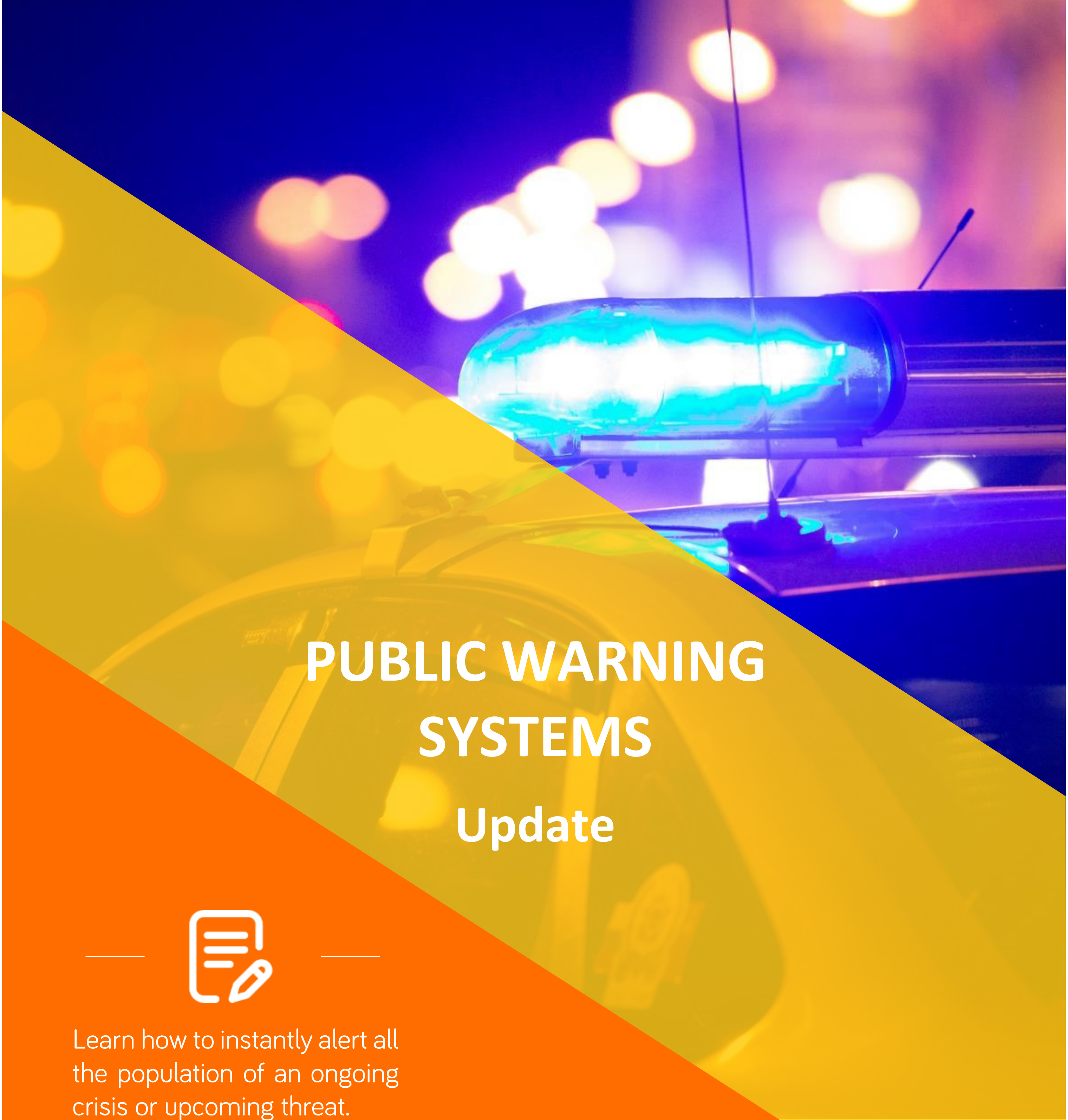

PUBLIC WARNING SYSTEMS

Update

Learn how to instantly alert all the population of an ongoing crisis or upcoming threat.

Be prepared for the unexpected.

Comply with the new EU legislation.

Version 3.0

PUBLIC WARNING SYSTEMS - UPDATE

Title: Public Warning Systems – update

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1 | EXECUTIVE SUMMARY

For the delivery of public warning, there appears to be no single solution that fits all the requirements for the timely notification of an emergency incident or situation. Therefore, a Public Warning System (PWS) ought to be a blend of the best attributes of the existing technologies, adapted to the particular demands of the country or territory in question.

In 2018, article 110 of the European Electronic Communications Code made it mandatory for all the Member States of the European Union to deploy a Public Warning system using telephone networks to alert everyone located in a specific area of an ongoing crisis or upcoming disaster[1], by June 2022.

This document presents an investigation of the various technologies that are available for public warning. It enables a comparison between the different technologies in use today and of those being considered, through initiatives in many countries, for the deployment of next generation PWS.

Research has already demonstrated that modern public warning systems can considerably reduce casualties in times of emergency.

By June 2022, all the EU Member States must have introduced effective and modern Public Warning Systems.

[1] European Electronic Communications Code available here: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2018.321.01.0036.01.ENG

2 | LIST OF ACRONYMS

3GPP	Third Generation Partnership Programme
ATIS	Alliance for Telecommunications Industry Solutions
CAP	Common Alerting Protocol
CB	Cell Broadcast
CBdd	Cell Broadcast data download
DAB+	Digital Audio Broadcast
EECC	European Electronic Communications Code
EENA	European Emergency Number Association
EGNOS	European Geostationary Navigation Overlay Service
EPC	Evolved Packet Core
ETSI	European Telecommunication Standards Institute
EU	European Union
EWF	Emergency Warning Functionnality
FCC	Federal Communications Commission
GSM	Global System for Mobile Telephony (2G)
Hbb TV	Hybrid broadcast broadband TV
ICB	Interactive Cell Broadcast
IMS	IP Multimedia Subsystem
IP	Internet Protocol
IPAWS	Integrated Public Alert and
ISO	International Standards Organisation
LB-SMS	Location-Based SMS
LTE	Long Term Evolution (4G)
MAMES	Multiple Alert Message Encapsulation over Satellite
MNO	Mobile Network Operator
OASIS	Organization for the Advancement of Structured Information Standards
PSTN	Public-Switched Telephone Network
PWS	Public Warning Systems
RDS	Radio Data Systems
SIM	Subscriber Identity Module
SIP	Session Initiation Protocol
SMS	Short Message Service
SMSdd	Short Message Service data download
SRSS	Selective Radio Signaling System
STF	Special Task Force
TR	Technical Requirements
TS	Technical Specifications
UMTS	Universal Mobile Telecommunications System (3G)
VoLTE	Voice over LTE
VOST	Virtual Operations Support Teams
WEA	Wireless Emergency Alert

3 l LIST OF STANDARDS

Standardisation Organisation	Reference of Document	Title of document	Date	Link
3GPP	23.041	Technical realization of Cell Broadcast Service	Latest version: 2019-03	LINK
ATIS	0700006.v002	Enhanced Wireless Emergency Alert (eWEA) via GSM/UMTS Cell Broadcast Service Specification	2018-02	LINK
ATIS	0700010.v003	Enhanced Wireless Emergency Alert (eWEA) via EPS Public Warning System Specification	2019-05	LINK
ATIS	0700043	Wireless Emergency Alert (WEA) 3.0 via 5G Public Warning System Specification	2019	
ETSI	EN 300 401	Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers	2017-01	LINK
ETSI	TS 102 182	Requirements for communications from authorities/organizations to individuals, groups or the general public during emergencies	2010-07	LINK
ETSI	TS 102 900	European Public Warning System (EU-Alert) using the Cell Broadcast Service	2019-02	LINK
ETSI	TS 102 796	Hybrid Broadcast Broadband TV	2016-08	LINK
ETSI	TR 103 338	Satellite Earth Stations and Systems (SES); Satellite Emergency Communications (SatEC); Multiple Alert Message Encapsulation over Satellite (MAMES) deployment guidelines	2015-05	LINK
ETSI	TS 103 337	Satellite Earth Stations and Systems (SES); Satellite Emergency Communications (SatEC); Multiple Alert Message Encapsulation over Satellite (MAMES) deployment guidelines	2015-05	LINK
ISO	22322	Societal security and emergency management	2015-05	LINK
OASIS	None	Common Alerting Protocol Version 1.2	2010-07	LINK
OASIS	None	Common Alerting Protocol, v. 1.2 USA Integrated Public Alert and Warning System Profile Version 1.0	2009-10	LINK

4 l INTRODUCTION

Tornados, tsunamis, hurricanes, floods, natural volcanic, and releases of deadly gas are examples of dangerous situations where Public Warning Systems (PWSs) can save lives. Whilst PWS were first thought to be needed to protect the lives of people solely in the cases of major emergency by warning the public of impending disasters, evidence from actual usage shows that authorities are now employing these systems for more localised, day-to-day, life-at-risk emergencies. More frequent use-cases include asking the public to help search for missing children, report sighting of fugitives, and take immediate action to stay safe during a marauding terrorist attack.

There is no doubt that effective early warning systems have substantially reduced deaths and injuries from severe weather events[2]. Early warnings of flooding risks have been shown to be effective in reducing flood-related deaths (Malilay et al. 1997). For example, there is a difference between the 1992-1994 flooding along the Rhine and the Meuse rivers and the 1995 flooding along the same rivers (Estrela et al. 2001). The two floods had similar characteristics; both were caused by persistent heavy precipitation. Ten people lost their lives and over 900 million US$ in damages occurred during the first event, while the economic cost was reduced by almost a half, no lives were lost during the 1995 flood due to awareness and behavioural changes.

In the last 70 years, sirens have been the most widely used PWS, together with radio broadcast. For public warning there is no single solution that fits all requirements to reach all citizens in case of an emergency. Therefore, multiple technologies need to be considered. This document investigates the various technologies that are available for public warning, and notably a mobile telephony based PWS, “Reverse112”.

[2] Costs and Benefits of early Warning Systems (David Rogers and Vladimir Tsirkunov, 2010): http://www.preventionweb.net/english/hyogo/gar/2011/en/home/index.html

5 I EU LEGISLATION

In 2018, article 110 of the European Electronic Communications Code (EECC) makes it mandatory for all the Member States of the European Union to deploy within 3,5 years a Public Warning system using telephone networks to alert everyone located in a specific area of an ongoing crisis or upcoming disaster: "By 21 June 2022, Member States shall ensure that, when public warning systems regarding imminent or developing major emergencies and disasters are in place, public warnings are transmitted by providers of mobile number-based interpersonal communication services to end-users concerned."[3]

While the text can seem quite vague, it gives some flexibility to the Member States to define the technology and how to implement it. More clarity is however brought in one of the recitals of the text in the scope of the "end-users concerned". By recital 293, "End-users concerned should be deemed to be those end-users who are located in the geographic areas potentially being affected by imminent or developing major emergencies and disasters during the warning period, as determined by the competent authorities."

Paragraph 2 of the article 110 of the EECC makes it possible for Member States to deploy alternatives to telephone networks-based alerting systems, such as apps. However, such alternatives should fulfil 5 requirements, as listed in the recital 294 of the same text: (1) it should be as efficient as the network-based technologies in terms of coverage; (2) reception of the alert by the user should be easy (users should not be required to login onto the app); (3) visitors entering a country should be informed of this alternative way of receiving alert; (4) the transmission of the alert should be free to the user; (5) the deployment of this alternative should be done in compliance with privacy laws.

6 I EVENT ALERT NOTIFICATION CYCLE TIME

Public warning is the capability to bring to the immediate attention of all people who might be impacted following the onset, or predicted onset, of an emergency so that they can take action to mitigate the impact of this incident.

The time it takes to communicate critical information in an emergency can mean the difference between safety and catastrophe. The ability to accurately deliver the right information, to the right audience, at the right time is crucial to any emergency planning effort.

The time passed between an event occurrence and the reception of the warning message by the citizen is the "event alert notification time".

The "event alert notification time" will depend on the nature of the threats that each country or region faces as shown in figure 1. This could be anything from an earthquake to several less time critical incidents.

[3] European Electronic Communications Code available here: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2018.321.01.0036.01.ENG

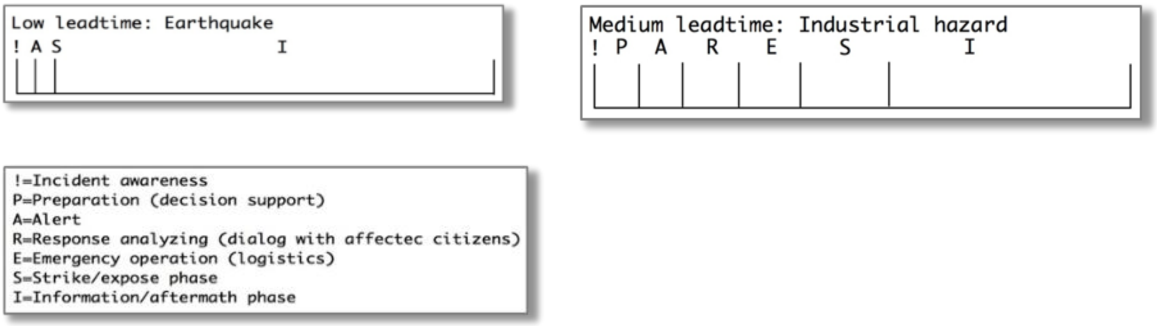


Figure 1: Event notification lead time

Good examples can be found in the "Costs and benefits of early warning systems" report (Rogers and Tsirkunov 2010) [4] about the relationship between the reliability of public warning, the lead time, and as a consequence, the cost-benefit of early warning systems (see the diagrams in figure 2).

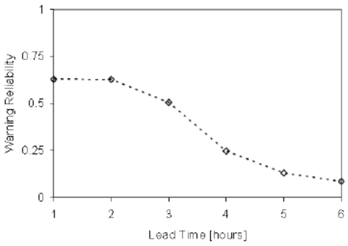


Figure 2: Warning reliability as a function of the lead time

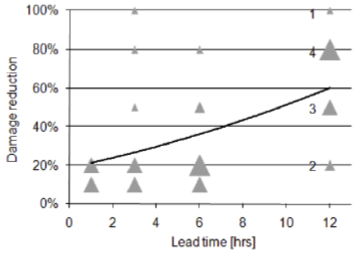


Figure 3: Damage reduction as function of lead time

Public Warnings are also a valuable mechanism to minimise damages and manage the emergency situations during and after emergency events. Many emergencies can potentially extend in time, even during several hours and even days, like big fires and floodings, changing the conditions continuously, requiring many different communications to the public.

[4] Costs and Benefits of early Warning Systems (David Rogers and Vladimir Tsirkunov, 2010): http://www.preventionweb.net/english/hyogo/gar/2011/en/home/index.html

7 I MEANS OF PUBLIC WARNING

Requirements for communications from authorities and organisations to individuals, groups or the general public during emergencies have been published by ETSI in ETSI TS 102 182. These requirements include the main means of PWS messages distribution:

- Mobile phones (cell broadcast (CB), location-based alerting using Short Message Service (LB-SMS), instant messages service (IMS), email, Push IP to smartphones, mobile apps…)
- Fixed phones
- TV, radio
- Sirens and long-range acoustic devices
- Variable-message signs and public address systems
- Internet (web, email, PC notification, social media…)

8 l PUBLIC WARNING SYSTEMS BASED ON TELEPHONY

As described in ETSI TS 102 182, different technologies fulfil different requirements. The present section intends to present the different technologies for mobile phone and fixed line phones.

8.1. Cell Broadcast

Cell Broadcast (CB) is a location-based technology that sends text messages that are displayed on the screen of the mobile device. It is a point-to-multipoint service.

With CB, it is possible to send a text message to a specific area (local, regional and nationwide) to a large number of subscribers, whose phones are configured to support and receive alerts, including visitors from other countries. Messages are sent in near real-time with location specific information, in the users' desired language and even if the network is congested. A CB message has a maximum length of 1395 characters.

Since CB is broadcast, it takes a single message to reach potentially all subscribers and roamers on the network, without needing to know the number of mobile devices within the affected area and without affecting the user's privacy. To send a CB message to reach all subscribers (potentially millions) takes seconds. The broadcast is repeated during a configurable period for the duration of the guidance to safety in that region. The message could also expire after a single broadcast or be repeatedly broadcast.

When a CB message is received by the user, it is displayed automatically on the mobile phone screen without any user interaction and with a special standardised ringtone and vibration, making the CB message instantly recognisable as an alert. In addition, the user needs to acknowledge the alert before being able to use the phone. Regarding people with visual disabilities, CB also allows in certain cases text-to-speech.

The message can be broadcast in single radio cell, in a group of cells or in the entire network, which makes the service location specific. As CB standardisation is evolving and improving the capabilities of the mobile networks and handset capabilities, it is possible since November 2019 to geo-target mobile devices with CB (using the phone's geolocation capability), resulting in an accuracy levels equal to those of satellite navigation. This has been mandated in the United States by the Federal Communications Commission (FCC) and as this capability has been specified by the 3GPP for Release 15, this requirement will become generally available in all handsets.

Messages can be broadcast in any language and displayed depending on the mobile device's language settings. This is the case in the United States with WEA (Wireless Emergency Alert) 2.0 (see in the part on the United States).

A major advantage of CB is that in GSM (2G), UMTS (3G.), LTE (4G) and 5G, CB is part of the mobile networks signalling and has therefore the highest priority over any other service for allocation of capacity. This means that CB will always work, even when the network is congested or deliberately shutdown for regular users (SIM class-based access).

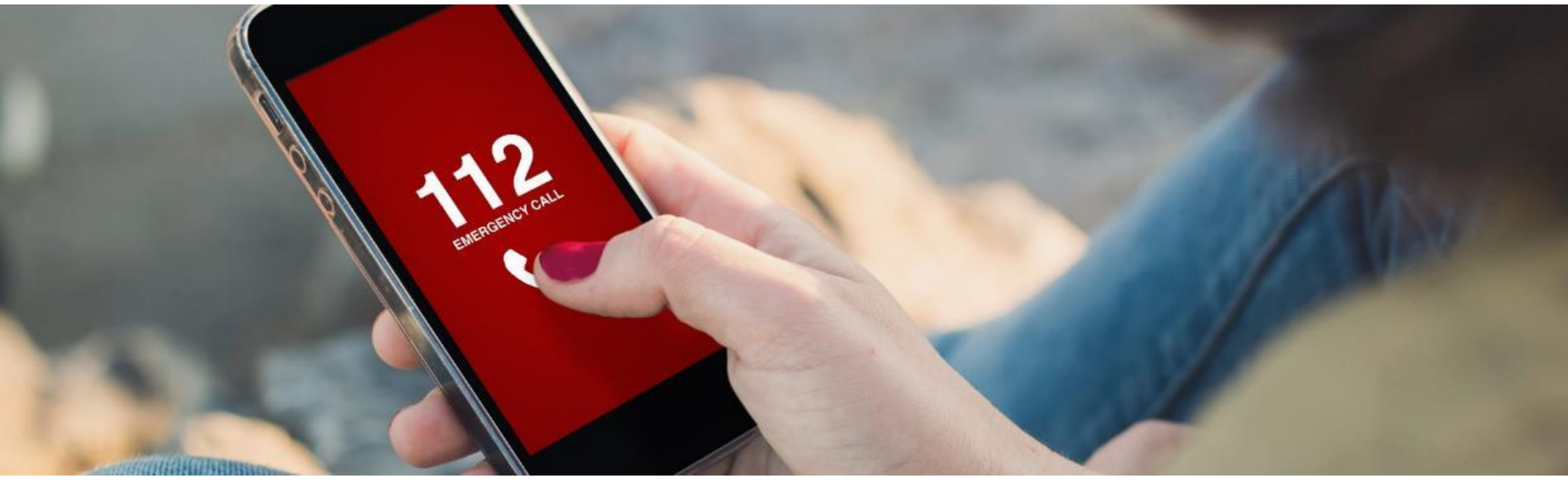
In order to receive the alert sent by CB, the users need to have a compatible device and the CB capability (in Europe: 'EU-Alert') enabled on their phone. It is however possible for public authorities to request the activation by default of this channel. This is still voluntary standard amongst device manufacturers, which is why some countries such as Canada, the United States or Peru had to mandate that all new mobile devices sold in these countries must now be CB compatible. Another possibility to make the phones compatible (including feature phones) is to force CB activation and the channel configuration via a small applet on the SIM card.

It should also be noted that users of a CB compatible mobile device can also opt out of receiving the alerts by disabling the service in the settings of their device. However, the public authorities have the possibility to enable a CB channel that has no opt-out possibility (e.g. for extreme or presidential alerts) or enable one or several opt-in channels for different alert categories (e.g. missing persons or test messages).

CB does not have the capability to provide automated system assurance in near real-time that the message successfully reached the vast majority of the intended recipients within the affected area. Nevertheless, the nature of some disasters and their speed to impact, such as a tsunami, means that system assurance is secondary to broadcasting the alert widely and as quickly as possible. There is an option though to make CB interative (ICB – Interactive Cell Broadcast) with an addition of a small dedicated applet on the SIM card. This way, delivery reports are available but more importantly, the alert message might be interactive allowing citizens to respond, should they need help, together with sending their location by a single click. ICB has been initially activated for the December 2004 tsunami in Asia.

CB is defined in 3GPP TS 23.041[5] for GSM, UMTS, LTE and 5G. Specific use of CB for PWS in Europe is specified in ETSI TS 102 900[6] and this service is called EU-Alert. This is supported in 2G, 3G, 4G and 5G mobile networks. In the US, the Wireless Emergency Alert (WEA) via CB is specified in ATIS 0700006.v002[7] (WEA in GSM and UMTS); ATIS 0700010.v003[8] (WEA in EPC) and ATIS 0700043 (WEA in 5G).

[5] 3GPP TS23.041: http://www.3gpp.org/DynaReport/23041.htm
[6] ETSI TS 102 900: http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=38226
[7] ATIS 0700006 : https://www.atis.org/docstore/product.aspx?id=28374
[8] ATIS 0700010: https://www.atis.org/docstore/product.aspx?id=28374



8.2. Location-Based SMS alert system

Location-Based SMS (LB-SMS) combines traditional SMS with cell-based location. This allows mobile network cell-based location accuracy and use the existing SMS channel which is already supported by close to 100% of all mobile phones worldwide.

LB-SMS identifies the actual list of mobile subscribers in the area and sends an individual SMS to each recipient. This allows showing a count of recipients in an area (situational awareness), individual delivery reports (real time status on successful delivery) and language specific content (based on recipients' country code). Practically, this means that it is also possible to send alerts to people who enter in the affected area after the alert was initiated and that it is still possible to update people who have left the area. Another possibility of LB-SMS is to alert the citizens of a country who are travelling abroad, should the country they are visiting face risks or threats.

The use of classical SMS implies the prior collecting of the number database (phone book) to acquire and to update and is subject to network issues. This last point, though, can be handled thanks to prioritised SMS (SMS with higher priority in terms of network bandwith). The SMS message can be broadcast in a single radio cell, sub-cell, in a group of cells or in the entire network, which makes the service location specific.

There are solutions today that enable LB-SMS without prior subscription while still delivering the message to the handset as traditional SMS. It consists of virtually connecting all the Mobile Network Operators (MNOs) on a PWS platform by using secured webservices. In case of an alert, this allows first the authorities to identify the total number of all mobile devices with a last known location within the affected area and view on screen in near real-time (less than 10 seconds) the aggregated and anonymised total for every mobile device located on all the networks providing coverage into the affected area. Certain solutions available today can also recognise SIM cards present in the area based on their nationality and help authorities to ascertain how to assist / evacuate tourists by providing necessary information in their native language, which would be more effective and easier to understand. The platform can then push the text in the desired language and the area of the alert to all the MNOs, which are in charge of sending an SMS to all the phones in the area. This technology can display real time statistics on the number of mobile phones detected and number of SMS received. No personal data is sent back to the platform, in respect of the data protection rules. It is also possible to update citizens on the alert status via

SMS, as the MNOs keep temporarily the distribution list of the mobile phone detected initially. Hence, the system provides the capabilities to locate, alert and confirm. Situation awareness is amplified and brings the benefit of providing effective assistance to tourists and assess if the risk-affected population has moved away from the area. LB-SMS can also be used to send follow-up alerts to recipients who received the initial alert, to ensure safe evacuations and mobilise emergency responders more effectively.

One of the most obvious advantages of using SMS is that it works on any handset that can receive traditional SMS. Neither handset settings nor significant infrastructure modifications are required. Since LB-SMS integrates with existing systems already in use by the mobile operators, the investment cost is relatevely low.

It should also be noted that users cannot by default opt out of LB-SMS. Their only way to do it is by turning off their device, setting it to silent or ignoring the alert. However, it is possible to set up different channels with one channel giving the possibility to opt out (for instance by sending a free SMS to a short number or on a website).

At the same time, being a universally known communication medium, LB-SMS has lesser chances of causing panic / hysteria for localised threats or while sending alerts for incidents such as flooding / snowstorm which can be predicted a few days in advance. LB-SMS also has the advantage of easy 2-way communication. This provides a simple, well-known mechanism for different demographic groups such as people with special needs, elderly, children, etc. to request assistance during evacuations.

The use of SMS has long been criticised for use in critical situations due to potential congestion in the network. However, the capacity in the networks has been largely increased in recent years and, used in the correct way, SMS can be a solid, reliable and efficient way to reach citizens in a matter of urgency. With the shift to 4G and 5G, the capacity of networks in increasing considerably. Most SMS traffic is now sent with package switched technology and the introduction of VoLTE and use of SIP as protocol for SMS traffic will make it possible to send tens of thousands of SMS per second through each operator’s network. This will be prioritised traffic, even when the rest of the traffic load is high in a mobile network. As an example, countries that have implemented LB-SMS are now able to send up to 10,000 SMS per second.

Finally, it should be noted that LB-SMS are compliant with privacy laws (even though some adaptations in national law might be required). The central components in typical LB-SMS are installed inside the mobile operators’ network. This guarantees the privacy of recipients. Thus, privacy sensitive information like mobile numbers and person identification data is never shared outside the operators’ networks.

8.3. App-based solutions

Mass alerting via apps is often a feature of a 112-app (see EENA apps document[9]). When citizens install a 112-app on their mobile phone, they would have to explicitly agree to provide information about their location to the app service provider. This allows the app provider to send location based alert messages to the app through internet or through radio[10]. Public warning Apps (mobile applications)-based solutions don't need the cooperation of the mobile network operators; the mobile operator merely acts as the ordinary bit-pipe.

The challenge to the technology is to get adequate number of people to install the app – enough to get the awareness about an incident to an acceptable level. This would involve marketing costs to improve awareness about the existence of the system. Visitors from abroad may also not be aware of the existence of the app and it could be a cumbersome process to install an app for every country visited. Solutions to foster the use of such apps could be: run awareness campaigns in the media and public places; require the apps to be pre-installed in the phones before sale and to include information on how to download the app in the 'welcome SMS' that are sent to visitors entering the country.

Finally, it should also be considered that potential cybersecurity issues (denial of service attacks) might impact system responsiveness under some circumstances.

8.4. SIM-applet based solutions

An interesting option to deliver emergency alerting to the vast majority of mobile users without, being dependent on the device manufacurers for compliance or the citizens to download an app. is by using a SIM applet on the SIM.

Alerts may be fed to the SIM applet by either CB (CBdd – cell broadcast data download), SMS (SMSdd) or IP (over BIP – Bearer Independent Protocol). The alerts are interactive, and citizens

[9] https://eena.org/wp-content/uploads/2018/11/112-Smartphone-Apps.pdf
[10] See example in Chile with the S!E app: http://www.sieapp.cl/en/

may respond in one click generating a returning call or SMS, asking for help. Reception and responding reports are available in various ways including infographics.

The main advantage of this solution is that the SIM card is a property of the mobile operator and therefore, might be quickly deployed among all mobile users in the country. This applet may be mandated by the authorities to be included in all new SIM cards and to be remotely installed on existing SIM cards using over the air platform.

Besides rapid distribution and the variety bearers, using a SIM applet allows selection of unique audio alarms and the alert display priorities, it is handset and technology agnostic, and it does not require the citizen to perform any download or configuration. Alerts might be location-based (depends of the alerts feeding bearer) and alerts are also interactive allowing ciitizend to generate a call or an SMS within a single click.

It should be noted that a SIM based applet may work on both physical SIM as well as eSIM.

8.5. Systems for landline phones

Geographic alerting via the fixed phone network is different to mobile telephony and must be handled with care. Voice calls made to fixed phone numbers (based on PSTN or IP) however, continue to play an important part of public alerting. Even if landline telephones cover mainly home/offices locations, it enables to send alerts to a population without mobile phones (such as elderly people) or a population without access to the network (for instance inside a building without connectivity). It also enables the use of this trustable media, in case of mobile network quality issues.

Modern PWSs are designed to use voice as a supplementary channel, especially in incidents with higher lead times. However, it is important to include elements for automatic scaling and the ability to detect and protect the public mobile telephone infrastructure from overload and congestion. Voice communication from PWS allows recorded or automated (text-to-speech) voice messages, as well as the ability to gather feedback via dual-tone multi-frequency keys (for instance: "please press 1 if you need further assistance"). This would enable further actions or other communication depending on live answers (phone script). The statistics on the people reached by the landline phones and their answer is available in real time. It is also possible to set automatic multiple subsequent calls in case of "missing" call.

Landline phone is an effective channel which enables to reach people from a public phone book (available for most European countries) but also people registered online on a public website, as it is for instance the case in Belgium, Greece, Norway or Sweden. Public phone books, in which numbers are linked to an address, constitute a first easily accessible database for a Geographic alerting system. Public registration website allows citizens to declare several phone numbers and several addresses of interest in case of an alert, for a second complementary database.

A risk to consider is the overload of fixed lines. This will not only slow the dissemination of alert messages, it will also cause problems with the outbound traffic from the area, such as emergency communications. Hence, PWS using voice alerts must include congestion control mechanisms. The risk of overload in PSTN happens when the number of telephone lines used simultaneously from the geographical alert system exceeds the number of available lines within the local telephone switch. Algorithms enable to avoid this situation, by optimising the alert speed as a function of the local lines available. New generation PWS such as the one in Sweden, Iceland and Norway include congestion control algorithms that can handle this problem.

Having considered the overload of fixed lines in the PSTN, IP telecommunications infrastructures are more concerned by a limitation of a maximum parallel data speed spending (routing and bandwidth problematics). But they are probably more flexible as they can adopt ad hoc strategies in case of an overload (data compression algorithm for example) for improving the simultaneous calls capacity. The overload strategies used are different per telecommunication operator. This justifies that the alert engine should be based on an adaptative network algorithm that dynamically tries the best strategy on a date/time and technology-based study. Some solutions are also able to process a live analysis to anticipate the best behaviour for each operator.

9 l PUBLIC WARNING SYSTEMS BASED ON TV

There are two different possibilities to disseminate information over TV:

- Insertion in broadcast signal. In this case, the emergency notification platform is connected to a gateway located after the signal output from the relevant TV station adding a "super title" slide to the existing TV signal.

- Insertion into set-top boxes. With digital video broadcast (more precisely multi-cast), the information is sent by the alert platform to the network service provider and from there to all the set-top boxes in the specific area of the target area.

10 l SIRENS AND ACOUSTIC DEVICES

Sirens are an effective warning system for outdoor use especially in areas with special warning needs such as dams, chemical plants, harbours, etc. Another advantage is that the system, if it is built in the right way, is able to work at least 4-5 days without external electric power. However, costs for investments, maintenance and surveillance need to be considered.

Furthermore, sirens can be used in a scalable way (from one siren to the whole area/country). Electronic sirens are also able to make spoken announcements. Sirens that only have one tone can only relay one message (i.e. go inside and close doors and windows and switch the radio on for further information) which may or may not be the right message in all cases.

Modern long-range acoustic devices add a new dimension to sirens, by means of being able to transmit clear voice communications through long distances. This makes possible to communicate different messages and accurate instructions to the public depending on the situation.

11 | THE USE OF SOCIAL MEDIA FOR PUBLIC WARNING

Recent events have highlighted the value of social media for citizens. As peer-to-peer communication to foster self-help capabilities, increase individual situational awareness or to help establish emerging response groups with volunteers. From a communications perspective, social media are a 'multi-directional, interactive communication tool' (Woodcock[11]). At its core 'social networking […] is a sociological phenomenon that brings people with shared connections into mutually acceptable constructs' (Crowe[12]).

Increasingly, emergency services have incorporated social media in their communication plans and actively disseminate alerts and warnings via existing accounts on major social networking platform like Twitter or Facebook. In this regard warning systems shall consider social media in their concepts as additional means to reach-out to specific citizen groups. In the context of alerts and warnings one can position such a process as "push" model, although it is argued, that social media itself provide 2-way communication to enable interactivity between the users. Thus, rumour management, the shaping of warning messages according to needs of specific citizen groups are inherently available. It is worth to be noted, that several studies about citizen perception reveal that information from official sources is trusted most – even in social media.

Furthermore, social media provide dedicated alert services to their users. 'Twitter Alert'[13], to name one of them, is high-priority tweets from select public agencies and public safety organizations, sent to subscribers as mobile notifications only during crisis situations. Aside from being delivered to a phone, Twitter Alerts are also highlighted on the home screen timeline. This is for instance working in France with 'Beauvau-Alerte'[14] or with the Hamburg Fire Brigade[15].

[11] Woodcock, J. (2009) Leveraging social media to engage the public in homeland security; available online at: http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA509065; accessed 25 April, 2012
[12] Crowe, A. (2012) Disasters 2.0: The Application of Social Media Systems for Modern Emergency Management, CRC Press

[13] https://about.twitter.com/de/products/alerts
[14] https://twitter.com/beauvau_alerte?lang=en
[15] https://twitter.com/FeuerwehrHH/status/1138752561488510977

New generation PWS include the ability to post on social media (mostly Facebook and Twitter) as part of their alert sending process.

Two of the roles of VOST (Virtual Operations Support Teams) groups are to support official originators in fighting hoaxes and dissemination of official messages. The way VOST operate varies from country to country, and sometimes even from region to region within one country, but operating under agreements with public safety organisations is a common practice, and this includes the support in relaying public warning messages. More information on the role of VOST is available on EENA's document on "VOST: Crowdsourcing and Digital Volunteering"[16].
Social networks are not designed for emergency situations, but they can provide important force multipliers if used wisely. A description of how social media can support public authorities can be found on EENA's document on 'What internet companies can do in emergency crisis situations'[17].

'Social Networking' is very important and its importance will grow. But its dependency on underlying technologies which are not designed for the acute phase of an emergency may make it vulnerable. Gateways should include such services, but as one part of a 'blended approach' to public warning.

12 I AMATEUR RADIOS

While the option of using amateur radios by skilled operators, also called HAM volunteers was largely forgotten, it should still be considered. During a disaster, when all the other traditional communication channels are down, amateur radios can be an efficient way to reach the population affected.

There are communities of skilled radio amateurs in each country, which can organise emergency communication, as long as the public authorities are in regular cooperation with those communities and can activate them when needed.

Notable examples of the use of HAM volunteers are the aftermath of the 2015 earthquake in Nepal[18], some weather alerts in the United States[19] or some exercices in the Caribbean[20].

[16] https://eena.org/wp-content/uploads/2018/11/VOST-Crowdsourcing-digital-volunteering.pdf
[17] https://eena.org/wp-content/uploads/2018/11/What-can-internet-companies-do-in-emergency-crisis-situations.pdf
[18]http://www.commacademy.org/2016/24%20-The%20Nepal%20Earthquake%202015%20-Amateur%20Radio%20perspective/24-Nepal_Earthquake-Amateur%20Radio-Thweatt.pdf
[19] https://www.domprep.com/healthcare/ham-radio-an-emergency-tool-for-public-health/
[20] https://journals.openedition.org/factsreports/4844

13 I NEXT GENERATION PUBLIC WARNING SYSTEMS

13.1. PWS with rich media

The PWS as specified in 3GPP has focused on delivering text-based warning notifications of limited content to the public at a large scale. Experience with the current PWS has resulted in some public safety alerting agencies having difficulties in trying to include all the essential information needed to inform the public within the limited size of the current PWS Warning Notification. Some of this essential information includes maps with public safety mark-up, images of missing persons, live news video broadcasts, evacuation information, latest safety briefings, weather warnings, emergency shelter locations and assembly points, etc.

3GPP has studied delivering more extensive multimedia warning notification content than is currently supported in PWS and investigating both the broadcasting of more extensive multimedia content for a PWS and the mechanisms by which users would be able to receive and view this multimedia content[21].

Use of rich media will also allow people with disabilities access to PWS. Deaf people could be warned with video that shows a person or an avatar speaking in sign-language, and blind people could listen to an audio stream.

13.2. PWS on Hbb TV

Hybrid Broadcast Broadband TV or "HbbTV" is a major new pan-European initiative aimed at harmonising the broadcast and broadband delivery of entertainment to the end consumer through connected TVs and set-top boxes and is specified in ETSI TS 102 796.

Insertion of warning messages into the HbbTV data stream has been investigated by the EU funded project Alert4all in which a description of this capability has been described in the project deliverable "Communication system for dissemination of alert messages: architecture and design document"[22].

13.3. PWS on DAB+

Digital Augio Broadcast (DAB+) is the future of radio in the EU and radio is still the predominant source of information and entertainment during rides in a car. DAB+ has the capability for the receiver to automatically switch to a station that broadcasts an alert. Some receivers even support automatic wakeup from standby. Such a station can be included in the broadcast ensemble on the fly. Once the alert message has finished, the receiver will switch back to the original station.

[21] 3GPP TR 22.815: http://www.3gpp.org/DynaReport/22815.htm
[22] http://www.alert4all.eu/images/deliverables_public/A4A_D3.6.DLR.v1.0.F.pdf

A backwards compatible, extended version for PWS on DAB+ is called EWF (Emergency Warning Functionality). It includes additional comprehensive multilingual text service elements based on the DAB+ Journaline text service.

Use of EWF will also allow people with disabilities access to PWS on DAB+. Multilingual Support reaches foreigners in their own language. In addition, the EWF text content can easily be used for public screens in case of emergencies where other contribution channels (like mobile internet) are not available.

EWF on DAB+ can easily be fed by CAP messages, like used in Germany by the MoWaS System.

For test purposes the DAB+ EWF system also supports a test mode. DAB+ receivers shall not react on test alarms unless they are explicitly enabled for test alarms by the user.

13.4. Emergency messages over satellite

ETSI has defined the MAMES protocol for Multiple Alert Messages Encapsulation over Satellite, which can carry for example Common Alerting Protocol (CAP) messages efficiently over a Galileo/EGNOS (the European navigation satellite programmes) satellite link. A Technical Report with MAMES Deployment Guidelines in ETSI TR 103 338 and a Technical Specification in ETSI TS 103 337 for the MAMES protocol have been published.

Due to their inherent broadcast capability, satellite-based networks are ideally suited for distributing alert information, especially to large areas or to regions with a poor (or possibly compromised) terrestrial communications infrastructure.

With this channel, an emergency broadcast request could be sent from a public authority to Galileo satellites, through a dedicated infrastructure. The message is then broadcast by the satellites to the Galileo receivers embedded in the phones (in September 2019, over 1 billion phones were Galileo-compatible[23]).

There are currently some plans to foster the use of satellites as a public warning channel. In 2018, the 'draft proposal for a regulation of the European Parliament and the Council establishing the space programme of the Union and the European Union Agency for the Space Programme' refers to this plan in article 44: "The services provided by Galileo shall comprise: […] an emergency service (ES), broadcasting, through emitting signals, warnings regarding natural disasters or other emergencies in particular areas"[24]. At the moment of writing this document, this proposal was still under legislative negotiations.

14 l USING MULTIPLE TECHNOLOGIES

In theory, the secret of success ought to be a blend of the best attributes of all the existing distribution methods. Each method has its own strengths and weaknesses, but blending them ensures that the weakness of each system is covered by the strength of another.

[23] https://www.gsa.europa.eu/newsroom/news/gsa-celebrates-1-billion-galileo-smartphone-users
[24] Draft proposal available here: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A447%3AFIN

The problem is that the emergency manager may be faced with a complex mix of different technologies which makes it difficult to determine which technologies are best suited for any specific emergency situation. Some algorithms can already help the decision makers to choose the best channels combination, as a function of the targeted population for a maximised impact.

New generation PWSs allow the selection of multiple channels based on the customer needs, the type of emergencies or the nature of messaging. A common sending engine allows emergency operators to use a common workflow to effectively select one or all means of transmission, with common or channel specific messaging. Operationally, this "compose once, send via multiple channels" principle allows the emergency manager to access a common alert sending workflow, agnostic of the technologies used. This workflow allows:

- Effective demarcation of affected areas on a map, using standard drawing tools or predefined risk areas. Standard file formats such as KLM allow map shapes to be shared from risk planning or modelling systems;

- Composition of messages, including attachments for newer channels such as social media and mobile apps.

It is also critical that messages are in line with the technology requirements. To avoid confusion, all delivery mechanisms must keep the same wording so that users do not become more confused as they see different messages. Furthermore, given the high public impact of sending wrong emergency messages[25], the sending workflow must put in place a mechanism for approvals or review of the message.

15 I COMMON ALERTING PROTOCOL – CAP

The Common Alerting Protocol (CAP) is a general format for exchanging all-hazard emergency alerts and public warnings over all kinds of networks. CAP allows a consistent message structure for every warning message to be disseminated simultaneously over many different warning systems, thus increasing warning effectiveness while simplifying the warning task. And CAP

[25] For example : https://www.nytimes.com/2018/01/13/us/hawaii-missile.html

provides a template for effective warning messages based on best practices identified in academic research and real-world experience.

CAP may also be used as an integration between several components in a PWS such as sensors (or other Key Integrator Systems) being able to automatically trigger alerts based on threshold

values. This leads to easy integration if both Key Indicators and outgoing warning channels are CAP enabled.

PWS must be capable of ingesting CAP data from another emergency system. This allows for alert content in the PWS to be populated with CAP data and disseminated to the public based on emergency manager review or using automated rules.

CAP can also be used to transmit information from PWS to CAP-compliant Message Consumers such as siren systems. Gateways can use web services to send transmission status reports to PWS, which can then be displayed on operator consoles.

Since CAP is a template, the actual interface standard on the use of various CAP parameters needs to be specified in a detailed specification. An example of such a specification is the CAP IPAWS Profile[26], which is used in WEA.

CAP is somewhat US centric and therefore Canada has published its CAP-CP (Canadian Profile)[27] variant and Australia has developed a CAP-AU-STD[28] varirant which could also be useable in other Asia-Pacific regions.

A European example of CAP usage is the adoption of the "CAP Profile Fire" by the Italian National Fire Brigade[29] in 2011.

[26] http://docs.oasis-open.org/emergency/cap/v1.2/ipaws-profile/v1.0/cs01/cap-v1.2-ipaws-profile-cs01.html
[27] http://capan.ca/index.php/en/cap-cp
[28] https://www.govshare.gov.au/item-details/?rid=57
[29] http://www.vigilfuoco.it/aspx/ReturnDocument.aspx?IdDocumento=4857

16 l PERATIONAL ASPECTS

16.1. Testing Public Warning Systems

PWS are fortunately rarely used and therefore spend most of their time “in standby”. However, the system needs to work when needed. The obvious way to ensure that is to set off practice alerts. The issue then is that the public would become used to the alert tones to the point of becoming desensitised to them if such practice alerts are set off too often.

Testing if the mobile operator’s infrastructure works can be done without actually sending messages to the general public. In the case of SMS, one can either send messages only to specific test devices or send blank SMS. Similarly, in cell broadcast, a test may be contacted across a small testing area or over a limited amount of radio cells.

On the other hand, there is also a need to constantly demonstrate the system in operation so that citizens can recognise it and can be reassured that it will work when needed.

‘Public Reassurance’ demonstrations may be scheduled on a regular basis, for example on an annual disaster preparedness day or at the beginning of the season of maximum natural hazard, or on a monthly basis. The test message should have a clear indication that a test is under way. In many countries, the tests are advertised in the media to raise awareness around it.

<u>Some examples:</u>

<u>Australia:</u> The national system administrator tests the “Emergency Alert” PWS manually on the hour, every day, 365 days a year. This is a localised test only to a set of pre-determined mobile numbers. Given the frequent operations usage of the system, public testing is not required. All enhancements to the system, such as the upgrade from 3G to 4G involved “Community Based Trials” to involve the public at pre-determined locations across Australia.

<u>France:</u> Sirens are tested on the first Wednesday of each month at around 12.00.

<u>Germany:</u> German authorities test the functionalist of MoWaS on a regular basis. Frequency and duation is up to the local governments. For instance, in Bavaria, sirens are tested twice a year. In conjunction with the provisioning of the new warning app NINA[30], dedicated tests in several parts of the countries have also been conducted.

<u>Lithuania:</u> Lithuanian authorities have a monthly test of a national LT-Alert CB system at noon on the first Saturday of each month. The test has several purposes:

- Make the public aware of the existing CB system;
- Allow the public to check proper settings of emergency messages reception on mobile handsets;
- Periodic check of the availability of the cellular infrastructure.

<u>Netherlands:</u> Dutch authorities have a monthly siren test at noon on the first Monday of each month. The tests are also advertised in the media.

[30] http://www.bbk.bund.de/DE/NINA/Warn-App_NINA.html

NL-Alert CB system is tested twice per year and this is also advertised in the media during the week preceding the test.

Sweden: Swedish authorities test the siren system at 15.00 every third month on the first Monday of the month. As it is a national test, a specific announcement is made in the national radio. The test has three purposes:

- Confirm to the good functioning of the system
- Make the public aware of the siren system
- Train the operators of the system

Radio Data System (RDS) is also tested the same day at 19.00.

Switzerland: Sirens are tested every year on the first Wednesday of February. It consists of two sirens – a general one at 14.30, which is then followed by a 'water alert'. In total, 7200 sirens are tested[31].

16.2. Procedures

There are often national and regional laws on the responsibility of issuing warning messages to the general public. Many of these are based on jurisdiction and boundaries, which are territory based. For example, a police chief of one city has no authority at all in another city.

In all cases, detailed records should be kept for all ongoing and completed notifications:

- Decision-taking procedure
- Role of the PSAPs
- Use cases: successful cases where PWS has been used
- Formal Emergency Plans, agreed between all stakeholders

[31] https://www.alert.swiss/en/precaution/testing-sirens.html

17 I EXAMPLES OF IMPLEMENTATIONS AND USE OF PWS

This section contains descriptions of implementations in various countries.

17.1. Australia

Emergency Alert (EA) is a service that provides the emergency services organisations (ESOs) in Australia with the ability to send warning messages based on either the registered service address (landlines and mobiles) or the last known location of a mobile on the network.

Following the loss of 173 lives in bushfires in the state of Victoria in one afternoon on 7 February 2009, known as "Black Saturday", the consequent Royal Commission (public inquiry) recommended implementation of a location based alerting system for mobiles. The Office of the Emergency Services Commissioner (OESC), Victoria, led the resulting programme to deliver that capability as Phase 2 of the "Emergency Alert Program" to design and deliver the "Location Based Solution (LBS)". Phase 1, the "Location-Based Number Store (LBNS)", had already delivered, in late 2010, the capability to send alerts as text-to-voice for landlines and SMS to mobiles. These were based on the registered service address of each subscriber. However, this excluded citizens whilst travelling through an affected area as well as all international visitors.

Since its launch in 2009, EA has been used in every Australian jurisdiction in over 2292 Campaigns to send almost 36.1 million warning messages. The public has a high level of awareness of, and confidence in, the capability. Since the introduction of LB-SMS in 2012, more than 14 million SMS alerts for more than 1400 localised and wide-area emergencies. The largest single campaign disseminated 800,000 SMS; the smallest, less than 500 at a delivery rate of 500 SMS per second. The overall successful delivery rate is 97%, confirmed automatically and in near real-time, by the SMS "delivery receipt" (the other 3% represents the multiple non-mobile phone devices that connect to the networks and are, thus, visible in the "device count", but not capable of receiving SMS – which can now be filtered through the IMEI).

Prior to implementation, OESC invested in a nationwide community education programme to inform everyone (in 30 languages), from children to senior citizens, in the forthcoming release of LBS and the importance of responding correctly to the advice in the warning message. Australia now repeats that annually through schools programmes and TV and radio broadcasts ahead of "Disaster Season" (November to April).

The user-authorities have developed protocols and Standard Operating Procedures for multiple life-at-risk scenarios for when "Emergency Alert" will and/or has been used beyond the large-scale disasters. Authorities have also created pre-drawn polygons with pre-formatted messages for iconic sites, for example, that are most likely to be affected by a terrorist attack, as well as for the wide-areas regularly affected by severe weather, floods and bushfires.

Emergency services in Victoria and New South Wales are so practiced in using the system as an integral part of their Incident Control Room environments that they are able to authorise, construct and disseminate alerts within 15 minutes of the decision to activate.

In December 2014, the post implementation evaluation of the LBS (conducted with communities and user organisations across Australia) published a number of findings. These included the following:

- A telephone alert is the preferred method by which the community wants to be alerted to an emergency.
- It is the official warning most likely to motivate households to evacuate or take other positive action required by the emergency services.
- 48% of people surveyed said that an official telephone alert is their main trigger for action above all other public warning capabilities.
- 80% of people who have received a telephone alert now expect to receive one for any future event.
- For those who rely on a single source for information in an emergency, 32% depend on their telephone for a warning, and
- 82% of people surveyed stated that their "safety beats privacy" when it comes to telephone alerts.

Australia is now in the process of further updating this EA system to add further capability and modernize EA features.

More information is available at www.emergencyalert.gov.au.

17.2. Belgium

Warnings to all citizens are always possible via radio and TV, but the new BE-Alert project introduced by the Federal Crisis Centre was officially launched the 13th of June 2017.

The BE-Alert platform can be activated at the municipal, provincial and federal level and uses different communication channels: voice calls on fixed phones or portables, SMS, e-mails, social medias like Facebook and Twitter.

This address-based system functions by selecting an area on a map and by sending a warning message to the people that had previously registered their address in the website www.be-alert.be.

In parallel, the Federal Crisis Centre have developed with the Mobile Network operators have implemented a system based on location-based SMS to warn the all the people that are present within a determined area, without any prior registration. This location-based system functions by selecting an area on a map and by sending a warning message to the mobile users identified by mobile operators. It has already been activated during numerous events.

The activation procedure of Alert-SMS is integrated in the BE-Alert platform making use of the CAP protocol. A manual activation procedure co-exists by means of backup.

17.3. Canada

Alert Ready (French: En Alerte), is the national warning system in Canada. The system consists of infrastructure and standards for the presentation and distribution of public alerts issued by government authorities (including Environment and Climate Change Canada and other provincial public safety agencies), such as weather emergencies, AMBER Alerts, and other emergency notifications, by all broadcasters and Last mile distributors in the affected region, including television stations, radio stations, television providers, and LTE mobile networks in the affected region. Canada’s Cell Broadcast-based PWS is a derivative of the United States’ Cell Broadcast-based WEA system and went live on 6 April 2018 on all Canadian LTE networks.

Public awareness tests are held twice per-year, in which a 30-second test message (60 seconds in provinces where bilingual messages are issued) is distributed to radio and television outlets, and a Cell Broadcast message is sent to wireless phones. One is held on a Wednesday in May during Public Safety Canada's Emergency Preparedness Week, and the second is held in November.

17.4. Chile

In February 2010, Chile suffered from one of the worst earthquakes in its history. The event was even more tragic as the country was hit also by a devastating tsunami right after the earthquake. Although the information was known and the US Pacific Tsunami Warning Center had delivered all necessary information in time, this precious information had not reached the public. Chile didn't have an adequate emergency alert and notification system to alert the target population in time. This has led to it suffering more casualties due to the Tsunami than through the earthquake itself.

Following the President's order, the Chilean Sub Secretary of Telecommunications (Subtel) issued on January 14th, 2011, an official tender for deployment of Chile's next generation emergency alert and notification system.

The system's first phase based on cell broadcast technology was handed over to operations in October 2011. It is now being expanded by further capabilities such as notification over TV, radio and Internet. The system in Chile was the first system of its kind in the Americas, advancing also the US American WEA Cell Broadcast public warning standards.

The system utilizes standard protocols based on OASIS CAP v1.2 (Common Alert Protocol)[32].

More information is available on EENA's case study document on 'Public Warning in Chile'.

17.5. Czechia

System of Warning and Information (hereinafter referred to as " USWI") is being built and operated in the Czech Republic in order to provide warnings and inform the population. USWI consists of notification centres (national, regional and levels of other operators), data and radio networks and final elements of alert and notification. USWI not only serves to announce a warning signal and to transmit emergency information to the population, but it also informs the population about the possible threats and precautions in the endangered area.

USWI is operated by Headquarter of Fire Rescue Brigade of the Czech Republic in Ministry of Interior (hereinafter referred to as "HQFRB") which specifies requirements for individual parts included in the system. HQFRB provides, operates, uses and controls the infrastructure of USWI which propagates the radio signals and controls the functionality of terminal elements. HQFRBCR specifies the principles for area coverage by the terminal elements.

Infrastructure of USWI consists of:

- Selective radio signalling system (hereinafter referred to as "SRSS") controls the terminal elements of warning and notification
- Terminal warning elements (hereinafter referred to as "TWE") alert the public.

TWE consists of electric rotary sirens, electronic sirens and local electronic information systems (municipal radio connected to USWI).

[32] http://docs.oasis-open.org/emergency/cap/v1.2/CAP-v1.2-os.html

SRSS is closed one-way digital system providing only trigger commands not allowing to see whether the terminal elements performed the required activity neither to see their level of operation. More sophisticated, two-way monitoring system of terminal elements (MSTE) is being tested on some parts of the territory. MSTE expands the existing system with parallel system which enables to collect, transmit, process, store and display the information not only from TWE, but also from terminal measuring points (detector of hazardous substances). Development of this system is often financed by EU Environment Operational Program.

There is only one warning signal "general warning" to alert the public. The warning signal has fluctuating tone for 140 seconds. Electronic sirens and local information systems give emergency information specifying the kind of danger (flood, chemical accident, radiation accident, etc.). Consequently are people more informed not only about the danger, but also about the necessary measures to protect lives, health and property (eg. via radio and TV, verbal inputs to electronic sirens, local information systems, mobile sirens and warning radio devices on vehicles). The preparedness of USWI in the Czech Republic is checked once a month, usually at 12 noon every first Wednesday of the month.

There was, in cooperation with mobile operators, tested the possibility to warn and inform public about the kind of danger and the necessary measures to protect lives, health and property by SMS messages on mobile phones based on the location of the users. Now is being prepared an application for smart phones that will allow users to receive warning messages about the danger and to call for help at European emergency number 112 and national emergency line 150.

Warning and informing the public of possible danger is a part of emergency plans. It includes regional emergency plans, emergency plans of the external area of nuclear plants and the external emergency plan in a case of a major accident according to the Act on preventing major accidents.

17.6. Finland

Sirens were the first form of early warning systems deployed in Finland. Upon hearing the sirens, one is supposed to go indoors, close the door and windows, turn off central ventilation unit and listen to the radio for further information and instructions.

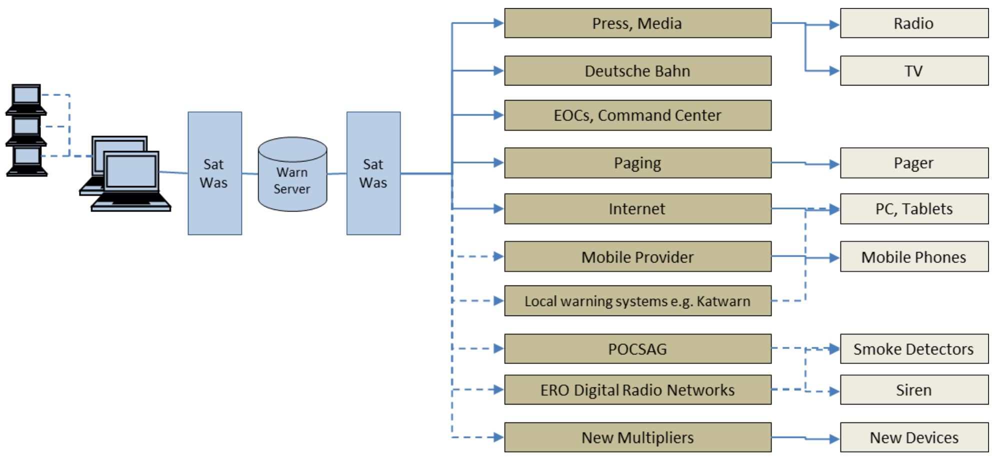
Finland deployed national public warning system by radio in 1990. Implementation was done by Yle (Yleisradio, Finnish Broadcasting Company) in co-operation with present company called Digita Oy. From the beginning of 2008 public warnings has been sent also via TV. Yle shows all public warnings on Text-TV (page 112). Yle can also send public warning with a message banner on top of the TV screen. At the same time one can hear noticeable sound of Morse code (CQ). This banner and Morse code feature is available only in transnational warning situations (all TV receivers in Finland will be activated). Regional warnings are only sent on radio. Authority in charge decides which method of public warning will meet sufficient coverage.

Public warning is regulated by the law. It obligates Finnish broadcasting companies to send public warning message via their network. The law determines which authorities are mandated to make public warning messages and it also defines the role of Emergency Response Centre (ERC) as a gatekeeper between authorities and Yle.

Most of the YLE released messages has been sent by radio (areal coverage) and by Text-TV. Emergency Response Centre release simultaneously parallel public warning messages in order to reach more people. 112Suomi application has been downloaded by approximately 1.7 million users. 112Suomi application is able to receive geographically targeted public warning messages in Finnish or in Swedish. Twitter and Facebook are second fastest way to reach people. www.112.fi role is very similar to Text-TV. All the different channels for public warning channels are managed in the Command and Control Centre of ERC Agency.

17.7. Germany

Federal and state governments agreed to use the radio as a major warning means for large-scale emergencies, disasters and in case of civil protection. With the proliferation of smart phones and other media, this basic warning mechanism has been extended. Since 2013 Germany has deployed a so-called Modular warning system (MoWaS)[33] which utilizes the government-owned satellite-based warning system (SatWaS). The use of SatWaS as a transmission medium makes the system less susceptible to power outages and loss of terrestrial transmission paths, as is often the case, especially in disaster areas. MoWaS is thus a stage of SatWaS where existing alerting and warning messages disseminated via press and media are complemented by additional communication channels and alerting authorities. MoWaS consists of three major building areas: Initiation, transmission path and devices.



MoWaS architecture (translated & adapted)

The initiation area includes the sender/receiver systems in the emergency operations centres and command centres on the federal and state level. The transmission path covers all components from the initiation to the alert authorities/ multipliers and the management of the devices, respectively. In the device area all devices are considered which are available to the end user – the citizens.

33 http://www.bbk.bund.de/DE/AufgabenundAusstattung/Krisenmanagement/WarnungderBevoelkerung/Warnmittel/MoWaS/MoWaS_node.html

Additionally, the Federal Office for Civil Protection and Disaster Assistance (BBK) developped an app called NINA - Notfall-Informations- und Nachrichten-App[34]. NINA is integrated in MoWaS thus enabling alert authorities to disseminate information to citizens via their mobile phones. With the built-in push-function citizens are continually informed about the hazards and threats. Besides, event-related behavior hints and general emergency tips from experts improve self-help capabilities in case of of potential hazards. NINA also offers basic information and advice in the field of emergency civil protection. The warning relates App NINA data mainly from the so-called modular warning system (MoWaS) which has already been used in 2013 by the federal government and all provinces for warnings of civil defense and disaster protection. In addition, the app also contains current information from the German Weather Service (DWD), as well as current water levels of the Waterways and Shipping Administration of the Federal Government (WSV). NINA is therefore another important channel for warning the population in Germany.

Additionally KATWARN[35] is available to citizens. KATWARN is a nationwide uniform warning service for mobile phones. When disasters such as major fires, bomb finds or hurricanes send the responsible disaster response authorities, fire service control centers or the German Weather Service on KATWARN warning information directly and spatially related to the mobile phones of the affected citizens. KATWARN is a free of charge service which was developed by Fraunhofer FOKUS on behalf of public insurance companies and has been in operation since 2010. With KATWARN behavioral information can be received in addition to sirens, loudspeaker announcements or messages on the radio. KATWARN tells you not only that there is a dangerous situation, but also HOW you should behave. The deaf and hard-of-hearing community is also supported. The key functions are:

- Official warnings for the current location (Guardian Angel)
- Official warnings for seven freely chosen places (e.g. Kita, office, apartment)
- Overview of warnings in the adjacent area
- Forward or share alerts e.g. Twitter
- Individual alert test function on your own smartphone

The app is available for iOS, Android and Windows Phone. Alternatively, KATWARN messages can be received by SMS/ email after registration.

[34] http://www.bbk.bund.de/DE/NINA/Warn-App_NINA_Einstieg.html
[35] www.katwarn.de

17.8. Greece

Under the leadership of the Greek Mobile Operators Association (EEKT) and in accordance to Greek National Regulatory requirements, the three Greek mobile operators (Cosmote, Vodafone and Wind Hellas) have decided end of 2018 to start with the implementation of Cell Broadcast for mass alerting Greek and foreign citizens using their services.

In Greece a centralised Cell Broadcast system is being implemented located outside of the premises of the 3 operators but within Greece territory.

The public warning solution in Greece is one of the first implementations in Europe after the entry into force of the European Electronic Communications Code (EECC) in December 2018 using the Cell Broadcast technology for the delivery of public warning messages to the general public. The Greek Cell broadcast based public warning solution is expected to go live in Greece by the end of 2019.

17.9. Iceland

Iceland is a hotbed for volcanic activity, with over 35 eruptions on and around Iceland in the 20th century. The 2010 eruptions of Eyjafjallajökull forced 600 people to evacuate their homes and caused enormous disruption to travel all around Europe affecting over 10 million travellers. In addition to volcanic activity, the diverse ecosystem of Iceland also triggers events like snow blizzards and tsunamis.

Sirens were the first form of early warning systems deployed in Iceland. Since 2012, ICESAR (the Association for Search and Rescue in Iceland) and 112 Iceland have used a homegrown SMS based alert system and as of 2019, have upgraded to location-based SMS Alert system.

Ensuring 100% coverage of the local population of 330,000 and an ever-increasing tourist population (reaching 2 million annual tourists recently) have been the primary focus for ICESAR and 112 Iceland. Since it is difficult to know beforehand the make and model of the phones entering Iceland with tourists, location-based SMS was the chosen as the channel for alerting.

The situational awareness and demographic data (based on nationality of sim cards) provided by the location-based system are useful to send multi-lingual messages that are easily understood by visiting populations. This helps in faster evacuations and smoother rescue operations.

The requirement to alert citizens / residents of Iceland travelling abroad in case there are potential threats or risks in the places they are visiting was another use case for implementing the location-based SMS alert system.

17.10. India

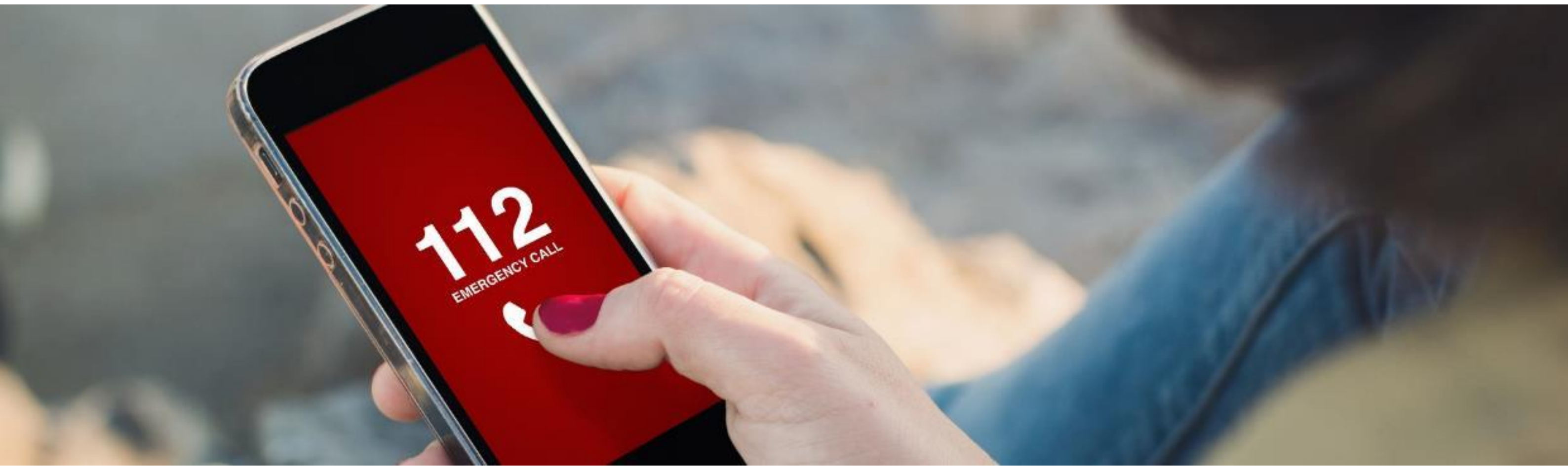
The coastal states of India make up 43% of the country's population. Annual cyclones and effects of tsunamis and other meteorological disturbances in the Arabian sea, Indian Ocean and Bay of Bengal claim thousands of lives and cause large scale material losses as well. In 2014, the tropical cyclone HudHud led to the deaths of over 600 people, displacement and evacuation of over 500,000 people and property damage of up to US$ 3.4 billion in the state of Andhra Pradesh alone.

In 2015, the National Disaster Management Authority of India (NDMA) kickstarted the National Cyclone Risk Mitigation Project (NCRMP) with the coastal states of Odisha and Andhra Pradesh. The projects are funded by the World Bank to alleviate the effects of perennial cyclones in coastal India, which result in significant loss to life and property.

The projects saw the commissioning of a multi-channel Early Warning Dissemination System (EWDS) – the first of its kind in India to use location-based SMS alerting technology to warn citizens. Along with location-based SMS, new siren towers, digital mobile radios, satellite based mobile data voice terminals were also commissioned by the two state governments.

The EWDS also integrates with traditional channels like TV, Radio and Siren to broaden coverage across the coastal districts of Odisha and Andhra Pradesh. Odisha State Disaster Management Agency (OSDMA) has commissioned the EWDS to cover 6 coastal districts with 22 coastal blocks, with assistance from the World Bank. On the same lines, Andhra Pradesh's EWDS covers 9 coastal districts.

Last mile connectivity, influx of tourists from other states and countries and the lower penetration of smartphones in rural districts were some of the driving factors to choose a location-based SMS solution in these states.



Emergency responders can also make use of the EWDS platform to coordinate rescue operations, resource deployment using the in-built group alerting feature.

In May 2019, Odisha was hit with Cyclone Fani, a tropical thunderstorm with intensity equivalent to a high-end category 4 major hurricane. The last instance of such high-intensity cyclone storm in 1999 resulted in the death of 9887 people in the state and affected over 12.5 million people. Over the years, Odisha’s State Disaster Management Authority has taken significant strides in disaster management and during Fani, the state managed to reduce casualties to 64. Over 12 million messages (LB-SMS) were sent during the cyclone and over a million people were evacuated to safety shelters. [36] [37]

Similar projects are set to take place in the remaining 7 coastal states as part of the NCRMP.

17.11. Israel

Israel is in the grip of multi-fold challenges that threaten the population's safety and security on a constant basis. Besides being in the firing line of missile and rocket threats, additional challenges are imposed based on the fact that Israel is located on the Syrian-African Break of the respective tectonic plates.

The Israeli Home Front Command and the National Emergency Management Authority "NEMA" have deployed an emergency alert and notification system based on new media age technologies. The Israeli standard has set a requirement where citizens can be reached within less than 20 seconds (on UMTS 3G networks) so that the entire Israeli population can be informed in time, reach protecting shelters and take respective measures. Figure 6 shows how much time citizens have to reach protective space depending on the distance to where the threat comes from. Recent measures show that the system’s lead time is 7-8 seconds until the message arrives on the recipients’ handsets.

[36] https://www.nytimes.com/2019/05/03/world/asia/cyclone-fani-india-evacuations.html
[37] Official Tweet: https://twitter.com/SRC_Odisha/status/1124052562678812672

Time to reach protected space

The cell broadcast-based solution is now being expanded by existing means such as TV, radio, sirens and Internet. All of which is going to be operated from one central platform.

Different sensors and sensor fusion engines are also connected to the system allowing additional input that is sent automatically (in case of an earthquake or Tsunami) or via human interface. The protocol used for the communication is CAP v1.2[38]

The system allows not only information flow from the municipalities to the population, but allows also using the same platform for interactive information exchange where the citizens can send help requests and information to the authorities over the same central platform by using a dedicated Smartphone application with “Panic” button. The messages from the citizens contain a default help message, created text or even a photo taken at the incident’s location.

This constellation provides the next evolutionary step where the given alert and notification system is fully integrated into the 112 eco system.

17.12. Japan

Earthquakes are a common occurrence in Japan. Japan has an advanced infrastructure of seismic sensors in the ocean around Japan that detects earthquakes and which generates messages that are broadcast to the citizens via the ‘Area Mail’ service. Area Mail is based on the Cell Broadcast bearer service. The 3GPP specified “Earthquake and Tsunami Warning System” (ETWS) has used both ‘Area Mail’ and additional Paging Channel bearers since 2007.

The ETWS detects the initial slight tremor of an earthquake, the Primary Wave and sends a warning message that an earthquake (Secondary Wave) is about to happen to the mobile devices

[38] http://docs.oasis-open.org/emergency/cap/v1.2/CAP-v1.2-os.html

in the affected area. ETWS can deliver the first notification to mobile devices within four seconds. This Primary Notification contains minimum information, such as “Earthquake” or “Tsunami”. The mobile device will display a pre-set message.

The Secondary Notification uses the ‘Area Mail’ service (which is similar to the Cell Broadcast bearer service). This bearer contains more detailed information in text.

17.13. Lithuania

Lithuania deployed a multilingual geographically targeted PWS based on cell broadcast technology in 2012 to complement the siren system. Emergency alert broadcasts can be initiated from municipal authorities for local – small scale – emergencies and from national level for country wide emergencies. Information about the system, the history of messages and a how-to on configuring mobile phones can be found here: http://gpis.vpgt.lt/go.php/lit/English (see also figure below). Wireless Emergency Alert Capable devices (according to CMAS) are fully interoperable to receive emergency broadcasts from Lithuanian PWS.

17.14. Netherlands

NL-Alert, based on Cell Broadcast technology as specified in ETSI TS 102 900[39] went live in 2012 and has been used more than 300 times since the launch of the service.

Devices that are sold in operator shops are pre-configured for NL-Alert. The NL-Alert/WEA service is available on Android, Windows OS and Apple's iOS devices.

The reach of the service in 2019 is 80% of population that is 12 years and older (therefore regarded as mature). Since December 2014 NL-Alert in mobile networks has been made mandatory for all common Dutch providers under Dutch Telecom law. The Dutch Government has decided to discontinue the use of sirens and only use NL-Alert.

Apart from Cell Broadcast, NL-Alert consists of multiple other channels such as public transport displays, an app, commercial displays and alerting via fixed lines for the elderly.

Additional information is available on: http://www.nl-alert.nl.

17.15. New Zealand

The New Zealands Ministry of Civil Defence and Emergency Management (CDEM) is responsible for providing national warnings and alerts about natural hazards to central government authorities, local authorities, emergency services, lifeline utilities, and broadcasters.

Warnings and alerts are used to inform agencies, authorities, and/or the public about emergencies.

CDEM uses multiple channels to send warnings and alerts before and during emergencies.

Multiple channels are used to make sure as many people as possible receive the information they need. This includes radio and television, websites, social media and others such as apps and sirens.

Alerts and warnings can be sent both nationally and locally depending on the emergency.

Emergency Mobile Alerts (EMA) is an alerting network in New Zealand designed to disseminate emergency alerts to mobile devices. Emergency Mobile Alerts are messages about emergencies sent by New Zealand authorised emergency agencies to capable mobile phones. The alerts are sent to all wireless providers (Spark, Vodafone, 2Degrees) who distribute the alerts to their customers with compatible devices via Cell Broadcast using the CMAS/EU-alert standard.

Cell Broadcast based public warning messages have been used in New Zealand since November 2017, and every year a test message is sent which is broadcast throughout New Zealand. The reach of the Control Cell Broadcast message has increased since the first test message resulting

[39] ETSI TS 102 900: http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=38226

that on November 2018 6 out of 10 mobile handsets (60%) received a test emergency alert message sent out by Civil Defence reaching 70% of the New Zealand population.

Additional information can be found on https://www.civildefence.govt.nz/get-ready/civil-defence-emergency-management-alerts-and-warnings/emergency-mobile-alert/.

17.16. Norway

In 2003 the Directorate for Civil Protection and Emergency Planning launched the first large scale test towards fixed phones – with good results. Since then solutions covering fixed phones have been used in large scale to alert all population only reachable through the fixed line network, such as the elderly population and visually challenged community.

In 2007 the first locationbased SMS alert system for mobile phones was tested in an area where a tsunami due to a mountain slide in a fjord was a major threat. In this case, several municipalities together with the Norwegian Water Resources and Energy Directorate, and regional authorities joined forces to build a system based on electronic sirens and a simultaneous warning-message delivered as a LB-SMS message to any mobile phone located in the alert area.

Public warning by mobile phones has been considered by national authorities in Norway, latterly in a report to the Ministry of Justice in November 2011 and is described as a possible future resource together with the sirens that already exist, without taking any decision on what technology for dissemination of warning messages to mobile phones eventually will be preferred.

However, municipalities and cities in Norway are taking action and using location-based SMS as part of their plan to improve population’s safety. Tourist prone municipalities (with ski resorts or along the coast) use the location-based SMS system to ensure they can reach all national and foreign tourists, as well as their local population if a critical event occurs.

The larger cities also have taken the technology to use and is now a central component in their public safety strategy. During the drought of 2018 the city of Oslo sent out 1 million messages to prevent forest fires. This resulted in no open fires being reported by the fire department after the message had been delivered.

SEVESO Industry in the county similarly uses Location Based SMS to communicate with all staff on site as well as to evacuate nearby population in the event of a disaster.

Location Based technology has been a key resource for cities and emergency services to understand the population density in an area of interest and to know the nationalities present. This allows for improved planning and better targeted communication to the public during a crisis.

17.17. Romania

RO-ALERT system allows sending Cell Broadcast messages to warn and alert citizens in case of emergency and is used under major circumstances, when people's life and health condition are endangered, such as extreme weather, ominous floods, terrorist attacks or other situations that are severe threats to communities. RO-ALERT messages can be received on the entire Romanian territory, wherever there is 2G/3G/4G GSM signal, and is complementary to the other alert/warning systems already existing.

RO-ALERT system is implemented on Romanian territory by the Ministry of Interior, through its General Inspectorate for Emergency Situations (GIES) and the technical support provided by Special Telecommunications Service, consequent to Emergency ordinance no. 72 of October 5th, 2017.

The Special Telecommunications Service is technically responsible for RO-ALERT implementation, set off and administration, as well as for creating the necessary secure channels, including implementation of security mechanisms for the equipment and RO-ALERT users as well.

RO-ALERT advantages:

- Broadcasting alerts adapted to the imminent event through the networks owned by the mobile phone operators;
- Rapid message sending to all users located in the threatened area, even under congestion of mobile phone operators' networks;
- Instant message display on the mobile terminal without any intervention of the user;
- Cyclic repetition of alerts at preset time frames;
- Receiving alerts by terminals using roaming services on the Romanian territory;
- Accuracy of alerts, solely based on information provided by authorized sources.

17.18. Singapore

Singapore is well-shielded from natural calamities and has a lower risk from destructive natural disasters like earthquakes, typhoons and tsunamis. But the country is still exposed to other effects of natural disasters or extreme weather changes such as floods, epidemics, etc. Other than these few natural disasters, Singapore, like any urban region has to deal with fires, explosions, and other man-made accidents. Terrorism and its impact on the people of Singapore is one of the primary concerns for the Government and the SGSecure national movement.

The Government understood the need for a multi-channel approach to warn the public. Singapore already had a siren system and published smartphone app in place. But the Government chose to implement a Location-Aware SMS Based Population Alert System (SPAS) combining advanced location technology with the simplicity of an SMS alert.

After significant research on viable location based alerting technologies, the Government decided on an SMS based system to ensure quick adoption and comprehensive coverage.

The three mobile network operators in Singapore were roped in by the government to implement this solution, since location-based alerting relies on location information from mobile networks to determine the last known location of subscribers who might be in the vicinity of the alert area.

As a part of the solution, a multi-channel alerting application was commissioned which could be accessed by emergency managers to initiate alerts and securely communicate with the mobile network operators. In light of the future requirements envisaged, the Government wanted a system which was capable of sending multi-lingual messages and scalable to integrate with other conventional and new age communication channels.

The system was successfully used by the Government in two incidents in operational trials - The CK Building fire in Tampines on Aug 17, 2016 and the Jurong West market fire on Oct 11, 2016.

Singapore's SPAS system now covers its 5.6 million residents and 15 million annual visitors through location-based SMS alerts.

17.19. South Korea

The Korean Public Alerting System is a standardized 3GPP system based on cell broadcast (3GPP TS 23.041[40]) and is provided over the LTE network since 2012.

17.20. Spain

In Spain, the General Directorate for Civil Protection (Ministry of the Interior) and the Regions are responsible for implementation of public warning measures.

In the case of the regions, public warning measures vary widely from one region to another, from with siren-based warning, to mass messages being sent to fixed lines, faxes, SMS or email.

The General Directorate of Civil Protection is in charge of all regulation concerning critical infrastructures, such as dams or nuclear plants, although at the moment each type has a specific national regulation to comply with (there is no single regulation that applies to all critical infrastructures).

For instance, the regulation concerning dams defines the minimum set of warning measures to be put in place; although it does not specifically indicate how often tests and user training exercises need to be carried out. The types of warning systems typically include:

- Acoustic warning based on sirens (Pneumatic/ Electronic) with specific signalling (i.e. French warning signal at a frequency of 200 Hz) to issue signals to the flooding area. Figure 4 shows the connectivity between the sirens (green lines) and the colour-coded representation of the signal power (from – 107 dBm to -67 dBm).
- Simultaneous and automatic telephony-based alert for subscribers in the flooding area, with information and detailed instructions provided using IVR systems.
- Alerting through media, and using the radio network, to provide instructions to be followed.

[40] 3GPP TS 23.041: http://www.3gpp.org/DynaReport/23041.htm

17.21. Sweden

Warnings and information via radio and television are complemented by the system for outdoor warnings. Outdoor warnings can be given in practically all built-up areas with more than 1,000 inhabitants and in areas surrounding nuclear power stations. The system consists of around 4,500 sirens. In the event of danger, the "Important Public Announcement" (IPA) siren sounds, followed by information via radio or television. The equipment in the outdoor warning system is owned by the state, while the municipalities are the users and also responsible for operation and maintenance.

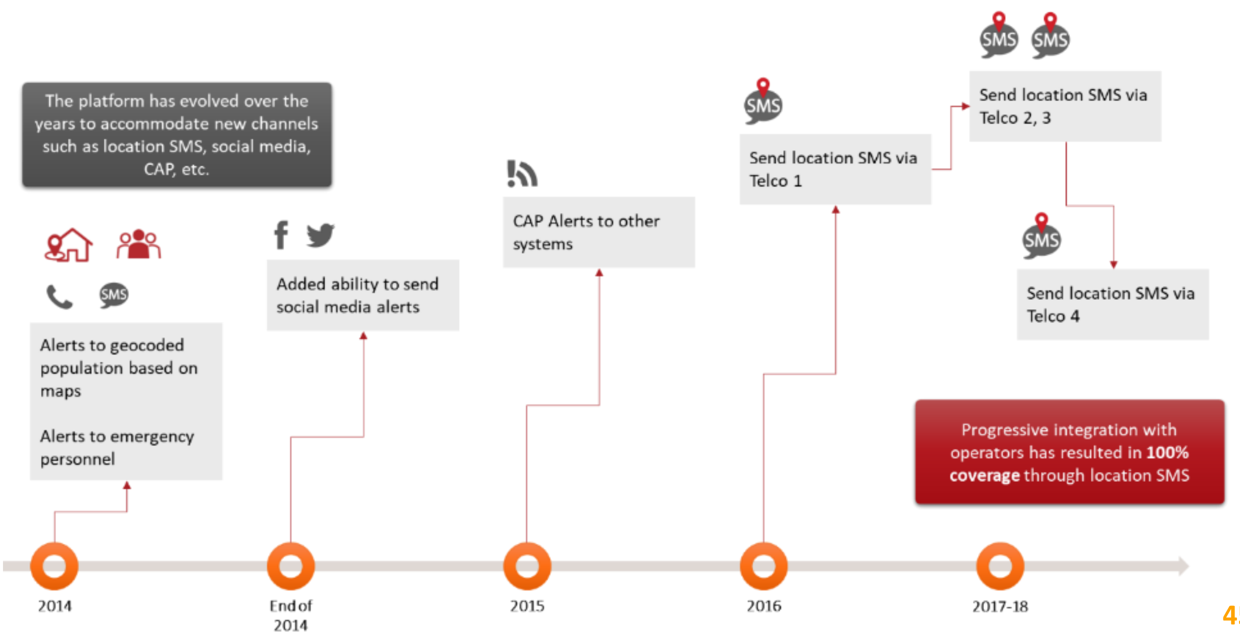
In Sweden, concerned authorities or fire chiefs sends what is called *"Viktigt Meddelande till Allmänheten"* (VMA) to the citizens during emergencies. Like most other European countries, these VMA alerts were sent only by radio and TV and sometimes by an outdoor system using sirens. Upon hearing the VMA by sirens, one is supposed to go indoors, close the door and windows and listen to the radio for information. When the danger is over a 30-40 seconds long signal is heard.

In February 2013 the Department of Defence handed SOS Alarm the task of modernising the existing public alerting system. The system was required to be able to send voice messages to fixed lines, text messages (SMS) to all cell phones (Swedish and international travellers) as well as to send text messages to cell phones carried by Swedish citizens travelling abroad.

With the change in national law around usage of location information during emergencies in June 2017, Sweden's modernised alerting system is configured to send location-based SMS to citizens and tourists during emergencies. The same system can also be used to send alerts to Swedish citizens travelling abroad.

Since January, a geofencing function has been implemented. This means that a mobile phone entering the area where a public warning is issued will receive the warning and even if the users have left the area, they will still receive a "danger is over" message when this is issued.

Sweden's current public warning system has evolved since 2013-14 to be a platform with multiple, modern alerting mechanisms.



17.22. Switzerland

The Swiss public alert system (EWS) relies on different components managed by the Swiss Federal Office for Civil Protection (FOCP). It is based on the central core service "Polyalert" that is redundantly hosted and relies on hardened network infrastructures. "Polyalert" has been individually developed to meet Switzerland's needs.

In Polyalert, the competent authorities create, publish and update alarms, alerts, and information to the citizens. Polyalert supports four languages and offers the authorities predefined text elements that are already translated in all four languages. The core system furthermore features a library with icons for event types and pictograms to visually support the authorities' recommendations on how to respond. All information is exchanged between platforms in CAP (Common Alerting Protocol) format.

Polyalert is used in all cantons by the local authorities (police), as well as by the national emergeny operation center. The system is also operative in the Principality of Liechtenstein. Polyalert clients are located in the operations centre of the aforementioned authorities. Additionally, there are web-based possibilities for creating messages for personnel outside the operations centre. Diffusion of the alerts, warnings and information created in Polyalert follows a multi-channel strategy:

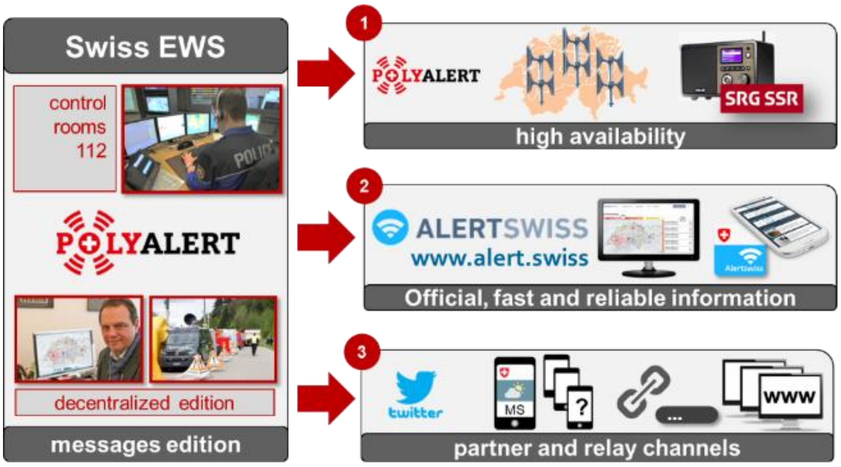


Illustration: the Swiss mutli-channel solution

1 - Distribution channels with high availability

These distribution channels are robust againsts blackout or failure of commercial networks (energy, internet, mobile phone network, etc.).

- 5'000 sirens are installed all over Switzerland to cover nearly 90% of the population. Around 600 of them additionally alert the population in case of critical risks in one of the major 80 dams in Switzerland. The sirens are electronically controlled and managed through Polyalert. The communication to the sirens itself relies on the Swiss secure radio communication network "Polycom" based on Tetrapol-technology.
- The public radio studios are directly served by Polyalert through a hardened network connection that is independent of the internet. The radio will broadcast the messages through FM/DAB+/IP-technology.

2 - Alertswiss online channels

"Alertswiss" is the brand name for the official distribution channels towards the population from the authorities. Since 2018, the competent authorities can use these channels for distributing their alerts, alarms and information. These channels are easy-to-use, with a special focus on reliability, capacity, and speed of delivery of the information.

- The current channels include the alertswiss mobile APP and the website www.alert.swiss.
- All alertswiss channels contain not only alerts, alarms and information in case of an acute emergency, but they feature a wide range of useful information about prevention and preparedness, as well as community functions and news, a blog, and a social wall.
- Moreover, there is a Youtube alertswiss channel for publishing videos with background content.

3 - Partner and relay channels

Different third party systems and partners relay the information in order to increase the reach.

- A twitter connection to Polyalert allows the local authorities to use their own channels.
- Different developments are ongoing to attach important third-party channels directly to Polyalert, which allows for a speedy and accurate further dissemination of the information.

17.23. Taiwan

The National Communications Commission of Taiwan auctioned spectrum licenses for LTE services in October 2013 and providing PWS via cell broadcast was a mandatory component of that license. The service has been active since 2015 and is compliant to the ATIS and 3GPP public warning Cell Broadcast standards.

The Taiwanese Public Warning Cell Broadcast Service supports 4 types of Cell broadcast messages: these are Presidential Alert, Emergency Alert, Alert Message, Monthly Test Message.

- Presidential Alert - Applicable to wide-ranged disasters and the ones that the public may be immediately harmed. The message is pre-set and cannot be turned off.

- Emergency Alert - Applicable to disasters where people may be harmed. It can be turned on or turned off via the mobile phone user interface as desired by the user.

- Alert Message - Applicable to alerts that can be prepared for a long time and are closely related to people's life. It can be turned on or turned off via the mobile phone user interface as desired by the user.

- Monthly Test Message - Cell broadcast system test message. The pre-set is turned off, and it can be turned on via the mobile phone interface as desired by the user.

The system has been used in 2017 13.731 times and in 2018 6.493 times. The Public Warning Service in Taiwan has been used for 22 types of disasters ranging from Tsunami, Earthquake, Industrial Fire, Debris flow, Nuclear accident, Power outage, Air quality alarm to reservoir discharge. Additional information can be found on : https://en.cbe.tw/

17.24. United States

Wireless Emergency Alerts (WEA), formerly known as the Commercial Mobile Alert System (CMAS) is an alerting network in the United States designed to disseminate emergency alerts to mobile devices. Public Authorities and certified organisations are able to disseminate and coordinate emergency alerts and warning messages through WEA and other public systems by means of the Integrated Public Alert and Warning System.

WEA/CMAS will allow federal agencies to accept and aggregate alerts from the President of the United States, the National Weather Service (NWS) and emergency operations centers, and send the alerts to participating wireless providers who will distribute the alerts to their customers with compatible devices via Cell Broadcast, that simultaneously delivers messages to all phones using a cell tower instead of individual recipients.

The WEA system is a collaborative effort among the Federal Emergency Management Agency (FEMA), the Department of Homeland Security Science and Technology Directorate (DHS S&T), the Alliance for Telecommunications Industry Solutions (ATIS), and the Telecommunications Industry Association (TIA).

The government can issuethree types of alerts through this system:

- Alerts issued by the President of the United States.
- Alerts involving imminent threats to safety of life, issued in two different categories: extreme threats and severe threats
- AMBER Alerts

18 l RECOMMENDATIONS

As explained in this document, a PWS should consist of a mixture of technologies that works best in a country. Most countries already have a warning system and the examples described in chapter 15 show that adding a technology in the mobile network can be and has been done and is being considered in many countries today. The rationale behind this is that only recently the case that many citizens have a mobile phone which they carry with them most of the day. These citizens can be reached on their mobile phone most of the time.

Therefore, the recommendations in the present document, as follows, are primarily focused on mobile networks technologies, which reflect the European Electronic Communications Code.

Stakeholders	Actions
European Authorities	Make sure the European Electronic Communications Code is correctly implemented.
National Government	Implement a multi-channel PWS with focus on technologies that can reach out to citizens and visitors based via mobile networks to cover local, regional and national emergencies. For Member States of the European Union and the European Economic Area, the deadline to implement a mobile phone-based Public Warning System is May 2022.
National / Regional Authorities	Create a clear Public Warning procedure with a clear description of responsibilities. Identify risks and targets in their jurisdiction and select alerting technology (or a mix of technologies) based on the threat analysis.
Emergency services	Define formal emergency plans including Next Generation PWS channels
National telecommunication regulator Network operators	To cooperate with National Government to facilitate the implementation of “Reverse 112”.
Mobile network operators	Cooperate with national authorities in the implementation of PWS.
Mobile handset vendors	Cooperate with operators and authorities to deploy rich media alerting.
European standards authorities	Co-operate with peers in other regions to facilitate interoperability and roaming.

19 I LIST OF DOCUMENT UPDATES

Version	Date	Title of document
1	25-06-2012	Public Warning
2	15-07-2015	Public Warning (update)
3	30-09-2019	Public Warning Systems - Update