



## White Paper



# A Comparison Between Broadcast Radio and Cellular Technologies for Emergency Public Alerting

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# Introduction

IAD Technologies Ltd (aka DIWA) has developed a system for nationwide Public Alerting based on Broadcast Radio technologies. The decision to use Broadcast Radio and Satellite systems as the primary communication channel, as opposed to cellular and internet based technologies, is outlined in this White paper.

DIWA, which managed the early technical development of the TSUNADO technology, was awarded a \$255,000.00 grant by the Callaghan Innovation Fund in 2013.

The New Zealand Ministry of Civil Defence and Emergency Management has been supportive of the TSUNADO development, and we have appreciated their assistance in getting a series of three Pilots (trials) in different regions of New Zealand to test the technology.

This Paper will examine the issues, and also the experience of these technologies in case studies sourced from within New Zealand and around the world.

## Executive Summary

### 1 Emergency Survival Kits

Ministry's "Get Thru" Website specifies a list of recommended items in it's Emergency Survival Kit. This includes as item 2 – a battery radio.

[\[http://getthru.govt.nz/how-to-get-ready/emergency-survival-items/\]](http://getthru.govt.nz/how-to-get-ready/emergency-survival-items/)



TSUNADO Alert Radios are battery operated radios with special alerting capability, with an alarm as loud as a smoke alarm, and a feature to last 5 – 10 days as they only turn on when there is an alert message.

### 2 Broadcast Radio Technology

is inherently simple, robust and reliable. With experience dating back to the early 1900's, the systems infra-structures have stood the test of time, and generally whatever nature has thrown at it. Relying on a smaller number of transmissions sites, there is generally a greater amount of resource put into these sites to ensure their uptime is as near to 100% as possible. Major

transmitters are backed up with not only UPS batteries, but substantial generators that will last for many days / weeks.

**Broadcast Radio is effective and reliable for all Public Alerting and Information, at all times. In combination with satellite broadcast, every region of New Zealand is covered.**

### 3 Mobile and Cellular Technologies

are by their very nature complex. They work by virtue of having many hundreds, if not thousands of transmission sites, in less than ideal physical locations, to achieve the “network” effect they require to cover a required area. They all require power, and very few have on site generators, meaning a loss of power will render them ineffective after a few hours when their batteries run out. They are also usually dependent on other technologies (Internet) to create the network communications backbone. In cases of power loss, earthquake damage, the networks may take many days, if not longer to restore service. Immediately after an event, these networks tend to be swamped by users, and become ineffective, with texts sometimes appearing after many days.

**Mobile and Cellular Systems are ineffective for Public Alerting, however may be used for Information dissemination when it can be expected that the systems will be operating correctly. These systems only work where good mobile coverage is provided.**

### 4 Ubiquitous

An ubiquitous and effective system for Public Alerting is imperative, and must work for all people, all capabilities, all environments, independent of their location, technical skills, and the time of day.

### 5 Information is not Alerting

It is important to understand the difference between **information delivery systems** that are designed for use when cellular and internet infra-structures are working, and **public alerting systems** that are designed for when a disaster may well have destroyed the systems we rely upon every day.

# 6

## Security and Public Trust

Many Emergency Alerting systems worldwide have been hacked, and the loss of trust thereafter makes the system ineffective.

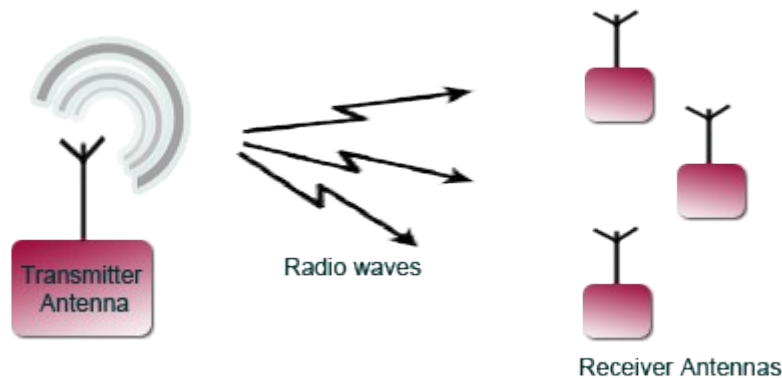
In any alerting system, an ultra-secure level of security in it's communications links, is essential, to ensure it cannot be hacked or misused, and that any messages delivered can be **fully trusted** by the recipients.

**TSUNADO Systems are built from the ground up to be ultra secure. The same cannot be said for Mobile text messaging.**

## What is Broadcast Radio Technology?

Broadcasting involves the dissemination of something over a wide area. In radio technology this is achieved by placing a transmitter on a high point overlooking the target region. This may be a hill or mountain, a tall building (eg. Auckland Sky Tower), or a Satellite in the sky.

Broadcasting implements what is called a one-to-many communication.



An advantage of Broadcast Radio is that only one transmitter is required, and available resources are typically applied to make this rugged and reliable. Also the location is usually chosen for its security and solidity during weather and disaster events. Satellites are obviously not prone to any such influences.

The Radio Receivers are also simple to construct, and the cost is small relevant to their cellular counterparts.

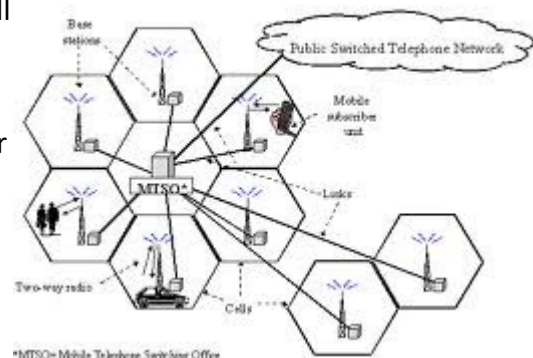
## What is Cellular Technology?

Cellular Technology is an ingenious grid system, providing two way communications traffic between central telephone / data systems, and small hand held devices, that make it possible to use them as personal communications devices.

So that battery life of the user devices can be extended as long as possible, the power required to communicate must be limited, and to achieve this there must be many hundreds of transmitters (aka cell sites, cell towers etc).

Because of the amount of data, these are usually connected to each other and the central systems via other technologies such as fibre and microwave links. All of these require secure electricity supplies, and the integrity of the fibre and copper links that carry the backbone data communications for this system to work.

These are complex systems.

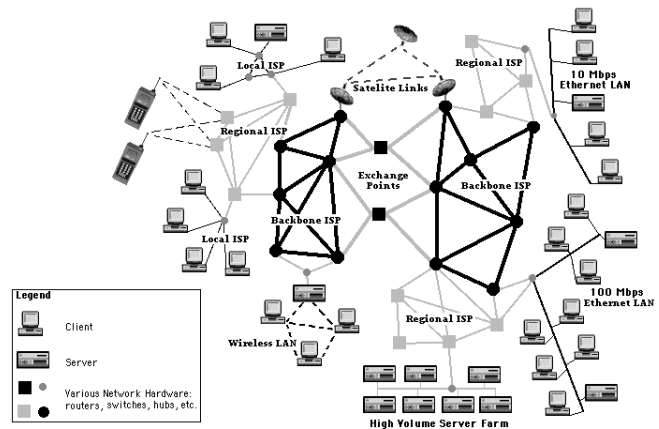


## What is Internet Technology?

Internet Technology is backbone communications system that underlies almost all data and telephony traffic today.

High speed fibre around New Zealand, and overseas (eg. Southern Cross cable) supported by Microwave and copper links provide the infrastructure that enables the internet to work. As well as these links, there is a huge amount of digital equipment that allows the physical links to be effective.

The reliability of the Internet is dependent upon the integrity of these links, and the smooth operation of the equipment.



# Critical Issues Common to Cellular and Internet Technologies

## Complexity, Ruggedness & Reliability

There are literally thousands of pieces of equipment that are required to operate correctly to keep these systems functioning. This complexity means that they are inherently fragile. Some years ago one misconfigured Internet Router in a critical location in Auckland brought down the Internet in the whole Auckland region for over 18 hours.[5]

## Reliance on Power

Cellular transmitters and receivers both require constant power to operate. In a disaster, power is more than likely to be unavailable, so these systems will be ineffective once batteries have run down, until power is restored.

In the last couple of decades we have seen our internet & telephony capability severely compromised for significant periods of time by major earthquakes, the infamous “rat and digger” episode [6], power outages in Auckland, and more. [5]

**It is at these times that the alerting systems must be able to be called upon to be effective.**

During the 3 day power outage in Auckland recently, people living in the Eastern Bays, Remuera, Ellerslie and St Johns were without power. Within hours of the outage most of the cell towers in the affected areas were inoperative, and most cellphones had lost power and could not be recharged. Messages were being sent using a Mobile App provided by the Auckland Council, to inform people of what was happening and when power was to be restored.

**Sadly, most residents in the affected areas were unable to receive these messages until after power was restored.**

The situation was considerably worse in Christchurch in February 2011, where large tracts of the city were physically cut off, with no power, telephone, or other means to communicate for many days.

## Cellular Communications

Cellular communications are inherently “point to point”. This means that for any device to communicate it needs a unique and separate “channel” to send and receive voice and data. Consequently, any mass broadcast using the basic cellular technology will take a significant amount of time, and is unsuitable for immediate notifications.

## Cell Broadcasting

An additional capability that exists in cellular systems (although not “out of the box”) is called **Cell Broadcasting**. This capability sends an SMS message to each mobile phone simultaneously, so that every compatible phone connected to that cell site receives an SMS text message.

**While this may seem ideal, there are, as with all systems, issues.**

The four main issues with using Cell Broadcasting as an alerting system are:

1. Cost - in New Zealand the cellular network will require an upgrade to every cell site on each of the three main networks, and this cost is conservatively estimated at around \$20 million per network. It is understood that there will be ongoing fees, as the customisation to the system will involve additional annual maintenance, the costs for such which will be passed back to the Civil Defence authorities.
2. Capability - the second issue is that not all phones have the capability to receive Cell Broadcast messages [2]. This will require a device upgrade for many cell phones users, with a considerable cost, and time for these users. Experience has also shown that where the access is managed through the higher level operating System (eg Android and Apple iOS), cell broadcasting can be turned off, and is usually set to “off” as a default. If the Telcos use the service (as they likely to) for other advertising messaging, as already seen overseas, it is likely that users will be further encouraged to disable the feature as it will be seen as “the spam channel”.
3. Alert - as with point to point SMS, the fundamental weakness of cell broadcasting is that receipt of a cell broadcast message does not necessarily act as an alert, and is purely informational. It is not a call to action as few handsets will always sound an audible alert even when a message is received. Access to mobile phones are limited during the evening hours, where many people turn them on to silent mode for work/life balance, or charge their cell phones in other rooms when they are sleeping, or turn them off altogether.
4. Fragility – as with standard cellular, the upgraded cellular sites will still require back-up power to operate, which means that the system will be inoperative within a few hours of a disaster where power is affected.

## User Experience

Because any user can use their cell phone, or send SMS without any control, the Cellular networks appear to be particularly sensitive to overload when a disaster event occurs. This is natural human behaviour, and is seen whenever disasters occur.

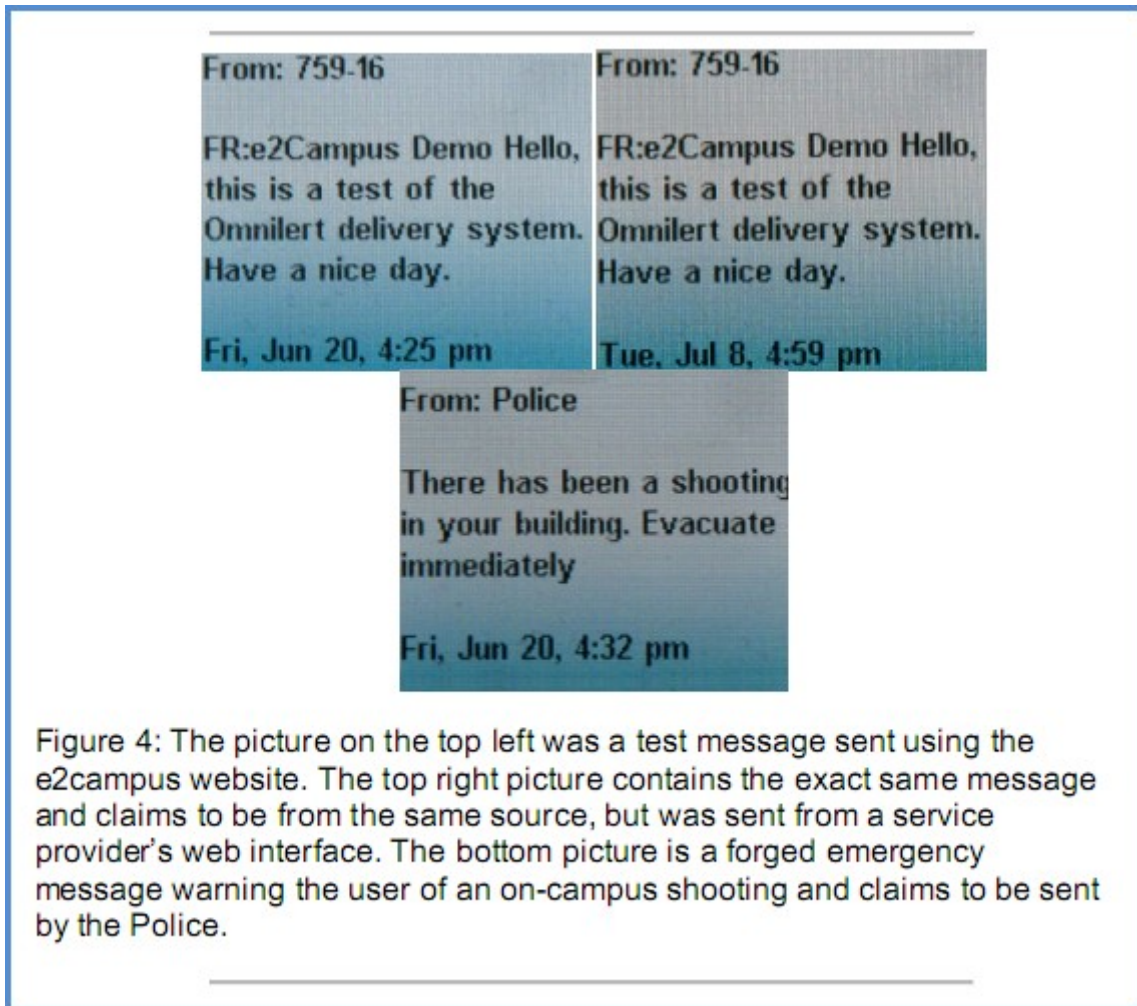
## Alert Message Security

Cell Broadcast and SMS messages are inherently insecure, as this example (Fig 4) from the USA shows, where it is possible to send a bogus message from an Internet Web Form that looks identical to one generated by an Emergency Alert System. [1] [7]



# Spot the Difference

This image is taken from a report *Characterizing the Limitations of Third Party EAS over cellular Text Messaging Systems* by Patrick Traynor PhD. of the Georgia Institute of Technology. [1]



## NOTE:

Based upon overseas experience, it is expected that the cell phone based systems of alerting will become a target for abuse. Even if false alerts are not presented exactly the same as real ones, a typical user will not know the difference, and it will be easy to cause panic and mayhem.

This is made simply possible because any cellphone user can generate an SMS message.

## Coverage

Cell broadcasting only works in areas where there is cellular coverage, and when, of course, these systems are operative

# Conclusion

**Cell Broadcast** messaging, and SMS messaging provide an effective means to distribute information **ONLY** when

- it can be reasonably be expected that the cellular and internet infrastructures are not compromised, and
- where the information is not expected to get an immediate action, and
- where the audience have cellphones that support the technology and
- the audience are not likely to have them switched off, and
- where security is not of the greatest concern

**Internet technology** messaging, via Email, RSS, and is relevant whenever

- there is no immediacy in the urgency of the messages
- it is expected the user will access the message at their convenience
- there is no threat to life or property

**TSUNADO, using Broadcast technology** is effective

- in creating an urgent call to action
- alerting any time, day or night
- when a trusted form of communication is relevant
- for on going communications immediately after a disaster
- for a minimum cost solution to central & local government

## Summary Comparison of Features

Feature	Broadcast (Alert) Radio	SMS Texting	Cell Broadcast	Internet Technologies
Alerting	Loud sound >85dB similar to a smoke alarm. Can wake anyone in a normal size house, and can be heard easily above television and stereo.	Text notification beeps can be turned off, and will not be heard when asleep.	It is not known how many cell phones in NZ capable of this feature, and the feature is not usually turned on by default, and can be turned off.	Email & RSS are elective forms of messaging only. Internet technologies are used in all other forms, but can be bypassed if required.
Information	Text screen with 5 rows of data allowing ~80 characters of information, with iconic data as well. Top two lines enlarged for ease of reading without glasses. Provides radio broadcast for spoken text in addition to text message.	Text alerts can provide ~120 characters of information	Text alerts can provide ~120 characters of information	As much information as required, when operative.
Usability	Can be installed easily in any home. No experience needed. Elderly need no help, as operation is all plug and play.	Works out of the box for those who use Text messaging.	Only available to the technically able, who own compatible cellphones, and requires technical expertise to configure.	Only available to the technically able.
Network Reliability	Relies on the Radio Broadcast infrastructure across three major providers. The experience over many years and major disasters shows that this is the most reliable.	Relies on cell network uptime and load. Experience indicates these networks are fragile technically, and susceptible to the high increase of load when a disaster strikes, that makes them unusable.	Relies on cell network uptime. Experience in Christchurch & Auckland indicates these networks are fragile technically, and susceptible to power outages	Relies on core internet infrastructure.

Cost	One off cost < \$100 per household amortised over a 7 year lifetime. Similar hosting costs nationwide.	Cellphone cost per user + network service charge.	Estimated \$20 million to upgrade each of the Telco networks to have this capability. Need to update each cell site individually with each software upgrade.	Not relevant
Battery life	Off power, >5 days. Fully charged until needed.	Off power, <1 day. Not always charged.	Off power, <1 day. Not always charged.	Normally none in homes
Portability	Normally in fixed location, powered on until needed. Then can be taken where needed.	Always portable, not always accessible .	Always portable, not always accessible .	Not relevant
Geo-targeted Location	Either programmed or GPS located according to version. Always know where they are.	Need to have Location Services (GPS) turned on.	Need to have Location Services (GPS) turned on.	Not relevant
Accessibility	For disabled people there is nothing to do but listen. If deaf, then can have strobe attachment, and view text message.	Need to be technically competent and have sight capability. Not suitable for mentally impaired.	Need to be technically competent and have sight capability. Not suitable for mentally impaired.	As individually set up
Coverage	100% coverage in New Zealand using Satellite, and in all other regions where major networks have FM Radio coverage.	Available where Cellular Data networks operate.	Available where Cellular Data networks operate.	Available where networks exist
Supporting Networks	SkyTV - Freeview, The Radio Network (Newstalk ZB), Radio New Zealand (National Programme), and smaller private Stations.	All networks support SMS and Mobile data for Apps.	None so far	Not relevant
Security	Atmel CryptoAuthentication security chip installed in every unit to secure authenticity of messages.	SMS messages are not secure. Cell phones vulnerable to hacking.	SMS messages are not secure. Cell phones vulnerable to hacking.	Internet Security is always an issue.
Technology Support	Support on every Tsunado unit.	Will work in all cell phones. App based messaging will require an up to date smart phone, with support for the three OS types.	Only works in compatible phones. And facility can be turned off by user. Older phones and will need to be upgraded.	No issue

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# What is TSUNADO?

Tsunado is a purpose built secure system for Public Alerting, designed to be effective during disasters, and to be a simple plug in device that works immediately, without user intervention or technical skill, anywhere in New Zealand.

The main component is the **TSUNADO Alert Radio**, a battery operated Radio with a very loud alarm and a message screen.

Additional extras that may be attached include a satellite adapter, GPS and Bluetooth, and external activation devices for those with disabilities.



## Complexity, Ruggedness & Reliability

The TSUNADO System is inherently simple. An FM Radio Station (or satellite) transmits a radio signal with the activation codes required to turn the TSUNADO Alert Radios on.

FM Radio and Satellite systems have resources concentrated on a few locations to ensure their continuity and uptime. This has been proven over many of decades of operation.

Where normal communications links to the Radio Station are compromised, then a manual activation procedure can be used where one-time codes are given via manual methods, that the announcer can use to manually activate the system. The manual communication can be via telephone, fax, emergency radio, amateur radio networks etc.

## Reliance on Power

The Radio Stations working with TSUNADO all have substantial and redundant backup power supplies, to ensure continuity of service. These include UPS and large backup generators.

The TSUNADO Alert Radios themselves can be unplugged and work for up to ten days on their internal battery.

## Broadcast Radio Communications

The TSUNADO system uses Broadcast Radio Communications to deliver the Alerts across the whole country. Because it is broadcast, the delivery of all messages is simultaneous to all recipients.

## User Experience

The TSUNADO Alert Radios do not require a licence to drive. Like their smoke alarm counterpart, they are installed, and they just work. Unlike a smoke alarm they can be plugged into a regular power socket, and the internal battery tends to last around seven (7) years.

When the alarm sounds the user has to do nothing but listen. A summary text message also

appears on the screen, with the first two lines in an enlarged font size, so that it can be read without glasses by most people. This is useful if the alert is activated at night and you cannot find your glasses. A back light makes the screen visible in the dark.

The system automatically turns the radio speaker on (when required), and turns it off after the message has been read by the announcer. This optimises power usage so the TSUNADO Alert radio can be used for longer periods of time.

## Alert Message Security

Each TSUNADO Alert Radio contains a **special ultra-secure security chip** [9] implementing a process called **CryptoAuthentication** to securely validate the authenticity of every Alert message. This makes it virtually impossible to activate the alarm from anywhere other than the TSUNADO Central System.

## This is imperative to retain TRUST in the system.

Emergency Alert Systems around the world have been compromised, and unfortunately they have subsequently become considered unreliable with the loss of trust. [4]

TSUNADO was designed from the ground up to be highly secure, to ensure that the public will always rely on any message delivered over the system.

## System Costs

All Alerting systems require a management layer, independent of the delivery system. Tsunado have quoted the cost of this layer on an annual basis including operating costs **AND** the delivery infrastructure at around \$800,000 per annum.

On top of that is the cost of the Tsunado Alert Radios. These start at around \$60 each. However there is only one required per household, and the costs of these may well be subsidised by parties such as Insurance Companies, Regional and Local charities. **Whatever method of purchase, this is not necessarily a Cost to Central or local Government.**

To facilitate provisioning of Tsunado Alert Radios, a Charitable Trust called Safer New Zealand Trust has been created, which will manage the funding for demographic regions where assistance is required for the purchase of the units.

## An Essential Part of Every Homes Preparation

**TSUNADO Alerting** is purpose built to work during disasters. It is secure and cost effective. It is suitable for people of all ages, technical capabilities, and does not require any special action to receive or view an Alert. Using both visual and audible indications it will provide effective alerting for 99.99% of the population with special adaptation. Based on an existing recommendation to have a battery powered radio as part of a survival kit, and the effectiveness of smoke alarms to get attention any time day or night, Tsunado is the first choice option for effective alerting in times of disaster.