Wireless Emergency Alerts

System Enhancement Recommendations

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that the greatest number of cellular devices will receive alert messages in the shortest amount of time, minimizing cellular network and handset resource usage.

- Increase Infrastructure Resilience – Resilience of the WEA infrastructure against failures of system components (such as network connections and data centers) can be increased by supporting backup communication channels or backup data centers. This would incur additional cost, but increase system availability during and after major disasters.

- Implement Mutual Trustworthy Platform Verifications – Various WEA system components may contain malicious software, which can be used by an adversary to issue false public alerts and warnings. Implementing Mutual Trustworthy Platform Verifications would verify the integrity of software running on WEA computer platforms. This would ensure that systems are in a trustworthy state and comply with the information assurance guidelines for WEA operation.

- Enhance the Accuracy of Geo-Targeting – The geo-targeting precision of WEA can be improved beyond the cell site or cell sector granularity that is possible today. The recommended improvement is based on broadcasting alerts to an area wider than the affected area and making use of the location awareness of mobile devices, so that a user is notified of an alert only if the mobile device is inside the affected area. These enhancements would prevent missed alerts caused by geo-targeting inaccuracy and reduce over alerting the public with irrelevant messages. This is expected to encourage more widespread adoption of WEA by emergency managers and the public.

- Utilize Geographical Emergency Affinity Subscriptions – Currently, a WEA message can only be received in and around the affected area related to that message. The recommended enhancement would allow the public to be notified when a WEA message is issued to their home area, even if they are physically outside that area at the time the alert message is broadcast.

- Implement Post-Disaster WEA Mode – Major disasters will potentially damage cellular networks and impact the ability to disseminate post-disaster WEA messages. For example, major hurricanes and earthquakes can cause random physical destruction to cellular radio transmission equipment (cell site antennas or complete cell towers). This would cause WEA coverage gaps for the affected CMSPs. The recommended enhancement is based on cooperation among CMSPs after disasters to allow subscribers of one CMSP to receive WEA messages from other CMSPs. This would allow continuity of WEA service during and after a disaster. The recommended enhancement would also facilitate emergency communications with the public via cellular devices using a temporary cellular infrastructure that can be deployed by first responders.

- Increase Text Message Length – Currently, WEA messages are limited to 90 characters because of a requirement to transmit the message using only a single "page" of cell broadcast. On the other hand, cell broadcast supports multiple page messages. The recommended enhancement is to modify the requirement so that WEA can use multiple pages of cell broadcast. This would allow the transmission of longer messages, which can convey more information to the public.

- Enhance Multimedia Support – WEA service currently supports only text messages. It is recommended that WEA also supports audio and video content in alerts. This would convey more information to the public about the situation and the required action.

The DHS S&T WEA Program Management Office should work with the National Telecommunications and Information Administration and the FCC to establish a technically focused Advisory Group to guide the long-term evolution of the Integrated Public Alert and Warnings System (IPAWS) and WEA in concert with the evolution of hybrid commercial and government architectures for National Security and Emergency Preparedness communications. The advisory group would take these and other recommendations under advisement and use their program knowledge and subject matter expertise to select an affordable number of recommendations for further analysis. The most significant results of the selective analyses would be estimates of the level of effort and cost required to achieve clearly identified milestones. The information would be provided as a proposed Plan of Action and Milestones for a project to implement the recommendation or set of recommendations under analysis. The advisory committee would then prioritize the results based on WEA program objectives and consultation with subject matter experts and make funding recommendations to senior leadership.

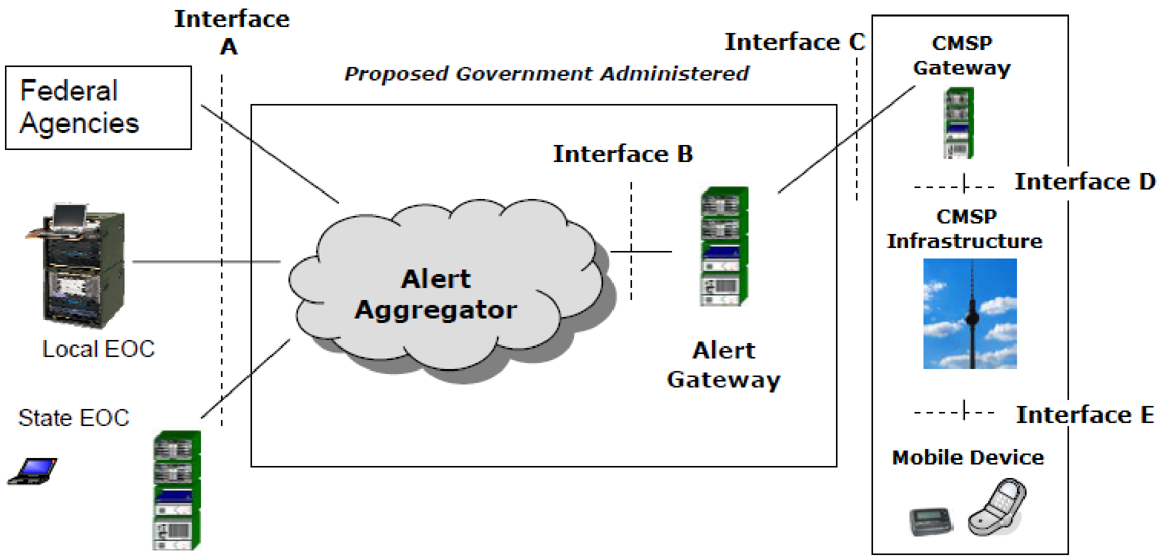


Figure 1-1 WEA Reference Architecture

At a high level, the following actions take place under this reference model:

- Alert Origination Systems (AOS) at the local, state, and Federal levels generate emergency alert messages for WEA using a data standard called the Common Alerting Protocol (CAP). These messages are transmitted to the Aggregator via Interface A.
- The Aggregator receives, authenticates, and aggregates emergency alerts from the AOS's and forwards them to the Federal Alert Gateway.
- The Federal Alert Gateway generates a Commercial Mobile Alert Message (CMAM).
- Based on CMSP profiles maintained in the Federal Alert Gateway, the Federal Alert Gateway delivers the CMAM over Interface C to gateways maintained by the appropriate CMSPs.
- The CMSP Gateway is responsible for formulating the alert in a manner consistent with the individual CMSP's available delivery technologies, mapping the alert to the associated set of cell site transceivers, and handling congestion within the CMSP infrastructure. WEA messages are transmitted using the Cell Broadcast Service (CBS) over-the-air interface.
- Finally, the alert is received on a customer's mobile device. The major functions of the mobile device are to authenticate interactions with the CMSP infrastructure, monitor for WEA messages, maintain customer options (such as the subscriber's opt-out selections), and activate the associated visual, audio, and mechanical (e.g., vibration) indicators that the subscriber has chosen as alert options.

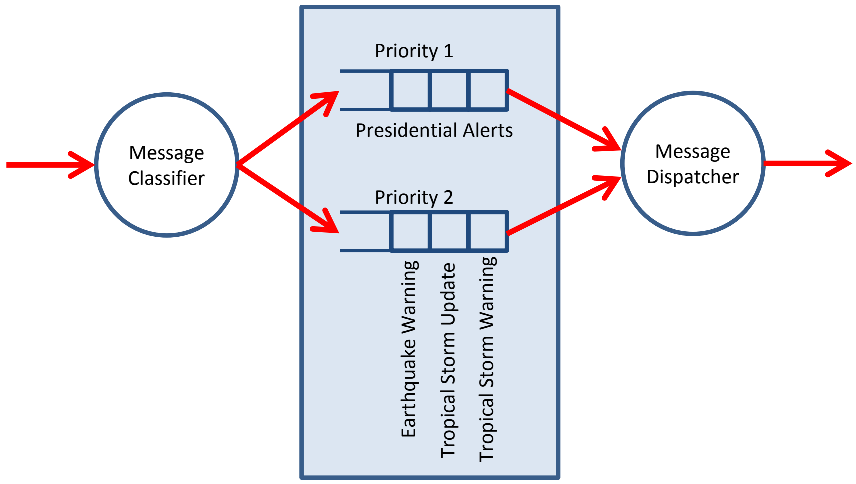


Figure 2-1 Logical Queues with Current Message Prioritization

2.1.2 RECOMMENDATION

Using a Multi-Level Priority (MLP) scheme and implementing Multi-level Priority Queuing (MPQ) is recommended to enable the timely delivery of the most critical messages. In this scheme, Presidential alerts still have the highest priority, but other alerts are assigned one of multiple priority levels according to a defined policy. Alerts at the same priority level have their own queue, and they are processed before queued alerts at lower priority levels.

Figure 2-2 illustrates the main functional components of the proposed MLQ implementation with three priority levels. Incoming messages are classified into one of three levels. Classification rules are established and can later be modified by a Policy Manager, which is a functional component of the system. Another functional component, the Message Classifier, evaluates multiple fields within each message (e.g., type, category, urgency, severity, certainty, event type) and uses the configured policy rules to assign a priority level to each message. Messages are then placed into different queues and serviced according to their priority level. For example, an earthquake warning can be placed into the Expedited Processing queue shown in the figure and processed before any messages within the Normal Processing queue. Messages in the same queue are processed in a FIFO fashion, as in the current implementations.

AOS, send a query to each participating CMSP over a new dedicated management plane interface, collect responses from the CMSPs, and return the aggregated responses to the AOS. The target area query problem is discussed in more detail in Appendix A.

Alternatively, the footprint discovery phase could be initiated proactively on a periodic basis (to discover any changes in CMSP capabilities), and the latest available information would be used at alert generation time. In this case, a database would be maintained by the Aggregator to support the proposed geo-targeting coverage discovery, thus eliminating the need to query all CMSPs at alert generation time. This capability would be useful for AOs to learn exactly where the alert will be delivered before pressing the Send button. They can fine-tune the target area before sending an alert to maximize the alerted target population, while minimizing sending alert messages to subscribers outside the desired target area.

- *Recommended Service #2: Provide a feedback loop.* A new management function can create a feedback loop based on a network of WEA broadcast sensors to verify an alert broadcast. Various WEA sensors can be deployed in each county that have the capability of receiving WEA messages from the major CMSPs serving that county. When a WEA message is broadcast by one of these CMSPs in that county, the sensors would receive the message and relay this information to the Aggregator over a new management plane interface. The Aggregator would, in turn, make this information available for AOS's.

  As an alternative to sensors, smart phones carried by various officials, such as police officers and emergency responders, can be programmed to relay the reception of WEA messages back to the Aggregator using the new management interface. The new capability would facilitate the confirmation of alerts delivered to the public and provide better measurement and analysis of WEA system behavior.

- *Recommended Service #3: Provide access to periodic federated reporting of segmented and end-to-end performance metrics.* A new management plane application would enable the collection and segregated delivery of various types of statistical data for each authorized AOS. This application would act as a repository for performance statistics. The Aggregator would collect various performance metrics, generate periodic status reports for AOS's, and make these reports available over the new management plane interface. Table 2-1 presents some sample metrics that can be captured and reported.

Table 2-1 Sample Metrics

Interface A Metrics	Interface C Metrics
Alert Messages Received	Transmission Control Cease Messages Received
Update Messages Received	Transmission Control Resume Messages Received
Cancel Messages Received	Link Test Messages Received
Test Messages Received	Acknowledgement Messages Received
Acknowledgement Messages Sent	Malformed Acknowledge Messages Received
Alerting Organization IP Addresses	TCP Session Connection Failures
TCP Session Connection Failures	IPSec Session Connection Failures
TLS Session Connection Failures	Interface Availability

- *Recommendation #1: Use multiple ISPs for Interface A.* Internet connectivity of a state or local AOS would typically use a single ISP. If this ISP experiences infrastructure damage and therefore ceases service in a disaster area, the AOS will not be able to issue any further alerts. One way to mitigate this would be to support two ISPs. During normal operation, an AOS would use just one of the two ISPs. If this ISP experiences service disruptions from damage or another reason, the AOS would be able to send alerts using the second ISP.

  Alternatively, a local jurisdiction may opt to rely on alert origination resources of adjacent jurisdictions or state-level resources to act as backup. This approach would allow local jurisdictions to avoid additional costs associated with multiple ISP subscriptions. However, adjacent jurisdictions must subscribe to different ISPs to have redundancy, and the necessary authorizations must be in place to allow different jurisdictions to originate alerts and warnings on behalf of others.

  Resilience against failures can be further increased by the multiple ISP approach if two ISPs serving an AOS employ different transport technologies. For instance, one ISP can have a terrestrial network, whereas the second ISP might have a satellite network. This would minimize the chances that both ISPs would fail simultaneously.

  The same approach can also be applied to IPAWS-OPEN, so that IPAWS-OPEN uses two different ISPs for connectivity. IPAWS-OPEN has two data centers, each of which is connected to all AOS's and all CMSPs. If each data center uses a different ISP for connectivity, WEA would remain operational for as long as at least one of these two ISPs is operational.

- *Recommendation #2: Use PSBN for Interface A.* The Middle Class Tax Relief and Job Creation Act of 2012 created the First Responder Network Authority (FirstNet) as an independent authority within the National Telecommunications and Information Administration (NTIA) to establish a single nationwide, interoperable PSBN.[12] If WEA Interface A support is built into the PSBN, AOS's and the IPAWS Aggregator can implement PSBN interfaces and use PSBN for WEA Interface A communications. An ISP can still be used as a backup channel for added resilience.

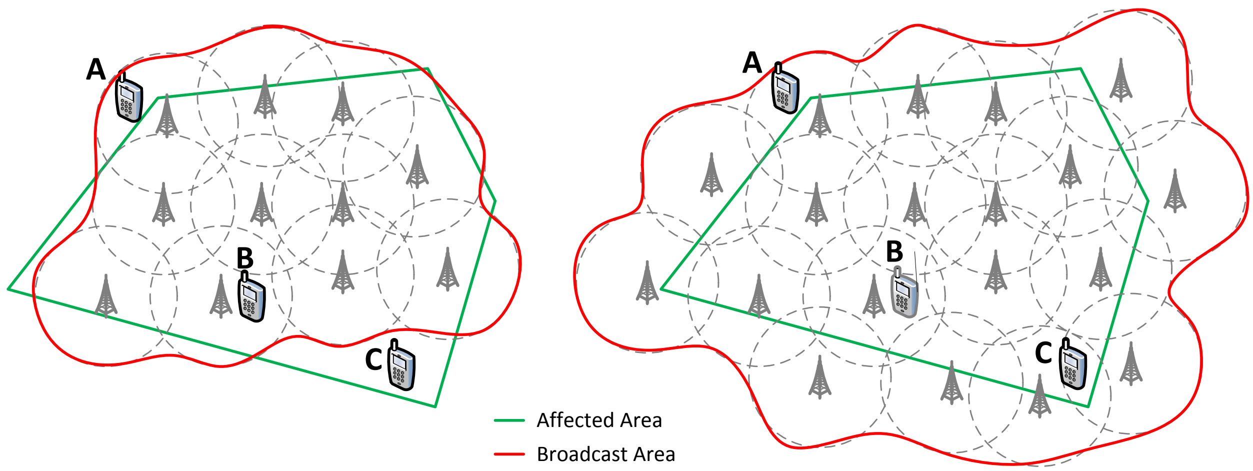
- *Recommendation #3: Implement a distributed architecture by regional data centers.* The current WEA architecture uses a centralized topology, where all WEA messages pass through one or two IPAWS-OPEN data centers. It is known that distributed topologies have better resilience against failures than centralized systems in general. Therefore, the resilience of WEA can be increased by implementing a distributed system architecture with multiple regional data centers. This would incur increased costs and more complex distributed data processing.

  A notional architecture of the recommended distributed architecture is shown in Figure 2-3. AOS's can send alert messages either directly to IPAWS-OPEN data centers, or to an available regional data center. Regional data centers would have similar functionality with IPAWS-OPEN, but less alert handling capacity. During normal operation, the regional data centers aggregate the alerts they receive and forward them to an IPAWS-OPEN data center. However, if the two IPAWS-OPEN data centers are down,

[12] http://www.ntia.doc.gov/category/firstnet

Figure 2-4(a), Handset A is outside the affected area but can receive the alert because it is inside the broadcast area; however, Handset C cannot receive the alert although it is inside the affected area.

Figure 2-4(b) depicts the recommended solution, where WEA messages are always broadcast to an area that is larger than the affected area. In the recommended solution, the handsets that receive a WEA message decide whether to alert the user, based on the user's location. In Figure 2-4(b), all three handsets receive the WEA message and compare their location with the affected area. Handsets B and C alert the user because they are inside the affected area, but Handset A does not.



(a) Existing WEA System **(b) Recommended Solution**

Figure 2-4 A Comparison of Broadcast Areas in Existing WEA System and in the Recommended Solution

An important characteristic of this approach is that the broadcast area no longer needs to exactly match the affected area specified by the AO; it suffices that the broadcast area fully covers the affected area. The exact boundary of the affected area is now passed to the mobile device, which determines whether it is located in the affected area.

The recommended solution requires mobile devices to have the capability of obtaining location information. This is not expected to be a serious limitation over the longer term because smart mobile devices are becoming more and more widespread every day. Smart mobile devices can typically obtain location information using global positioning system (GPS), triangulation based on signal reception, or an indoor positioning system. Because these operations drain battery power, mobile devices can check their locations at regular intervals instead of continuously. When a mobile device receives a WEA message, it can use its last known location to determine whether to alert the user. Alternatively, reception of a WEA message can trigger a location update on the device, increasing accuracy. Updating location only after receiving a WEA message would conserve battery power, but would introduce additional delay before an alert is displayed to the user. Older-generation devices that do not support the recommended functionality would simply display every received alert, as in the current practice, though they may display more alerts due to larger broadcast areas. The recommended solution also requires protocol changes to support inclusion of area information in cell broadcast message headers as previously described.

2.6.3 EXPECTED BENEFITS

Enhancing the geo-targeting accuracy of WEA would reduce missed alerts and over alerting. This is expected to encourage more widespread adoption of WEA by emergency managers and the public.

2.7 UTILIZE GEOGRAPHICAL EMERGENCY AFFINITY SUBSCRIPTIONS

This functionality would allow the public to receive WEA messages broadcast for a specific geographical area, while being at locations outside that area.

2.7.1 RATIONALE

As WEA penetration increases over time, its deployment and use in actual emergencies reveals potential shortcomings that need to be addressed to encourage participation by emergency managers and their user populations. WEA was used when Hurricane Sandy struck the U.S. East Coast in late October 2012. Several emergency messages were issued for blizzard warnings, flood warnings, and evacuation notifications in various locations along the East Coast. Although WEA was successful overall during the storm, some commentators expressed concern that "individuals who may be from the East Coast but were not physically in the storm-affected areas when alerts were being sent would not have received the messages."[18]

The desired functionality is that individuals should be notified when an alert message is issued to their home area even if they happen to be outside that area at the time the alert message is broadcast. WEA could be enhanced with this capability as described in the next section.

2.7.2 RECOMMENDATION

Figure 2-5 depicts the recommended solution. For a given emergency event, the associated alert message can be targeted to a subset of the population that belongs to one of the following categories:

- People physically present in the affected area, often directed to take some action, here called "affected individuals."

- People who were present in the affected area when an initial alert was issued but later relocated, possibly as directed by the initial alert. Here they are called "relocated individuals." Ideally, relocated individuals would receive updates to the initial alert.

- People outside the affected area who have an interest in the affected area, such as family, property, business relationships, or other responsibilities in the affected area. Here they are called "related individuals."

The recommended solution uses the same approach described for enhanced accuracy in geo-targeting (Section 2.6), based on location-aware smart mobile devices. When a WEA message is broadcast by a CMSP, it will be broadcast to an area wider than the affected area. The alert message will include a descriptor of the affected area in its header, and each mobile device will determine whether the alert is of interest to the user.

[18] http://www.govtech.com/public-safety/National-SMS-System-Successful-During-Superstorm-Sandy.html

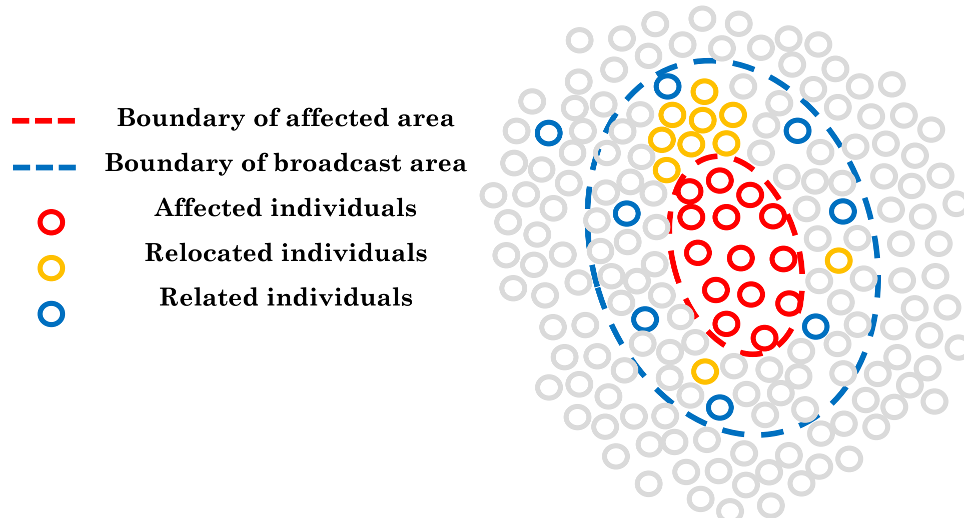


Figure 2-5 Illustration of Different Alerted Categories

The additional steps that would be required for the geographical affinity subscription capability are as follows:

- To enable alerting related individuals, users would have to configure their devices. They have to specify their locations of interest, which could be done through a user interface with a map on the device.

- When a message is received, the device would make a decision based on the current location, as well as the user-specified locations of interest.

This solution also supports alerting relocated individuals, as follows:

- When a device receives an alert while inside the affected area, it alerts the user and also stores the alert.

- If the device later moves outside the affected area but still receives an update to the initial alert (possible since a wider broadcast area is used), it recognizes this as an update to the earlier message and notifies the user.

Because the recommended solution requires the broadcast area of a message to be wider than the affected area, consideration must be given to the recommended size of the cell broadcast area relative to the affected area. Users will only receive related or updated alerts from inside the broadcast area. Choosing a wider broadcast area would potentially reach a larger number of users who expressed interest in the affected area or who moved outside the affected area. However, widening the broadcast area would increase the network-wide broadcast volume. Analysis is needed to assess whether this presents a serious concern and to determine a reasonable boundary for the broadcast area. Message prioritization can be used to give related alerts and updates a lower priority, so that they are broadcast only when cell broadcast capacity is available. If the analysis reveals significant challenges, a potential alternative solution would be to rely on subscription-based, non-broadcast mechanisms to reach the remaining concerned users.

2.7.3 EXPECTED BENEFITS

A Geographical Emergency Affinity Subscription would allow the public to receive WEA messages broadcast for a specific geographical area, even while at locations outside of that area.

2.8 POST-DISASTER WEA MODE

Implementing a new operational mode among CMSPs would allow continuity of the WEA service after a disaster. It would also facilitate emergency communications with the public via cellular devices using a temporary cellular infrastructure that can be deployed by first responders. The cellular infrastructure of one CMSP or the newly deployed temporary infrastructure would be used to send WEA alerts to subscribers of all CMSPs whose infrastructures have been damaged.

2.8.1 RATIONALE

WEA has inherent characteristics that make it more resilient than other emergency alert channels; it is likely to remain operational after a major disaster to disseminate alert and warning messages to the public. In particular, handsets are battery operated, which increases the likelihood that most will remain functional for some period after a loss of power. In addition, the geographically distributed deployment of cellular sites and associated infrastructure allows parts of the system to operate even if other parts experience failure. These features make WEA an attractive candidate channel for dissemination of new, lifesaving information about emergent dangers that may develop after the immediate incident.

Most CMSPs make major, continuing investments to improve the reliability and availability of their cellular networks. Nonetheless, major disasters will still potentially damage the cellular network and impact the ability to disseminate post-disaster WEA messages. For example, severe hurricanes and earthquakes can cause random physical destruction to cellular radio transmission equipment (cell site antennas or complete cell towers), which would cause coverage gaps for affected CMSPs. Subscribers to an affected CMSP would not receive new WEA messages in the gap regions even though some other CMSP might still have cellular infrastructure operating in those regions.

Figure 2-6 illustrates overlapping coverage of two CMSPs in one area. On the left, the entire area is getting service from both CMSP A (blue cells) and CMSP B (pink cells) before the disaster. On the right, CMSP B is shown to experience damage in the west side of the area, so cells X and Y are not functioning. Similarly, CMSP A is shown to experience damage in the east side of the area, so cells 1 and 2 are not functioning. Subscribers of CMSP B will experience the loss of WEA service in cells X and Y, even though these cells are partially covered by CMSP A; subscribers of CMSP A will experience the loss of WEA service in cells 1 and 2, even though these cells are partially covered by CMSP B.

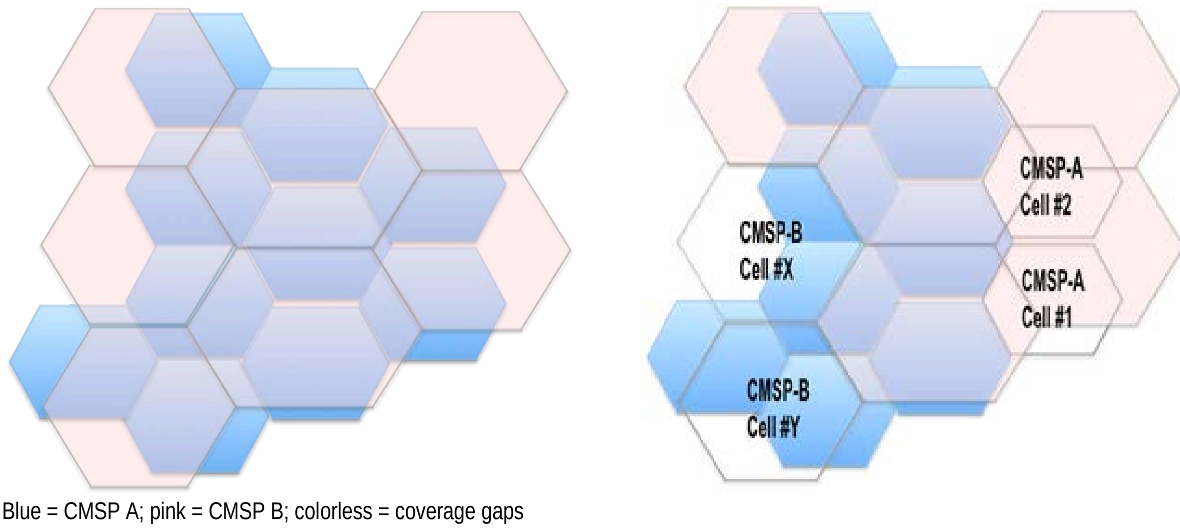


Figure 2-6 Cellular Coverage of Two CMSPs Before (left) and After (right) a Disaster

In other scenarios, all CMSPs providing service to a region may experience failure caused by infrastructure damage. This would especially be likely if several CMSPs in a region share cell towers. In this case the only way to send new emergency messages to the region would be to set up a temporary cellular infrastructure.

2.8.2 RECOMMENDATION

A new post-disaster mode of operation for cellular networks would enable subscribers to receive WEA messages from other CMSPs when the CMSP they subscribe to experiences service disruption. This mode could be activated on demand, enabled only after a major disaster or other event that causes cellular infrastructure damage to one or more CMSPs. The WEA post-disaster mode would guarantee that all WEA-capable mobile devices receive WEA messages as long as there is at least one operational CMSP in the area or if a temporary infrastructure is deployed in the affected areas.

The recommended solution requires cooperation among CMSPs after disasters to maximize the reception of additional WEA messages. It also requires the widespread use of cellular devices that can support multiple RF spectrum ranges and cellular protocols. This is not considered to be a significant hurdle because most mobile devices today are designed to support many legacy and new cellular protocols as well as international roaming. Unlike standard cellular roaming, mobile devices will not be able to originate or receive phone calls with the recommended solution, primarily because of the capacity limitations of cellular networks. Supporting higher numbers of subscribers during a disaster could reduce the performance of a network and therefore cause increased congestion. It is likely that CMSPs would be more amenable to accept the recommended solution if they receive assurance that their network will not experience additional load or potential loss of revenue caused by increased congestion.

The recommended solution would also facilitate the use of a temporary cellular infrastructure that can be deployed by first responders when the entire cellular infrastructure in an area is damaged. Setting up a temporary cellular infrastructure would require the availability of a limited number of mobile radio transmitters with centralized controllers and cell broadcast functionality. Core network connectivity to the temporary transmitters could be provided by a satellite; other network alternatives are also feasible. These temporary systems would then be deployed at selected emergency areas to restore WEA service and to facilitate other emergency communications with the public via cellular devices.

WEA post-disaster mode does not introduce any traffic load to a given CMSP network from subscribers of other CMSPs because all WEA messages are transmitted as cell broadcasts. Each operational CMSP will continue to broadcast WEA messages regularly, with the addition of new admission control mechanisms that allow devices from other CMSP networks to receive these broadcasts.

In WEA post-disaster mode, mobile devices must always attach to and use their primary provider network when it is available. The primary provider network would remain the preferred network for all voice and data communications and for receiving WEA messages. If a mobile device is able to access its primary provider network, the control software in the mobile device would ignore signals from all other networks, even when these other networks have stronger signals. A mobile device will switch to the recommended post-disaster mode only when it is no longer able to reach its primary provider network or any network where it is authorized for roaming. When a mobile device determines that it should switch to the post-disaster mode, it would first find a serving network with WEA post-disaster mode enabled. It would verify the authenticity of the serving node and then register to be able to receive WEA messages from that network.

All WEA cell broadcast messages can be assigned globally unique identifiers in post-disaster mode. Then, the existing process for handling cell broadcast on mobile devices will ensure that repeated receptions of cell broadcast messages will be ignored, regardless of which CMSP tower transmits the alert.

Implementation of the recommended mode requires software upgrades on the mobile devices and in the cellular network infrastructure to support new authentication and registration operations. Authentication can be implemented similar to the Universal Mobile Telecommunications System (UMTS) mutual-authentication procedures,[19] but these procedures can be simplified because mobile devices are not required to provide regular voice and data communications in WEA post-disaster mode.

2.8.3 EXPECTED BENEFITS

Implementing the recommended post-disaster mode would allow continuity of WEA service after a disaster. It would also facilitate emergency communications with the public via cellular devices using a temporary cellular infrastructure that can be deployed by first responders.

2.9 INCREASE TEXT MESSAGE LENGTH

Currently, WEA messages are limited to 90 characters because of a requirement to use only a single "page" of cell broadcast for each message. Using multiple pages would allow longer messages, which can convey more information to the public.

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[19] European Telecommunications Standards Institute Technical Specification (TS) 133 102, "3G Security, Security Architecture."

2.9.1 RATIONALE

The current 90-character limitation for emergency alerts, specified by the FCC,[20] restricts AO's ability to provide detailed information to the public in the event of an emergency. Mobile subscribers are advised to monitor other alert channels such as television or radio for more information about an alert, but this may not be possible due to lack of television or radio access, lack of power, or infrastructure outages. Restricting message size to 90 characters is not a cell broadcast limitation. Existing protocols would readily support longer messages if the FCC-imposed restrictions were removed.

2.9.2 RECOMMENDATION

Supporting messages longer than 90 characters would not require any changes to the Interface A or Interface C protocols. Arbitrary message lengths are already supported by the <parameter> element of the CAP messages and by the <CMAC_text_alert_message> and <CMAC_text_alert_message_length> elements of the CMAC messages. The only change required for these two interfaces would be amending the CAP IPAWS Profile[21] and the ATIS/TIA Commercial Mobile Alert Service (CMAS) Interface C Specification[22] to permit the use of longer messages.

WEA currently uses the automated 90-character message generation functionality implemented in IPAWS-OPEN. Various CAP fields are used to generate alert text instead of relying on an AO to enter free-form text. If message sizes are increased, this functionality would have to be modified to generate longer messages with more information.

WEA messages longer than 90 characters would require using multiple pages over the cell broadcast channel. Both Global System for Mobile Communications (GSM) and UMTS networks support multiple page cell broadcast, up to a maximum of 15 pages.[23] As a result, WEA messages up to 1350 characters can be supported by the existing standards. The only additional requirement for the CMSP infrastructure would be to separate long messages into multiple pages (1 to 15), none exceeding 90 characters.

2.9.3 EXPECTED BENEFITS

Increasing the WEA message length beyond 90 characters would allow more detailed information to be conveyed to the public.

2.10 <u>ENHANCE MULTIMEDIA SUPPORT</u>

WEA can be enhanced to support the delivery of alerts with audio and video content.

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[20] 47 Code of Federal Regulations (CFR) Part 10, FCC 08-99, 22 September 2008.
[21] OASIS, Common Alerting Protocol v1.2, "USA Integrated Public Alert and Warning System Profile, Version 1.0," October 2009.
[22] J-STD-101, "Joint ATIS/TIA CMAS Federal Alert Gateway to CMSP Gateway Interface Specification," October 2009.
[23] ATIS-0700007, "Implementation Guidelines and Best Practices for GSM/UMTS Cell Broadcast Service," October 2009.

2.10.1 RATIONALE

WEA currently relies on the cell broadcast service provided by CMSPs to deliver text alerts to the public on their cellular devices. More effective alerting would be achieved if the alert messages were enriched beyond simple text; in particular, if multimedia content was supported. Broadcasting an appropriate audio or video stream related to the emergency event could help the public better understand and deal with the emergency situation. Because the cell broadcast service currently offered by CMSPs is limited to text broadcast, an alternative would be needed to deliver multimedia content. This section addresses this need by exploring how a multimedia broadcast service could be made available for use by WEA when alerting the public.

2.10.2 RECOMMENDATION

Today's cellular multimedia delivery is based on unicast delivery, with users streaming stored video or live television in a client-server mode. In unicast delivery a separate point-to-point connection must be established and maintained separately for each recipient. This type of operation on the radio interface is practical for a small number of subscribers who stream audio or video content simultaneously. However, it does not scale as the number of subscribers increases, thus requiring many simultaneous connections to be established and maintained. This would generate a large amount of traffic on the air interface, where spectrum is a limited resource.

Studies have shown that it is more efficient to broadcast a video stream within a cell site when the total number of users simultaneously accessing the stream in the same cell is more than some threshold.[24] The capacity enhancing techniques developed for point-to-point communication (which is bidirectional) cannot be used for broadcast because the broadcast radio channel must serve multiple users simultaneously. In other words, the broadcast signal cannot be adapted to individual users and must always be strong enough for the mobile with the poorest radio quality. In contrast, unicast has associated uplink feedback and the radio resources can be tailored to the user's current channel conditions instead of the worst case.

Broadcast has a capacity advantage over dedicated point-to-point connections when many recipients are using the same cell. Because the audience of a WEA video alert would potentially be very large, broadcast would be the most appropriate delivery mode for WEA audio and video. Therefore, there is a need for point-to-multipoint delivery on the radio interface that can support broadcast services more efficiently. The Third-Generation Partnership Project (3GPP), which is the organization responsible for the GSM and UMTS standards, already addressed multimedia broadcast and multicast and developed the Multimedia Broadcast and Multicast Service (MBMS) standards specification.[25] MBMS introduces small changes to existing radio and core network protocols, which make mobile broadcast a relatively inexpensive technology to introduce. MBMS adds a set of functions that control the broadcast delivery under the term "broadcast service center" [equivalent to the cell broadcast center (CBC) for CBS] as well as channels for point-to-multipoint radio transmission within a cell. MBMS uses the General Packet Radio Service (GPRS) and Enhanced Data Rates for GSM Evolution (EDGE) packet data channel (PDCH) in GSM, and it uses the forward access channel (FACH) and the secondary common control physical channel (S-CCPCH) in UMTS. It uses multi-slot operation to set up a multimedia broadcasting channel in GSM, supporting up to five timeslots per MBMS session, and can achieve up to 256 kbps as a user bit rate.

[24] F. Hartung et al., "Delivery of Broadcast Services in 3G Networks," *IEEE Transactions on Broadcasting*, Vol. 53, No. 1, March 2007.

[25] 3GPP TS 22.146, "Multimedia Broadcast and Multicast Service (MBMS)," December 2011.

WEA may not work well for this kind of sub-county alerting. The subscribers of a CMSP that supports only county-level geo-targeting would receive confusing and potentially conflicting messages in this scenario.

Table A-1 presents the different messages that would be received in each target area by a CMSP that supports sub-county–level geo-targeting and a CMSP that supports only county-level geo-targeting. Subscribers of the second CMSP will get all of the alerts issued in the county, not just the ones targeted for their sub-county area. In this example, subscribers to the second CMSP who are outside both Areas 1 and 2 unnecessarily receive the Evacuate and Take Shelter messages as conflicting instructions. Furthermore, subscribers to that CMSP who are inside Area 1 or Area 2 receive an Evacuate message followed by Take Shelter, which is conflicting. If the alerts contained free-form text to describe the relevant area, it may be possible to mitigate the confusion to some degree, but the description will have to conform to the 90-character limit of WEA.

Table A-1 Alerts Received in Different Target Areas with and without Sub-County Geo-Targeting Support

Target Area	CMSP with Sub-county–level Geo-targeting	CMSP with County-level Geo-targeting
County	Civil Warning	Civil Warning Take Shelter Evacuate
Area 1	Civil Warning Take Shelter	Civil Warning Take Shelter Evacuate
Area 2	Civil Warning Evacuate	Civil Warning Take Shelter Evacuate

A new management plane service is recommended to solve this problem, as described in Section 2.2. This service would allow querying a target area to learn its existing geo-targeting capabilities and the actual footprint of a WEA broadcast. This querying could be done either periodically or before sending each alert.

GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile Communications
GUI	Graphical User Interface
IA	Information Assurance
IP	Internet Protocol
IPAWS	Integrated Public Alert and Warning System
IPSec	Internet Protocol Security
ISP	Internet Service Provider
OPEN	Open Platform for Emergency Networks
JHU/APL	The Johns Hopkins University Applied Physics Laboratory
MBMS	Multimedia Broadcast and Multicast Service
MLP	Multi-Level Priority
MPQ	Multi-level Priority Queuing
NIST	National Institute of Standards and Technology
NTIA	National Telecommunications and Information Administration
NWS	National Weather Service
PDCH	Packet Data Channel
PDP	Policy Decision Point
PSBN	Public Safety Broadband Network
RF	Radio Frequency
S&T	Science and Technology Directorate
S-CCPCH	Secondary Common Control Physical Channel
TCG	Trusted Computing Group
TCP	Transmission Control Protocol

TLS	Transport Layer Security
TNC	Trusted Network Connect
TS	Technical Specification
UMTS	Universal Mobile Telecommunications System
WEA	Wireless Emergency Alerts
WSDL	Web Services Description Language