

Enhanced Geo-targeting Goals and Options for Wireless Emergency Alerts

Alert Originator Requirements Interview Study

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Executive Summary

Deployed for the first time in 2012, the Wireless Emergency Alert (WEA) system is a relatively new delivery mechanism available nationwide [SEI2014a]. The unique characteristic of this system is its ability to disseminate short alert messages in designated geographic areas affected by an emergency situation using cellular broadcast technology, avoiding undue impact on the wireless infrastructure. Despite the benefits of receiving timely, geographically targeted alerts while avoiding network congestion, large segments of the population may be choosing to opt out of receiving broadcast alert messages via their phone. In addition, the adoption of WEA-based systems by alert originators has been slow for a number of reasons.

The primary goal of this work is to gain insight into WEA adoption and acceptance issues in order to develop strategies for how the underlying challenges related to precise geographical targeting, context awareness, message length and structure, and alert relevance might be overcome. The work is part of Carnegie Mellon University's research project titled "Enhanced Geo-targeting Goals and Options for Wireless Emergency Alerts" that aims to improve the effectiveness of the current WEA service.

To understand the challenges underlying WEA adoption and acceptance, we chose to study a small group of emergency personnel who have direct experience working with emergency alert systems, including WEA-based instances, and have experienced first-hand both the benefits and challenges of these systems. The emergency personnel, who assess emergency situations, craft and ultimately disseminate WEA messages, are referred to as alert originators (AOs). These subjects were selected from the sample population of about 600 AOs assembled from a combination of sources.

Using qualitative, semi-structured interviewing techniques utilizing the pre-defined set of questions listed in Appendix A, we spoke in detail with eight AOs in order to understand their impressions and challenges using the WEA service, document their experience of how the WEA service has been received by the general population, and gather their suggestions on how the system could be improved. We augmented these interviews with data collected through five additional interviews that followed an open approach rather than a semi-structured approach with a pre-defined set of questions. Initially the purpose of this second group of interviews was to (a) collect general information about WEA for determining the focus of semi-structured interviews and formulating formal interview questions, (b) identify further contacts who would lead us to credible subjects to interview, (c) and explore collaboration opportunities for future field trials of selected WEA improvements. Nevertheless, these interviews also provided valuable insights that complement and support those obtained through the semi-structured interviews. Therefore we included them in our analysis.

We analyzed the collected data using the Grounded Theory method [Corbin2008], aimed at qualitative discovery and assessment of significant insights. The significant results were grouped into five insights that can be used to guide future design and iteration of the WEA service with respect to better geographical targeting, message content, message augmentation, and alert relevance:

- 1. 90 characters are not enough to convey meaningful information to the public.** Most participants in our study stated that they are unable to craft meaningful messages to the general population within the constraint of 90 characters. They felt that allowing longer messages would be a positive step towards minimizing public confusion and increasing message relevance. This insight reconfirms a yet-unfulfilled need that the alerting community has been aware of since the inception of the WEA service.
- 2. Geo-targeting of WEA messages is seen as the long sought out goal by AOs.** A majority of the AOs in our study stated that more geographic precision is required within the WEA service in order to better deliver relevant messages only to those impacted by emergency situations. They believe that utilizing geo-targeting will rectify many of the key challenges faced by the WEA platform.
- 3. The WEA service needs to interface with social media to be relevant.** Social media was emphasized as a common tool already being used by AOs. Understanding how to align the WEA service within the constellation of existing social networks emerges as an important future theme.
- 4. There are two distinct conceptual models of WEA: a mere warning alarm and a richer media application with follow through.** Questions around how to improve and evolve the WEA service uncovered two distinct mental models for the system. Some participants perceived WEA as a “bell ringer” technology, akin to sounding the first alarm, which should rely on other communication channels for specifics of an emergency situation. Others believed the natural evolution of WEA messages is to uncover ways to directly embed or reference additional information and media within the messages themselves to convey more actionable information without violating original principles of the WEA service, or to augment it with effective incident follow-up and closure mechanisms for better situational awareness.
- 5. Better outreach and education for both the public and potential AOs will improve acceptance and adoption of the WEA service.** AOs agreed that not enough has been done to educate the general population around what WEA messages are, why they are important, and how the public should respond when they receive a message. Most participants saw education and outreach essential to the success of the WEA service.

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1. INTRODUCTION

Carnegie Mellon University's research project titled "Enhanced Geo-targeting Goals and Options for Wireless Emergency Alerts" (CMU WEA Project) aims to improve the effectiveness and adoption of Wireless Emergency Alerts through various approaches, in particular better geographical targeting and context-awareness.

The *Alert Originator Requirements Study* (AOR Study) constitutes the initial phase of the CMU WEA Project. The AOR Study aims at validating central perceptions about the WEA service and discovering new information, both through interviews with select Alert Originators (AOs). The central perceptions are documented by relevant previous studies [NRC2011, Nagele2012, Casteel2013, DHS2013, NRC2013, SEI2013a, SEI2013b, SEI2014a]. Discovery of new information implies extending and building on previous findings. These studies, discussed in Section 2, provided the motivation for the AOR Study and determined the research goals and questions. The current report presents the AOR Study's main results, focusing on insights derived from AO interviews, which are needed as input for the CMU WEA Project's remaining phases.

In Section 2 we discuss the relevant background. The background frames the work presented in this report in terms of Goals, Assumptions, and Research Questions discussed in Section 3.

In Section 4, we discuss the protocol we used for collecting the data through interviews with AOs from California, Kansas, Massachusetts, Texas, and Florida. These AOs were selected from the sample population of about 600 AOs assembled from a combination of sources. The subsequent analysis of data was conducted based on the Grounded Theory approach [Corbin2008].

Based on the analysis undertaken, the research team created top line summaries for each interview (Appendix B), and these were followed up by a workshop to synthesize the data collected. The data synthesis workshop was attended by key members of the research team and yielded a set of insights and topics. These insights are grouped into five *Primary Insights* and a number of *Secondary Insights*, which are discussed in Section 5. The Primary Insights represent those themes that the research team felt were the most strongly voiced by the AOs. The Secondary Insights represent those themes that the research team deemed also worth reporting, but were not included in the Primary Insights. The insights are enhanced with additional data gathered from open interviews with AOs and experts in the San Francisco Bay Area and in Washington, D.C (Appendix C).

Section 6 relates both the Primary Insights and the Secondary Insights back to the Research Questions. In Sections 7 and 8, we respectively summarize the work and provide the implications of the results for the remaining phases and components of the CMU WEA Project. The impacted phases and components include (a) a follow-on AO Survey, which covers a larger population of AOs and is more quantitative in orientation, (b) a Testbed development, which creates a test environment and implements several recommended WEA enhancement options, and (c) a Trial, which leverages the Testbed to carry out field studies of WEA enhancement options with real subjects.

2. BACKGROUND

Several previous studies and workshops have reported on the effectiveness and adoption of the WEA service and suggested strategies for possible improvements for WEA delivery. Since the findings of these works influenced this study's goals and are validated in this report, we summarize the relevant ones here.

2.1. Geo-targeting in WEA

Research conducted by SEI [SEI2013a, SEI2013b] identified trust, both on the part of the AOs as well as the public, as a key factor in the success of the WEA service. Based on the analysis of the AO trust model research, maximizing AOs' use of the WEA service requires maximizing three key outcomes: appropriateness, availability, and effectiveness. Geographic specificity was identified as a critical component in building trust through appropriateness [SEI2013a, SEI2013b]. Being able to set an appropriate polygon size is an important factor in improving the response to alerts [Nagele2012]. A related study examined the degree to which adding a geo-targeted map helps improve response to a cell-phone alert [Casteel2013].

The importance of geo-targeting is also reiterated in several other reports. DHS's WEA service recommendations [DHS2013] and SEI's WEA best practice recommendations [SEI2014] conjecture that AOs will use WEA messages more extensively if alert messages can be better targeted to the size and location of the geographic region impacted by the emergency event. In particular, a DHS recommendation [DHS2013] states that better geo-targeting enhancements "would prevent missed alerts caused by geo-targeting inaccuracy and reduce over-alerting the public with irrelevant messages," adding that such outcomes would in turn "encourage more widespread adoption of WEA by emergency managers and the public."

The WEA service targeting based on the current county designations using the Federal Information Processing Standard (FIPS) codes are effective in some cases, but not all. For example, in some states, counties have a huge geographic footprint, and notifications of an emergency in the far corner of a county may send useless information to many who are hundreds of miles away. Conversely, in major metropolitan areas where the distances are smaller but population density is higher, current WEA geographic granularity may result in many people receiving alerts for a localized event that is not relevant to them.

SEI's study on WEA integration considerations [SEI2014a] contrasts the targeting approach based on the FIPS codes with a more granular polygon approach. Many AO tools support the specification of an alert area with a polygon, but the WEA messages are often issued to all FIPS codes intersected by that polygon, significantly expanding the originally targeted area. Even when commercial mobile service providers support polygon-based targeting, it is not clear to what degree they are over-approximating the specified polygons during cell-tower mapping, and how such mapping affects disparities between

sparsely populated rural areas with few long-range cell towers and densely-populated areas with many short-range cell towers. While Tier 1 carriers have started using more granular geo-targeting, changes in cell tower coverage and differences in geo-targeting precision related to different tower and population densities continue to maintain the status of targeting resolution as a top concern.

2.2 Miscellaneous WEA Limitations and Enhancements

The SEI study [SEI2014a] also posits that continual WEA technical improvements in an evolving infrastructure and the ubiquity of smartphones may enable novel technical solutions both for improved geo-targeting and for addressing other current limitations of WEA-based services. This potential of capable mobile devices to address such limitations was also alluded to in both the 2011 and 2013 editions of the NRC-commissioned workshop on current knowledge and research gaps [NRC2011, NRC2013], the 2013 edition of which reported that alerting systems in the future may not be solely responsible for geo-targeting.

In addition to geo-targeting specificity, other WEA limitations and enhancements mentioned by the above studies and reports include:

- Message length: Both NRC reports [NRC2011, 2013] and the DHS recommendations [DHS2013] point to the 90-character limitation of current WEA implementations as a hindrance with the proposition that a modest increase in message length might be beneficial. The 2013 NRC and DHS reports suggest that the message length could effectively be extended by pagination strategies based on broadcasting multiple constituents in successive bursts. SEI's integration considerations study [SEI2014a] links the character limitation, compounded by geo-targeting imprecision, to undesirable post-emergency impact, specifically to the possibility of triggering increased voice or internet traffic leading to congestion. The Federal Communications Commission's Communications Security, Reliability and Interoperability Council (CSRIC) is already considering an increase in the character limit.
- Lack of understanding of AO requirements: SEI's study on WEA integration considerations [SEI2014a] stress the importance of eliciting and specifying emergency management agencies' requirements for WEA services.
- Role of context: The 2011 NRC report [NRC2011] points to growing smartphone capabilities in terms of inferring the physical location and circumstances of the recipients and the possible role such capabilities might play in relevance-targeting of the alert messages.
- Interest targeting: Currently, a WEA message can only be received in and around the affected area related to that message. The 2013 DHS recommendations [DHS2013] as well as the 2001 NRC report [NRC2011] suggest enhancing WEA delivery by allowing the public to be notified when a WEA message is issued to their home area or to a recipient-specified area of interest.
- Multimedia support: The WEA service currently supports only text messages. The 2013 WEA report [DHS2013] recommended that WEA also support richer media content in alerts. This would convey more information to the public about the situation and the required action.

3. GOALS, ASSUMPTIONS, AND RESEARCH QUESTIONS

The work reported in this report focuses on (a) how more precise, granular geo-targeting capabilities in the WEA service will impact the AOs' ability to craft more contextually relevant alerts, (b) what the AOs' opinions are for improving the alert messages' effectiveness and relevance based on their knowledge and intuitions of the public's behavior and perceptions, and (c) the AOs' understanding of what the public might want in terms of filtering of received messages and customization of how and when these messages are received.

3.1. Goals

The table below states the goals of the report expressed in *Goal-Question-Metric* (GQM) [BasiliEtAl1994] format. GQM is a method that is commonly used by empirical software engineering researchers in study design to articulate an investigation's high-level goals, expected outcomes, context, and perspective in a standard format. Components of the GQM statement are labeled from G1 to G6. These components are used to refine the GQM statements into concrete research questions defined in Section 3.2.

Validate	previous findings and recommendations regarding the viability, limitations, advantages and use of the WEA service (G1)
and	
identify	impediments and opportunities regarding the adoption of the WEA service by AOs (G2) and acceptance of the WEA service by the public (G3)
for the purpose of	prioritizing, developing, and evaluating enhancement goals and options for future wireless broadcast services (G4)
with respect to	increased geo-targeting specificity (G5) of alert messages and improved relevance (G6) to their recipients
from the perspective of	Alert Originators (G7)
in the context of	emergency alert systems and services used by different jurisdictions, agencies, and response communities throughout the nation (G8).

3.2. Assumptions

The following assumptions apply to the population sampled in the study. The validity of the findings reported is therefore contingent on these assumptions.

- | |
|---|
| A1 AOs have a sense of the needs of public regarding the consumption of emergency alerts and how the public feels about them. |
| A2 AOs have a sense of the weaknesses and strengths of the WEA service. |
| A3 AOs have a sense of what it would take to address the weaknesses of the WEA service. |
| A4 AOs have a sense of how to leverage the strengths of the WEA service. |
| A5 AOs use (or are willing to use) WEA messages only in limited circumstances due to current limitations of the WEA service and the delivery mechanisms underlying them. |

3.3. Research Questions

The study goals stated in Section 3.1 are refined into the following research questions. The labels in brackets indicate the relationship of each research question to the components of the GQM statement and to previous findings expounded in Section 2.

- | |
|--|
| RQ1 Is more precise/granular geo-targeting likely to improve the effectiveness of WEA messages? (G1, G5) |
| RQ2 Is increasing the relevance of WEA messages to recipients based on the recipients' context likely to improve the effectiveness of the WEA service? (G1, G3, G6, role of context) |
| RQ3 Is better control by the recipient of which messages they will receive and which messages they wish to disregard likely to improve the effectiveness of the WEA service? (G1, G3, G6, interest targeting) |
| RQ4 Is having a feedback mechanism (implicit or explicit) in WEA delivery from the recipient back to the AOs likely to improve the adoption of the WEA service? (G2, G7) |
| RQ5 Is the use of better alert creation tools that help create meaningful and targeted alert messages |

likely to improve the adoption of the WEA service? (G2, G7, multimedia support)

RQ6 Is relaxing the length limitation of a WEA message likely to improve the effectiveness of the WEA service? (G1, G3, message length)

RQ7 Do different kinds of AOs have different needs and reasons for adopting and using WEA messages? (G2, G7, G8)

RQ8 Are certain improvements to WEA more important than others in terms of their potential to improve the effectiveness of the WEA service? (G2, G3, G4)

4. METHODOLOGY

4.2. Participant Selection

The data collection portion of the work involved in-depth interviews with a set of subjects selected from the sample population of about 600 AOs assembled from a combination of sources. A substantial effort was made to balance the subject selection and maintain diversity of location and scale. We included AOs from entities that operate on local (e.g., city, county), state and national levels, and sought representatives from all regions of the country. We included participants dealing with a range of emergencies, including weather related ones (e.g., hurricanes, tornadoes, flooding), earthquakes, fires, shootings, as well as cases of abducted children.

Initially we set out to include as many AOs that had adopted WEA as possible. This turned out to be a very difficult task, since WEA adoption is still in the very early stages: finding subjects with requisite direct experience proved elusive. Therefore, we chose to also include AOs who have direct experience working with other emergency alert systems, such as AlertSCC used in Santa Clara County, but are open to using the WEA service in the future. A number of local emergency services organizations to which some of these AOs belong are already set up to issue WEA messages, but are currently either rarely using the WEA service or not using the WEA service at all. Quite a few are in the process of becoming authorized AOs, or are prepared, but have not had the opportunity or need to issue WEA messages. We augmented these with informal, non-structured interviews with five other local AOs and experts who were willing to talk to us.

4.1. Profile of Participants

Table 1 summarizes the profile of our participants. This list includes AOs who were interviewed using the non-structured approach (the last five entries in italics).

All participants held senior roles in various emergency management organizations with mandates over different jurisdictions (national, state, county, local). The states represented in this sample were California, Kansas, Massachusetts, Texas, and Florida.

The participants' titles spanned Senior Coordinator of OES, Director of OES, Program Lead of Emergency Communications, Emergency Management Liaison, Assistant Director of Emergency Management, Preparedness Coordinator, Director of National Center, OES Coordinator, Emergency Management Specialist, EOC Coordinator, and Head of Protective Services. Their affiliations spanned Santa Clara County, City of Palo Alto, National Weather Service, Harris County, Johnson County, State of Florida, State of Massachusetts, National Center for Missing and Exploited Children, NASA Ames Research Park, and Department of Homeland Security/FEMA.

Table 1. Profile of AORS interview participants.

Alias	Scope	Likely Type of Alert, Emergency, or Event	Base Region	State
KFT	County	Shootings, Fires, Earthquakes	West	CA
KDR	City	Shootings, Fires, Earthquakes	West	CA
MGR	National	Tsunami, Hurricanes, Tornadoes, Wildfire	East	N/A
FSZ	County	Tornadoes Hurricanes	Center	TX
MMY	County	Floods, Earthquakes, Tornadoes, Hazardous Materials	Center	KA
BKN	State	Hurricane	East	FL
CBE	State	Bombings, Plane Crashing, Fires, Hurricanes	East	MA
BHR	National	Child Abductions	East	N/A
LBN	Local	<i>Fires</i>	West	CA
AKT	Local	<i>Security, Hazardous Materials, Fires, Earthquakes</i>	West	CA
WWR	National	Any	East	N/A
PSR	Local	<i>Security, Hazardous Materials, Fires, Earthquakes</i>	West	CA
LBA	Local	<i>Security, Hazardous Materials, Fires, Earthquakes</i>	West	CA

4.2 Interview Protocols

4.2.1. Semi-Structured Interviews

For the core eight subjects (first 8 rows in Table 1), the interviewers used a semi-structured approach, combining questions and observations. This field study approach is called *Contextual Inquiry* [Ross2012]. This allowed us to understand the context in which AOs work with emergency situations and alerts, as well as uncover any related needs and pain points. Two of the interviews were conducted *in situ* where we were able to observe AOs at their desks while they illustrated how they dealt with an emergency situation or created emergency alerts. The remaining semi-structured interviews were conducted remotely through Skype or over the phone.

During the semi-structured interviews, a mixed interview protocol was adopted to elicit both targeted and emergent information. Targeted questions were aimed at validating or refuting our research hypotheses and solution ideas. A script composed of a sequence of primary questions and follow-up questions guided interviews. Diverging from the script was allowed to capture emergent information by letting the subjects drive the interviews. For example, one of the insights uncovered due to this kind of flexibility revealed the importance of connecting social media to WEA. Appendix A contains the interview script with primary and follow-up questions.

4.2.2. Open Interviews

The five additional interviews followed an open-ended format: they did not use a pre-determined structure with a set of questions and did not take advantage of the Contextual Inquiry approach. Four of these interviews were *in-situ*, and conducted in the San Francisco Bay Area. One was remote and conducted over the phone. Two open interviews were conducted together. In each case, either the participants specifically requested an informal meeting with a broader scope or we had not yet formulated the interview protocol, but accepted to meet in order not to miss the opportunity. During these meetings, the research team also discussed collaboration opportunities and additional matters with the participants, extending their scope and giving them a multiple purpose. The relevant observations were nevertheless recorded and summarized using the same approach as the semi-structured interviews.

4.3. Data Collection and Analysis

4.3.1. Approach

The data from all interviews were analyzed using the Grounded Theory approach [Corbin2008]. Grounded Theory is a qualitative research methodology that operates effectively in a reverse fashion from traditional hypothesis-based scientific research. Unlike traditional models of research that begin with a hypothesis, grounded theory is an exploratory method that is centered on data. The theory is constructed through the analysis of data, thereby making the findings and theories developed within a study “grounded in the data”.

The key goal of the Grounded Theory study is to discover a research participants’ main concern and how they continually try to resolve it. Researchers must repeatedly ask themselves, “What are the main problems the participants are grappling with, and how are they trying to solve them?” In most behavioral research endeavors, persons or patients are units of analysis, whereas in Grounded Theory, the unit of analysis is an *incident* – such as a statement made by a participant during an interview. Throughout the interviewing process, significant statements made by research participants are recorded through a process known as “noting.”

The empirical data collected through these notes are then sorted and clustered in order to identify patterns. From these patterns, researchers generate themes that explain the common ways in which the research participants in the study resolve their central concerns. These concerns are then related to research questions. The results of Grounded Theory are not a set of statistically significant probabilities, but a set of statements about the relationships among concepts, or an integrated set of conceptual

hypotheses developed from empirical data. Because deviations from the scripted questions are allowed to capture emergent information, often not all questions from the initial set are addressed during an interview, and hence quantitative results on the questions are typically not gathered or reported. Such quantitative results are best obtained through other research methods, for example, through a follow-up survey.

4.3.2. Data Collection

In the interview protocol, a debriefing session followed each interview. The researchers who participated in an AO interview met as a group immediately after the interview session to capture what was learned. During these discussions we captured key themes, significant quotes, and data points from our conversation with the AO. We captured this data on Post-It® notes. The tactile quality of Post-It® notes made it easy for the team to scan pieces of data and engage with them in a collaborative fashion. Noting also provided a shared sense of ownership in the process, making it easy to build upon the ideas of others.

After each interview, one researcher was assigned to review the audiotapes from the AO discussion to capture any additional relevant data points and generate an interview summary for each participant. These are the *topline summaries* included in Appendix B. The interview summaries provided highlights and key findings from the AO discussion for members of the team who were unable to attend the AO interview.

4.3.3. Data Aggregation

Next, after all the interviews were complete, the entire research team met during a half-day data synthesis session to review the data that had been collected on the Post-It® notes from the interviews and generate additional notes by going through the topline summaries (Figure 1). Observations from the eight semi-structured and five open interviews were aggregated at this point. The team gathered the notes and clustered the data into themes.

Common quotes and ideas were clustered together. The tangible nature of this process allowed the team to synthesize the data collaboratively, enabling a shared understanding of the key themes. The process enabled the team to visualize and sort the common statements and ideas that were communicated by the AOs interviewed.

After several hours of discussion and debate, the team arrived at five *Primary Insights* that we collectively believed were emergent and important and that directly bear onto the research questions. All additional insights were captured in the *Secondary Insights* list.



Figure 1. Snapshots of the data synthesis session.

5. INSIGHTS

In this section, we report on the AOR Study results grouped into five Primary Insights and a number of Secondary Insights. The Primary Insights cover topics and themes that were most strongly articulated by the AOIs, and they have a more direct bearing on the research questions. We discuss each of the Primary Insights through inclusion of specific quotes from the participants and examples from the emergency messages sent to the public. Both the Primary and the Secondary Insights are later used in the discussion and recommendations sections to derive implications for future studies, in particular for the AO Survey and Trial components of the CMU WEA Project.

5.1. Insight One

I1 90 characters are not enough to convey meaningful information to the public.

The most common problem reported by the participants is working within the current 90 characters constraint of the WEA service. All participants interviewed stated this stringent character limit was simply not enough to convey relevant messages to the general population. The AOIs emphasized the need to include information in the alert messages pertaining to the originator, relevance, expected action, and external sources, which the 90-character limit hardly allow.

"We can't just issue a casual message. To get people's attention, probably one of the most limiting factors of WEA is the 90-character length. So you really can't have a full-blown explanation of what the emergency is in 90 characters. Now that the system is capable of more... it is an educational process to [show] the public what [WEA message] is. It is not a text message, it is not an email... it arrives on the carrier's frequency on the phone... With this biggest issue we have, we work with local authorities to just get the people's attention." (BKN)

"You throw in the time, type of warning, the action that people need to take, to check media... that is all that you can put in there..." (MGR)

"[In relation to missing children with autism]... because children with autism are attracted to larger bodies of water... This would also need more than 90 characters to explain it." (BHR)

Some of the participants worked with other systems where the message length was less constraining, most notably the full AMBER Alerts system with the 160 character limit and Twitter with the 140 character limit. Their experience suggests that even those systems can be too limiting to include important details:

"The next challenge is the 90 characters and that is something everybody is aware of. I have brought it up with the wireless industry... we have been working with wireless industry since 2004 for AMBER Alerts when people had to sign up for that and we have lots of historical

information... It used to be 160 characters. And we could barely get enough information into that." (BHR)

Because there is little awareness by the public around wireless emergency alerts, WEA messages carry the additional burden of both educating users as well as conveying information about the emergency at hand. Most participants in our study concurred that they believe a key reason users opt out of the service is because they are simply confused when they receive a WEA message for the first time and are unsure how they are supposed to follow up. Extra information in the message may address this problem, which the current message length limit does not permit.

In addition to increasing the amount of content expressible solely by text, the most frequent observation by the participants was the need to include pointers to supplemental information or photos. This need is illustrated by an example of a Twitter message, which includes both the URL for the follow up and an image (Figure 2). Such presence of mixed media in alerts is related to both message content limitation and the intent of the alerts.



Figure 2. Police alert about a potentially dangerous individual sent via Twitter.

Closely related to message length is message structure. During the interviews, one AO stated that there are three components to a good alert message:

"Key elements that you need in an effective message are: clarity from whom it is coming... that by itself is challenging (so people know that it is not spam)... Next is: what is going on, and why I should care?... what is in it for me?... the last one is: what is the expected action, what do I do with that? ... There are cases when you have to [send] a mini URL" (KDR)

The length limitation makes it difficult to properly articulate each of these components.

5.1.1. Insight One Implications

In order to develop a greater understanding of how to leverage this insight, we identify key opportunities and recommendations that could be pursued in depth during the Trial phases of the CMU WEA Project:

- 1. Will longer WEA messages make them more effective?**

The Trial could present users with a variety of message lengths and test these lengths with users in order to understand if longer messages that accommodate more information make a difference. The results would be used to speculate whether the length limitation is a root cause or just a symptom of a deeper issue related to the positioning of WEA within the landscape of alternative or complementary delivery channels.

- 2. Are there structuring conventions that can be established to convey information most effectively within the character limitations of WEA?**

The Trial could structure alert messages in a variety of ways (use of abbreviations, different ordering of information, different schemes of prioritization to decide inclusion and exclusion of information, different ways to abbreviate information, etc.) in order to understand if certain message construction strategies would increase alert relevance within the existing length constraints.

5.2. Insight Two

I2 Geo-targeting of WEA messages is seen as the long sought out goal by AOs.

Most of the experts interviewed believe that geo-location functionality provided by modern smartphones will enable more precise control over the dissemination of WEA messages. This functionality will allow a recipient's smartphone to suppress the alert message if the phone determines that the recipient is outside the targeted geographical area. For such on-device filtering to be possible, the WEA message must carry the geo-target with it. While the current approach of sending WEA messages to users in a targeted area with cell phone coverage is seen as a vast improvement over most landline emergency systems, many participants underscored some of the drawbacks of the pure textual cell broadcast approach.

"The reason why [we adopted an app for emergencies] is because you can draw a circle or a polygon on a map and you can send alerts to that area based on [where] people ... are. So people are not getting a coastal flood warning if they live in the western part of the state." (CBE)

"How do you alert the public without over-alerting them... with WEA technology that uses cell broadcast... Because it is a broadcast, the radio signal can bleed over [to untargeted areas]. So you can be outside of the threat area and receive the warning,... so it is not relevant to you... You

systematically increase the likelihood of desensitizing people ... This phenomenon is most common in the rural locations..." (MGR)

"... We have our ability to send WEA [messages], we have processes in place, but we have not used it because of the limited range of capabilities of that technology... Our challenge is that our county is [large] with [many] cities... That is a lot of geographic space and a lot of population..." (FSZ)

Utilizing the geo-location functionality embedded within most smartphones sold today would allow the WEA service to more precisely target people within a designated area. Most participants interviewed believe that utilizing geo-targeting based on smart-phone geo-location capabilities will rectify many of the key challenges faced by the platform.

The special situations include AMBER Alerts for which a larger area such as a whole state still needs to be alerted for cases of abducted children. Nevertheless, issuing AMBER Alerts for cases of certain missing children such as autistic children wandering off would also require only coverage of a limited area.

"In Maryland it is going to hit the whole state. In New York they have broken it down to the areas. ... In New York there are a lot of abductions that are on foot, then we could use it on the county level... But if we could use it for missing child with autism that wander off (last year we had 14 who died)... then we would do WEA just for a neighborhood or a slightly larger area... [or around large bodies of water] because children with autism are attracted to larger bodies of water." (BHR)

The most effective ways of describing the targeted area is a key question. The participants expressed their desire to define these targeted areas in a variety of ways, such as based on regions on a map, distances from the source of the emergency (as a circle) or through the provision of an arbitrary polygon that defines the emergency area:

"... We need to leverage the capabilities of those smart phones. For example, ... with these vertices or polygons (that describe weather threats), if we could push [WEA messages] [to the phones]... some studies show that this could improve the public response to them." (MGR)

Geo-targeting represents only one dimension of context-aware filtering of information. The reports from participants suggest that there may be other important factors, such as time of day or other elements that are specific to the recipients' context. For example, we learned from one AO of an incident where many recipients of the WEA messages complained about having been disturbed with a message sent in the middle of the night. Nevertheless, geo-target-based filtering emerged as the top concern pertaining to context-aware filtering on the device.

5.2.1. Insight Two Implications

This insight raised the following questions that could be addressed in the remainder of the CMU WEA Project:

1. **How to best represent the geo-target at the alert generation state?** We could determine the respective uses, advantages, and disadvantages of (a) different ways of representing geo-targets (through polygons, circles, distance from a given point, geographical markers) and (b) having different levels of accuracy within each type of representation.
2. **How to effectively transmit the geo-target to the phone?** There are several distinct ways to deliver the geo-target to the users' devices, given (a) the current limitations of the WEA service, (b) the desired level of message delivery accuracy and precision, and (c) that some phones are smart (and thus can leverage the geo-target embedded in the alert message) and other phones are dumb (hence the embedded geo-target is not only useless, but can also taint the content). If WEA messages are allowed to be longer, embedding compressed representations of the geo-target into the message might become feasible. Future studies could investigate the feasibility of such representations and possible ways of effective geo-target embeddings.
3. **How to best leverage the geo-target once it is delivered to the phone?** Simple client-side filtering is the obvious choice. Leveraging maps to allow the user to visualize his/her position with respect to the geo-target is increasingly seen as the gold standard, an effective strategy for making alerts more relevant and actionable. Other strategies that involve user interaction with the geo-target could also be contemplated. We anticipate testing the effectiveness of several plausible strategies that take advantage of the geo-target on the user device.

5.3. Insight Three

I3 The WEA service needs to interface with social media to be relevant.

Given the rapid adoption of social media services such as Twitter, Facebook, and Nextdoor, participants expressed great interest in connecting emergency alerts and the WEA service to relevant social media. It was illuminating to hear the extent with which participants interviewed already used such social media channels within the context of their emergency management role. The rise of social media has certainly altered the public's expectations about the timeliness of emergency alerts:

"We have a wide range of use of public alerts and notifications from natural disasters to hijacked cars...to VIP visits,... It is not just earthquakes or crimes, it is all hazards and the fact that we are trying to cope with the proliferation of the social media and the change in the expectations of the public... you expect to be notified as soon as possible. 10 years ago your expectation was, if something bad happened an hour ago, it would be nice if something came over the land-line. But now you expect something immediately." (KDR)

"We appreciate the digital environment. We appreciate social media. We have a mobile-friendly web site, but Facebook and Twitter is one way people can access emergency alert information on their mobile device." (FSZ)

The participants saw social media outlets as valuable communication channels and easy, lightweight mechanisms for conveying information to the public (Figure 3). Social media are also being used in non-emergency situations, for example to engage the public and increase overall preparedness and awareness (Figure 4).

"We are trying to get to people where they live. [That is] the reason we adopted social media, and we have been an early adopter.... Our police chief did first-ever "tweet along", our lieutenant <Name> would drive with the chief, and every time he would make a traffic stop or pull somebody over, there would be a tweet about it. And it seems kind of like a gimmick, but since [then], there has been a bunch of agencies that have done it. We are doing it as a means to engage populations where we feel there is a gap in outreach for public safety, especially youth and parents of young children... typically people 30 or younger or parents of young children because they are very busy..." (KDR)

"Two weeks ago we had a fire on Foothill, and Page Mill Road was closed from 280... At the scene we had a conversation and we decided there was little danger of fire spreading, and so there was no imminent danger, more dealing with traffic ... So we decided to send it out via Twitter. Not imminent threat to life, more of a headache..." (KDR)

Palo Alto Police @PaloAltoPolice · Jun 13
Traffic Update: Page Mill Road is now completely open again. Thanks for your patience and happy Friday!
[Expand](#) [Reply](#) [Retweet](#) [Favorite](#) [More](#)

Palo Alto Patch @palopatch · Jun 13
Brush Fire Contained in Foothills Area off Page Mill Road fb.me/6UnaXpgr
[Expand](#) [Reply](#) [Retweet](#) [Favorite](#) [More](#)

Palo Alto Police @PaloAltoPolice · Jun 13
While @PaloAltoFire crews mop up the fire, westbound Page Mill Rd traffic from Hwy 280 is closed. 1 hour ETA. We'll advise when it's open.
[Expand](#) [Reply](#) [Retweet](#) [Favorite](#) [More](#)

Palo Alto Police favorited
Palo Alto Weekly @paloaltoweekly · Jun 13
Vegetation fire on upper Page Mill Road. Barricade on westbound Page Mill, police are diverting traffic onto Arastradero. @PaloAltoPolice
[Expand](#) [Reply](#) [Retweet](#) [Favorite](#) [More](#)

Palo Alto Police @PaloAltoPolice · Jun 13
Happening now: Vegetation fire on upper Page Mill Rd near Foothills Park Gate 3. Smoke visible. Crews on scene. Please avoid the area.
[Expand](#) [Reply](#) [Retweet](#) [Favorite](#) [More](#)

Figure 3. A sequence of Twitter messages describing a fire situation.

"... In the past when something was going on, if we at the state wanted to let the public know ... we had two ways to do it: radio and TV (traditional media) or send messages or make calls to the local authorities... those were traditional things... it was difficult to get out the message to the

public... social media changes things because it cuts out the middleman in our messaging and what we want to put out... it is very good to get out messages unfiltered, and media picks it up very quickly." (CBE)

"In social media, about 95% of our effort is [directed to] Twitter and Facebook... We use the same account for both preparedness and alerts... We see retweets..." (CBE)

One of the AOs also reported on the increased adoption of community-based social networks, such as Nextdoor (a neighborhood-based social network that is rapidly gaining popularity), and speculated that such networks could play a greater role as alternative emergency information dissemination outlets.

AOs imply that some users may want to consult multiple information sources before trusting the validity of news or information. While the WEA service is a broadcast communication system reserved for alerting the public to emergency situations, it lives in the context of an ecosystem of broadcast and interactive communication systems. There is potentially great value in allowing the platform to hook into existing interactive communication systems. This would build on existing and well-studied user behavior and likely increase the efficacy of the system. However the concern from wireless carriers is that allowing interaction with other wireless Internet services will negatively impact network load and counter one of the primary goals of using the wireless broadcast technology in the first place – that of reduced impact on the wireless infrastructure.

Several AOs in the study expressed belief that, despite the required investment in resources for building presence and participating in the social media, these communications channels are extremely valuable because they allow the AOs to build relationships and trust with the public over time.

"There are those that have an instinct to back away from social media, especially Twitter because it involves resources, it involves engaging with the public, it involves that two-way interaction. But Twitter is the best thing to happen in emergency management and emergency management information...Twitter for us is an extraordinary tool. I don't have to write seven or eight press releases during an emergency. I all have to do is create the bullet point in 140 characters. And I would rather do that 20 times a day because it allows me to give the public information in real-time." (FSZ)

The AOs speculated that with a trust relationship built over time and a two-way dialog established, when an emergency happens, the public is more likely to follow official instructions. This work of building and maintaining trusted relationships never stops and it also includes sending out reassuring messages, such as in cases of tragic events.

The interviews with AOs identified that social media is currently an integral part of how emergency personnel communicate and interact with the public at large. While social media has some drawbacks, these drawbacks are clearly outweighed by the benefit of the network effect that is gained through these platforms as well as their ability to effectively and efficiently convey information to the public. It is important that further iterations of the WEA service do not merely replicate what social media platforms are already achieving and attempt to create an alternative platform. Instead, we recommend

considering how the WEA service can co-exist within the constellation of social media platforms and how social media's inherent features and functionality can be leveraged within the WEA service.

Palo Alto Police @PaloAltoPolice · Sep 22
No additional information is available for release at this time. The 200blk of Grant Ave is closed to traffic. (3/3)

Palo Alto Police @PaloAltoPolice · Sep 22
There were no disruptions to courthouse operations. Court remains open. Vic is an adult male. We are awaiting coroner arrival. (2/3)

Palo Alto Police @PaloAltoPolice · Sep 22
A suicide via firearm has occurred on the sidewalk in the 200blk of Grant Ave. No danger to public safety. (1/3)

View more photos and videos

Figure 4. Twitter messages from the police reporting a tragic incident.

Recent research supports the AOs' perceptions regarding the role of social media. Liu et al. [Liu2014] investigated the effect of social media on disaster response, and concluded that social media increased participants' intended likelihood to seek additional information and take action. Liu et al. stated that "participants were more likely to seek further information from Twitter when the initial disaster information was in the form of a tweet than a web page."

5.3.1. Insight Three Implications

New questions arise as a result of this insight, which could be worth pursuing in future studies:

- 1. What are social media sources that users typically consult during emergency situations and how might WEA messages help direct and connect users to those sources in an intuitive way?**
- 2. How can links to social media (and other information sources) be included in WEA messages without unduly violating WEA design objectives?**

To address these questions, future studies may present users with a variety of messages that integrate social media sources or similar resources using various embedding options (such as URL links, buttons

and hashtags) to determine which sources are relevant and fit within the constraints of the WEA service. However, to be definitive, such studies would require issuing alert messages in real rather than simulated situations, or devising protected social media and Internet regimes. For example, the evolution of LTE and small-cell technology may permit cost effective caching and distribution of extra information by the cells without undue network impact. As a first approximation, the Trial phase of the CMU WEA Project could investigate whether users would follow social media or external links embedded in alerts, gauging the propensity of the public to consult with external sources if those sources were accessible directly via the alerts.

5.4. Insight Four

I4 There are two distinct conceptual models of WEA: a mere warning alarm or a richer media application with follow through.

A key unresolved issue that emerged in the AOR Study was around the core conceptual model of WEA, which impacts how the users of the system envision it evolving. Some participants viewed the system -- either because of its limitations or because of its intent -- as an alarm bell with minimal functionality, similar to a siren.

"In its current state, WEA is like an alarm bell technology. It alerts you that there's an emergency and to go find out about the emergency from other sources." (BHR)

"Now, with 90 characters, all WEA can realistically be is a bell-ringer technology." (FSZ)

"There are a lot of legacy devices out there. For example, there are people in my family who have a flip phone. If you have WEAs with links, images or attachments, not all devices are provisioned to access that kind of information." (FSZ)

Others see the current WEA service as the early beginnings of a rich interactive communications platform that will eventually evolve to include maps, images, and links to additional information that is curated by emergency management programs. Enhancements in that context could also entail integrated follow-up, feedback, and closure mechanisms that generate a two-way trail for better traceability and response measurement.

"I've been begging to just get a link (in the WEA message) to www.amberalert.gov and we would maintain the data on that site... The wireless industry is concerned that everybody would go to that and bring down the system. This is the debate we have right now and the argument we use is that people already go to amberalert.gov anyway since they don't have enough information (in the WEA message)." (BHR)

"I think in the future with WEA, you'll definitely see more text. I'd really like to see some sort of graphics. I'm pushing really hard for graphics and being able to push the vertices to the device through a graphic. Now we just do county codes... I would also like to see more ability for the user to configure WEA [messages]. For example, I'd really like to see engagement from the disability community. (MGR)

"One of the challenges we have here in [this state] is that on any given day, we have thousands and thousands of tourists in our state. Now most of these tourists don't know what county they are in, or the highway numbers. So characters alone don't really work for these tourists." (BKN)

In particular, the rich media messages could provide for extending the purpose of AMBER Alerts to missing persons of all ages (Figure 5).



Figure 5. Police alert about a missing person.

A clear challenge of the WEA service is that it is currently designed to be a broadcast only (one-way) communication system that is delivered to a device that is conceptually understood to support two-way communication. Further, the WEA service is situated in a technology landscape in which users expect interaction. While the evolution of technology is a moving target, this insight points to a need to

determine a perspective and strategy regarding the *mental model of WEAs*. Since AOs will be an essential element in the evolution and growth of the WEA service, it is important that they have an understanding of how FEMA and other stakeholders view the system and its evolution, and then develop a collective vision.

Another aspect of interactivity is follow through. For WEA alerts to be beyond an alarm bell, receivers of WEA messages may need to know how an emergency situation evolves and when the emergency is over. At present time, WEA does not provide for linked “clear all” type of closure messages when the emergency is over.

5.4.1. Insight Four Implications

New questions that arise as a result of this insight are:

- 1. How does the AO community move from the confusion over what WEA is supposed to do to a more clearly understood and consistent vision?** The disparity between different views of WEA, what it is and what it should be, was a fundamental issue. Clarifying this vision is paramount for the evolution and success of the WEA service.
- 2. Is it possible for the WEA service to support interactivity?**
The Trial could present users with WEA messages with varying levels of interactivity, including mechanisms for feedback, follow-up, and closure. While full interactivity may not be technically feasible in the next iteration of the WEA service, this exercise will provide insight into the appropriate mental model for future iterations from the perspective of the public at large.
- 3. What media sources can be leveraged to provide interactivity?**
We could present users with WEA messages augmented with a variety of media sources that are easily accessible from a mobile device (images, maps, links to external sources) in order to determine if the rich information that users might need to assess the relevance of the incoming alerts can be offloaded to these platforms. Although this violates a founding principle of the original WEA service, it may motivate future technical investigations and innovations that attempt to circumvent the current concerns regarding wireless data backchannels that may cause network congestion.
- 4. Is it desirable to follow up WEA messages by status and closure updates that are linked to the original alert? If so, what are the most effective ways to achieve this?**
At present the WEA service does not support closure messaging or other forms of follow-up messaging traceable to a previously issued alert when the emergency situation associated with the alert is over or evolves over time. Could future WEA service support protocols that provide incident-level traceability and threading?

5.5. Insight Five

I5 Better outreach and education for both the public and potential AOs will improve acceptance and adoption of the WEA service.

One of the key challenges our research team faced throughout this work was recruiting proficient and active WEA users. While it was easy to identify and recruit participants with positions in emergency management, most did not use WEA and were uncertain as to how it worked. Additionally there was concern that if they did use the system, the public response to errors that are an inevitable part of learning a new technology had the potential to create a public relations firestorm for the organizations that they are a part of.

"I recall when WEA was initially rolled out and I was kind of excited about it. And then it rolled out with no outreach... it was just ... there. I don't think there has been enough push to make both the receivers and the providers aware of what WEA is and what it can do. You've got to talk this thing up, otherwise you risk people just turning it off and people in emergency management not using it." (BK)

"The beginning of WEAs and AMBER Alerts was very painful for me. We were under the gun to get it out there, and a lot of people complained about this obnoxious tone that was created by the National Center. It's the same tone that goes over the television and radio -- but people were not expecting that tone to come out of their phone. There could have been a much better public awareness around what the tone meant. When we first launched WEA, I had to do 70 press interviews in one week because people didn't know what it meant. Now people complain about not getting an alert." (BHR)

Many of our participants believed that there exists a substantial need for outreach and education for the general public. They explained that the benefits of the WEA service, as well as the appropriate action that should be taken upon receiving alerts, remain elusive to the majority of the general population.

"Outreach is a huge part of this. A couple of years ago, I was in Las Vegas and I was the host of a panel discussion and I said we've got enough engineers in the room. What we don't have enough of are people to do outreach.... We can cover what we need to do with technology. It can be done. But unless we reach out to the general public, there's going to be a lot of confusion. I was banging my fist on the table about this point. Did they listen? Ah... I don't think so. I think more could be done." (MGR)

"AMBER [Alerts] ... are very, very different... When you send WEA alert with that loud tone to get people's attention ... it is designed to create alarm in people to let them know they are in danger and get them to take immediate action because they are in danger. The AMBER Alert

is totally different. The people you are alerting are not in any danger, but we believe they may have information that can save the life of a child. That child is in danger. So that is why there is a major difference... People don't even understand what this tone is and why it is coming from the phone... There could've been much better public awareness ... But some awareness is there now." (BHR)

Public education may also address fears of privacy invasion. Many members of the public expressed initial concerns regarding their invasion of privacy based on the erroneous assumption that geo-targeting meant that the WEA service was tracking their location. If geo-targeting is performed through filtering on the smartphone and the public is educated about this capability, citizens' fears about the WEA service monitoring phone locations may be alleviated.

While education outreach may fall outside the scope of the CMU WEA Project, it remains an important insight gained from this study. A consistent message that we heard from the participating AOs is that "build it and they will come" marketing approach for the WEA service will likely prove unsuccessful. There is a wealth of technical knowledge and development that can be brought to bear in future iterations of the WEA service. It is our belief that marketing WEA and educating both the public and AOs about the benefits and functionality of WEA will be as, if not more, essential to the success of the WEA service.

5.5.1. Insight Five Implications

New questions arise as a result of this insight. The following questions are worth answering in follow-on studies:

- 1. How might government agencies, disaster response organizations, and commercial mobile service providers better market WEA and educate the public about the WEA service and its benefits?**

FEMA, DHS, FCC, Red Cross, Department of Justice (AMBER Alerts) and other bodies could conduct or sponsor a survey to identify possible delivery methods and channels (television, direct mail, social media, direct communication from service providers) for marketing and education. Use of this information could determine the channels that will be most effective for educating the public about the WEA service and its benefits.

- 2. How might the WEA service inspire confidence by allowing end-to-end assessment of AO requirements?**

A follow-on study could experiment on how to provide end-to-end testing for AO requirements through user feedback mechanisms, similar to other broadcast media such as radio and television (which for example use Nielsen ratings or push-button mechanisms to assess usage or solicit simple feedback).

5.6. Secondary Insights

The Secondary Insights listed here cover an additional number of topics and issues that were articulated during the interviews. As noted before, the Secondary Insights were those that were not as prominently emphasized by the AOs interviewed as the Primary Insights. Thus the research team did not deem these as significant as the Primary Insights , but considered them still worthy of mention for completeness.

- **Language issues.** Two AOs in our study reported the need to address multi-language and translation issues for any type of an emergency message that is sent out. Tackling multiple languages may be a good application for context-aware filtering. If alerts could be issued in multiple languages, the phone could be set to choose the one in the user's appropriate language.
- **Technical Issues.** While the public is receptive to WEA, people do not want to be needlessly interrupted. The technical problems in the system implementation cause repeated messages for some recipients. One participant commented on the general attitude towards AMBER Alerts and cases of complaints related to repeated messages due to technical problems with the system:

"99.9% of the people out there want to be involved and want to be that person who has the information, but they don't want to be annoyed every 5 minutes. " (BHR)

- **Performance Measurements.** Currently there is no way to measure the technical performance of the system. We heard anecdotes of cases where two people in the same location received messages 15 min apart because their phone models or carriers were different. One AO (WWR) emphasized that the carriers in general do not report back on the effectiveness of WEA because of liability issues.
- **How effective is WEA?** The overall effectiveness of the WEA is also very difficult to measure. Our participants mostly heard from the vocal minority that was complaining about the problems with the WEA messages.
- **Celebrate success stories.** WEA's adoption could be bolstered by more "success stories". Anecdotal evidence for AMBER Alerts broadcast through WEA suggests that these have directly helped in resolving at least 12 cases of missing children. However, no systematic evidence is being collected.

"Some of the most successful stories that we get with WEA is with tornadoes and when people are in the location where they would not normally receive an alert, like in a church [that is in immediate danger]..." (MGR)

- **Training wheels and growing pains.** Ramp-up protocols and best practice guidelines for AOs do not exist. Several of the participants reported being burned in their first attempts to send WEA

messages because they didn't anticipate the flood of responses. In one case, a department's main phone was completely inundated for a better part of the day.

- **My phone knows me.** Context awareness of the personal phones and their extensive knowledge of their users behavior and prior history is something that can be better leveraged.

6. DISCUSSION

In Section 3 we stated the research questions (**RQ1-8**) and related them to the study goals. Below we summarize the report's findings from the perspective of these research questions. We repeat them here and comment on the extent to which the findings support each.

RQ1 Is more precise/granular geo-targeting likely to improve the adoption and effectiveness of the WEA service?

Collected data strongly suggest that geo-targeting will improve the adoption and effectiveness of WEA messages. Supporting evidence is discussed in detail in insight I2.

RQ2 Is increasing the relevance of WEA messages to recipients based on the recipients' context likely to improve the adoption and effectiveness of the WEA service?

The evidence related to this question is inconclusive. This question is discussed in insight I2 only in relation to geographical context. However there is no indication that the AOs believe general context awareness is a central issue. Certain elements of context (e.g., timing of messages) were brought up and could be worth investigating further.

RQ3 Is better control by the recipient of which messages they will receive and which messages they wish to disregard likely to improve the adoption and effectiveness of the WEA service?

We have no evidence either way because currently the recipients only have a mechanism to completely opt-out. This question was not probed deeply with the participants since it is more suitably explored through studies conducted with the public.

RQ4 Is having a feedback mechanism (implicit or explicit) in WEA delivery from the recipient back to the AOs likely to improve the adoption and effectiveness of the WEA service?

Collected data only weakly supports this hypothesis. The absence of ways to measure the technical performance and the effectiveness of WEA messages is discussed in the Secondary Insights.

RQ5 Is the use of better alert creation tools that help create meaningful and targeted alert messages likely to improve the adoption and effectiveness of the WEA service?

Collected data supports this hypothesis. Alert creation appears is a pain point for AOs, as discussed partially in insight I1 and in the Secondary Insights.

RQ6 Is relaxing the length limitation of a WEA message likely to improve the adoption and effectiveness of the WEA service?

Collected data strongly supports this hypothesis. The topic is discussed in detail in insight I1.

RQ7 Do different kinds of AOs have different needs and reasons for adopting and using WEA messages?

Collected data supports this hypothesis to some extent. The evidence is subtle, but present in several insights and it is best articulated for AMBER Alerts (for example, vis-à-vis weather- or disaster-related alerts) in insight I5.

RQ8 Are certain improvements to WEA more important than others in terms of their potential to improve the effectiveness and adoption of the WEA service?

Collected data strongly supports this hypothesis. Based on the insights I1 and I2, message length, inclusion of URLs for follow-ups and geo-targeting are the most important aspects that need to be improved in order to increase WEA adoption for AOs. Also, the public awareness and smart utilization of social media are important for increasing adoption for the general public (insights I3 and I4).

7. CONCLUSIONS

In summary, the interviews with the participating AOs confirmed that some of the most pressing issues that need to be addressed are related to the message length and the ability to include additional aspects or relevant information, such as geo-targets, links and images (insight **I1**). More precise targeting of WEA messages, in particular geographically-based targeting, is an equally important requirement to improve the system adoption and use (insight **I2**). Targeting would also benefit from inclusion of other dimensions of context-awareness. The AO Survey and Trial phases of the CMU WEA Project may, for example, further validate and explore the specific parameters of context-awareness (e.g., time of day and relationship to the affected area).

Two other significant themes that emerged during the interviews are related to the increased influence of the social media (insight **I3**) and the questions around the core conceptual model of WEA (insight **I4**). In particular, the need for examining and building meaningful relationships with the social media is a topic that deserves attention. Integration of social media represents an opportunity to build on existing user patterns and will likely increase the efficacy of the WEA service.

8. RECOMMENDATIONS

The insights gleaned from the AOR Study represent significant opportunities. They suggest possibilities for influencing behaviors and improving the adoption and use of the WEA service. In order to take advantage of such opportunities, the Trial phase of the CMU WEA Project could focus on rapid iteration through the design space via a series of targeted experiments to evaluate the best options. In particular, we recommend approaching this phase with the mindset of the “lean startup” methodology [Reiss2011]. This means setting up a rapid *hypothesis-experiment-evaluate-pivot* loop to develop and test successive prototypes.

8.1. Recommendations for the AO Survey

The main goal of the planned AO Survey is to probe deeply into the Primary Insights **I1-5** and the Secondary Insights that have been developed through the analysis of data.

The data collected through the Survey should be quantitative in nature. It should indicate numerical values (e.g., on a Likert 4-point scale) for a series of statements to substantiate AOs’ agreement with the overall findings at a larger scale.

In addition, the AO Survey should provide confidence ranges and identify which of the insights are the most relevant to certain AO subgroups, such as those that already have some experience with WEA vs. those that are yet to adopt the system. The findings could also be broken down by AO groups according to their scope, such as those that operate on a county or city levels vs. nationally.

8.2. Recommendations for the Trial

CMU’s test-bed environment (the Testbed) will be used to conduct field trials (the Trial phase) that will evaluate promising WEA enhancement options. The AO Survey findings and the quantitative results of the AO Survey should inform which items to probe into during the Trial phase. The opportunities to test for the Trial phase are:

- Enhancements of the WEA messages through increased length, links, or images;
- Definition of the targeted area through a number of different tools and mechanisms, such as geographical or street map markups, polygon specifications via vertices or circle specifications with a radius and center;
- Efficient embedding of geo-targets directly in WEA messages for subsequent filtering on recipient devices;
- Incorporation of different contextual parameters, such as time of the day and speed and direction of movement into the alert filtering process;
- Development and strengthening the mental model of WEA as a warning bell or a rich media application;
- Prototyping feedback, follow-up, and closure methods for better situational awareness for AOs and the recipients, for example by having all (or some) of the recipients phones send response

messages back to the originating systems or the ability to clear out outstanding alerts when an emergency is over.

WEA improvement opportunities to prototype and implement are plentiful. Follow-on studies should prioritize these opportunities according to potential impact, technical feasibility, amenability to rigorous evaluation, and availability of resources.

9. TERMS AND ABBREVIATIONS

The following terms and abbreviations are in this document and in the Appendices that accompany this document:

- WEA – Wireless Emergency Alert
- Geo-targeting – Geography-based or geographical targeting
- CMU WEA Project – CMU research project titled “Enhanced Geo-targeting Goals and Options for Wireless Emergency Alerts”
- AO – Alert Originator
- AO Survey – The online survey component of the CMU WEA Project, which targets a larger population of AOs to reconfirm initial findings
- AOR Study – Alert Originator Requirements Study phase of the CMU WEA Project
- Testbed – The test-bed development phase of the CMU WEA Project, which builds an environment for evaluating WEA enhancement options in an end-to-end manner
- Trial – the public usability trial phase of the CMU WEA Project, in which several WEA enhancement options are evaluated on the Testbed using real subjects

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11. LIST OF APPENDICES

Appendix A – Interview Questions

Appendix B - Topline Summaries from Semi-Structured Interviews

Appendix C - Topline Summaries from Open Interviews

APPENDIX A – INTERVIEW QUESTIONS

ID Interview Question Category

0 Demographics & Ice Breakers

- 0.1 Name
- 0.2 Role
- 0.3 Organization
- 0.4 Years of experience as an Alert Originator (AO)
- 0.5 Tell us about your experience/background as an AO.
- 0.6 Tell us briefly about your work and walk us through a typical day.
- 0.7 What do you like the most about your work?
- 0.8 If you could change one thing, what would that be?

1 Background on Emergency Alerts

- 1.1 Do you currently issue emergency alerts?
- 1.2 How frequently do you issue alerts?
- 1.3 What types of alerts do you issue? What alert services do you use to issue them?
- 1.4 What kind of experience do you have with WEA?
- 1.4a *Follow-up: What are your general impressions about WEA?*
- 1.5 Which emergencies alert services/channels are you using to disseminate alert messages?
- 1.5a *Follow-up: Why? What are the advantages of using these alert services/channels?*

2 Creation of Emergency Alerts (if using WEA, focus on WEA message creation)

- 2.1 Could you show us [or tell us if not in operation center] us how you react to an emergency situation that might result in an alert, and how you create an emergency alert?
- 2.2 Which tools are you using to create emergency alert messages?
- 2.3 *Follow-up: Is there a preferred tool? Which one?*
- 2.4 Do you think the current alert creation tools you are using are intuitive enough?
- 2.4a *Follow-up: What are some of the features in the existing alert creation tools that you really like?*

- 2.4b *Follow-up: If not, what are the features you want it to have?*
- 2.5 Do you need your tools to provide more support in constructing alert messages? Elaborate.
- 2.5a *Follow-up: Are they sufficient in their capabilities to target to appropriate geographical area and to appropriate people?*
- 2.6 Do you need your tools to provide more post-issuance support (tracking, archiving, analysis)? Elaborate.

3 Appropriateness of Existing Alert Message Formats (e.g., Common Alerting Protocol - CAP)

- 3.1 Do you feel that you are able to include all necessary details in an alert?
- 3.1a *Do you feel that you are able to include all necessary details in a WEA message?*
- 3.1b *Follow-up: Is there any information that you often feel is not properly captured in a longer alert message, but would be beneficial to be present in a WEA message?*
- 3.1c *Follow-up: Is there any information that you often feel could be captured in a longer alert message, but not captured in a WEA message?*
- 3.2 Do you use specialized stored templates when creating alert messages?
- 3.3 Are you aware that you can either let IPAWS-OPEN create WEA message text from the data you provide, or you can write your own WEA message text?
- 3.3a *Follow-up: Which of these methods (automatic construction of WEA text or constructing your own WEA text) do you use or would you prefer?*
- 3.4 Could alert messages include references to other sources where the public could obtain additional information? If so, what kind of sources?
- 3.4a *Follow-up: Ask the same question about WEAs. If asked, give examples: a URL to issuing EMA site; social media, e.g., Twitter hashtag.*

4 Adoption of WEA

- 4.1 Do you believe fewer AOs are using WEA than one would like or expect?
- 4.1a *Follow-up: If so, what are the reasons?*
- 4.2 When do you use/prefer non-WEA alerting services over WEA? (Example: Blackboard Connect) Why? How do they compare in experience and effectiveness?
- 4.3 If we could implement a single improvement to the current WEA service, or address one limitation, what should that be?
- 4.3a *Follow-up: Can you convey the critical information needed for an alert within the 90-character message limitations of WEA?*

5 Public Feedback Regarding Alert Messages (focus on feedback on WEA if WEA is used)

- 5.1 Do you keep track of how many recipients receive and read alert messages? [Very few services provide this tracking capability. Reverse 911 systems can track how many calls are answered. Email can track message receipt and opening. No other methods offer tracking.]
- 5.2 What kind of feedback/statistics do you get on effectiveness and appropriateness of alert messages?
- 5.2a *Follow-up: What kind of feedback/statistics would you like to gather to gauge the effectiveness and appropriateness of alert messages?*
- 5.3 Do you hear about the public wanting to opt out of WEA messaging?
- 5.3a *Follow-up: How pervasive is the desire to opt out? What are the reasons?*

- 5.4 Do you hear about the public wanting to customize the way they receive messages or having more control over the messages they receive? If so, what kind of messages and under what circumstances do they want to receive them?
5.4a *Follow-up: Do you know how many recipients want to customize their alert profile or message receipt preferences?*
- 5.5 Do you have information on whether the recipients act on the messages received?
5.5a *Follow-up: Is it the majority or minority of the recipients who act on alert messages received? If minority, why don't they?*
- 5.6 What differences do you see in how people react to WEA messages vs. alert messages received through other IPAWS channels?

6 Geo-targeting and Interest Targeting of Alert Messages

- 6.1 What geographical range do emergency situations handled by your organization tend to cover? What geographical range do the alerts issued by your organization tend to cover? (Street/Block/Neighborhood, Multiple Streets/Blocks/Neighborhoods, Town/City, Multiple Towns/Cities, County, Multiple Counties, Region, State, Multiple States, National)
6.1a *Follow-up: Is the geographical coverage the same for WEA messages as it is for alerts delivered through other channels?*
- 6.2 Is geo-targeting precision a problem?
6.2a *Follow up: If we made geo-targeting much more precise than is currently possible for recipients with GPS capabilities, would that help?*
- 6.3 Currently, the minimum required geo-targeting for WEA is at the county level. Is this sufficient for your needs?
6.3.a *Follow-up: If this level of geographical specificity is not sufficient, what would be sufficient?*
- 6.4 Would you initiate more WEA messages if they were better targeted?
6.6 Are you working or have plans to work with wireless carriers regarding more precise geo-targeting? If so, elaborate.
6.7 Currently, a WEA message can only be received in and around the affected area related to that message. Should the public also be notified when a WEA message is issued to their home area or a user-specified area of interest, even if they are physically outside that area at the time the alert message is broadcast?

7 Contextual Relevance of Alert Messages

- 7.1 Do you think targeting based on recipients' interests, profiles, patterns, preferences, and situation, and not just location, will increase effectiveness and adoption of WEA alerts?
7.1a *Follow-up: What kind of contextual or situational factors should/could be considered for effective targeting?*

Additional Factors and Closing

- 8.1 Are there any issues or opportunities that influence the use of an alert service (either from the public's perspective or from your perspective) that we have not covered?
8.2 Is there anything else that we should know?
8.3 Would you be willing to discuss this topic further with us if we have any follow-up questions?

APPENDIX B – Top Line Summaries from Semi-Structured Interviews

The interviews summarized in this section were conducted by subcontractors Drs. Mirjana Spasojevic and Rachel Hinman, following the semi-structured approach described in Section 4. One or more members of the core research team attended as observers. The identities of the AOs are concealed as required by the research protocol.

Interview (Alias CBE)

CBE works as the Preparedness Coordinator at a state emergency management authority (they don't have counties, this is a state level agency). He is responsible for public education and outreach, and connection to social media.

Background

Traditionally they used radio and TV for emergency alerts. They sent a WEA through FEMA during a 2013 bombing emergency. CBE worked with FEMA to craft and send the message, but the state alerting agency didn't push the send button. The main manhunt phase went on between midnight and 5am with the public transportation being shut down and "shelter in place" order for Boston issued.

Social Media

Traditionally they used radio, TV for notifying public about emergencies and for preparedness aspects but social media eliminated the need for the middleman. About 95% of the effort is focused on twitter and Facebook, but they also use YouTube account for video. Typically they use one account for both alerts and general announcements. Social media allow them to follow up.

Alert App Development

They developed a location-based mobile alerts application. Motivation: a local company built the app before WEA was available. The main advantage was the ability to select an area on a map and send the message only to people in the area and directly to their phones. The application is a generic application that offers different types of commercial services and the emergency functions are being transitioned to the state-wide alerting service. The advantage of the app approach is that the messages can be of much longer length than WEA. The downside of the app is that it is an opt-in system. In contrast, WEA is an opt-out system.

How messages are created

How messages get created varies depending on the event. They don't use templates a lot. They have a template for the alerting app to be filled in with the information. For small event in one community they offer help to local governments and ask whether they need help and they may manually break down the message into smaller tweets.

Experience with WEA

"When WEA was first introduced, it was used for blizzard and ice storm warnings, but NWS retracted that, and now it's not being used for these kinds of warnings to avoid "cry for wolf" and trigger opt-out. We don't place it officially at the top of the emergency hierarchy - we need to use some discretion so that we don't annoy people."

CBE doesn't think that WEA needs to do the closing out messages because people need more information anyway and other (richer) information sources provide that.

Future for Alert Messaging Systems

CBE believes that there is always going to be multiple ways of alerting the public. WEA is as close to being universal in terms of reach for things like a statewide travel ban, where WEA would be quickest and most effective. What is missing from WEA is a way to enhance it, with images and ability to follow up or close out an alert with updates (at a lower level/mode of alerting). But Chris still sees WEA being appropriate for severe emergencies.

Interview (Alias: KDR)

KDR works as the Director of Center of Emergency Operations for a city. All emergency services are centralized in this city through the Emergency Operations Center. Because services are centralized, KDR's role spans multiple "emergency" scenarios: floods, fires, earthquakes, missing persons, terrorism, etc. They are the 3rd busiest 911 center in the county because of the proximity of a nearby major university, to a neighboring densely populated large county, and with visits from dignitaries.

Shifting Public Expectations

KDR mentioned that one challenge his organization faces is keeping up with social media and the changes in expectation of the public. He shared that the expectation of immediacy is something that he and his team must balance against the desire to not report false or inaccurate information to the public. This challenge has necessitated the need for a PIO (Public Information Officer). The reason they have embraced social media is because they have the desire to meet people in their home. It's a means to engage segments of the population - particularly youth population - in public safety and outreach.

KDR felt people at the county-level are following more traditional systems of mass notification systems, but the center in KDR's city is using a variety of mass notification systems in order to have the greatest reach.

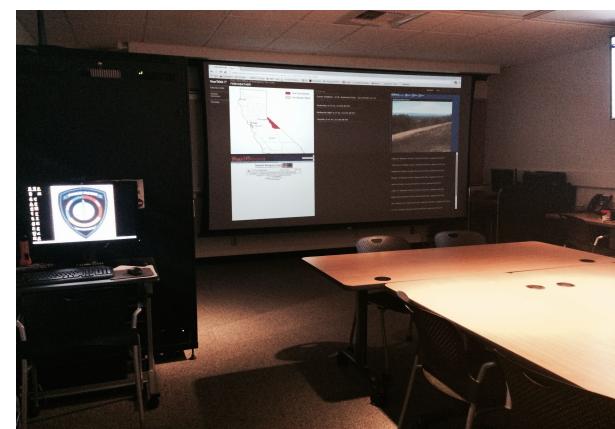
There are five different alert systems used by the city. In addition five additional means of public notification are also used to complement these systems. These multiple systems create challenges, though.

Key Challenges: Managing Disparate Systems and Coordination between Jurisdictions

KDR cited disparate systems and coordination between jurisdictions as a key challenge for mass notifications. KFT underscored that coordination between jurisdictions is a key challenge for the mass notification systems. He provided the example of how one of the county lines between two other large counties is a creek that is prone to flooding. Flood alerts sent without coordination between the counties could cause more harm than good.

While KDR's group does not currently use WEA, he was able to share with us the tools that they currently use to send mass notifications. The current tool is mainly used for dispatchers and allows them to draw polygons around emergency areas and construct messages using an online form. He stated that he felt there were three components to a good alert message:

1. Who the message is coming from
2. What the emergency is about ("What's in it for me" for the user)
3. Expected Action



Dispatcher's Environment

At the end of the interview, KDR allowed us to observe their dispatch center. This was an important environment to observe because the vast majority of mass-messaging alerts are sent by people working in the dispatch centers. The room we observed was dark with three women at cubicle desks - each with between 3-5 computer monitors at their desk. All three women were on the phone, dealing with emergency calls. The general vibe of the room was intense. It was clear that dispatch centers are very busy environments - much like an air traffic control station - with dispatchers juggling multiple emergencies and problems at once.

Relevant question:

- *How might we simplify the WEA interface to accommodate the frenetic environment of dispatchers?*

Interview (Alias: FSZ)

FSZ is working in a county Security and Emergency Management Office – as liaison to both the county judge and the mayor of the major city in the county who are in charge of the security and emergency management. He leads communications and outreach. The county is one of the largest counties in the country with over 4 million people.

Communication Channels and Types of Emergencies

The county uses the website for the bulk of outreach and preparedness education. It also has a mobile version of the site that is more suitable for access from phones. They also have Twitter and Facebook accounts and use social media extensively. The county alerts is an opt-in system for people who register to get alerts via email. They also have “reverse 911” capabilities to send pre-recorded messages to landlines as described by a polygon on the map. The office itself has a setup for interaction with the traditional media and can easily reach broadcast channels (TV, radio). The emergencies that they most frequently deal with are weather types of emergencies and for those they partner with the National Weather Service. Many of the services are also provided in Spanish.

Unique Challenges and WEA limitations

The county size of over 1500sq miles and large population make use of WEA with its current constraints rather challenging for smaller scale, localized emergencies that occur on an everyday basis. They view the threshold for using WEA rather high, because it means broadcasting to the entire county and they have significant approval process in place for that. The 90-character constraint is another obstacle – their experience with twitter that provides 140 characters suggest that even that can be too constraining. Fortunately, twitter character limitations can be resolved with links and images.

“Twitter is the best thing that happened to the Emergency Management!”

FSZ is a very enthusiastic supporter of the social media in EMA and public emergency preparedness and outreach. He believes that social media provide an important way to engage directly with the public and have a two-way dialog and make it sustained even though it is an investment. This is important to do before the emergency strikes. He sees social media as an effective tool for sending short timely updates during the emergency. FSZ also believes that social media are important for building trust with the general public, since people tend to triangulate and seek opinions from others via social media before deciding how to respond to behave during an emergency (e.g. whether to stay home).

WEA: Town Bell vs. Rich Media Application?

FSZ thinks that WEA is in a rather nascent state and at present its main utility is as a “town bell” to make people aware that there is some type of an emergency. It is mostly to be used to let people know “something is going on, tune in to the local media”.

Top line Summary

Interview: (Alias: BHR)

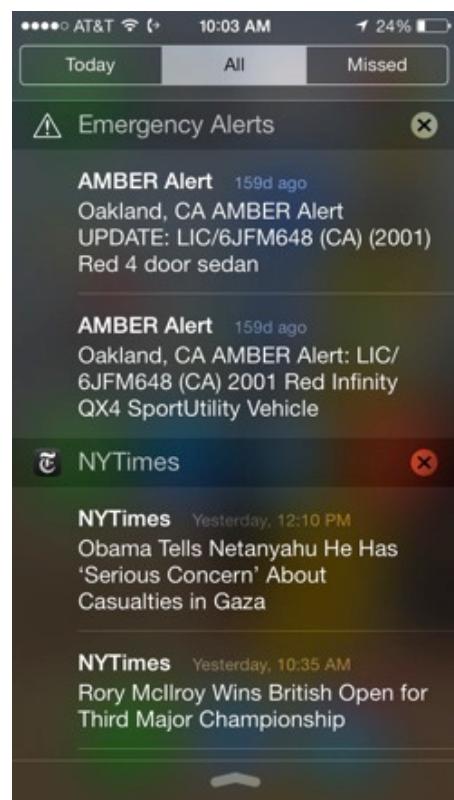
BHR is a senior executive at a national center for protection of children. His office manages AMBER Alerts. Previously BHR worked in a state police department and set up their AMBER Alerts plan.

Process

In the case of missing children law enforcement agencies issues initial responses and AMBER Alert is a secondary response. The national center checks for validity of messages and target areas. They use multiple channels: WEA, phone apps, websites, digital road signs and work with specific sites like Facebook, Twitter, Google, Yahoo on search results and announcements/ads. The agency had 12 confirmed successful stories of recovering children due to WEA messages. They typically have less than 200 warnings sent out per year. (<http://missingkids.com/amber>, see annual AMBER Alert reports)

Special Context

BHS articulated the difference between AMBER Alerts and other WEA messages: in case of AMBER Alerts the recipient is NOT in danger, but they may have information regarding somebody who IS in danger. Yet the WEA is set up to use the same tone for all alerts. Recipients have complained about these tones being annoying and disturbing their activities.



Pain Points

The WEA pain points that BHR talked about:

- Public awareness (used to be a significant issue, now improving)
- Length of WEA messages
- A dedicated site for links for follow up (e.g. amber.gov)
- Repeated messages that some receive (cause is not always clear and may be carrier specific)

Other issues and comments

- There is a perception that a lot of people opt out or complain, but BHR thinks that this needs to be put into perspective with respect to the total number of people reached.
- Some carriers override silent modes.
- Overall sentiment: "99% of people want to be helpful, but not annoyed."
- Geo-targeting is supposed to help WEA but it is not as helpful to amber alerts because of the unknown location of the missing child.
- New opportunities: integrate notifications about children who wander off without supervision (e.g. autistic children) or elderly

Example AMBER Alerts:

Areas for Follow-Up and Pilot Evaluation

The unique context of AMBER Alert messages suggests possibility of handling them in a completely separate WEA (sub) system with different needs and design goals. This also suggests that a pilot for AMBER Alert types of notifications needs to be designed and handled separately.

The opportunity to expand AMBER Alerts to include children who face dangers but are not abducted is a good area to investigate in a pilot. The relatively local nature (local neighborhoods) for such cases is ideal for geo-targeting. The difficult part is what to set up as a follow up service to receive potential tips.

Interview (Alias: KFT)

KFT is a senior emergency planning coordinator for a county. KFT describes his role as “emergency management.” “We are conduit between the population and emergency support services during emergencies.” KFT has a background in software engineering and has worked in emergency services for the past eight years.

Currently KFT helps manage a landline based emergency alert system in the county. He estimates that only 5% of the county population is signed up for this service. KFT recognizes that the number of landline phones is shrinking, while mobile devices are growing - making a mobile-based system desirable. He felt it, “... the natural next step.”

KFT shared that he saw several key advantages to the WEA service versus the landline system the county currently has in place:

- Network bandwidth
- Reach
- Engagement
- Geo-targeting
- No “sign-in” required.

The most common alerts are heat, cold, and wildfires but the anticipation of big earthquakes is a constant concern. He said that system use varies greatly depending on jurisdiction. Some residents complain about the frequency of alerts, while other residents complain when alerts are not issued.

Language

KFT shared that there are approximately 100 languages used in the county. He anticipated that crafting WEA messages in multiple languages would likely be challenging, as most digital translation services are not especially effective and accurate. He feels language translation is something that often requires human intervention.

- *Can users indicate language preference?*
- *How many languages will be supported?*
- *How might we automate language translation?*

Milling Effect and Social Media

KFT had little concern around the potential issue of creating public panic. KFT shared that most people do not overreact to emergency alerts. Instead, the milling effect often occurs - people triangulate information from a variety in order to validate alert information before acting.

KFT shared that he felt it was difficult for government agencies to use social media services because they are an official entity. KFT assumes that it would be difficult to control the content and perceptions around information shared on social media service.

KFT also mentioned that often times the people who are most at risk/vulnerable during emergencies don’t have a particularly positive relationship with government entities. The fact that the source of the emergency alerts is a government entity poses a challenge in reaching these segments of the population.

- *How might social media be used to help users of the system triangulate emergency information?*

Appropriate Follow-Up and Feedback

KFT shared that while he anticipates the WEA service will help reach more users and create more contextually relevant messages based on geo-targeting, it likely won't help with follow-up. KFT mentioned that follow-up - actions a user should take once the alert is issued - is the hardest problem to solve. Follow-up is challenging because the actions a user should take can vary greatly depending on the type of emergency being reported. Follow-up also often requires coordination with other public services - which creates another layer of complexity for dispatchers/emergency personnel (example: many "missing person" reports are elderly people with memory issues. They are often reportedly found on buses or some form of public transportation).

Relevant questions:

- *How might the WEA service enable appropriate follow-up?*
- *Can the WEA service enable coordination with other public service?*

Interview (Alias: MGR)

MGR has been with a large national organization for 22 years. He started out as an intern at this organization in has been at its headquarters since 1999. He has overseen the "weather side" of the wireless emergency alert system there. He is currently pushing hard with wireless industry to make improvements in wireless emergency alerts. MGR stated, "It's not easy...it's the kind of thing where everybody isn't quite on the same page. Everybody has different motivations." MGR is also co-chair of a subgroup that is working on recommendations to the government and industry for alert messaging.

Political Challenges for WEA

MGR reported that cultural aspects and motivations of the different stakeholders involved are the most challenging aspects of pushing progress for WEA. "There's a lot of pushback from the wireless industry because they see Wireless Alerts as a text-only service." MGR said that we must push the vertices to the device so that the device can plot out the threat relative to where the user is currently located. Unfortunately, players in the wireless industry don't want to use data resources in that way. Carriers are concerned about of over-congestion of the network, but MGR and his team are still pushing.

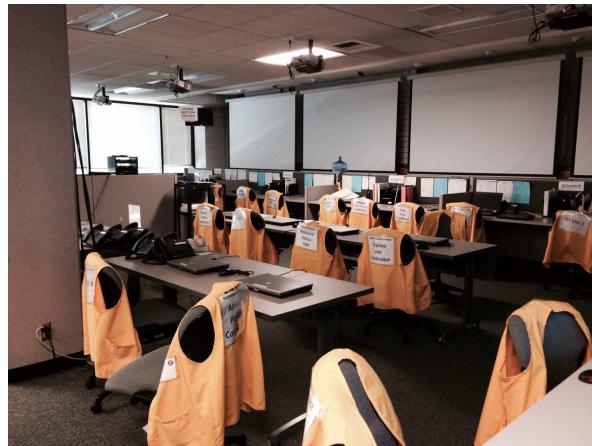
Relevant questions:

- *Emergent theme of cultural issues as a key component to WEA adoption and use.*
- *Are concerns about over-congestion on the part of carriers well founded?*

"Way more than 1-2 per week."

Of the interviews we've conducted thus far, MGR had the most experience with WEA alerts, sending "way more than 1-2 per week." He was able to communicate how the system currently works (describing vertices and polygons) the tools used to create the messages, and current pain points of the WEA service because he has first-hand knowledge of sending alerts.

When we asked him about the frequency with



which they send alerts, he said that they come in fits and starts. He directed us to weather.gov for a list of the types of alerts they send but mentioned Tsunami warnings, dust storm warnings, typhoon warning as the most common. Blizzard warnings have been suspended because of public feedback. "You've got to be patient with the public feedback."

MGR explained to us that WEAs are especially challenging in rural areas because the user can be outside the threat area and still get the message, which is most common for rural users. Cities have higher-density with more cell towers, and towers are able to closely approximate the polygon. In rural areas, towers will cover a large area and mistargeting becomes a problem - especially in the mountainous west - small area affected by flash flood but large cell-tower coverage sends

When we asked MGR about the tools they currently use to create the alerts, he replied by saying, "We do it Ass backwards, now." He described how ideally, they would craft the messages in CAP (Common Alerting Protocol), but that most weather forecasters come from a Teletype legacy. Forecasters often break down Teletype messages into "... their most atomic parts" and create the CAP from that. MGR relayed that forecasters don't have a lot of control in the message creation process because it's currently an automated process: Teletype >> CAP Translation >> System creates CAP >> WEA sent. Each event type has a canned WEA message that is automatically sent. However, forecasters do have greater control over Hazard Service messages, where they have the opportunity to create messages natively in CAP.

Preventing Message Fatigue

MGR relayed that the most common responses by the public when they receive a WEA are surprise and confusion. In order to prevent message fatigue, his team tries to be judicious on the types of alerts they send out. They generally activate the WEA on the initial warning (which produces the distinct sound) and then send follow-ups via text message.

Future Systems

MGR feels WEAs could improve in the following ways:

- Increased character length
- Including graphics in the message
- Pushing the vertices to the device
- Ability for users to configure/select preferences.

Interview (Alias: BKN)

Every county in BKN's state has emergency management alert capabilities. The most common WEAs in this state are related to weather warnings. Licenses have been purchased for all counties in the state. So far, more than 25 have completed the certification/application process, and the rest are in the process.

"The most limiting factor of WEA is 90 character limit."

BKN's understanding was that the 90 character limitation was created by carriers, but feels that it is problematic in terms of crafting a relevant message. BKN feels there is an opportunity to deliver more compelling and useful data to users - maps, photos, and links to additional news sources - that currently isn't possible with the system. He feels that in addition to increasing the number of characters (to at least 120), the inclusion of additional media would help with relevance and go a long way in preventing users from opting out of the system.

"The problem with it is that it's one-way."

Another key issue that BKN noted was that the broadcasting model of WEAs is potentially problematic. People expect to be able to respond or interact with a message, and people can't currently do that. He felt that allowing the system to hook into additional news sources or social media would help people understand the system.

Geographic Specificity and Timing

BKN echoed what many experts have articulated - geographic specificity as well timing of the alerts are important factors. He gave the example that sending an amber WEA message at 2am to an entire county. "The geo-location piece needs to be all or nothing" because the carriers are being proprietary about the towers that can be used. BKN gave an example of how when he carried a work and personal phone that had different carriers, he received a message on one carrier and not the other.

Relevance to "non-locals"

This is a state that sees a lot of tourists throughout the year. On any given day, there could be one million tourists in the state. Most of these tourists are not aware of the county, town, or sometimes even city they are in, or how to navigate highways. A key problem emergency management in the state is grappling with is how to craft messages that will be relevant to users who are not familiar with county and highway names. BKN sees this as an important challenge for states such as his with high numbers of tourists throughout the year.

WEA has a Marketing Problem

An issue that BKN brought up in the conversation was that he felt that WEAs have a marketing problem with the general public. He felt outreach so far has been insufficient. He stated that because the message is not a text message or an email, many people don't know "what" the message is when they receive it. As a consequence, he feels most people who receive messages end up turning them off.

Interview (Alias: MTY)

MTY is the Assistant Director for a county emergency management organization. Their county has a population of over half a million. MTY told us that her county has done all the work to become an alert originator, but they have not put it into practice yet because they do not feel confident about the process. They do feel that they will adopt WEA into their policies and procedures within the year.

MTY conveyed the majority of their threat risks are weather related – tornados, ice storms and windstorms. His county has one of the biggest rail system hubs in the US, so hazardous waste threats are also an emergency situation that MTY's group deals with on a somewhat common basis.

"We don't currently use WEA."

MTY is a proponent of the WEA service, but also is aware of some of the limitations of the system. He is a supporter of Web EOC. MTY, like many participants saw the 90-character constraint as a key barrier to his county's adoption of the WEA service. He feels there's a long way to go to get the characters limitation increased. MTY's understanding was that the 90 character limitation was created by carriers but feels that it is problematic in terms of crafting a relevant message. Like many other participants, he sees there is a big opportunity to deliver more compelling and useful data to users - maps, photos, links to additional news sources - that currently isn't possible with the system. He feels that in addition to increasing the number of characters (to at least 120), the inclusion of additional media would help with relevance and go a long way in preventing users from opting out of the system.

"Licensing Issues"

Another key issue that MTY noted was that the licensing model for the Web EOC is not the most economical solution for the number of counties in the state.

"Geographic Specificity and Timing"

MTY shared that in his state there are vast amounts of sparsely populated land and the current WEA service makes it difficult to deliver relevant messages to the public because of the lack of geo-specificity that can be delivered. "I can't light up 100,000 people just to let 5,000 people know they need to evacuate. And that's what would happen with the current system. We need more specificity in order to deliver the right message to the right people."

One Dispatch Center

MTY shared that his county has one dispatch center for all emergency management groups – fire, weather, and law enforcement – in one facility in one CAD system.

We're Waiting for End-to-End Testing.

MTY shared that one recommendation he has requested is that the WEA service gives emergency personnel the ability to create end-to-end tests. Similar to “This is a test of the emergency broadcast system” that is used for television and radio. Latency is also an issue. Testing will give them a better handle on the issue.

280 Character is the Recommendation we gave

MTY shared that the 90 characters is a limitation is a result of the old CDMA system and that with new 4GLte networks, his group has set forward a recommendation to increase the maximum character limitation to 280 characters.

Social Media

MTY shared that they currently try to integrate hashtags into current alerts and that they use social media (Facebook and Twitter) in order to keep users abreast of emergency messages.

Mental Model of WEA Service

“I see WEA as a bell ringer.” But he thinks it will ultimately be “the tool” for reaching the public about emergency alerts but that the WEA should rely on existing and evolving media channels for additional information on emergency messages.

APPENDIX C – Top Line Summaries from Open Interviews

The interviews summarized in this section were conducted by the core research team, consisting of Dr. Martin Griss, Dr. Hakan Erdoganmus and Harsh Vinayak. They followed an unstructured approach. Their main purpose was to elicit base information, identify additional interview candidates not in our original contact database, and explore collaboration opportunities. The identities of the AOs are concealed as required by the research protocol.

Interview (Alias: AKT)

AKT is an experienced emergency management professional with 10 years of experience with the United States Coast Guard on multiple Incident management teams and with FEMA teams. She is a planning support unit leader with a local fire department and an emergency management specialist in a large government complex.

"Text, phone call or email does not generate the appropriate response"

AKT pointed out that text, phone call or email does not always invoke the correct action but is helpful in getting the initial push. His organization currently uses the Emergency Notification System (ENS) which is opt-in/opt-out based. AKT mentioned that role-based feedback is important - if the recipient is the first responder, the action expected is more complex than if the recipient is a family member.

"More lucrative to partner with close-by cities."

Since his organization is under the federal government, coordination through appropriate channels will be required to conduct a pilot here. It would be more lucrative to partner with close-by cities and to have a Plan B with them.

"Extensive alerts can cause more hysteria"

WEA messages are used as a crisis communication channel to the public, but AKT is not sure about use by first responders. There is a chance that if alerts are extensive, they can cause hysteria among people.

Interview (Alias: PSR)

A close contact of research team, PSR heads the protective services of a large complex of a government organization.

His organization uses a proprietary system to send messages to various employees who work in the complex. The system is about two years old, and is mandated by the larger organization. It can be activated from any site.

Experiences with a proprietary emergency system

All employees (including contractors with badges) are automatically registered in the system via office phones, emails and organization supplied mobile phones as well as SMS; some folks opt-in with personal mobile phones. It has text-to-speech.

The system supports various named notification lists, including people in specific buildings. For example, the Disaster Assistance and Response Team can be activated via the system. Messages are sent to specific addresses, not geographically targeted. Therefore, for example, people from one building can be informed not to come in to work.

PSR wants to train his dispatchers to use the system; right now only two employees are trained and authorized. In principle, any incident commander and EOC commander should have training and authority to use. He would like dispatchers trained to create and send messages, however they would not be authorized to send messages on their own authority. The incident commander would have the authority to have dispatchers create a message as directed by the incident commander. The incident commanders would not learn how to use the system themselves, although they would need an understanding of how it works.

Once the emergency operations center is stood up, all emergency notification messaging authority would shift from the incident commander to the EOC. While today it is the EOC directors who have the training, in reality, they are too busy to create the messages. There needs to be technical support staff in the EOC to actually create and send the messages. It could even be the PIO folks. The EOC Director would tell them what to write.

The system has a reply option ("I got message"), and even an "accountability option" (which asks recipients to go to a specific web site and add information). Its messages are of various lengths, depending on target device(s); set of messages must be carefully crafted.

They test the system once a quarter - using a "test group". The system has been used only once in a real emergency situation.

Issues with existing system

However, people in part of the complex are not government employees, and they are not covered by the system, nor can they be, even though they are served by the emergency personnel of the organization. They have no plans to piggy-back on neighboring cities' emergency management systems. It's not clear whether they can be authorized for those systems.

PSR also brought up "leakage" of secure messages to social media, or even morphing of real messages to erroneous rumors. He gave an anecdote of how a test message at one site got misinterpreted as a real event.

Opportunities

Something akin to WEA to cover "anyone" on the site might be useful. If we had a local cellular solution working, or were using neighboring city's system, they would need to know how to coordinate WEA messages with complex's system.

PSR will consider allowing/encouraging some of the complex employees and his folks to participate in a pilot, but concerned about these issues: the time of the effort, training requirements, representativeness of the participants (too favorably disposed, possibility of actionable results or permanent follow on).

Interview (Alias: WWR)

WWR is the deputy director of a federal organization responsible for emergency alerts. He has several years of experience in the AO community and is a veteran. Two of his deputies were also present during this interview.

"All Alert Originators and citizens complain about geo-targeting"

WWR's understanding is that in the short term issues with geo-targeting can be mitigated by having more options for consumer opt-in. The opt-in options can be offered in three categories - imminent threats, weather and flash floods. In the longer term, geo-targeting needs to be precise. While considering options for precise targeting, WWR is

concerned about data applications within the selective network traffic and retaining the broadcast nature of emergency alerts. One of his deputies displayed concern about congesting the “air interface” as well.

“Increasing the length of the WEA messages”

The same deputy pointed out that FCC had a CSRIC and the unofficial recommendation from FCC was to increase the character limit of the WEA message from 90 characters to 316 in a few years. The cellular carriers are willing to increase the limit to 280-300 as well. While maintaining the timely arrival of the WEA messages, an extended WEA message with a polygon or an image would be helpful in passing on more information to the recipient.

“Most Alert originators choose to send WEA messages”

Another key point discussed was which CAP messages become WEA messages. WWR echoed that AOs set fields in CAP that say “Send in WEA”. AOs can deselect WEA and choose to send the emergency alert via different channels. AOs need to have appropriate permission for the appropriate type of messages. Most AOs choose to send messages using WEA, and almost all use CMAM text.

“Cell carriers use different methods to map polygons”

While Sprint overlays the coverage map on the polygon (entailing more overlaps than others), ATT, Verizon and T-Mobile map polygon to cell towers. WWR mentioned that carriers say that they target to the polygon but in reality we don’t know what they are doing - they do it on a “best effort” basis and do not promise anything beyond this. Second deputy pointed out that telecom systems provides a good research for coverage on tower targeting. However, it is difficult to enforce upon other carriers to use a better coverage technology.

Interview (Alias: LBN)

LBN is the emergency services coordinator of local city fire department.

“Initiated alerts 4-5 time in 4 years”

LBN pointed out that there were two ways to initiate alerts in her city. One is using the county’s emergency alert system through CERT notifications, Amateur radio operators, and staff. The other is using SWAT or a tool for fire alerts when they had to reach out to public outside. LBN was satisfied with using the county system, which included both emergency alerts (free) and community (paid) notifications.

“County system’s user interface is easier to use”

LBN mentioned that county system’s UI is simple enough to use without training: log in, create a message, record and write it. It currently supports voice, email and SMS. LBN uses the system once to test messages. The system has approvers who approve the alert before release. Generally it is the battalion chief. For the Police, it is the Captain. Dispatch manager is also trained and approved.

“Maintaining a Facebook page and a Twitter handle”

The Public Information Officer of the city maintains a Facebook page and a Twitter handle to connect with people. All the press releases are posted on social media sites. At times ‘Nextdoor’, a community social network is used to inform people in a community. ‘Pulsepoint’ can be used to listen to scanner and radios.

“Not having to register to get an alert is huge!”

A close-by city has highest opt-in penetration. LBN’s city had only 2,000 subscribers out of a population of 75,000. Daytime population at a nearby large company alone is 24,000. Therefore most aren’t registered and possibly live out of the county.

Negative anecdotes about alerts

LBN also talked about an incident when an AMBER Alert was sent to everyone in the city at 3 am annoying most people. Another incident that was criticized was when an alert was sent out for a pancake breakfast and not for an actual emergency.

Interview (Alias: LBA)

LBA is well known to the research team. She is director of the emergency operations center (EOC) of a large government-run complex with several thousand employees and tenants. She is the person who is primarily responsible for sending Alerts.

Experiences with third-party system

The agency LAB works for uses a third party system as part of its “Emergency Notification and Accountability System.” The complex has not used it as heavily as some other sites in the mid-west that have more weather related events. Currently the system has over 4,000 names on its database of recipients.

Challenges in using the system

Some of the challenges mentioned by LBA were: in selecting a common use tool, the agency had to deal with the fact that some of the larger sites already had their own tools (not this site) and so the design was targeted to their needs. Several improvements are possible in the system, but its very costly to have it customized to specific needs.

All the complex’s civil servants and contractors are automatically included in the system database and as such should receive notifications that are sent out. All others must be manually entered into the system contacts directly by someone with access to the tool. Due to limited resources, they are not currently manually entering tenants, interns or visitors into the system. The database is auto -populated with email and phone information and building locations from the HR database. Employees can also add additional emails and phone numbers manually. Thus quite often the database is not completely up-to-date. The system allows one to define lists or groups, and some priorities as to use of email vs. phone vs. SMS first.

The system can be finely targeted to a single building or a role list, or other meaningful group (like a test group). The system is relative slow: to send emails, one-at-a-time, can take up to 5 minutes and phone calls can take even longer, 25 minutes or longer. A problem is many labs have a single shared phone, but this phone number may registered for each person, so for some alerts, the phone rings multiple times, resulting in complains.

The system is “better than nothing but requires lot of manageability on the user components”.

Opportunities

The larger complex with its civil servants and tenants form a multi-jurisdictional environment. A well-targeted enhanced WEA message could reach many of the people, and not only those in any database. The site is willing to participate in a usability trial for enhanced WEA.

The complex has a Twitter account, but it is not used by the EOC.

The agency has runs agency-wide tests once a year and a minimum of one site test once a year for the emergency system. At this point these are one-way tests. They have done two-way tests twice but have received many complaints – and they can't do this during office hours. They have to send out a notice beforehand that there will be a test.