

The capacity of communication networks and emergency warning systems to deal with emergencies and natural disasters

Submission to the Senate Standing Committee – Environment and Communication

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Executive Summary

This submission has been prepared to highlight a range of issues that need to be considered and factored into any strategic planning with regard to future communications requirements for emergency services. I am aware that numerous initiatives, strategies and working groups exist across Federal State and Territories to work through this complex issue. As an experienced telecommunications expert, I have concerns that based upon lessons learned over the past few years as we still do not seem to have a robust strategy that addresses many of the issues identified.

Given the fundamental importance of a robust communications infrastructure and services, this document probes and challenges many areas to qualify the reasons why the Government needs to carefully consider future requirements and approaches.

Although I understand that State and Territory Governments are responsible for their own emergency service agencies, I believe that the office of the Auditor General and Emergency Management authority do have responsibilities in relation to policy and governance. Furthermore given the importance of spectrum allocation and telecommunications legislation I would assume that ACMA would also be involved at a strategic level.

Following are the key points that are addressed:

- The need to produce a comprehensive telecommunications strategy paper for major emergency and incident events. This paper should explore the end to end requirements for all aspects of emergency management including public warning systems, emergency services networks and data gathering sensor networks for incident prediction and management.
- Highlighting the opportunity to identify residents living in designated high risk areas and developing a specific alerting approach for them.
- Discussing the key issues regarding emergency services requirements for access to high speed radio networks and how this can be achieved.
- Investigating options to provide a common emergency radio platform across State and Territory borders.
- Whether the NBN provides any benefits to emergency telecommunications and what considerations need to be made.

Background

I am an independent telecommunications and IT consultant with over 40 years experience in the industry. I have been involved in many areas of communications related to emergency warning systems both in Australia and overseas.

As a telecommunications engineer in the UK I worked for many years on the national emergency warning system that was provided for the **"4 minute warning"** nuclear attack scenario. This system covered the whole of the British Isles and was maintained operational from 1960 to 1992.



Early warning system police console



Remote battery powered receiver unit

<http://www.ringbell.co.uk/ukwmo/Page211.htm>

Over the past 20 years I have been involved in various telecommunications projects related to emergency management operations, I believe that the experience has given me an excellent understanding of the numerous challenges.

I have recently worked with overseas organisations dealing with communications strategy regarding mission critical national infrastructure as well as emergency communications networks; this has provided me with a significant insight into alternate approaches to this area of need.

Recognising that reliable and accessible communications are a fundamental component of any integrated solution to emergency management it is important to consider that expertise is often so specialised in a particular area that a holistic view isn't taken of the problem. Having such a wide ranging experience across all facets of communications including network planning, switching, transmission, external plant, microwave, satellite and cellular particularly relating to emergency services I consider myself well qualified to comment on our national requirements.

Observations made in this submission are based upon my experience and desktop research; therefore I may not be fully acquainted with strategic initiatives that are underway to address the issues I have raised.

Terms of reference

1. *The effectiveness of communication networks, including radio, telephone, Internet and other alert systems (in particular drawing on the spate of emergencies and natural disasters of the 2010/2011 Australian summer):*

(i) in warning of the imminent threat of an impending emergency,

In any major emergency or natural disaster it is essential that critical communications facilities are maintained to provide the capability to deliver alert warnings and status reports to the general public where they may be at risk and may need to evacuate their homes or place of work.

The fundamental attributes of a communications bearer that will deliver an alert message are as follows:

Reach

The communications bearer should provide a comprehensive geographic footprint to ensure that as many residences as possible are covered and can be contacted.

Availability and reliability

The bearer should provide a high degree of availability and where possible not be affected by adverse conditions and in particular abnormal network traffic demands.

Data capability

The bearer should be capable of carrying small alert data packets detailing emergency status and instructions to a resident.

Addressable devices

The network and bearer should support the ability to send messages only to relevant receiver units based upon their geographic location to ensure that the right alerts reach the right people.

Cost

Where possible the capital and operating costs of this facility should not be excessive and involve extraordinary infrastructure development.

Inter-operability

Given the large number of emergency bodies that might despatch alert messages to a multi-nodal platform, it is essential that the system and bearer supports internationally determined standards such the Community Alert Protocol (CAP).

The current approach

To date, various methods of alerting are being deployed across States and Territories. It is acknowledged that they do provide a high degree of information to community members at risk.

It is important to consider that whatever the application used for alerting is, there is an underlying fundamental requirement that the physical communications bearer and power supply to the device remain intact for it to remain effective.

As communications technologies have evolved, the community have an expectation that services will always work, thus enabling them to stay in touch and be informed. Unfortunately, in any major incident the two key factors that lead to link failures are excessive network traffic leading to overload and service failure due to physical infrastructure damage or power failure.

Although various means of community alerting are in use today, they are in many cases sub-optimal and require a more comprehensive approach. Following are the main options in use today and where the limitations lie.

Radio and television

Although Radio and Television provide a robust and ubiquitous means of disseminating information they suffer in three areas when being used for on-air broadcast to provide emergency alerts and situational status of an incident:

- a) Information provided is the same for everyone in the broadcast area, even though the incident implications will inevitably vary within this same zone. Broadcasting evacuation notifications and high priority alert notifications that are heard by community members not in immediate danger can cause fear and unnecessary panic.
- b) During most disasters sustained mains power outage is often a consequence, this being the case television soon becomes ineffective. Furthermore, increasingly portable radios are often not equipped for long-term, stand alone battery options. Re-chargeable facilities are sub-optimal as during a sustained power outage the ability to re-charge the radio is often not available. Furthermore during major incidents battery stocks are soon depleted in local shops.
- c) ***TV and Radio cannot wake people up when the emergency occurs at night!***

Fixed line telephone

Fixed line telephone services have previously been a communication channel of choice to reach community members, however increasingly many people are opting to rely on their mobile telephone or Voice over IP through a broadband service as their primary means of communication. The standard fixed telephone is a fairly reliable communications medium, where a standard fixed telephone is present as the central exchange battery will support the service for a long period even through sustained power outages (with exception of mains powered cordless telephones).

Although an option for narrowcast alerting, consideration for fixed line services should be as follows:

- a) Telephone exchanges are designed and constructed to meet “Normal” busy hour traffic demands which means that during normal day to day operations adequate switching and line capacity is acceptable (Standard Grade of service (GOS) is 1% meaning that 1 call in 100 could fail). However during abnormal incidents, telephone exchanges can become over-loaded and cease to be effective. In these cases, fixed telephony as a means to alert can be severely compromised, particularly when urgent evacuation alerts are being despatched.
- b) Fixed telephone alerts that rely on the landline for dissemination can often take hours to send all the messages to the available list of phone numbers. In the event of a fast-moving bushfire, this may not be the best means of alerting residents.
- c) Computer generated “Interactive voice response” (IVR) systems are used to send multiple concurrent voice calls to the community. When this facility is used, it is essential that the ISDN services are directly connected to the local IVR system to ensure “end to end” visibility and warrant the correct and timely delivery of calls to recipients. I have observed that some solutions are sending these calls to outsourced IVR organisations to generate and deliver these calls. This is both inefficient and presents considerable risk to the timely delivery and audit of calls. Where this type of service is used, it is essential that the IVR servers are directly connected to public network ISDN primary rate services typically in the local geography served.
- d) Many people now rely on mains/battery powered cordless telephones in their homes; in these cases if a fixed basic telephone is not available a sustained power outage could render this an ineffective means of contacting residents.
- e) Increasingly, many home owners are migrating to Voice over IP type telephony solutions. These services may not always be recorded on the “Integrated public number database” (IPND) which is to be referenced as a part of the National Emergency Warning System (NEWS).
- f) Although full integration with the IPND is specified to assist in the correct correlation of a home address to a fixed telephone number this relationship is sometimes not immediate or accurate as numbers are “Ported” between different voice carriers.
- g) It is important to consider that emergencies can also occur at night; people sleeping may often not answer a ringing telephone in the middle of the night or indeed may not even hear it. This being the case, it is important to realise the potential for the non-delivery of alerts.
- h) Although fax machines can be used for less important update narrowcasts, it is important to realise that all facsimile machines are mains powered and are therefore susceptible to mains outages.
- i) Finally, although telephone exchanges and line plant are generally fairly robust, in the case of major inundation or bush fire there is significant likelihood that the serving exchange, local overhead line plant or exchange trunk connections could be damaged by the event.

In summary fixed line narrowcast alerting has been a useful means of contacting people at risk; however the facility is by no means the best solution.

Furthermore, migration from standard voice services to mobiles and Voice over IP (VOIP) are meaning that it will become increasingly difficult to ensure that alert messages are sent to all residents in a defined high risk area.

Note:

Significant expenditure has already been made at State and Federal government levels to develop solutions in this area as well as to augment the existing IPND to provide greater accuracy of addresses to telephone numbers.

Mobile telephone

It is well acknowledged that mobile telephones are becoming the ubiquitous means of communication for the masses. This being the case, it can be an excellent tool to use for alerting individuals. However it is extremely important to realise the considerable limitations that are presented when using this communications medium.

Although potentially an excellent medium for alert notification it also presents a range of challenges, these include:

- a) Major incidents (eg. The London bombing) have demonstrated the problems encountered with mass calling on mobile networks often rendering them inoperative. Therefore if a major incident occurs, typically numerous calls will be originated and terminated across local cell sites, this will invariably compromise both the cell site radio spectrum capacity (airwave channels) and trunk capacity connecting to the cell site. This being the case the ability to send mass alert messages to mobile handsets could be seriously compromised.
- b) Mobile coverage is typically fairly reliable in metropolitan areas, however in some country locations which may be prone to bushfire or flooding mobile coverage may not be as reliable hence leaving mobile users somewhat exposed and possibly unable to receive alert notifications. I understand that consideration is being made to extend coverage zones in some areas to ensure that mobiles receive connectivity, this being the case it is important to consider the fact that network congestion might still render mobile users inoperative even if coverage is extended.
- c) From my experience I have noticed some warning systems send messages to third party organisations to relay group message narrowcasts to mobile users. This provides no “end to end” visibility and potentially could lead to major delays in message delivery or indeed the loss of messages. Where SMS is used as an alerting method the system should be directly connected to all mobile operators SMSC gateways. I believe that legislation should be made to ensure that any alert system requires direct connection to a carriers (ISDN for voice /SMSC for SMS)
- d) Providing messages only to mobiles in the affected area is important, this can be achieved in two ways:
 - **Location based services (LBS)**
This requires the cellular operator to enable LBS applications across relevant base stations; the network then becomes aware of mobile users active on a particular cell. When an emergency is determined to affect an area in proximity to this cell targeted SMS can be sent to relevant mobile users.

Network congestion could impede the ability to rapidly determine connected users and deliver targeted messages.

- **Cell broadcast**

Mobile handsets are able to display various attributes relating to the serving base station, this device display can be addressed and an emergency alert displayed. This is an alternative to LBS and SMS and is also used in some countries. Once again however abnormal traffic loads could potentially compromise this approach.

- e) As well as SMS, voice calls can also be generated to be delivered to mobiles identified as being connected to a particular base station.
- f) As with the fixed-line option, an emergency alert at night would probably go unanswered as an SMS or even a voice call on a mobile may not be noticed.
- g) During periods of sustained power outage, re-charging mobile handsets could be a major problem.
- h) Finally, although Telstra is the major mobile provider in regional locations, Optus and Vodafone do have coverage in some “High risk” areas. It is therefore essential that full carrier inter-operability is assured for cell broadcast and LBS services.

Internet

Although social networking and the internet can be a useful tool in the dissemination of important information to the community they can also be problematic, following are issues to consider:

1. Internet connectivity will be supported by either fixed line (ADSL/Cable) satellite or wireless broadband. Once again during major incidents, network performance could be such that abnormal contention of back haul capacity or wireless spectrum (wireless broadband) could render an internet connection unreliable or unusable.
2. Information disseminated through social networking sites such as Twitter and Facebook is un-moderated and could be sent by anyone causing significant disruption and possible fatal consequences. In major emergencies community members may react rapidly without checking the source and validity/authenticity of information.
3. Emergency management authorities are increasingly providing updated websites on emergency incident status. Whilst network connectivity and power supplies are maintained this is an excellent means of communicating with the public.
4. In many cases the computer or laptop used will rely on mains power to service an internet connection. Once the batteries are exhausted the device will be unable to connect to the internet and will therefore be unable to receive subsequent alerts.

Other alert systems

As well as the public telecommunications networks and commercial TV and Radio there are other facilities that can be embraced to deliver emergency warning notification to specific members of the community:

1. For remote locations where no radio or fixed line coverage is available L Band/C or D+ satellite services can be utilised. These are low bandwidth options that can be used for rapid narrowcasting to people at-risk.. Typically the remote service will be locally powered by generator, solar or wind power thus ensuring they continue to receive status reports.
2. Citizen band, Short wave and HF radio can be used for local country areas.
3. External flashing lights and sirens are used in some townships that are prone to cyclones and flooding, these are reliable and known to local inhabitants.
4. Conditional road signs can be used to advise motorists of major incidents.

Suggested approach to community warning

Community alert requirements are not unique to Australia, indeed there are many global initiatives and standards evolving that address inter-operability and messaging, the most notable being the “Community Alert Protocol” (CAP). Originally one of the main alert bearers identified was radio paging as it enjoyed a reputation for reliability and was used purely to receive small text messages. Unfortunately with the advent of mobile telephones many paging networks have been de-commissioned (with the exception of the Victorian Emergency Alert System – EAS).

Radio has been identified as the most effective medium to deliver alert messages, since the 1980s a technology has existed that allows data signals to be sent on FM/AM radio channels. This is typically known for traffic information where alerts are sent to car radios. This technology is well proven and very reliable. It is now known as Radio Data Service (RDS) and is used for community alert systems in many countries. It is the most cost effective means of achieving geographic reach and delivering small data alerts on an addressable basis.

Existing radio transmitters can be used, these typically cover a radius of hundreds of kilometres, the equipment required at the transmitter site is a small rack mounted unit. Connection to the unit can be through standard land-line service or for diversity satellite links. Various emergency agencies are able to despatch targeted messages to geographic areas. The messages are received on dedicated receiver units that can be supported on battery power for over 960 hours.



Fig 1. Sample of rack mounted RDS Encoders/Decoders

This approach is used extensively across the US for Tornado alerts and is connected to the National Oceanic and Atmospheric Administration (NOAA) centre. Other countries also use these systems for Earthquakes, Tsunami, Bush fire and Volcano alerts.

There are numerous receiver units available, robust wall mounted units can be provided for homes. These units have in-built high intensity sirens ensuring that a sleeping resident will be awoken immediately. Furthermore a range of peripheral devices can be provided such as pillow vibrators for deaf people. These units vary in price however many are less than A\$100, in the US residents living in high risk areas receive subsidies for the US government buy the units from retail stores.

The main benefit of adopting the RDS approach is as follows:

- Greatest geographic coverage available covering most “High risk” areas
- Low infrastructure cost – Simple encoder/decoder units located in ABC transmitter sites
- Immunity from public network overload (Mobiles / Fixed line)
- Low cost receiver unit
- Sustainability of unit during extended power black outs – **>960 hours**
- Loud alert siren ensuring that residents are awoken at night
- Fully addressable units allowing narrowcast messages to be despatched to specific areas
- Large screen providing up to xx characters of text
- Messages can have 8 priority levels from low to severe
- Receivers can hold up to 10 messages at once
- The LED has a back light ensuring that the screen can be read during a power outage
- Ability to send messages to vehicle radios to ensure that people driving in high risk areas are notified of emergencies
- Where major facilities such as hospitals or nursing homes are involved, the units can be directly connected to the Local Area Network providing desktop alerts in the event that standard internet connections are lost.
- Ability to use the units for a back up to alert volunteer first responders where public cellular networks have failed

- Use of the RDS unit to trigger local community alert sirens where terrestrial links have failed
- High levels of transmitter reliability as typically ABC radio towers are located on hill top sites
- Ability to integrate into existing joint command and control systems such as WebEOC



Fig 2. Sample of RDS home based receivers

It is acknowledged that the most likely occurrence of a major incident will be in a high risk zone; these zones will be prone to the following:

- Bush fire
- Flooding
- Cyclone
- Tsunami

Obviously these zones are known and recorded, within these zones all known residences can be recorded by their Geo coded national address file (GNAF). Having listed these residences, the emergency authorities will have an inventory of all “At risk” properties. Once these sites are mapped with relevant GNAF locations, a further mapping exercise can be undertaken to identify the coverage of ABC radio in those areas. Once this has been ascertained it will be easy to identify all transmitter sites.

From this data, it will be fairly easy to calculate the number of encoder/decoder units required across the transmitter sites and how many home receiver are required. The total cost of this exercise may be less than that of all the mobile network augmentation for LBS and integration that is being considered.

(ii) to function in a coordinated manner during an emergency, and

In any emergency it is essential that all response and recovery personnel have access to reliable and highly functional communications facilities.

First responder alert

In many high risk areas first responder personnel are volunteers who have to be contacted immediately for mobilisation. For many years radio paging has been a reliable method of alerting personnel, however over the years paging networks have been retired (with the exception of Victoria -EAS). In place of paging, my understanding is that many volunteers are contacted by landline or mobile telephone. In the case of a major incident, this could present problems due to network congestion, line plant failure or power failure to an exchange or cell site. It is therefore essential that first responders have a reliable means of emergency call out.

The RDS as well as being used for community alerts, is also used for first responder notification. This is a cost effective and reliable option to consider.

Support communications during a major incident

Although all emergency services agencies use high availability private radio networks often supported on "Government Radio Network" GRN infrastructure there are issues to consider:

- Basic radio services supported on 400MHz networks support voice and low throughput text data extremely well, however they are unable to support high speed data file transfers to facilitate activities such as video streaming. Where these services are used to provide enhanced situational awareness, commercial cellular networks have to be used. Although this supplies the required functionality under normal circumstances, under network congestion situations these file transfers could be severely affected.
- During major incidents, many agencies and professionals (eg. Doctors and nurses) will be required to assist in response and recovery operations. Typically these people will rely upon mobile telephones to communicate. In the event that the cellular network is overloaded it will be extremely difficult to contact them.

(iii) to assist in recovery after an emergency;

Following recent major disasters it is evident that the re-building phases need adequate infrastructure to support logistics and general operations control. There is no doubt from the time a major incident occurs to a long way into the recovery process wireless communications are one of the key enablers. In situations where mobile base stations have been destroyed or rendered unusable it is essential that some form of rapid deployment communications facility is deployed to support the local community.

One suggestion is to contract a mobile operator to store a deployable base station with a number of activated handsets on call for 24 hour deployment in the event of the major destruction of a local communities communications facilities.

Furthermore, where backhaul infrastructure has been destroyed an alternative bearer should be made available (satellite or microwave).

2. *The impact of emergencies and natural disasters on, and implications for, future communication technologies such as the National Broadband Network.*

From my observations, the National Broadband Network provides little in the way of benefits to the community for emergency situations. Indeed most alerting and communications requirements are supported by lower bandwidth communications bearers.

Consumer based high speed broadband fibre optic appears to provide negligible benefits for emergency management. Indeed, communications requirements for emergency situations require “hardened” infrastructure to ensure reliability. To ensure that the NBN is constructed and deployed to “hardened” high availability standards may incur significantly greater costs.

In a major incident situation, most of the high speed data requirements will take place over wireless as emergency response and recovery units will be operating in the field.

3. *The scope for better educating people in high-risk regions about the use of communications equipment to prepare for and respond to a potential emergency or natural disaster;*

High-risk areas are well known to emergency authorities, people living in these areas are normally aware of the risks that they face. Providing a reliable and meaningful facility to alert them of danger and keep them informed should surely be beneficial. A discrete desktop or wall mounted unit (RDS) to alert them of impending danger or the need to evacuate would be beneficial. A standard national approach would mean that education and awareness could be simplified.

4. *New and emerging technologies including digital spectrum that could improve preparation for, responses to and recovery from, an emergency or natural disaster;*

Given the issues relating to mobile networks becoming overloaded, it is essential to investigate options to provide preference to essential users.

SIM priority

Mobile telephones are recognised overseas as an essential service and measures can be taken to ensure that designated SIM cards are programmed to be high priority thus over-riding normal users. Measures could be taken to mandate that cellular operators should provide a “Priority over-ride” service if any emergency service personnel are connected to the network.

This SIM priority service is used in the UK and is known as “Access overload control” (ACCOLC), in the US it is known as “Wireless priority service” (WPS). To date I have seen no mention made of any equivalent approach being applied to mobile networks. By providing this functionality, there would be some degree of service certainty for essential services users.

Access to 700MHz spectrum

With the upcoming retirement of 126 MHz in the 694 MHz – 820 MHz band (Analogue TV), the nation is presented with an excellent opportunity to allocate some radio spectrum for emergency service operations. Based on media coverage I am concerned to see that this spectrum is being considered to be sold as the 'Digital dividend' to commercial operators to support wireless broadband!

Obviously given the radio propagation benefits of this frequency band it is extremely attractive to any commercial operator given the reduced cost of infrastructure (less base stations and backhaul) and ability to support high speed data carriage. Conversely it is ideally suited to be allocated to emergency service operations for the same reasons.

Presently, most emergency services agencies use analogue or digital radio systems in the 400 Mhz band. Although well proven and cost effective, given propagation limitations, these networks require numerous transmitter and repeater sites that are both costly and present more points of potential failure in a major disaster.

It is therefore essential to consider the allocation of a block of spectrum for emergency service operations. I understand that other countries have already recognised this and are in the process of ensuring relevant spectrum allocation, indeed President Obama in his 2011 State of the Union address announced that USA emergency services would be allocated 20 Mhz of the 700 MHz spectrum !

Allocating spectrum in this band will provide many benefits including:

- The provision of high speed wireless data bearers to provide an accelerated picture of operations improving decisions support from command and control centres using streaming video from remote cameras. Furthermore building layout charts could be sent to appliances en route to emergencies.
- It is acknowledged that emergency agencies across the States and Territories do not support the same radio networks or devices. Using the 700 MHz spectrum will provide a transition platform for inter-operability and harmonisation so that cross border incidents can be better managed and emergency personnel assisting at major incidents can use the same radio devices on the same frequency.
- Given the improved coverage footprint of the 700MHz spectrum, a reduced number of transmitter sites and terrestrial links will be required thus reducing operational costs.

5. Any other relevant matters

Emergency control centres linking with community care organisations

Ensuring that all residents have been informed and where necessary assisted with evacuation is essential. In some cases frail aged or disabled people living alone may be at risk and be unable to evacuate themselves in an emergency. Emergency coordination centres need to ascertain resident's status promptly to ascertain whether they require assistance.

In most situations people receiving home assistance will be registered with Community care organisations. Ideally some protocol and communications will be introduced to enable emergency teams to ascertain people at risk and who requires assistance based upon their recorded disabilities.

Push to talk facilities on mobile networks

In situations where large numbers of emergency and recovery support personnel use mobile telephones, there is an opportunity to improve operational functionality by utilising the “Push to talk” or PTT facility that can be implemented on mobile networks. Investigation could be initiated to gauge the benefits of this enhancement and whether any mobile providers would make it available.

Recommendations

- Given the complexities and importance of communications facilities for emergency management particularly in major incidents I believe that a comprehensive strategy paper needs to be compiled exploring all areas and making relevant recommendations. This paper should provide an “End to end” view of emergency management requirements and in particular address the issues of inter-operability across the State and Territory emergency agencies.