

ADVANCES IN FOREST FIRE RESEARCH

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Emergency Alerting Technologies Relevant to Forest Fires

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Abstract

California wild and forest fires in 2017 resulted in over 100 fatalities. While WEA alerts were transmitted to mobiles in selected areas, the power and network outages limited their delivery. WEA is similar to the SMS Broadcast system used elsewhere. It does not require subscription, and can be geotargeted, usually by map polygon. There are already available and in development other alerting technologies. The Emergency Alert System on radio and TV in the U.S. has been in use for many years. It is a broadcast break-in system that overrides program content. This was used in one location for the wildfires, but not elsewhere as geotargeting is not possible with this system. It is an analog broadcast technology architecture. AM and FM Broadcast in the U.S. now has HD Radio that is mixed analog and digital. A limited data message can be carried and used for selective delivery of messages. DAB, DAB+ and DRM also can carry a message payload, which can be used for a selective delivery mechanism when the receiver has location position. This may be in a vehicle radio/navigation system. The current digital television system in the U.S. and some other countries is now being replaced by ATSC 3.0. This provided a superior modulation format, Layered Division Multiplexing (LDM) for delivery of program content and alerts to suitable mobiles. An IC for UHF reception and prototype mobiles have been developed. No external antenna is required. Both of these new technologies are tested as delivering alerts independently of the mobile network. Within the limitations of radio and TV propagation, such capabilities would provide technology redundancy. The television signal propagation may be limited in rural areas, but ATSC 3.0 is capable of having on frequency repeaters to make a single frequency network for improved coverage of program content and alerting. Multilingual alerts based on the CAP Event Terms list with Message Formats are being provided for.

1. The Lifesaving Value of Alerting

Some comparisons are made between disasters that are unalerted and others which have alerts beforehand.

1.1. Samoa and American Samoa Tsunami 2009

1.1.1. Fatalities comparison

In the 2009 earthquake and subsequent tsunami, there were 22 confirmed fatalities in American Samoa and 147 in Samoa. While the tsunami in American Samoa was 4.6 to 6 m high the Samoan landing was 6.1 to 9 m high. This explains in part the difference in fatalities

1.1.2. Benefit of Alerting Comparison

The fatality ratio is 22 to 147. The height ratio is 6 to 9. Compensating for the height, the ratio is 1 to 4.45. In American Samoa the radio station operator, DJ Ms Lupe Lohman, initiated a tsunami alert. <http://news.bbc.co.uk/2/hi/asia-pacific/8282741.stm>. This was relayed by criers, church bells and other means. In Samoa, no alerting was recorded, and the radio station had no Emergency Alert System. At the NAB Trade show in 2017, I spoke with the representatives of Triveni (a Viavi division) who stated that it was one of their products that was used. Samoa at that time was a protectorate of New Zealand. Such equipment is not in use in New Zealand, but SMS Broadcast is now in use to mobiles.

1.2. Indian Ocean 2004 and Tohoku, Japan 2011

1.2.1. Fatalities Comparison

In the 2004 Indian Ocean earthquake and tsunami, there were an estimated 227 898 fatalities and in Japan there were 22 303 fatalities and missing. While the tsunami height in Indonesia was 30 m for a 9.3 magnitude quake, the 2011 earthquake and tsunami in Tohoku had a 40.5 m height for 9.1 magnitude.

1.2.2. Benefit of Alerting Comparison

The fatality ratio is 22 303 to 227 898. While the height and earthquake magnitude differ; they somewhat cancel each other at a 40.5 m and 9.1 magnitude in Japan versus 30 m and 9.3 in Indonesia. Compensating for the differences the benefit ratio is 1 to 13.5. This is much higher than for Samoa, however in Japan there were many more mitigation measures implemented beyond alerting. The cost of the alerting system has not been obtained in writing. It is worth noting that this system was installed in 2009 and is considered to have delivered sufficient benefit to pay for that investment in two years.

While this analysis of only two examples is unsatisfactory for assessing a standard deviation of results or of differences with control examples, the problem is the lack of comparable examples. As an illustration, compare the Haiti earthquake 2010 magnitude 7.0 with 300,000 fatalities and Christchurch New Zealand 2010 magnitude 7.1, or 2011 magnitude 6.1 or 2016 magnitude 5.7 with considerable damage in the latter but with two noted fatalities and 100 injuries in 2010, 185 deaths in 2011. None of the events included alerting the public. It may be possible to use factor analysis to extract some factors relevant to the alerting question, but that requires a large amount of related set data. Such a set of data does not appear to be available. One would hope that future researchers are able to improve on this with future data after some more implementation of alerting in the future.

1.3. Evaluation of Wild and Forest Fire Fatalities in the U.S.

1.3.1. Los Angeles Times 2018-12-03

This is a newspaper report copied and is in the appendix as an attachment. In one of the fires there were 88 fatalities in Butte County. The headline noted that more than one third of the cellular recipients did not receive alerts. A subscription alerting service was used.

1.3.2. Cellular at risk of wildfires

This is an engineering evaluation of cellular or mobile base stations and the risk of fires at their locations, which may be on high land. It is in the appendix. No discussion of fatalities is included.

1.3.3. Gatlinburg 2016 Nov 28 firestorm

This report is applying to Gatlinburg, Tennessee and is in the appendix as an attachment. While there were a limited number of fatalities, being 14, this is included because the Emergency Management Office lost its communications and was unable to initiate an Emergency Alert to mobiles or broadcasters. While satellite or amateur radio hypothetically could have been technologies to use in such a situation, the lack of landline and internet phone were also rendered inoperative. This highlights the importance of redundant technologies.

1.3.4. NBNBC Telecommunications Outage Report 2017 Firestorm

This report applies to wild and forest fires in California in 2017 and is in the appendix as an attachment. Napa, Sonoma and Mendocino Counties were affected with 44 lives lost.

2. The Importance of Redundancy for Emergency Alerting, Including Technologies

2.1. The Fatalities noted in 1.3 total 132.

This is a situation where one single or few technologies were used. The Emergency Alert System using broadcast radio and television was only used in one alert, and no fatalities in that area were noted. It is also worth noting that broadcast coverage areas are normally much larger than forest fire areas. This technology at that time would have alerted large numbers of recipients for whom the alert was irrelevant. The lack of selection of alert delivery as a polygon on a map is highly desirable. Alerting delivery presently has the potential to give rise to large numbers of people evacuating, with a potential for traffic congestion that could have been a serious hindrance to firefighting, police and ambulance crews. There is no suggestion that this is an advisable course of action for alerting should such problems arise.

If an appropriate area could be selected, given the conservative benefit of alerting noted in 1.1.2 as being 4.7, the fatalities could have been reduced to 28, saving 105 lives compared with using a single technology. The results for Japan in 2011 suggest that more technologies produce better results.

3. An Outline of Broadcast Alerting Developments.

3.1. HD Radio, DAB, DAB+ and DRM.

In the U.S. there is AM and FM digital broadcasting added to the analog carrier. It is possible to replace the analog carrier with digital only. On FM there is a 200 kHz station spacing and this allows for digital carriers alongside the analog signal. There is a limited data rate available for alerting messages, which may include a map polygon, jurisdiction or receiver type for selectivity. A receiver may obtain the current location from the navigation system or via Bluetooth from a mobile. AM HD Radio has very limited alert data capacity, but this has potential. Selectivity may be implemented by selecting between the alert audio and the program audio. On FM there are up to 3 digital programs, of which one is replicating the analog signal. In a region, one may be a news, alert and weather program with lower data rate. This may be possible on DRM, but research is needed.

DAB and DAB+ are multi-station and digital only. It may be possible to designate one as a news, alert and weather program with lower data rate. The alert message data would provide the selection criteria for program or alert audio selection. This would only require software added to the consumer receiver and a means of determining the location, e.g., vehicle navigation or Bluetooth to a mobile.

3.2. ATSC 3.0 “nextgenTV” and DVB.

The ATSC 3.0 or nextgenTV system included alerting audio+data (as A/331) and video as separate from the TV program, which may be 4K or UHD with High Dynamic Range and Wide Colour Gamut. It is a transport technology that may be used for new technologies in the future as a complement to the present internet. The audio may be immersive. Other HD or SD TV channels may be included, or UHD when a 7 or 8 MHz bandwidth is available. The video is HTML5, not an inflexible format. The modulation is Layered Division Multiplexing (LDM). There is a QPSK high power and low data rate layer, and a selectable constellation lower power high data rate component. The alerting and a Standard Definition video with stereo plus the alerting data is in the QPSK. This UHF band signal may be received by a little antenna in a suitable mobile. Prototypes have been demonstrated. While this expands the potential audience to such mobiles, the importance here is the delivery of alerts. This system is broadcast in South Korea and USA currently. India, Brazil, Jamaica have announced, and Canada and Japan are expected to replace their digital TV system with ATSC 3.0. It can carry European SD and HD video. In addition to cinema quality video and audio, it is also IP based. Enabling delivery via the air, satellite, or cable as well as the internet. China is participating also. The importance here is the better delivery of alerts than possible with DVB to mobiles. In order to reach more remote areas, it is possible to replace TV translators with Single Frequency Networks (SFN) for wider coverage without additional spectrum required. U.S. broadcasters have released considerable spectrum to the mobile providers.

3.3. Cable, fibre and telco TV.

The various systems all have low bandwidth data delivery possible. When the Set Top Box has its location data by one of various means, the selective alert delivery can be implemented. This is anticipated development work. The distribution of these fixed line systems in rural areas is not expected to be high, but they are important for urban areas.

3.4. Satellite TV and radio.

In the U.S. this is DirecTV, Dish Network and SiriusXM. These all provide alerting currently, but with better alerting technology, these distributions can be improved. Other countries have various systems which are likely to be amenable to better alert delivery. Satellite delivery for Earthquake Early warning has an added delay that becomes significant.

3.5. Internet alerting.

There are many forms of internet alerting. A distribution to broadcasters is via the internet. Then there is Federation of Internet Alerts, Google Alerts and more including subscription services.

3.6. Message content.

The OASIS-Open Emergency Management Technical Committee has developed an Event Terms list which is now a committee note for the Common Alert Protocol standard x.1303 of itu.int. This standard is adopted by over 70% of the world, including much of Europe. Each term may have a detailed spectra which is not defined. Based on this Committee Note, a collection of historical alerts, various lists from many sources and other

research a list of Message Formats {currently 427} these include many for fire alerts and fire risk messages. A tab for wildfire messaging is in the spreadsheet. The Message Formats have been translated into a first draft for many languages. The intent is to enable multilingual alert generation by Emergency Managers who only know one language. Also, using this message added data and the codes, alerts in neighbouring countries for emergencies that are cross-border can reasonably easily be made. Information from previous work has been incorporated. The intent is to have a level playing field for consumer electronics manufacturers to be able to implement one version of software to be able to process alerts in any country. English, Spanish, French and Portuguese are some of the languages translated.

3.7.WEA and SMS Broadcast to Mobiles.

Currently many mobiles receive alerts from WEA (in the U.S.) or SMS Broadcast (many countries) and other SMS or subscription services. In the U.S., authorized Emergency Managers using Alert Origination Software may send alerts to the FEMA IPAWS system to various recipients including mobile service providers and broadcasters. With the anticipated implementation of ATSC 3 or nextgenTV to mobiles, there is the likelihood of the mobile receiving multiple alerts from one origination message. Identification of this to reduce alert fatigue by the public is designed into the complete system. Between the various sources, the technology redundancy should provide much improved reliability of distribution. Intelligent Highway Signs, loudspeaker systems and other technologies may also be incorporated.

3.8.Systems Interoperability Standards and some applications.

Alerting Protocols; Common Alert Protocol (CAP) with Event Terms list expanded as core protocol. This may be translated to Emergency Alert System (EAS) based on FCC Part 11 rules for analog and legacy television and analog radio. Improved EAS adapted for HD Radio, DAB, DAB+ and perhaps DRM. DVB Alerting distribution where applicable. CAP based messages on ATSC 3 in HTML5 which can be translated to CAP if needed. Others may be adapted e.g., for Japan.

Earthquake Early Warning using an appropriate version of CAP with delivery optimized for speed. If possible, within 3 seconds of detection.

Healthcare; EDXL-HAVE, HL7 and others

Other Emergency Management; EDXL-DE, EDXL-RM. EDXL-TEP, EDXL-TEC, EDXL-SITREP, XchangeCore. Google Earth, Esri, NAVTEX, <https://www.g2.com/categories/emergency-management> atsc3advocate.com. <https://onemediallc.com/resources/>

4. Conclusions.

4.1.Audience Relevance.

This is always important with any media content distribution. The audience of an alert should as much as is reasonably practicable, be those for whom the alert is intended. That audience of this paper is gathered to address Forest Fires. Consequently, while much more could be stated on these subjects, those things are considered not as relevant. A public opinion survey regarding alerting is attached as Research_Study. Questions are welcome to fbell@kynx.us

4.2.Anticipated Costs and Benefits.

The major expense for such improvements is for improved software for the consumer receivers where that is practicable. Vehicle digital or satellite radio receivers may have their software upgraded as part of the dealer maintenance. Older vehicles may be replaced with newer ones which may already have the software from the factory. Some devices can have software downloaded to a USB for vehicle upgrade or directly to the device. Once developed, the cost is the time and effort including informing the users. Other consumer electronics like radios have new replacements in time. The cost of the infrastructure for alerting delivery is significant, and the cost of developing that is also significant. The benefit of lives saved is considerably more significant. In “Risk and Reason” by Cass Sunstein, the value of a life for public policy purposes in the U.S. when written was in the range of \$US 1 M to \$10 M. Other countries may have such assessments made. An honest assessment of this aspect is helpful for making economic decisions. Disasters and wars may be made lesser problems by such considerations.

A desirable capability is that of delivering alerts to mobiles. ATSC 3.0 or nextgenTV has this capability designed in and is also designed to be significantly better to deliver such alerts to mobiles than previous digital TV systems. Much of the world is using DVB or ISDB which have been improved. DVB-H was a commercial failure, and probably a poorer performer with a limited range. DVB-NGH has been developed as a successor, but the implementation commercially has been limited by the range. That is primarily arising from the type of modulation ATSC 3.0 uses LDH which has a high power low data rate component for inherently greater range. Future mobiles providing for this and DVB-NGH would require development. A Mark One nextgenTV evaluation model has been produced but is not yet publicly available. While there is much progress, this particular aspect has remaining significant work to be done, and the benefit is not at present apparent to the public if this cost is to be recouped by a full increase in product price.