Disaster Response

When you restore the mobile network,
you rebuild the human network

Mobile Network Public Warning Systems and the Rise of Cell-Broadcast

Introduction

Over recent years, the increase in both the frequency and destructiveness of disasters has led to a heightened focus on the implementation of disaster preparedness measures. According to the World Bank[1], one of the three key sectors where investment can be focussed to help minimise the effects of, or even prevent, disasters is that of early warning systems. Although the exact value of early warning systems is difficult to calculate, there is little doubt that an effective Public Warning System (PWS) is an essential part of an effective early warning system and can substantially reduce deaths and damage from certain disasters by giving the population time to flee a tsunami, flood or severe storm and enabling them to protect their property wherever possible. Effectively delivered early warnings also give governments and infrastructure providers more preparation time and hence a better chance of protecting critical infrastructure[2]. This report aims to provide an Introduction to Public Warning Systems and background to the most applicable technology used to deliver them, the Cell Broadcast Service.

Considerations for a Public Early Warning System (PWS)

In 2006, prompted by the increased interest in early warning systems generated after the Indian Ocean Tsunami in 2004 and Hurricane Katrina in 2005, the European Telecommunication Standards Institute (ETSI) produced a report on mobile-based technologies that became the basis for an emergency messaging service. Among the key requirements identified were the following:

- Capacity and speed - The provision of alerts that take a maximum of three minutes to arrive and can reach 97% of the citizens in the targeted area within five minutes.
- Network Congestion - The system must be able to deliver high message volumes across congested networks.
- Security and authentication - Public Warning messages should only be sent from authorised users. Subscriber privacy should be maintained.
- Performance - The system must be configured for high availability and geographical redundancy where possible.
- Handset or device requirements - Emergency messages should be instantly recognisable as an alert and remain on the handset until manually cancelled by the user. The system should allow for different alert levels to be set[3].

The report suggested several mobile technologies (Paging, CBS, SMS, TV, MBMS, MMS, USSD, Email, IM Service) and concluded that Cell Broadcast Service (CBS) and Short Message Service (SMS) were among the most suitable technologies for delivering a mobile-driven PWS.

Establishing Two Main Candidates - SMS v. Cell Broadcast Service (CBS)

A further ETSI report[4] on the suitability for both CBS and SMS in providing a Public Warning System (PWS) outlines the basic characteristics of each technology, both of which have existed in the GSM specification for a considerable time[5].

SMS Characteristics: SMS is familiar to most mobile users worldwide. It is ideal as a personal one-to-one messaging solution, however for bulk messaging applications such as a PWS, it requires the establishment and maintenance of a database of target numbers. Any bulk messaging solution necessitates that messages must be sent individually to each number in the database. In an emergency situation, where networks are often severely congested, the volumes created can further increase congestion and lead to delays in message delivery. The SMS message is sent direct to the handset number and messages received on the handset are independent of its location[6]. Therefore when a warning message is sent there is no guarantee the recipient is present in an area that the warning applies to, potentially leading to confusion.

CBS Characteristics: Although Cell Broadcast System (CBS) is not as familiar as SMS to most mobile users, it has several key distinctions that make it more applicable as a PWS service. These include:

Message Display - The message can be displayed on the handset with no user interaction and a distinct warning tone sounded. CBS also has the capability to deliver messages in multiple languages.

Message Delivery - CBS works on a broadcast i.e. one-to-many basis; One message can be sent to millions of devices quickly and the message is broadcast to all connected handsets within a designated target area. The area can be as large as an entire network or as small as a single cell.

Message Security - Another key advantage of CBS is that it addresses certain security concerns. The recipients remain anonymous as CBS does not require registration of numbers or maintenance of a number database, and messages are sent to all users within a geographic area. Unlike SMS,

1 Natural Hazards, Unnatural Disasters, The Economics of Effective Prevention, World Bank 2010 - Available for downloading at https://openknowledge.worldbank.org/handle/10986/2512
2 For further information, see Cost and Benefits of Early warning systems GAR 2011, by Rogers & Tsirkunov ISDR/World Bank at http://www.preventionweb.net/english/hyogo/gar/2011/en/bgdocs/Rogers_&_Tsirkunov_2011.pdf
3 ETSI TS 102 182: "Requirements for Communication from Authorities to Citizens during an Emergency"
4 ETSI TR 102 444 V1.1.1 (2006-02) Technical Report Analysis of the Short Message Service (SMS) and Cell Broadcast Service (CBS) for Emergency Messaging Applications, available at http://www.etsi.org/deliver/etsi_tr/102400_102499/102444/01.01.01_60/tr_102444v010101p.pdf
5 Work on standardisation began in 1985 and became GSM TS 03:40 technical realization of the Short Message Service (SMS).
6 It is possible to dynamically retrieve from the network which handsets are present in the target area and then send appropriate SMS alerts, however this is complicated and the system would still possess all other disadvantages of SMS-based PWS.

where messages can be sent from any source and the identity of the sender is difficult to verify, CBS messages can only be sent by authorized personnel who have been given access to the system.

CBS therefore has key practical advantages in terms of implementation for a disaster alerting and warning system:

- It can be displayed automatically with no user interaction,
- It can be delivered quickly to millions in seconds
- It can send differentiated messages to designated areas,
- It is not affected by and will not lead to network congestion,
- It does not violate citizen privacy
- CBS can only be sent from authorised, verified sources.

There are two primary areas where CBS is perceived to have a disadvantage when it is compared to SMS for use as a PWS. The first is that it can only be used for 1-way communication[7]. Secondly, it has not been standardized as a method of display on handsets[8], which has led to differing levels of support across handset models and may require manual configuration by users. Despite these disadvantages, CBS is the most implemented technology in delivering PWS.

PWS and CBS development and standards

The 3rd Generation Partnership Project (3GPP)[9] began a project in 2006 to define the requirements of a PWS in order to enhance its reliability, security and resilience. The resulting technical specification document[10] gives general criteria for the delivery of alerts, the content of messages and handset features of PWS-capable handsets. The specifications also include the additional requirements of specific PWS implementations such as the Earthquake and Tsunami Warning System (ETWS) in Japan and the Commercial Mobile Alert System (CMAS) in North America.

Important 3GPP standards for the definition of PWS are the following:
3GPP TR 22.968 Study for Requirements for a Public Warning System (PWS) Service
3GPP TS 22.268 Technical Specification: Public Warning System (PWS) Requirements

The implementation of a PWS does not specify which alerting technology has to be used. However from the 3GPP requirements and specification documents, the work done by ETSI and experience gained from existing PWS implementations such as NTT DoCoMo's Area mail system implemented in 2007, Cell Broadcast Service emerges as the dominant technology for PWS. CBS has existed since 1988 and is already standardized in 3GPP, some of the important standards for Cell Broadcast are the following:

3GPP TS 23.041 - Technical Realisation of Cell Broadcast Service (CBS)
3GPP TS 44.012 - Short Message Service Cell Broadcast (SMSCB)

In addition to the 3GPP standards, other standards have been created for PWS and Cell Broadcast (see Appendix 1). An important point to note is that CMAS and EU-Alert are compatible and so a universal standard exists for US and EU citizens.

CBS Architecture: Technology and Implementation

What does a CBS message look like?

Cell Broadcast has been included in current 3GPP 2G, 3G and LTE standards and it is planned to be included in further evolutions. The basic structure of a cell broadcast message has however not changed significantly since it was first defined in the original GSM standards. A CBS message consists of 88 Octets (1 Octet = 8 Bits of Data) of information. The first 6 Octets are used to identify and define the message characteristics, the next 82 are used to carry the message payload itself. This allows for a total number of 93 Characters[11] to be used in a single message page, a total message may consist of 15 concatenated pages. The basic structure for a single message page[12] is as shown on the following page:

7 One way communication can be seen as an advantage , as it prevents automatic call backs which could overloaded emergency call centres
8 However Handset behaviour has been standardised within implementation CMAS has its standard (J-STD-100, Mobile Device Behavior Specification)and EU-Alert (ETSI TR 102 850, Analyses of Mobile Device Functionality for PWS)
9 3rd Generation Partnership Project (3GPP) is a collaboration between the following international telecommunications associations: Association of Radio Industries and Businesses (ARIB)-Japan, Alliance for Telecommunications Industry Solutions (ATIS)-USA, China Communications Standards Association (CCSA)-China, European Telecommunications Standards Institute (ETSI)-Europe, Telecommunications Technology Association (TTA)-Korea, and Telecommunication Technology Committee (TTC)-Japan. It is responsible for the GSM, UMTS and LTE standards.
10 3GPP TS- 22.268
11 93 characters if sent using the default 7-bit GSM alphabet; for some languages a 2x8 bits per character are required and then only 41 characters can be sent in a single page
12 Defined in 3GPP TS23.041 and previously in ETSI GSM 03.41

Octet Number (1 octet = 8 Bits)	Field
1-2	**Serial Number** The serial number identifies the CBS message. It contains information about the geographical scope of the message, i.e., where the message is valid. This can be either PLMN wide, location area wide (Service area in UMTS) or cell wide. In addition, it can determine if the message is to be immediately displayed on the end device. It contains the message code, which differentiates messages with the same message identifier (message codes can be allocated by the operator). How the handset should respond to the alert and also an update number which differentiates old and new versions of the message and therefore prevents the redisplay of old messages.
3-4	**Message Identifier** The message identifier identifies the source and type of the CBS message. Numbers in the range of 0-999 can be defined by the operator and correspond to the channel that is selected on many end user devices. For example, the message identifier for channel location is typically 50. The device or the SIM can store several message identifiers and these can correspond to the "services" that the device looks for. For Public Warning Systems (PWS)[13], networks are only allowed to use identifiers between 4352-6399. These are used to identify different types of alerts: for example 4370 is the CMAS Identifier for a presidential alert .
5	**Data Coding Scheme** If the message is not set to immediate display, this parameter tells the mobile handset how to display the message and which alphabet/language to use when interpreting the message. Through the use of an interface on the handset the user is able to ignore messages in an unfamiliar language. However, some warning messages may be transmitted in mandatory languages that are forcibly displayed.
6	**Page Parameter** This contains information about the total number of pages in the CBS message (maximum 15) and also where this particular page of message content is within that total sequence of pages.
7-8	**Message Content** The last 82 octets contain the message content, which can be either text or binary.

What parameters govern the display of CBS messages on a mobile device?

The display of a CBS message on the end user's device is governed by either the geoscope (part of the serial number) or the Data Coding Scheme. When the geoscope is set to 0 this takes precedence and automatically displays the message without user intervention. If this value is not set to 0 then the Data Coding Scheme defines how the message is to be displayed and what intervention is required from the user. Multiple languages can be dealt with by using either a specific Message Identifier for each language or the Data Coding Scheme whereby a specific value indicates the language to be used[14].

How is a CBS message created and sent?

The basic architecture of CBS is very similar across all GSM and 3GPP standards. In its simplest implementation CBS consists of one Cell Broadcast Centre (CBC), which is typically located in the network of a mobile operator, and at least one Cell Broadcast Entities (CBE), which for early warning systems are often based with government or a trusted authority.

13 Defined in 3GPP TS 23.041
14 A detailed description can be found from one2many "Displaying Cell Broadcast Messages" Alert notifications in Public Warning systems http://one2many.eu

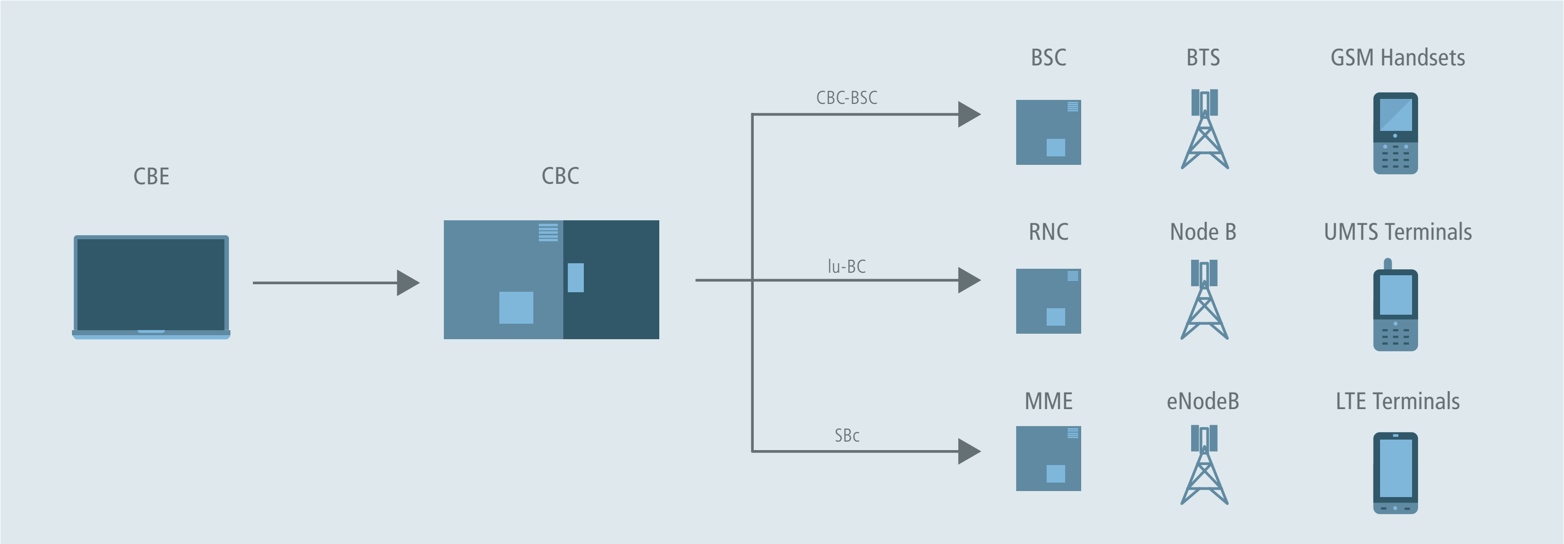


Fig 1: Basic CBS Architecture

The CBE is the messaging interface to the CBC. The CBE is a user interface used by the message creator to both compile the message and then specify the location (or locations) of message recipients. Once defined, the message is sent to the CBC, which maps the target area to the mobile network cells and then sends the cell broadcast message to the required radio access network(GSM, 3G, LTE), which will manage the message broadcast to the end user[15].

15 Note: Cell broadcast is not unique to GSM based networks as there are standard interfaces that have been developed for CDMA networks in addition.

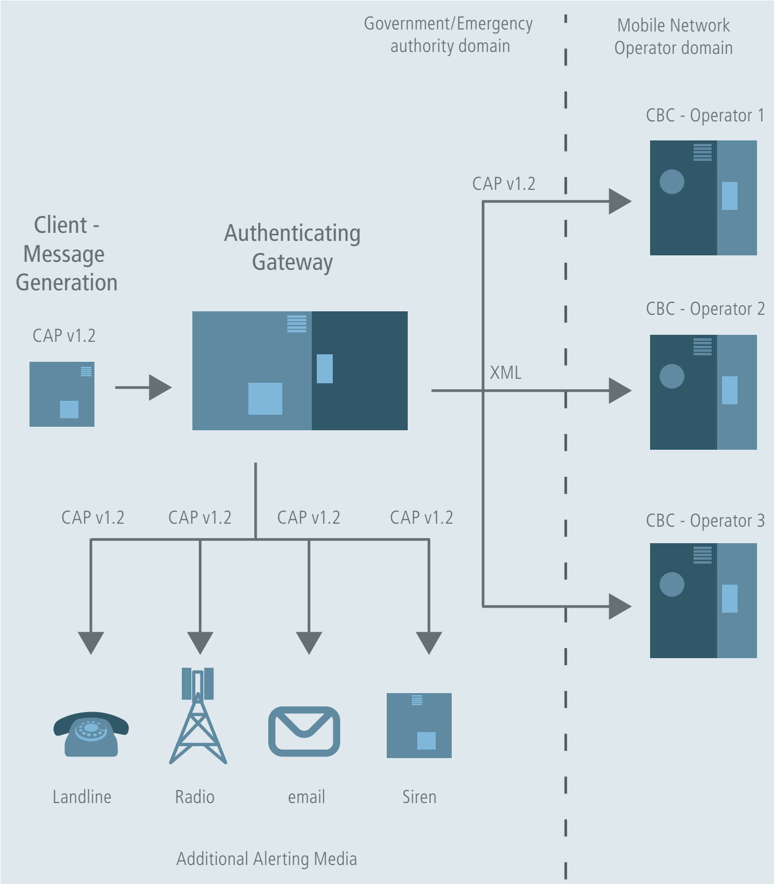


Fig2: Sample PWS Architecture

In the majority of PWS implementations of alert and early warning CBS systems, the single CBE is replaced by two stages. The responsibility for both of these stages is usually located with the government or the controlling emergency authority.

Message creation – The message is first created by authorised personnel from governmental or federal departments or by authorised emergency managers.

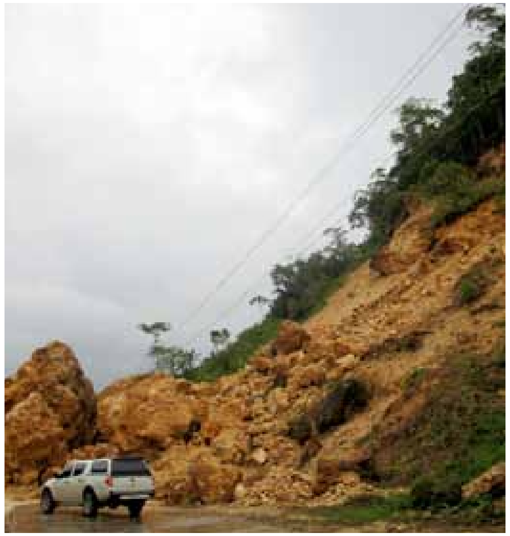
Message Validated – The message is then sent to an aggregator gateway, the purpose of this gateway is to authenticate the sender and to validate the message contents to prevent unauthorised use of the system or the sending of inaccurate or malicious information. The aggregator also stores CBC service provider profiles in order to enable information dissemination to all CBCs. In some instances, this aggregator also provides links to other non-CBS alerting technologies such as SMS, Sirens, links to radio stations, etc.

Message Sent – Once validated the message is distributed to a single or multiple CBC's which then distribute(s) the message through the respective radio interface.

The CBE-to-CBC interface is not defined within 3GPP and the protocols can vary with each CBC provider. However the majority of interfaces between the gateway, messaging client, and other alerting inputs and outputs are based on extensible markup language (XML) based protocols. (These include the Common Alerting Protocol v1.2[16] standard).
To provide security and ensure message integrity in many implementations, both the link (encrypted via VPN) and the message payload may also be encrypted.

CBC Location – This depends on the architecture of the solution but it is possible for the CBC to be located either individually within each mobile network operator, shared between operators. Alternatively, a service provider could provide a hosted CBC function.

16 The Common Alerting Protocol (CAP) is the format that is becoming the standard for exchanging warning messages. It is an open standard created by the Organization for the Advancement of Structured Information Standards (OASIS). The standard defines a general XML-based format for exchanging emergency alerts and public warnings between different kinds of networks and devices. This allows for a consistent warning message to be disseminated simultaneously over many different warning systems.



User Perception of CBS as a PWS

User familiarity and participation is crucial to the success of CBS as a PWS. A two-year study on using CBS as a citizen alert system conducted by Delft University of Technology in the Netherlands[17], showed that the reach achieved by a cell broadcast alert was initially low(between 25-51%) but when technical problems had been overcome and citizens had been educated about the system this figure rose to 72-88%. An overwhelming majority (94%) of survey participants viewed cell broadcast as a useful addition (though not a replacement for) the current warning systems.

The report suggested that the biggest challenge lay with successfully involving the public in the system and their acceptance of it. The public would need to be educated by sustained awareness programmes and possibly incentivized to purchase the correct compatible handsets. To ensure acceptance they state that care must be taken during implementation to ensure that the system meets expectations, as a poor experience leads to reduced acceptance and hence reduce the effectiveness of the system.

Main Challenges to Effective CBS Implementations

CBS has a clear advantage over other technologies for delivering mass public warning and emergency messaging applications, *so why hasn't it not been implemented in more networks?*

The 2006 ETSI paper[18] suggests the following reasons:

Difficulty in business case for operators: The global impact of disasters is increasing, in 2011 the economic damages from disasters were the highest ever registered at $366 billion[19] mitigation of these costs is increasingly a key focus of both public and private organizations. This has led to a more favorable climate for investment in PWS. Though operators such as NTT DoCoMo and Dialog have taken the lead in investing in PWS implementations, many operators have yet to consider it a worthwhile CSR initiative. However, cell broadcast is available as a software feature on most existing networks and the cost is not large when compared to other network implementations. Operator involvement is better instigated as part of a government-led, countrywide warning strategy where multiple operators are committed and where many of the operational costs are borne by the state or a governmental body (see Case Studies 1 and 2).

Handset Problems: There were initial concerns that enabling cell broadcast functionality in a handset would lead to significant increased battery consumption. A 2007 report by the University of Linkoping, Sweden[20] found that additional battery consumption is small in comparison to other features available on handsets (namely MP3, Java gaming and camera/flash). This is even more relevant for today's high-performance handsets with features such as Bluetooth, Wi-Fi, UMTS, full color displays, and built-in MP3 players – all features that consume significant battery power.

Handset Compatibility and Interface: For cell broadcast to be truly effective as a PWS, its implementation needs to be standardized across the majority of handsets. Currently, the service still needs to be enabled manually on most handsets and this process can be different for various brands and types of handsets. This is seen as a major barrier for implementation. There is also a lack of a standard interface to the user: options for cell broadcast can be difficult to find and hidden away in settings or options menus, messages. One possible solution is to standardize settings in a similar fashion to the presentation and management of SMS or to include it within the SMS management menus. Remote activation of the CBS service on the handset, though defined within 3GPP, does not appear to be implemented in any current PWS system[21]. Although standardization of user interface and phone compatibility is still a problem, many of the proposed PWS implementations seem likely to follow the CMAS implementation where a client application is implemented on the handset - The client standardizes the presentation and maintains the integrity of the compulsory Presidential alert.. Thus, as the Commercial Mobile Alerting System (CMAS) alert capable phones (see Case Study 2) are made available for the US market, it will become commonplace for device manufacturers to enable the feature automatically on new models. In the Netherlands CMAS based clients are implemented by some manufacturers as CMAS and EU-Alert are compatible. In addition the use of a CBS client on the handset does allow an operator (or government) flexibility in differentiating services delivered over the CBS system, for example subscription to monetised CBS services can be separated from alert functions.

National Legislation: This is the key factor for PWS implementation. All successful PWS implementations have to be supported by government and regulatory bodies. In the USA, the national legislation and framework provided by the Federal Communication Commission (FCC) subsequent to the Warning, Alert and Response Network (WARN) act enabled a large take up of CMAS among operators despite the participation being voluntary. In addition, the key role in aggregating and validating alerts has to be played by a national agency or governmental body to lend credibility and legitimacy to the message sources.

17 Report on the Use of Cell Broadcast as a Citizen Alert Ssystem - Lessons from a two-year study in the Netherlands (2005-2007), by J.W.F. Wiersma, Dr. H.M. Jagtman, and Prof. B.J.M. Ale (Delft University of Technology, Safety Science Group), May 2008.
18 ETSI 102-444.
19 Annual Disaster Statistical Review 2011 - Centre for Research on the Epidemiology of Disasters (CRED)
20 Support for Cell Broadcast as a Global Emergency Alert System – Batchelor thesis - Karin Axelsson, Cynthia Novak, University of Linkoping, June 2007
21 Defined in 3GPP TS 25.331[16]) Technical Specfication Group Radio Access Network; Radio Resource Control (RRC).

Four Case Studies of CBS Implementations from Around the World

Case Study 1: Earthquake and Tsunami Warning System (ETWS), Japan

The prevalence of earthquakes in Japan led to NTT DoCoMo's development of an earthquake early warning system. Called "Area Mail", the system went live in 2007. It takes alerts provided to NTT DoCoMo by the Japan Meteorological Agency (JMA) and disaster/evacuation information provided by local governments or authorised bodies and broadcasts them to the general public via CBS. When an earthquake of sufficient magnitude occurs, a message is sent from the JMA to the CBC at NTT DoCoMo. The message is broadcast (in Japanese) to base stations in relevant areas and appears on compatible handsets as a pop-up screen accompanied by a warning tone. To avoid confusion with other messages, the warning tone sent by the alert is distinct, standardised and agreed upon by all operators (KDDI and Softbank have since implemented ETWS). It is not possible for users to change this alert tone)[22].

The 3GPP Public Warning System Specification (PWSS) Earthquake and Tsunami Warning System (ETWS) was based on NTT DoCoMo's Area Mail solution and is now a standard that can be used for similar implementations in other countries. There are respective ETWS standards for 2G, 3G and LTE. The ETWS standard differs from the existing Area Mail solution; earthquake warnings in Area Mail have a fixed length message that takes approximately nine seconds to be delivered. The ETWS shortens the initial delivery time by sending two messages; the first contains the minimum information needed to alert citizens (this is sent using the paging channel which enables the message to be delivered in about four seconds) and the secondary notification (sent by cell broadcast) follows about 20 seconds later with the full disaster information that is typically sent in an Area Mail message[23]. Using the paging channel also ensures that users whose handsets are in the connected state will receive the emergency information. This was not possible in the conventional Area Mail service as users on a call would not receive messages.

The Tsunami warnings enhancement became operational in 2012 and now warnings are received from sensors in the 66 coastal zones that the JMA has deemed to be at risk. The automatic tsunami warning message (in Japanese only) delivered to citizens contains basic information such as, "A tsunami warning has been issued". It does not contain details about the size or arrival time of the tsunami; it is expected that this information will be delivered by other media channels or via the more detailed Area Mail message which follows and will be issued by national and local public bodies.

All handsets that were compatible with the previous Area Mail system launched after November 2007 are compatible with the current service. As with other CBS services, certain handsets will require that settings be configured in advance so that the service can become operational[24].

Case Study 2: The Commercial Mobile Alerting System (CMAS), USA

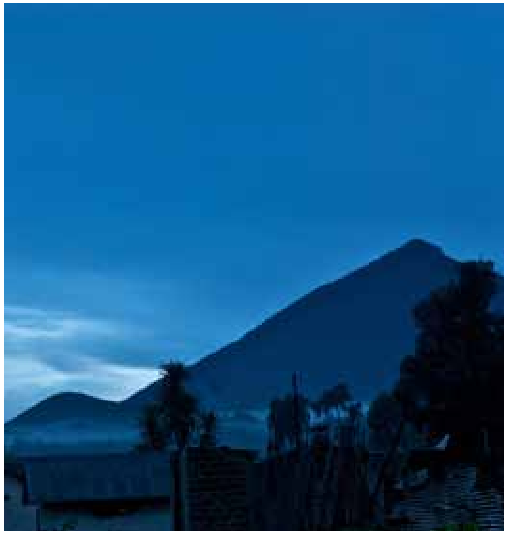
The Commercial Mobile Alerting System (CMAS) is the North American implementation of the 3GPP PWS. The system is technology agnostic and is part of a national alerting project called Integrated Public Alerting and Warning System (IPAWS). This project was initiated after the Warning, Alert and Response Network (WARN) act[25] was signed into law on 13 October 2006. The Federal Communication Commission (FCC)[26] subsequently established that CMAS would be a system where an alert aggregator/gateway receives, validates, authenticates and formats alerts from federal, state, tribal and local sources and then forwards them to the commercial mobile operator's message gateway. The gateway processes the alerts and delivers them to user handsets. In the current stage CMAS providers must be able to transmit alerts to targeted areas no smaller than a county[27].

The alerts are defined into three categories: Presidential, Imminent Threat (such as a storm or tornado) and Amber alerts. These alerts are automatically received by the latest WEA- (Wireless Emergency Alerts) compatible handsets. However, subscribers can opt out of all but Presidential alerts. Subscribers with WEA-compatible handsets will receive alert messages when roaming to another provider in the US and abroad that offers CMAS or EU-Alert.

Much of the architecture of the CMAS system lies outside the responsibility of 3GPP, which mainly covers the reception of the CMAS alert by the CBC and the distribution of the message to CMAS-capable mobile devices. The responsibility for aggregating, authenticating and prioritizing alerts should lie with a trusted government agency, thereby ensuring that the CMAS system is only used for immediate threats to life, health or property. Message generation is available only to government officials with responsibility for public safety health and security, using only authorized individuals and closed message distribution to and from the aggregator gateway – this ensures the integrity of the message and reduces the likelihood of spoofing or malicious messages[28].

The first CMAS Message was broadcast on 27 June 2012 and had only been operational for a few weeks when CMAS alerts were triggered by the National Weather Service issuing a tornado warning in the Elmira area of New York. The messages arrived almost instantly and, despite the

22 Early Warning - Area Mail, Takashi Seki, Takeshi Okada, Mayumi Ikeda,and Takaaki Sugano https://www.ntt-review.jp/archive/ntttechnical.php?contents=ntr200812sf2.html
23 "Advanced Warning Message Distribution Platform for Next-Generation Mobile Communication Network", by Itsuma Tanaka, Kenichiro Aoyagi, Anil Umesh, and Wuri A Hapsari (NTT DoCoMo Technical Journal Vol 11 No.3, September 2009).
24 NTT Area Mail Handset Operating and Setting Procedures (in English) contains information on compatible handsets and is available at http://www.nttdocomo.co.jp/english/binary/pdf/support/trouble/manual/network/area_mail.pdf
25 http://transition.fcc.gov/pshs/docs/emergency-information/cmas-warn-act.pdf
26 CMAS Alerts – FCC – Public Safety and Homeland Security Bureau http://Transition.fcc.gov/pshs/services.cmas.html
27 CMAS is targeted using geocodes for counties in the initial phase. The technology does support targeting areas smaller than the county using polygon shapes, but it is not yet used.
28 Appendix 1 - CMAS Reference Architecture.



fact that the area did not normally suffer from tornadoes, the warnings were seriously heeded by subscribers[29]. During Hurricane Sandy CMAS use was widespread in affected areas, evacuation messages were sent via CMAS in the worst hit areas of New York. Generally reception to the service appeared positive although the fact that the alerts weren't received on all handsets seems to have confused some.

Case Study 3: EU-ALERT, Europe

In Europe, the Netherlands has taken the lead among several European countries in examining CBS as an effective PWS service[30]. The generic name for the project is EU-ALERT but individual countries will replace the EU with their country code, e.g., NL-ALERT for the Netherlands and UK-ALERT for the United Kingdom. The system will be able to accommodate specific country requirement, however core functionality will remain the same, thus ensuring that roaming handsets will behave in a standard manner across European countries. EU-ALERT has been defined by EMTEL and is integrated into the 3GPP PWS standard in a similar manner to CMAS and ETWS. Similar to CMAS and ETWS, the Dutch study has concluded that cell broadcast[31] would be the best bearer technology for EU-ALERT[32].

The NL-ALERT system is now active with country-wide coverage. Initial testing has revealed that the cell broadcast works well on 2G handsets but that smartphones on the 3G network were less well supported[33]. There has been significant work done on informing the customers as to which phones will work with NL-ALERT and a step-by-step guide published on the NL-Alert Webpage on how the function can be switched on[34].

Customers in Holland seem to be responding well to the NL-ALERT system with nine out of ten respondents to an online survey being in favour of the system[35]. The survey revealed that people value the fact that the supplemental warning information is supplied with the initial alert; respondents believed this would make message recipients more likely to take appropriate action. One concern raised in the survey was that the NL-ALERT system must be used sparingly and only for issues where there is a significant threat; overuse of the system will lessen public confidence and reduce its impact and effectiveness.

Case Study 4: DEWN, Sri Lanka

Prompted by the devastation caused by the Indian Ocean Tsunami of 2004 (which resulted in some 35,000 deaths in Sri Lanka), the Sri Lankan Disaster Management Centre launched the Disaster and Emergency Warning Network (DEWN) project. DEWN was developed as a non-commercial initiative by a partnership between Dialog Telekom PLC, Dialog-University of Moratuwa (UoM) Mobile Communications Research Laboratory and Microimage work. The project began in 2006 and the system became operational on 30 January 2009 after completing a successful pilot period.

In the DEWN system, disaster and warning, information is supplied from multiple sources (such as Pacific Tsunami Warning centre, Met office, etc.). A message is sent to the Emergency Operation Centre (EOC) of the government Disaster Management Centre. In a potential disaster scenario, DEWN is used first to alert emergency personnel on their individual phones; public alerts are issued only when a threat is adequately verified, thereby reducing false alarms. The EOC acts as the message aggregator where the message is verified and authenticated. Once this has taken place, the customized alerts are sent via the secure DEWN alerting interface and the CBC. Messages can then be sent out via SMS for directed messages and cell broadcast for mass alerts. The messages are delivered in three local languages and can be received on basic CB-enabled 2G handsets and smartphones enabled with a downloadable Java app, or sent to a specific specially developed DEWN alarm device that contains a loud siren and flashing lamp designed for public spaces.

Though the service uses the cell broadcast function of Dialogs network, warnings can also be delivered to other non-CBS-enabled local providers so that they can be further disseminated through bulk SMS.

29 "New Cell Phone Weather Alerts Already Protecting Lives", FCC Blog, 30 August 2012.
30 Report on the Use of Cell Broadcast as a Citizen Alert System, by J.W.F. Wiersma, Dr. H.M. Jagtman, and Prof. B.J.M. Ale (Delft University of Technology Safety Science Group), May 2008, available at http://www.ceasa-int.eu/wp-content/uploads/2010/04/Cell-Broadcast-Trials-University-Delft.pdf
31 As Specified in TS 123 041.
32 From ETSI TS 102 900 V1.2.1 (2012-01) Emergency Communications (EMTEL); European Public Warning System (EU-ALERT) using the Cell Broadcast Service.
33 http://www.government.nl/documents-and-publications/press-releases/2011/12/23/nl-alert-introduced-nationally.html - NL Alert Introduced Nationally, 29 December2011.
34 This guide is available at http://instelhulp.nlalert.nl
35 http://english.wodc.nl/onderzoeksdatabase/belevingsonderzoek-pilots-nl-alert.aspx?cp=45&cs=6796 -
"Peoples Perception of NL-ALERT", Holzmann, M., Warners, E., Franx, K., and Bouwmeester, J. (I&O Research , Berenschot Groep, WODC).

CONCLUSION: The Future of Cell Broadcast as a PWS

The increasing frequency and destructiveness of disasters together with the increasing global reach of mobile networks has focussed governments and operator attention towards providing Public Warning Systems over mobile networks. The Cell Broadcasting Service is currently the most practical mobile-based technology that satisfies the majority of criteria defined internationally as requirements for a PWS and operates effectively on GSM, UMTS and E-UTRAN networks in addition it is the only standardised PWS technology.

A CBS system enables the fast delivery of important information on a broadcast one-to-many basis and can be targeted to areas that can be as large as a country or as small as a single cell. The message itself can be categorised, which allows for a different presentation for each category on the handset. However, the presentation is not currently standardised across all services which has led to different implementations across manufacturers. The CBS is often not enabled by default on many handsets and requires the user to enable the service manually; this process is again different on many handsets and can lead to confusion amongst users. However as implementations of CBS based PWS increase new handsets will have the feature enabled by default in some large markets. In the Netherlands the process of enabling new handsets for NL-Alert began a year prior to its launch. In addition cross compatibility between EU-Alert and CMAS mean that CMAS client can be easily adopted for EU-Alert handsets (by removing the Presidential alert option).

The architecture of successful PWS implementation requires countrywide access that covers the majority of the population. It is vital that warnings and alerts are validated and authenticated by respected and credible channels before dissemination to the general public.

Many thanks to Manuel Cornelisse and Peter Sanders of One2Many and to Mathew Pitt-Bailey and Pawel Bilinski of Alcatel-Lucent for their help and contributions.

In most implementations, this role has been played by a government or national organisation. Therefore, a strong governmental lead, driving legislation and implementation together with continued operational involvement, is one of the most crucial elements for building a national CBS PWS implementation (although successful systems have in the past been initiated by operators such as NTT DoCoMo). Operationally, the message aggregation from multiple inputs and authentication generally lies outside both 3GPP and the carrier domain.

As CMAS and ETWS solutions mature, and more governments take the lead in implementing them, handsets compatible with PWS Cell Broadcast implementations will become more commonplace which could minimise the need for manual configuration. Due to the specific requirements of ETWS (regarding speed of message delivery), governments and operators currently considering PWS implementations of cell broadcast seem to be pursuing a route more similar to the CMAS standard. Since it began in June 2012, CMAS has already been tested during the July “Derecho storm” and recent hurricanes Isaac and Sandy. Potential implementers of CB based PWS may be waiting until FCC/FEMA release reviews of CMAS performance during these events.

Despite being in the early stages of widespread implementation, the role of mobile in creating modern, effective PWS service is evident. Although IP messaging services may offer increased flexibility and potential when disaster strikes, Cell Broadcast Service is still currently the most effective and reliable medium for the rapid delivery of warning messages, to as many subscribers as possible.

APPENDIX 1: International Standards for PWS or CBS

Europe:

ETSI/EMTEL
ETSI - The European Telecommunications Standards Institute (ETSI) produces globally-applicable standards for Information and Communications Technologies (ICT) including mobile technology. Emergency Telecommunications (EMTEL) was set up within ETSI in 2002 to address aspects related to the provisioning of telecommunications services in emergency situations. The following standards have been developed by EMTEL:

TR 102 444: Analysis of the Short Message Service (SMS) and Cell Broadcast Service (CBS) for Emergency Messaging Applications; Emergency Messaging; SMS and CBS
TS 102 900: European Public Warning System (EU-ALERT) Using the Cell Broadcast Service
TS 102 182: Requirements for Communications from Authorities/Organisations to the Citizens During Emergencies

North America:

ATIS
The Alliance for Telecommunications Industry Solutions (ATIS) develops standards for communications in the North America region. As a result of reports and orders from the Federal Communication commission, chiefly the 2006 WARN report, they developed standards for the Commercial Mobile Alert System (CMAS) which has been implemented throughout the United States.

ATIS Only Standards
ATIS-0700006, CMAS via GSM-UMTS CBS
ATIS-0700007, Implementation Guidelines and Best Practices for CBS
ATIS-0700008, CBE to CBC Interface Specification
ATIS-0700010, CMAS via EPC PWS Specification

Joint Standards for CMAS
As CMAS is technology independent and is applicable to both GSM and CDMA networks, the following standards were developed jointly with the TIA (the standards body for CDMA, see below):
J-STD-101, Federal Alert Gateway to CMSP Gateway Interface Specification
J-STD-102, Federal Alert Gateway to CMSP Gateway Interface Test Specification

PWS and Cell Broadcast standardization outside 3GPP[36]

Telecommunications Industry Association (TIA is the North American standards institute for the CDMA ecosystem), in addition to joint work on CMAS with ATIS, has developed standards specifically referring to CDMA
IS-824, Generic Broadcast Teleservice Transport Capability - Network Perspective
TIA-637-A, Short Message Service (SMS) for Wideband Spread Spectrum Systems
TSB-58I, Administration of Parameter Value Assignments for CDMA2000 Spread Spectrum
Standards Support, specifically for CMAS has been specified in:
TIA-1149-1, CMAS over CDMA Systems

Handset Standards:

Handset compatibility is crucial to the success of a PWS implementation. In an attempt to standardize the presentation and behavior of mobile devices, the following PWS standards have been developed and refer specifically to handsets:

ETSI	TR 102 850: Analysis of Mobile Device Functionality for PWS
ATIS/TIA	J-STD-100 Mobile Device Behavior Specification
ATIS	ATIS-0700013 Implementation Guidelines for Mobile Device Support of Multi-Language CMAS

ITU Emergency Standards

The International Telecommunication Union (ITU) has produced many recommendations on emergency telecommunications. As part of the ITU Study Group 2, it has produced the specific guidelines document ITU-T SG2: "Requirements for Land Mobile Alerting Broadcast Capabilities for Civic Purposes". This document is intended for use by telecommunication operators, policy-makers and regulators. It outlines best practices and design considerations for the deployment of Public Warning Systems (PWS). However, the main focus of the document is to promote the use of the Common Alerting Protocol (CAP) standard for public alerts and hazard notification in disasters and emergency situations.

36 Whitepaper – Cell Broadcast Emergency alerts – One2Many - http://www.one2many.eu

APPENDIX 2: Overview SMS vs Cell Broadcast

Characteristic	Short Message Service (SMS)	Cell Broadcast Service (CBS)
Service		
Transmission Type	Messages sent **point-to-point**.	Messages sent **point-to-area**.
Message Dependency on Mobile Number	**YES** - requires the input of specific phone numbers and database maintenance.	**NO** - does not require the input of specific phone numbers.
Message Dependency on Location	**NO -** message received independent of location, only registered numbers notified.	**YES** - all mobile stations within a defined geographical area notified
Two-way Communication	**Yes -** users can both receive and respond directly to the sender.	**Not direct response** - users cannot reply directly but can respond through numbers or URLs included in message.
Sensitivity to Disaster network conditions	Will often succeed in poor radio conditions, due to air occupancy for a short message of only a few tens of ms. Uses signaling radio channels, which can be subject to congestion in a disaster. Huge volumes can be subject to delays if sent during a disaster.	Broadcasts are sent on dedicated channels therefore **congestion unlikely**, though delays to message delivery may occur in areas of poor coverage.
Repetition	No repetition rate.	Messages can be repeatedly broadcast periodically by the GSM BSC/BTS within the range 2 s to 32 minutes. In a UMTS environment, the highest repetition rate is 1 s.
Roaming	Visitor often reliant on home network for message routing.	Message delivered to **ALL** mobile stations present in target cell.
Security and message integrity	**Poor** – no indication that a message is generated by a legitimate authority, and message can be "spoofed" from other phones.	**Good** - safeguards prevent an outsider from generating a cell broadcast message, therefore false or spam alerts are unlikely.[12]
Message		
Message Size	**140 160 characters**. Maximum of 5 messages can be concatenated	**93 characters**. Maximum of 15 Concatenated Pages
Message Type	**Static** messages will be sent only to all registered numbers.	**Custom** messages can be sent to different areas to reflect different alert status or hazards.
Message Display Notification	Display can be controlled by user	For subscribed handsets messages can be automatically pushed to the screen and a distinct alert sounded
Handset Compatibility	Compatible on all handsets.	Compatible on most handsets but may require manual configuration or software client on handset. Presentation may differ across handsets.
Reception	Message received once the mobile is switched on.	No message received if broadcast is sent whilst mobile is switched off. However, if updates to the cell broadcast are sent, they will be received when mobile is switched on.
Delivery Confirmation	**Yes** - sender can request delivery confirmation.	**No** - no confirmation of delivery.
Language selection	**No**. Identical to all receivers	**Yes**. Messages can be broadcasted in subscriber's preferred language

12 Defined in 3GPP TS23.041 and previously in ETSI GSM 03.41

Disaster
Response

When you restore the mobile network,
you rebuild the human network

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