DISASTER RESPONSE

DEWN - DIALOG'S DISASTER AND EMERGENCY WARNING NETWORK

JANUARY 2015

Introduction to DEWN

On December 26th 2004, a massive undersea earthquake off the coast of Sumatra, Indonesia, measuring 9.1 on the Richter scale caused a huge tsunami that affected people in fourteen countries. The Indian Ocean Tsunami, as it has become known, was one of the deadliest natural disasters ever recorded causing the deaths of almost 250,000 people, injuring a further 500,000 and displacing almost 2 million. While many parts of the world were celebrating the festive season with family and friends, communities by the Indian Ocean encountered waves with a height of up to 30 meters that left death and destruction in their wake. Local economies were devastated and in many cases communities which hinge on fishing and tourism are still to fully recover. Indonesia suffered the most casualties, followed by Sri Lanka, India and Thailand.

Reports from Sri Lanka at the time indicate that in addition to the absence of an early warning system, there was also a general lack of understanding about what a tsunami was. Even after the tsunami had struck there was little awareness in the inland communities of what had happened by the coast. The word tsunami in either Sinhala or Tamil (two native languages) actually meant very little as there had been no prior experience. Many of the 35,000 lives lost in Sri Lanka could have been saved if a simple warning to evacuate coastal areas had been delivered. There was a window of approximately 90 minutes between the earthquake and the arrival of the waves on the Sri Lankan East coast and an even longer period until it hit the Sri Lankan West coast. A warning delivered 90 seconds in advance of the impact would have enabled many people to get to higher ground and make themselves safe. Some estimates indicate that around 85% of lives in Sri Lanka could have been saved if such a system was present in 2004.[1]

Many staff members at Sri Lankan mobile operator Dialog were impacted by the disaster with family members or loved ones included in the lists of casualties and injuries. Dialog were one of the first to set-up a Disaster Relief calling centre as part of their community development initiatives following the Tsunami. For those staff members working in technology and innovation the scale of this disaster proportions brought multiple dimensions of disaster management into focus, not least of which was the use of technology to aid preparedness and/or relief efforts. It was suggested that GSM technology could be used as an effective early warning mechanism.

In 2005, Sri Lanka had 18% mobile penetration and the industry was growing at a rate of 42.5%. Dialog had 63% market share and the feeling was that mobile could positively contribute to development in the region tremendously in subsequent years. These ideas led to the development of the Disaster and Emergency Warning Network (DEWN). The development of DEWN was spearheaded by project partners Dialog Telekom (as Dialog Axiata was then known), Microimage, a software company, and the Dialog-University of Moratuwa Mobile Communications Research Laboratory.

The DEWN system uses widely available mobile communications technologies such as short messages service (SMS) for early warning and cell broadcast (CB) and its purpose is to provide a cost effective but reliable mass alert system. The network

[1] What happened in Sri Lanka? And why it won't be so bad next time – Prof. Rohan Samarajiva LIRNEasia, Presentation 19 Jan 2005

connects mobile subscribers, emergency responders, community leaders and the general public to a national emergency monitoring centre which is now housed at the National Disaster Management Centre (NDMC).

This case study from the GSMA Disaster Response team outlines the DEWN system from initial conception, through development and revision. These latest advances were officially launched as DEWN v2 on the 10th anniversary of the Indian Ocean Tsunami, in 2014, by the Speaker of the Sri Lankan Parliament, the Honorable Chamal Rajapaksa.

Dialog Outline

Dialog is Sri Lanka's leading mobile network with over 35% total market share comprising more than 9 million connections[2]. The business is led by Dr Hans Wijayasuriya as CEO and is renowned for a focus on using its network and operations for development, innovation and sustainability purposes.

The sustainability arm of the business functions as an innovation lab where enriching products and services can be delivered to the public. CSR initiatives at Dialog aim to deliver low cost communications and to minimise barriers to entry for Sri Lankans. Listed among Dialog's achievements in the areas of Mobile for Development are:

- First operator to launch a public early warning system (2005)
- First Lankan operator to launch a mobile money service (2012)
- First operator in the world to launch an interoperable mobile money service alongside its competitors Etisalat (2014)

Sri Lanka - At a Glance

Population	21.9 million[3]
GDP per capita (PPP)	6,500 USD[4]
Mobile Connections	26.1 million[5]
Unique Subscribers	10.8 million[6]

[2] GSMA Intelligence
[3] CIA World Factbook 2013
[4] CIA World Factbook 2013
[5] GSMA Intelligence
[6] GSMA Intelligence

Covering just under 65,000 km^2 the climate in Sri Lanka is tropical monsoon while the terrain is mostly low and flat, rising to mountainous environments in the south central interior. Sri Lanka is still developing but has made enormous advances in the past twenty years. For example, the percentage of those living below the national poverty line has fallen from 29% in 1996 to 7% in 2013.

The most common natural disasters on an annual basis include flooding, extreme winds or storms, droughts, lightning and landslides.[7] Only 15% of Sri Lankans[8] live in large cities or towns which can amplify difficulties in responding to disasters all over the country given the sometimes limited nature of the country's infrastructure.

Disaster	Date	No. Killed
Earthquake (seismic activity)	Dec-04	35399
Storm	Nov-78	740
Flood	May-89	325
Flood	May-03	235
Storm	Dec-64	206
Storm	Dec-57	200
Mass movement wet	Oct-93	65

Source: "EM-DAT: The OFDA/CRED International Disaster Database

[7] Sri Lanka National Report on Disaster Risk, Poverty and Human Development Relationship published by Disaster Management Centre Sri Lanka, United Nations Development Programme in Sri Lanka & United Nations Development Programme Regional Centre, Bangkok

[8] CIA World Factbook 2013

Figure 1 - Pictures of the tsunami striking the coast of Sri Lanka - Dec 26th 2004

Pictures courtesy of the Sri Lankan DMC

DEWN Version 1 2005-2014

Design Requirements

Initial research into the concept of using GSM networks for an early warning system yielded positive results. The next step was to establish the goals of the service and how these would address the needs of the public. The principal objective of DEWN is to provide early warnings of impending disasters to communities in disaster-prone areas using GSM networks. The initial design requirements for the alerting system were that the system would be:

- A facility for instant alert delivery
- Effective in alerting citizens at day or night
- Immune to mobile network congestion
- Capable of providing methods of obtaining further information through a call back facility
- Comprehensible in local dialects
- Capable of mass dissemination as well as focused direction to specific locations or people
- Able to use multiple alerting methods to ensure message delivery
- Easily affordable and not limited to an exclusive community

Further research into the areas of GSM technologies which could be applied then followed; cell broadcasting, location-based technology, SMS and software features of handset operating systems. At this time, Cell Broadcast was in the very nascent stages of consideration anywhere in the world as an alerting tool. The first public trial of Cell Broadcast as an alerting tool took place in The Netherlands between 2005 and 2007 and the first demonstration broadcast of Cell Broadcast on 3G took place in 2006.[9] Until this point, the global convention for warning citizens was a siren or loudspeaker and traditional communications such as radio. Smartphones - as we know them today - were yet to proliferate and most handsets in use in Sri Lanka at the time were Nokia or Motorola which ran Java, Symbian or Microsoft operating systems. This in itself provided both opportunities and hurdles for the DEWN development team to overcome.

Public Alerting Systems

The simplified process flow chart for any public alerting system is shown below and all three elements need to be constantly present, functionally effective and consistently reliable.

[9] Cell broadcast trials in The Netherlands: Using mobile phone technology for citizens' alarming, Reliability Engineering & System Safety, July 2009

Data Collection

At the time of DEWN's initial development, the main sources in the region for emergency information were the National Disaster Management Centre in Sri Lanka (inaugurated in 2005 after the Indian Ocean tsunami), the US Geological Survey, the Pacific Ocean Tsunami Warning Centre (PTWC) and members of the public. While the DEWN system was designed to transmit the data received from such sources to the public in a simple and concise format, alongside the DEWN developments there were many advancements made in the level and accuracy of data collected from these sources.

Data Interpretation

One of the issues with data interpretation in 2004 was that there was a lack of knowledge of the potential scale of a tsunami impact. The science used at the time was simply not advanced enough to realise the possible implications of such a tsunami. Since then, more recording stations including sea-level indicators and weather stations have been established resulting in many more data sources being available today.[10] In addition, the depth of knowledge and the forecasting ability of scientists have increased. The PTWC report much progress in determining earthquake characteristics and tsunami forecasting.

Message Dissemination

In any public warning system the messages needs to be sent through as many channels as possible. Although Dialog developed the DEWN system using the GSM network as a base technology, a GSM handset was never considered to be the only means to alert the public. The media would be alerted so that both TV and radio channels could also be used to alert the public. In addition, special DEWN alarm devices were designed (see Box.1) as a means to send the alerts to the public. These devices were developed by the Dialog-University of Moratuwa Mobile Communications Research Laboratory, and were in the early stage a critical tool. Importantly, the DEWN alarm devices helped bridge the process in familiarizing the public with an integrated multi-media warning system.

SMS and Cell Broadcast

GSM Technology

Following a disaster, both mobile and fixed telecommunications networks can become congested almost immediately. This is a limitation of mobile networks in any emergency situation as network capacities are designed to manage an average load given particular numbers of subscribers and not for large spikes which can occasionally occur. As an illustration, in the immediate aftermath of the Great East Japan Earthquake in 2011 on the NTT DoCoMo voice network, originating-call attempts jumped 60 fold and receiving-call attempts jumped 40 fold when compared to levels just prior to the earthquake. After the 2011 earthquake in Van, Turkey network traffic jumped 4x times on the core network in the region. As a result of this limitation, a practical work-around is necessary on GSM networks in addition to the utilization of other communication methods to transmit messages, both warnings before a disaster and subsequent updates after a disaster.

[10] Advances in Tsunami Warning Systems Since the Great Sumatra Earthquake of 2004, Presented by Dr. Stuart A. Weinstein, Asst. Director PTWC, LIRNEasia Lecture Colombo, June19 2014

BOX 1: DEWN Device

The DEWN device was developed by the Dialog-University of Moratuwa Mobile Communications Research Laboratory. These devices were distributed to communities to act as an additional means to alert the public. Equipped with GSM functionality and an FM radio receiver the devices had to meet the following requirements:

- Alarm triggered by reception of either SMS or Cell Broadcast from a recognized source
- Alarm siren and flashing light display
- Compact size, portable and low-power consumption
- Powered from mains power supply but with battery back-up
- Capable of multi-lingual support with a user-friendly GUI and colour touch screen
- GSM call-back facility to receive further advice from a hotline
- Message acknowledgement
- Remote and local testing function

The device is placed in locations such as police stations, places of religious worship and community centres and complements the DMC's 77 multi-hazard early warning towers dotting the coast of Sri Lanka.

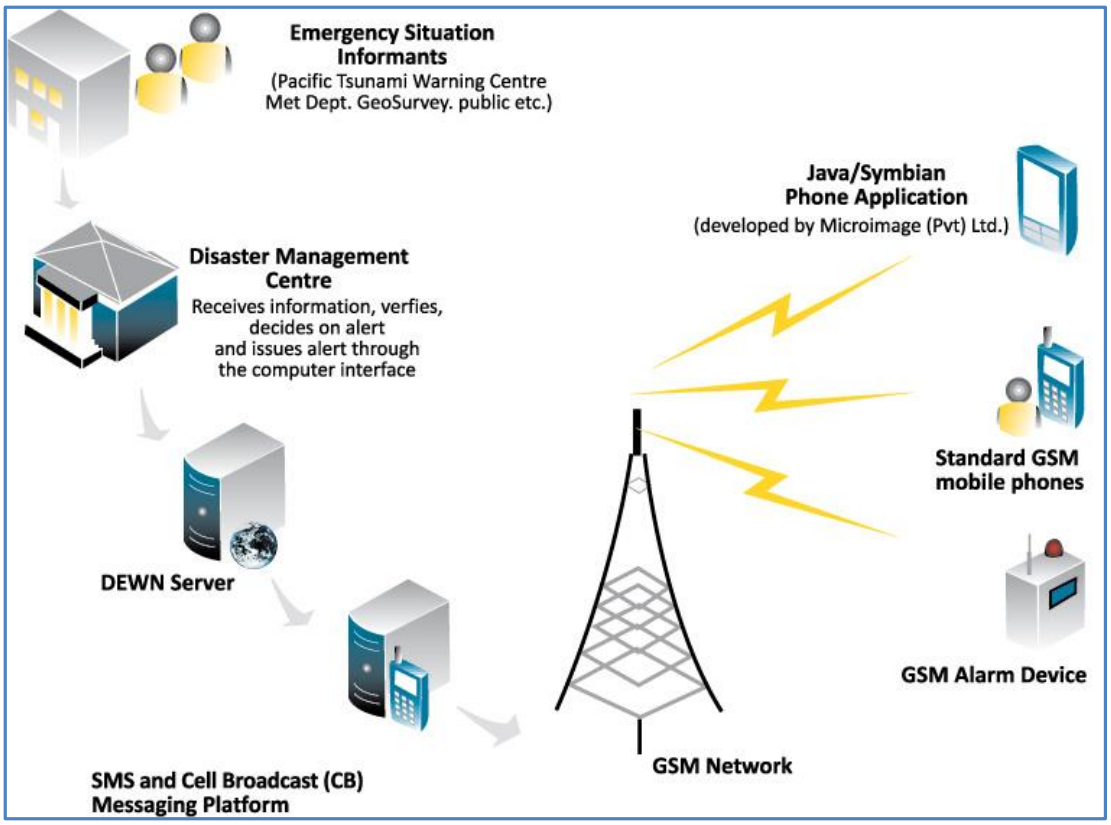

Figure 2 – Diagram of data flow and message dissemination in DEWN v1

SMS

The short message service is one of the most important services in any mobile operator's portfolio. The usage numbers are staggering (19.5 billion SMS messages sent every day globally in 2013)[11] and throughout the 1990's and 2000's, SMS was one of the main revenue drivers for operators all over the world. However, given the structure of the GSM network and the channels that SMS uses on the air interface, SMS is prone to congestion, although much less so than a voice call. In the lead up to a disaster, mobile networks may experience technical challenges and so early warning service design should consider the attributes of the network and its management to avoid adding additional pressure onto the network[12]. The SMS message is sent directly to the handset number and messages received on the handset are independent of its location. As a mass-alerting tool, this means SMS may not be as location friendly. There is no guarantee the recipient is present in the applicable area which could lead to confusion. However, for a more focused alert, SMS can be very applicable.

Cell Broadcast

Fortunately, GSM already has an in-built facility for such a workaround. Cell Broadcast is an under-utilised signaling channel on the air interface between the handset and the transceiver and in basic terms allows the GSM network to function as a traditional radio, so every handset in the area can pick up that broadcast message. Furthermore, Cell Broadcast has the

[11] Informa Press Release April 30 2013 available at http://www.informa.com/Media-centre/Press-releases--news/Latest-News/OTT-messaging-traffic-will-be-twice-volume-of-P2P-SMS-traffic-this-year/

[12] Towards a Code of Conduct : Guidelines for the use of SMS in Natural Disaster – GSMA Disaster Response, Souktel and Qatar Foundation

unique feature of not being subjected to or contributing to network congestion. Since it uses a signaling channel it is not affected by traffic channel availability and it does not carry voice traffic.

Cell Broadcast as a GSM technology has several other key distinctions that make it readily applicable as a public alerting tool. These include:

- Message Display - The message is displayed on the handset with no user interaction and a distinct warning tone is sounded.
- Message Delivery – Cell Broadcast 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.
- Anonymity - Another key advantage of Cell Broadcast is the recipients remain anonymous since it does not require registration of numbers or maintenance of a number database and messages are sent to all users within a geographic area.

Time is of the essence in impending emergency scenarios so SMS and Cell Broadcast were considered to be the two best methods to use GSM technology for public alert systems.

BOX 2: Common Alerting Protocol

The Common Alerting Protocol (CAP) is an XML-based data format that standardises and simplifies the exchange of data for public warnings and emergencies between alerting technology types. CAP allows a warning message to be consistently transmitted simultaneously over multiple warning systems to many different applications e.g. TV, radio, mobile phone, fixed phone or public signage.

CAP increases warning effectiveness and simplifies the task of activating a warning for those responsible for issuing them. However, like many protocols, CAP does not address any particular application or telecommunications method but rather addresses the message itself.

Key benefits of CAP include:

- reduction of costs and operational complexity by eliminating the need for multiple custom software interfaces to the many warning system inputs/outputs
- message formats can be converted to and from the "native" formats of all kinds of sensor and alerting technologies
- formation of a basis for a technology-agnostic national and international "warning internet."

CAP forms the basis of emergency alert services run by many multi-agency bodies around the world including those in the US by the Dept. of Homeland Security/FEMA and by the National, State and Territory governments in Australia.

Figure 3 - Pictures of the aftermath of the tsunami in the days after Dec 26th 2004

Pictures courtesy of LIRNEasia

DEWN: Directed and Mass Alerts

DEWN was designed with two alerting objectives in mind. The first is to direct alerts to a set of relevant community stakeholders and the second is to direct mass alerts to the general public. Pre-alerting trained community stakeholders means that when the general public receive the alert, the community leaders are ready to support and reaffirm the need for action. The public could turn to these leaders for further guidance. Such stakeholders include those responsible for emergency services in areas such as police hierarchy, village chiefs, government agents, monks or other religious leaders and hospital administrators.

For directed alerts to registered stakeholders, it was decided to use SMS messaging since the numbers are limited and congestion would not arise. This relies on a centralised database, which contains a predefined set of numbers for each stakeholder in each region. The direct alert service also supports additional features such as message receipt acknowledgement and the return delivery of status updates with respect to the disaster situation to the national DMC.

Mass alerts to the general public on the other hand use Cell Broadcast messages enabling the alerts to be sent to as many recipients as possible.

Sri Lankan Development

DEWN alerts are issued through a secure computer application where the text, geographical area and recipients (individuals or groups) can be selected for the message which is automatically drafted in the three main languages of Sinhala, Tamil and English. The interface between this application and the GSM network entities SMS Centre (SMSC) and Cell Broadcast Control (CBC) is done via a message broker. The messaging system supports the internationally accepted Common Alerting Protocol with the ability to easily integrate other generic alerting mechanisms. The message broker and the DEWN server enable the link between the DMC - data collection and data interpretation – and the public to occur through Dialog's GSM network - data dissemination.

The local software firm, Microimage, was a key partner in overall design and developed the message broker and DEWN server in addition to the required multi-lingual alerting client for mobile handsets. The DEWN message broker middleware connects to the Dialog SMSC for SMS and the CBC for Cell Broadcasting. The server and client software are widely configurable and offers advanced and customised options.

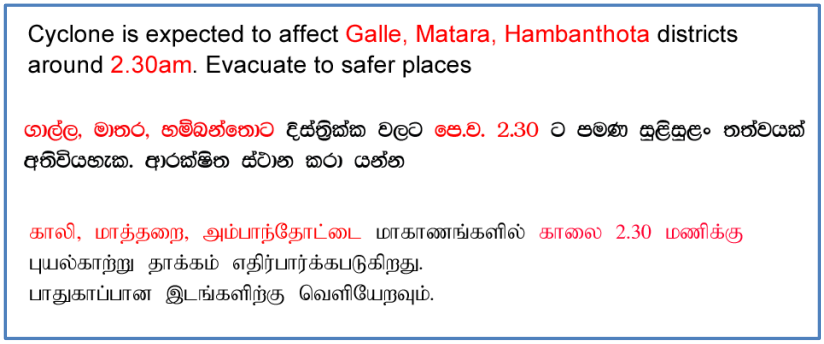

Figure 4 – An example of DEWN messages in three languages English, Sinhala and Tamil

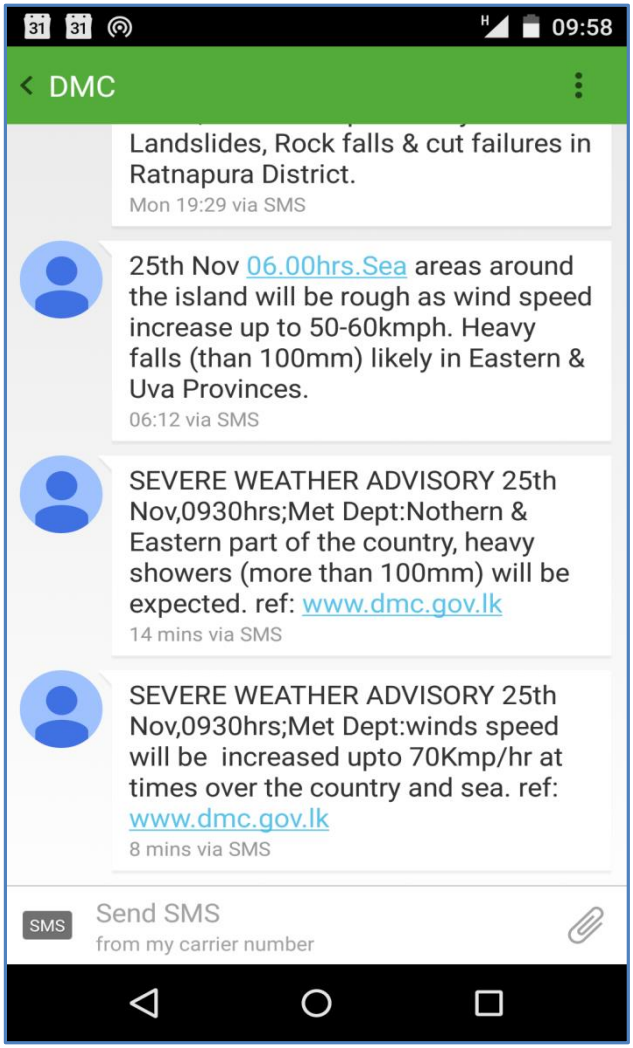

Figure 5 – An example of how DEWN messages appear in English on a handset

DEWN Messages

Data collection takes place at the DMC and once data analysis indicates a possible threat to the public, a message is sent to the Emergency Operation Centre (EOC) of the DMC. 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. This is very important as public confidence in the system is critical to its success. The EOC acts as the message aggregator where the message is verified and authenticated. Once this procedure has completed, the customized alerts are sent via the secure DEWN alerting interface and the CBC. As previously stated, messages can then be sent out via SMS for directed messages and cell broadcast for mass alerts. Some handsets receive the message via a Cell Broadcast enabled Java app which is downloadable to early version smartphones.

Although DEWN was designed in reaction to the Indian Ocean Tsunami, it has become utilised as an all-hazard early warning system by the DMC. Between Dec 23rd 2013 and Oct 24th 2014, the DMC has sent 375 SMS alerts to 5000 community and government chiefs. As an example, two recent messages warned residents both locally and nationally of heavy rainfall and the possibility of landslides, as follows:

21 Oct NBRO; landslide watch, if rain continues in next 24hrs, be watchful on possibility of Landslides and cut slope failures in Ratnapura and Badulla districts.

23rd Oct 0530hrs (Met) Showers/thundershowers will occur over most parts of the island (afternoon & night). Heavy falls (more than 100mm) likely at some places.

Each of these messages is transmitted in three languages as shown in Figure 4. The transmission of such messages enable workers such as tea-pluckers and fishermen to be aware of any threats and enables villagers in the hill country to gauge the level of danger in the rainy season.

Through the design and implementation of DEWN, it has been noticed that technology alone will not significantly impact disaster management. There is a requirement for public awareness, education and engagement with regard to both the early warning system and the correct procedures upon message reception. These issues have been noted by practically all countries which have rolled out or are rolling out a public early warning service. [13,14,15]

DEWN Version 2 2014 onwards

Widen the DEWN Community

DEWN v1 brought the first early warning system to Sri Lanka helping to build more resilient communities all around the country. However as technology changes and evolves, so too must the services which depend on that technology. This is true for both the GSM network and the surrounding eco-system which DEWN has built up. While DEWN currently has three methods to alert a mobile handset; SMS, Cell Broadcast or via a Java App, Cell Broadcast is only available on the 2G network. Since the launch of DEWN, 3G phones have become more widespread in Sri Lanka and indeed 4G is also now available. This requires the upgrade of all 3G sites in Sri Lanka to become Cell Broadcast compliant.

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[13] *FEMA and Ad Council Help Americans Prepare for Severe Weather* – FEMA Press Release – May 30 2013 available at http://www.fema.gov/news-release/2013/05/30/fema-and-ad-council-help-americans-prepare-severe-weather

[14] *Report on the use of cell broadcast as a citizen alert system - Lessons from a two-year study in the Netherlands (2005 – 2007)* J.W.F. Wiersma, Dr. H.M. Jagtman, Prof. B.J.M. Ale Delft University of Technology

[15] Mobile Alerting Trials: Project Report April 2014, UK Cabinet Office available online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/298687/Mobile_Alerting_Trials_Project_Report_FINAL.pdf

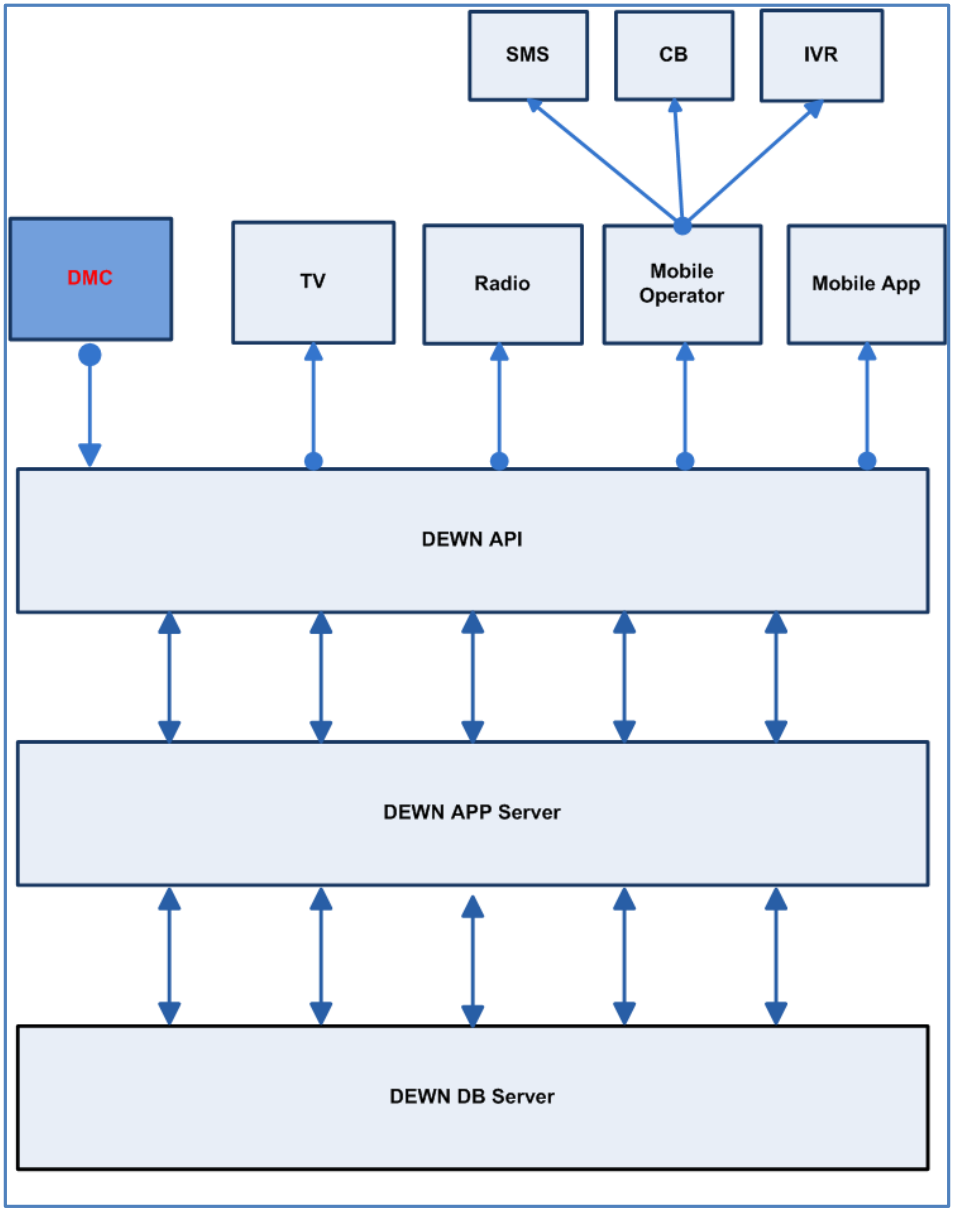

Figure 6 – High Level Architecture for DEWN v2 encompassing new methods for message dissemination and access to other operators

Sri Lanka's Primary Warning Tool

The Sri Lankan DMC has chosen DEWN to be their key priority tool in their five year plan from 2014 onwards. As a result of this, the Sri Lankan government has become more involved and the service must be opened up to other operators and service providers. This will be done through an API which will sit between the DEWN Server and all other entities. The API, as a software-to-software interface, will allow many different applications from different sources to talk to each other without any user knowledge or intervention. See Figure 6 for details. Since security and privacy of mobile subscribers and other users of DEWN is critical, it is necessary throughout the testing period to ensure the robustness of the platform. Private data and user information will be transmitted via secure and encrypted Secure Socket Layer (SSL) links. Advancements such as these position DEWN to become a regional alerting tool in the future and the API can enable DMC in other locations to link into the service to both provide inputs and to receive outputs.

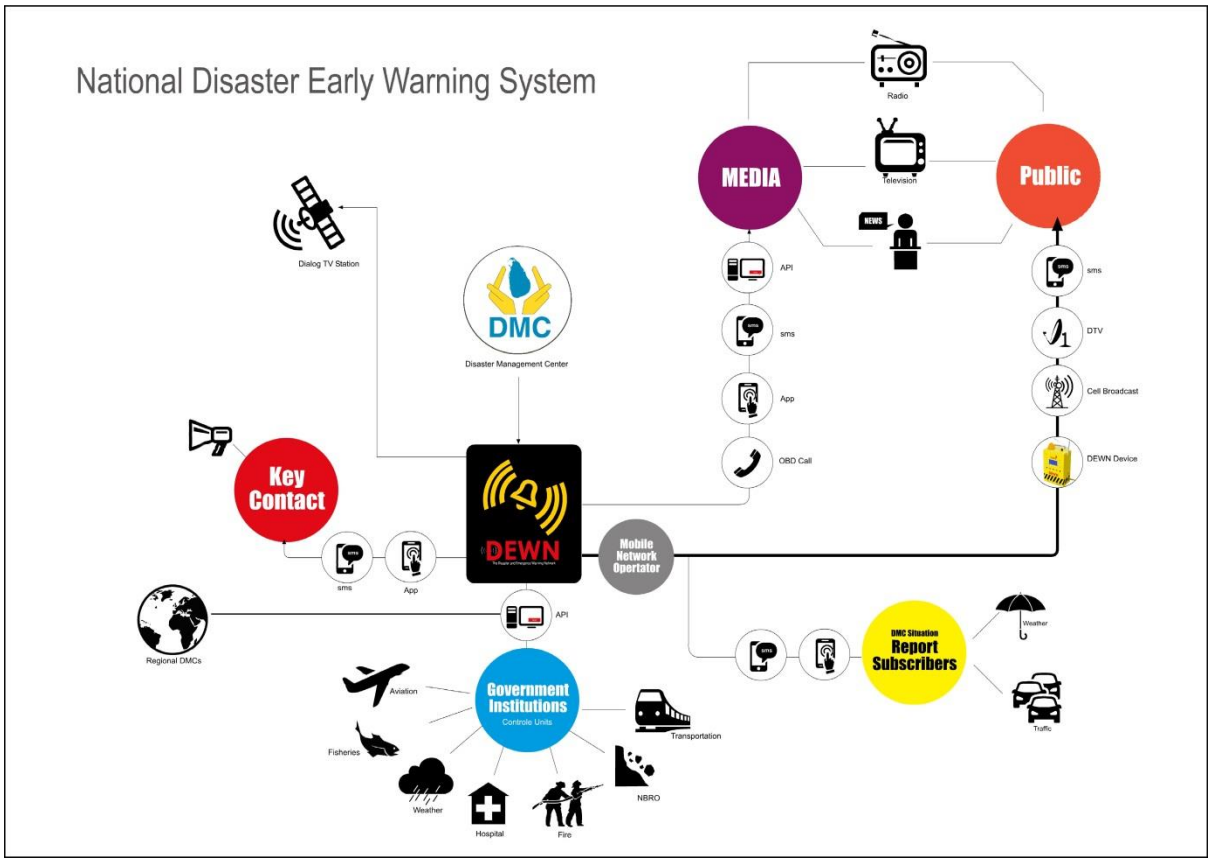

Figure 7 – Sri Lankan DMC vision for DEWN v2 with multiple input and output methods

API, Android App & OBD

To make the system as broadly accessible as possible and to allow third parties to build an ecosystem around it, an API (Application Programming Interface) has been made available as part of the new system, with centrally authenticated connections to ensure due authorizations and access levels.

As the penetration of smartphones in Sri Lanka grows it is prudent to have Apps which can be triggered to issue alerts to the handsets also. The API and new technical processes behind the service make this possible. The App accepts notifications from either SMS or Cell Broadcast in addition to API-driven signals. By keeping the API open it is intended to allow third parties to develop independent apps for different platforms (mobile or otherwise), feeds to services such as Twitter and RSS, and utilize alerts for dissemination on other media.

A pre-recorded OBD (Out-Bound Dialing) service, restricted to select user groups due to load issues, has also been developed as part of the new system. This is intended to be used for early-stage warnings to key personnel, as well as to segments who may have sight difficulties or find it difficult to understand written messages.

DEWN Expansion

What's next for DEWN? To date the service has been developed on a voluntary basis by all partners and is currently only available to Dialog subscribers. To keep the project moving and to allow it to become self-sufficient, there are plans in place to house DEWN within a wider set of alerts including those for traffic and weather updates. This wider platform will be available for a small subscription fee to subscribers of other Sri Lankan networks. The DEWN alerts themselves, as a national service, will remain free to all mobile users regardless of operator. Furthermore, DEWN can also become available to operators in other countries and all partners and the Sri Lankan DMC are enthusiastic about seeing the alerting net grow in such a fashion. Thushara Dharmawickrama, Sustainability and Corporate Affairs at Dialog, outlines the tasks and challenges ahead: "We are speaking with new possible partners within the telecommunications sector to identify ways to expand the alerting network to bring this ecosystem to more people." One of the benefits of using the API and the new version of the CAP protocol is that other parties can come on-board with minimum effort via the standards interfaces and protocols. Dialog, of course, have a history of such with their mobile money service eZ Cash which has now expanded to become interoperable with Etisalat Sri Lanka.

Conclusion

This case study details the extensive developments undertaken by Microimage, University of Moratuwa and Dialog in developing an effective public warning system for Sri Lankans. The tragic events of 2004 led to the development of a tool that is used daily by local community leaders, emergency services, religious chiefs and the general public. From early beginnings with purpose-built alarm devices and basic smartphone compatibility, DEWN v2 issues alerts in many different formats; has full functionality for Cell Broadcast on 3G networks, issues SMS messages and allows message acknowledgement and works with an Android App. The economic and social benefits of this ongoing project continue to have a positive impact in Sri Lanka.

Dialog's Mobile Communications Research Laboratory at the University of Moratuwa, Sri Lanka, funded by Dialog, ensures timely technology enhancements are integrated into the DEWN roadmap and that the project is adequately managed and expanded. The contributions extended by the university research fellows, students and staff towards DEWN are voluntary and do not expect a return apart from the success of the system.

Microimage, the key software partners of DEWN and the authority which develops the core of the platform does their part of the implementation without any cost to the service or stakeholder.

The development of DEWN stands out as a best practice example of a non-commercial undertaking and demonstrates how multi-sector entities pooling their respective strengths can develop a high-quality national service to alert citizens of impending danger. Dialog, Microimage and the University of Moratuwa Mobile Communications Research Laboratory are to be commended for their efforts to date in developing DEWN v2 and for the ongoing advances they are making in this important field.