need to be informed by both technical and social and behavioral science research.

Questions?

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