SYDNEY CBD EMERGENCY EVACUATION SYSTEM

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ABSTRACT

"City of Sydney: Central Business District Emergency Evacuation System"

In the wake of the 2004 Madrid and 2005 London terrorist bombings, the NSW Government and the City of Sydney identified a requirement to implement a rapid response emergency information system to ensure public awareness, public safety and highlight emergency evacuation routes within the City should the need arise.

In reviewing the aftermath of the bombings, the ability to alleviate mass panic proved paramount, immediate situational warnings and advice must be delivered to rail passengers in the proximity of adjacent stations, station approaches, city workers and the public. The Sydney CBD system required high visibility Variable Message Signs (VMS) to be installed at strategic points within the CBD and railway station entrances coupled with loud-speaker groupings to immediately alert the public of an emergency or exigent situation. The entire system is controlled from a single control centre.

The New South Wales Roads and Traffic Authority (NSW RTA), Intelligent Transport Systems (ITS) was tasked to design a system capable of panoptic coverage of Sydney's Central Business District (CBD), deliver long-term reliability and efficient performance with minimal maintenance requirements. ITS's specialisation is the design of high visibility electronic safety, advisory or warning signage.

This study highlights the importance of providing immediate, efficient mass warning(s) and evacuation advice throughout the CBD via a single system.

As this system is the first to be installed in Australia, ITS's system analysis, project methodology, costings, design/development, strategic placement and control processes for the scrolling Variable Message Signs (VMS) and loud-speaker systems are discussed.

This study examines the infrastructure and installation requirements necessary to implement the system, specifically it will; 1. Describe the processes and modelling analysis used to design and implement a line-of-sight radio communication system to overcome the constraints of high-rise buildings within Sydney's CBD. 2. Describe the analysis and modelling undertaken for the strategic siting of VMS's and loud-speaker groupings within the CBD. 3. Describe the public awareness campaign undertaken to educate the public regarding the system's importance to their safety. 4. Describe the upgrades identified to maintain the system's efficiency in line with technology changes, and. 5. Describe the custom built control software and explain emergency agency/control centre responsibilities.

This is the first emergency information system designed and installed in Australia and the project's processes and strategic analysis to achieve immediate use combined with long term

reliability will provide an efficient knowledge base for projects requiring comparable outcomes in equipment and solutions, both in Australia and internationally.

In French
Ouvert en 1932, le Sydney Harbour Bridge (SHB) n'a guère été conçu pour supporter le volume actuel de circulation routière. La croissance exponentielle du trafic a nécessité le remaniement des couloirs de circulation et du contrôle de routier) afin d'utiliser au mieux les voies sans nuire à la sécurité des utilisateurs. Le projet (pour trouver la solution d' une sécurité routière maximale, aussi bien pour les équipes rattachées au pont que pour les conducteurs, a été confié à une division de l'autorité Roads and Traffic Authority, l'ITS.
Le domaine d'expertise d'ITS Manufacturing est le design de panneaux routiers électroniques de haute visibilité. Cette étude analyse l'importance de la capacité du SHB de transporter efficacement tout véhicule sur le pont qui traverse la baie de Sydney. Elle presente egalement sa capacité A utiliser les panneaux électroniques à message variable et les panneaux de limitation de vitesse pour communiquer aux conducteurs tout changement de configuration des couloirs de circulation dû aux travaux de maintenance ou aux accidents.

L'analyse du système ITS, le design, le développement et le devis –3 panneaux à message variable, 49 panneaux DE limitation de vitesse variable, 3 médianes mobiles et un nombre de panneaux statiques sont étudiés.
Les données jusqu'à et après l'installation des panneaux électroniques sont considérées selon les thèmes suivants :
1. Les contraintes de configuration des couloirs de circulation du SHB, les vitesses maximales et leur effet sur la sécurité des services d'urgence.
2. La comparaison de signes conventionnels avec les signes d'incidents électroniques, les signes de vitesse maximale variable et les signes informationnels variables.
3. L'importance de maintenir efficacement la circulation quand la fluidité d'un couloir est réduite pour quelle que raison que ce soit et où la vie humaine est menacée ou potentiellement menacée.
Les informations statistiques de cette étude incluent des données empiriques et anecdotiques recueillies PAR ITS Manufacturing, des équipes du SHB, du Traffic Management Centre (TMC) et du Bridge Work Alliance (BWA). Tous vont ainsi contribuer aux bases de connaissances techniques pour les projets futurs.

1. INTRODUCTION

The Sydney Central Business District (CBD) Emergency Warning and Advisory System is an element of the New South Wales (NSW) State Emergency Alert System [1] and is now referred to as SydneyAlert [2].

This system is governed by Emergency Management NSW (EMNSW) [3] and is administered by the NSW State Emergency Management Committee (NSW SEMC) [4] under the *State Emergency and Rescue Management Act 1989 No 165*.

Emergency Management NSW is an interlaced, multi-level agency which works cooperatively with the Federal Attorney-General's Department and forms a state liaison with the national Attorney-General's group "Emergency Management Australia" [5].

The NSW State Emergency Alert System is multi-faceted, state-wide and initiated by a specific emergency, or emergencies, therefore for the purpose of this paper, only the SydneyAlert system will be discussed and will be referred to by its Intelligent Transport System's original concept and development name, the "Sydney CBD Emergency Warning and Advisory System".

Please note: "Emergency" is defined in the; *NSW State Emergency and Rescue Management Act 1989 No 165* (http://www.legislation.nsw.gov.au/).

2. REFERENCES

1. NSW State Emergency and Rescue Management Act 1989 No 165
2. NSW State Disaster Plan (Displan)
3. Sydney CBD Emergency Sub-plan

3. BACKGROUND

In the wake of the 2004 Madrid and 2005 London bombings, the NSW Government and the City of Sydney acknowledged a significant terror event within the central business district (CBD) would have catastrophic effect(s) on transport, communications, the business community, the public and the event would have the potential to disrupt the City in the near to medium term.

Whilst it is generally accepted that without credible intelligence a random unplanned event can not be predicted [6] past events have shown the need for immediate damage mitigation in the form of broad media communication to the public within the immediate vicinity of the event and warnings to the community outside the immediate event zones [7].

Acknowledging the recommendations from Madrid and London, the NSW Premier's Department invited NSW Government Agencies, the City of Sydney and elements of the National Counter-terrorism Task Force to review the CBD's vulnerability to an unplanned terrorist event and its impact upon both national and state critical infrastructure and the public. The relevant review outcomes Note 1; a requirement to implement a rapid response emergency information system to ensure public awareness, public safety and highlight emergency evacuation routes within the City should the need arise, were approved by the NSW Cabinet Standing Committee on Counter Terrorism. Stage one included, the communications and public information strategy and establishment of a working group to scope works associated with the design, development, installation and commissioning of the equipment [8].

The working group, Counter Terrorism and Disaster Recovery Steering Committee, were tasked with identifying the locations for the 98 audio systems, 13 Variable Message Signs (VMS), control points, communications and infrastructure to provide an emergency

awareness system for the CBD to alert CBD users, visitors and the public of an unplanned event which has the potential to impact their safety.

4. PROJECT OBJECTIVES [8]

- To improve the safety of people in the Sydney CBD in the event of a terrorist incident or severe natural disaster.
- Provision of a siren and audio messaging system to advise people of the above events and to assist in the management of crowds during special events in the Sydney CBD.
- Provision of VMS at strategic locations with high pedestrian activity to provide further advice on incidents. VMS would also especially assist aurally impaired people.
- Ability to use the VMS to provide rail passengers with special event and emergency information on the rail system.
- Provide the NSW Police at the Sydney Police Centre, the ability to remotely initiate the warning siren and warning messages when required.
- Provide the NSW RailCorp from the Rail Management Centre, the ability to remotely, display messages when required.

5. CBD GEOGRAPHY

Like most major cities in the world, Sydney has defied its environment and has grown over the available land mass – Including high and low elevations throughout its geographical coverage, including the CBD.

Therefore to isolate specific locations/areas within the CBD, the committee divided the CBD into three ‘zones’ – These zones would enable the emergency response teams to direct their attention to specific areas with the aim of minimising any collateral damage to the public/infrastructure surrounding the event zone and indicate defined exit paths from the event location and surrounding CBD zones [9].

The three zones are identified as ‘precincts’ and designated City North, Mid City and City South. Please note: For the purpose of this paper only the CBD will be addressed, the North Sydney Precinct does not form part of the CBD Emergency system.

The CBD is high density/high-rise with the lowest pedestrian point being (approximately) 1.4 metres above mean high water mark, the two significant highest points (excluding buildings and/or other man-made structures) are Observatory Hill, approximately 39 metres elevation and the area south east of Hyde Park approximately 46 meters elevation [10], therefore consideration had to be given to the most effective use of the available resources to ensure consistent functionality across all the CBD’s elevations.

Whilst the elevations differ substantially throughout the CBD, the CBD’s ‘street blocks’ are square/rectangular and the streets are straight, therefore point to point radio was considered the most efficient and cost effective medium for communication between the sites.

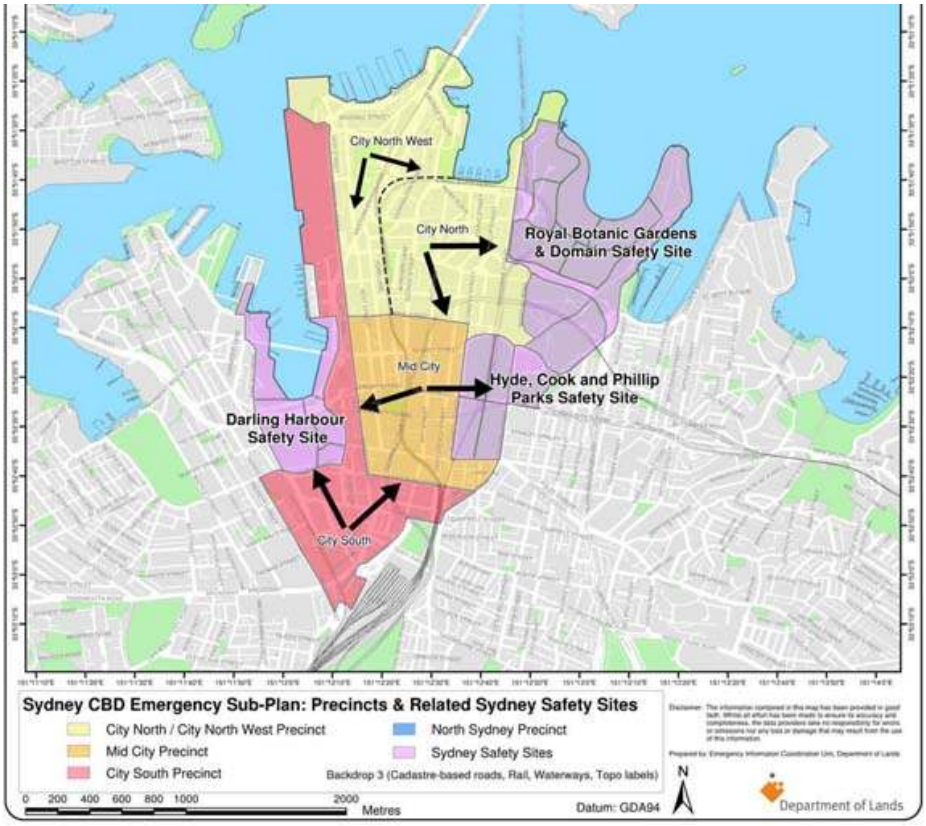

Figure 1 - Sydney Emergency Sub-plan Precincts

6. PROPOSED EQUIPMENT [NOTE 1, [8]]

- Audio: An integrated series of speakers at the identified major intersections throughout the city, totalling, 98 speaker systems. Audio is designed to attract attention and also designed to augment visually impaired members of the public.
- Visual: To visually display an alert warning and, to augment audio impaired members of the public, 13 Variable Message Signs (VMS) at strategic locations to ensure the pedestrian public does understand the emergency. These VMS's are single line with the ability to 'scroll' right-to-left if the messages require more than 18 characters.
- Directional radio antennas to propagate the messages throughout the desired zones, and, Control points to ensure the CBD is covered via radio and if necessary, cable. A total of 16 Repeaters, 8 of these used for VMS connections to wireless network (5 VMS direct cabled to Router) 30 ADSL Routers, 25 connected to radio units, 5 direct to VMS. The largest Nodes contain 10 radio units, longest number of radio 'hops' is 7.

Figure 2 - Above left, speakers, control housing and aerials. Above right, single line scrolling Variable Message Sign, control housing and aerials.

7. METHODOLOGY/MODELLING

Radio was initially considered the best method to control the devices throughout the CBD. To achieve the objectives ITS Manufacturing first looked at the geographic layout of the CBD, these geographic views were continuously modelled using multiple CBD aspects to determine the elevations and the potential impact those elevations may have on signal propagation, particularly when high volume traffic conditions occur – Such as container delivery, removalists, busses or other high vehicles which can impede signal propagation, either through parking, stationary at traffic lights or traffic congestion [13].

CBD and radio wave modelling determined line of sight radio communication could be used as the controlling device, after three months of analysing, reviewing and modelling the collected data regarding pedestrians, vehicles, high vehicles and taking into account the potential for intrusion from CBD low interference potential devices (LIPD) [11], it was considered that distances under half a kilometre were achievable and over the shorter distances reflected waves should not dramatically affect the operation of the system.

To prove the above, George Street is considered the “main street” of Sydney, it is straight but has elevation changes so it was selected as the ‘test-bed’ for radio. Radio transmissions within cities do suffer loss, phase cancelling and scatter (calculations/testing have proven this). To prove the model, George Street was selected as the test and ITS Manufacturing chose to undertake the situational tests in-situ. The final test model which was ‘live’ transmissions showed that this was not the best medium for the system. George Street is

atypical of any major city, 4 traffic lanes, 2 footpaths, no centre median, high density vehicular traffic and covered on both sides by high ‘slab-sided’ buildings, the majority multi-story and did provide a test for the engineers because the horizontal beamwidth would not allow signal propagation throughout the length of the street without distortion, phase changes and reflected waves.

Findings:

- CBD streets with high-rise buildings are ‘valleys’, not ideal for wider radio beamwidths.
- If radio were to be used as controllers and repeaters, if one unit was removed because of the incident/event, the remaining units dependent upon that ‘chain’ would not receive the signal and the system could potentially fail its objectives.
- Atmospheric effects and LIPD, whilst mostly minimal, could have an impact upon radio.
- Radio is effective within the localised 'node' areas and should be viewed as the option.
- Beamwidths within the radio wave’s propagation would be subject to ‘scatter’ within the City’s streets. And,
- Financial costs, upgrades, changes due to propagation challenges, ie; blockages due to construction, aerials, siting, etc.

Based on the model/testing, to ensure the system’s expectations were to be achieved for public safety, the initial communication delivery to the devices was modified to ensure there were no ‘weak-links’ which could be exploited by the removal of a radio repeater, therefore the devices were grouped as clusters or 'nodes'. The initial communication to any cluster/node is now achieved via cable, radio is only used to transmit within the cluster/node. This ensures the system’s integrity and provides an effective means of ensuring if a CBD block is lost, the remainder still operate.

The concept was achieved by modelling the CBD based on ‘potential’ interference and to achieve the outcomes, the Fresnel theory was used to validate the model. Based on the theory, the system can achieve its stated outcomes, but can potentially suffer via ‘casual’ interference [Note 3] over shorter distances. If the interfering party remains within the signal’s transmission envelope throughout the transmission period there is potential for the signal to be lost or reflected without achieving the transmission’s aim, this includes the probability of ‘leap-frogging’ [12].

CBD and geographic modelling also produced the best option for mounting the speakers, radios and VMS’s. Existing traffic signal (lights) and their vertical mounting poles are generally sited to offer an unimpeded view from CBD intersection to CBD intersection. It was decided that the speakers and radios would be mounted on existing traffic signal structures, these structures are approximately 3.1 metres high and mounting the equipment above 2.8 metres was calculated to give adequate point-to-point line of sight coverage.

Variable Message Signs (VMS) would be mounted in high visibility areas on specially constructed horizontal ‘booms’ and mounted on existing light pole structures. The ‘booms’ enabled the best visual distance between each VMS within the CBD and as they are suspended over the kerbside lane, they deliver high-visibility messages to both pedestrians and motorists.

Figure 3 - George and Bathurst Streets intersection

At CBD railway stations and ferry terminals the VM Signs are located on vertical structures, portals or are aligned to deliver their message at the entrance to the railway station or ferry terminal.

Figure 4 - Circular Quay Railway Station Variable Message Sign, radio/aerials

Modelling commenced with two areas, the first being the Circular Quay area, this area is 'flat', elevation 1.4 metres above mean high water mark, has adequate line of sight and was selected for:

- High pedestrian traffic area (public transport terminus, bus/train/ferry),
- Noted visitor/tourist area,
- High density at both peak and non-peak times, and
- Public congregation area.

The second was Central Station area (southern side of the CBD [10]), this area slopes both east to west and north to south and drops in elevation by (approximately) 34 metres. At the lowest point (George St), the elevation is almost at the same as Circular Quay and has the same conditions for selection, as mentioned above. However it was assessed as having the potential to be affected by the surrounding elevations and high traffic volume, particularly public transport and high commercial vehicles, which could impede the area's ability to propagate radio signals.

To overcome perceived constraints surrounding the Central Station area, particularly the drops/rises in elevation, by calculating and mapping the 3dB points and by adjusting the boresight, direct line of sight was achieved over considerably smaller distances than the City North and Mid City precincts. In addition, to ensure no signal loss was experienced the shorter distances in effect, acted as 'relay points' to the next receiver/transmitter, this enabled the system to operate effectively even through casual interference.

The Central Station area became the model for the remaining sites within the CBD.

Note. Five of the Variable Message signs in the immediate vicinity of Central Station did not require radio control and are cable connected directly into RailCorp's control hardware.

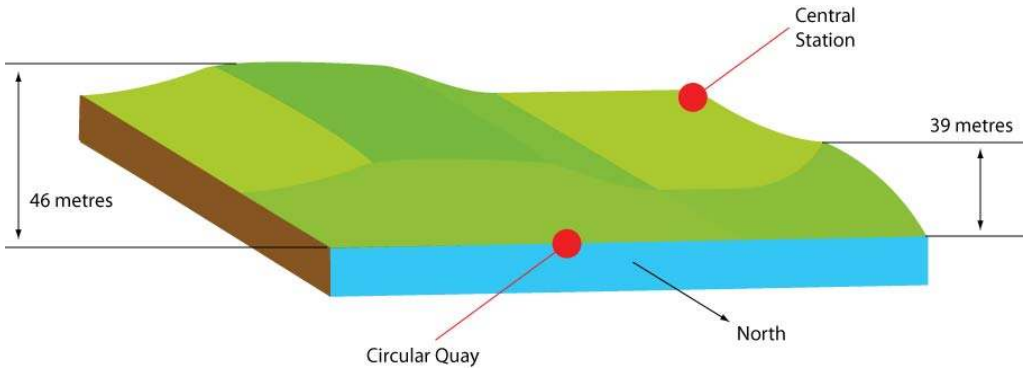

Figure 5 - Sydney elevations (illustration left as 'patchwork' to show elevations)

8. CHALLENGES

Large cities continuously grow and change and ITS Manufacturing has no control over major CBD projects and their impact upon the system. Initially there were three control points for the equipment; one in CBD North, one in CDB Mid and one in CBD South. Each control point would be responsible for the equipment located in each precinct.

This was proven unachievable, disruptions within the CBD over which ITS Manufacturing had no control over necessitated a re-work of the communication process throughput based on the incident location, response time by Emergency Services and the ability of the system to be an uninterrupted service.

One failure due to the incident or equipment module failure could affect the entire system's ability to perform as required. The image below demonstrates one of the possible failure points within the system. Note the aerials and control housing are completely obscured.

Figure 6 - George Street construction, safety barriers/scaffolding

In addition power issues were a concern, should power suddenly be lost due to the incident/event, to ensure continued operation during the incident/event, all radios, controller housings, control cabinets and VMS's have a UPS/battery back-up installed.

To enable the simplest activation and management of the system, all control and operating software was purpose designed and produced by NSW RTA ITS Manufacturing.

9. NODES

The possibility of a 'blockage' or 'incident' within the system which could dramatically impact upon the entire system's performance required revising. The three proposed control points were redistributed into 'zones' with each control point being identified as a 'Node' (node being a cluster or grouping of equipment in a single location). Each of the now twenty nine 'nodes' were 'cabled' from the control centre to the 'node', each identified within the three precincts. Once at the 'node', the cable was terminated and radio was used to control each of the devices within the 'node'. The shorter distances required less power and ensured the signal was received prior to any phase shifting due to reflections or interference.

10. EQUIPMENT LOCATIONS

The identification of the three CBD precincts/zones enabled the project to identify specific sites for the equipment and associated control points. Site selection took approximately three months for observation, analysis, consultation and review to maximise the most appropriate and effective locations for the equipment.

Factors considered when selecting the sites included:

- High density pedestrian traffic locations – At peak and non peak periods,
- High volume vehicular traffic – At peak and non peak periods,
- Exit routes as defined in the Sydney CBD Emergency Sub-plan [9],
- Pedestrian and social congregation points,
- High visibility locations and line of sight for the Variable Message Signs (VMS),
- Combinations of VMS and speaker systems in the same locality,

- CBD access and control points for the controlling hardware/software,
- Unimpeded line of sight for radio communications,
- Heavy vehicle container deliveries,
- CBD entry and exit points [9],
- Public transport routes, major pick-up/set-down locations and terminuses,
- Railway stations and Ferry terminals,
- Vehicular tunnels under the CBD and their access/egress points, and
- Residential properties and high-rise accommodation within the CBD and their safe zones for exit.

Other factors included:

- Building construction, renovation and building maintenance requiring scaffolding and/or lane closures for heavy vehicles, etc.
- Deliveries/delivery points (heavy – 12 tonne plus/light vehicles under 12 tonne but high storage space),
- Significant/major public events/celebrations,
- Visitor/tourist peak times, casual CBD users, both pedestrian and vehicular (day/night),
- Nightlife within the CBD, and
- Public entertainment areas (Darling Harbour/Circular Quay/Martin Place).

In addition, the global economy has enabled commercial entities to trade 24 hours a day, 365 days a year, Sydney's CBD can be categorised as a commercial and financial hub and does operate on global time zones and operates 24 hours/day. Therefore consideration had to be given to ensuring equipment siting(s) did not disadvantage those people working outside daylight business hours within the CBD Note 2.

To deliver the greatest 'spread' across the CBD, speakers/radios are located at major intersections, high density pedestrian areas and adjacent to railway stations and ferry terminals. Each site has 2 speakers both angled in different directions to deliver the audio at specific streets.

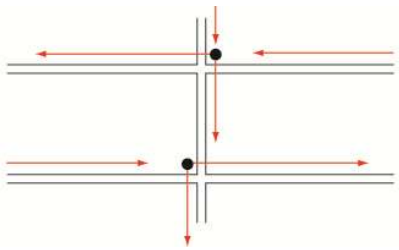

Figure 7 - Speaker/message direction (example)

Each railway station, ferry terminal, major intersection and high density pedestrian areas have access to one, if not two, alarm speakers. In addition, the CBD's street layout enables the messages to be heard at longer distances, this has been proven during tests, trials and validated during the monthly testing regimes. In this case, one could assume that the required Sydney CBD streetscape (slab faced heritage buildings) has ensured that the audio messages will be carried through-air until overridden by the next speaker system. In this way, all messages are heard.

11. CONTROL POINTS

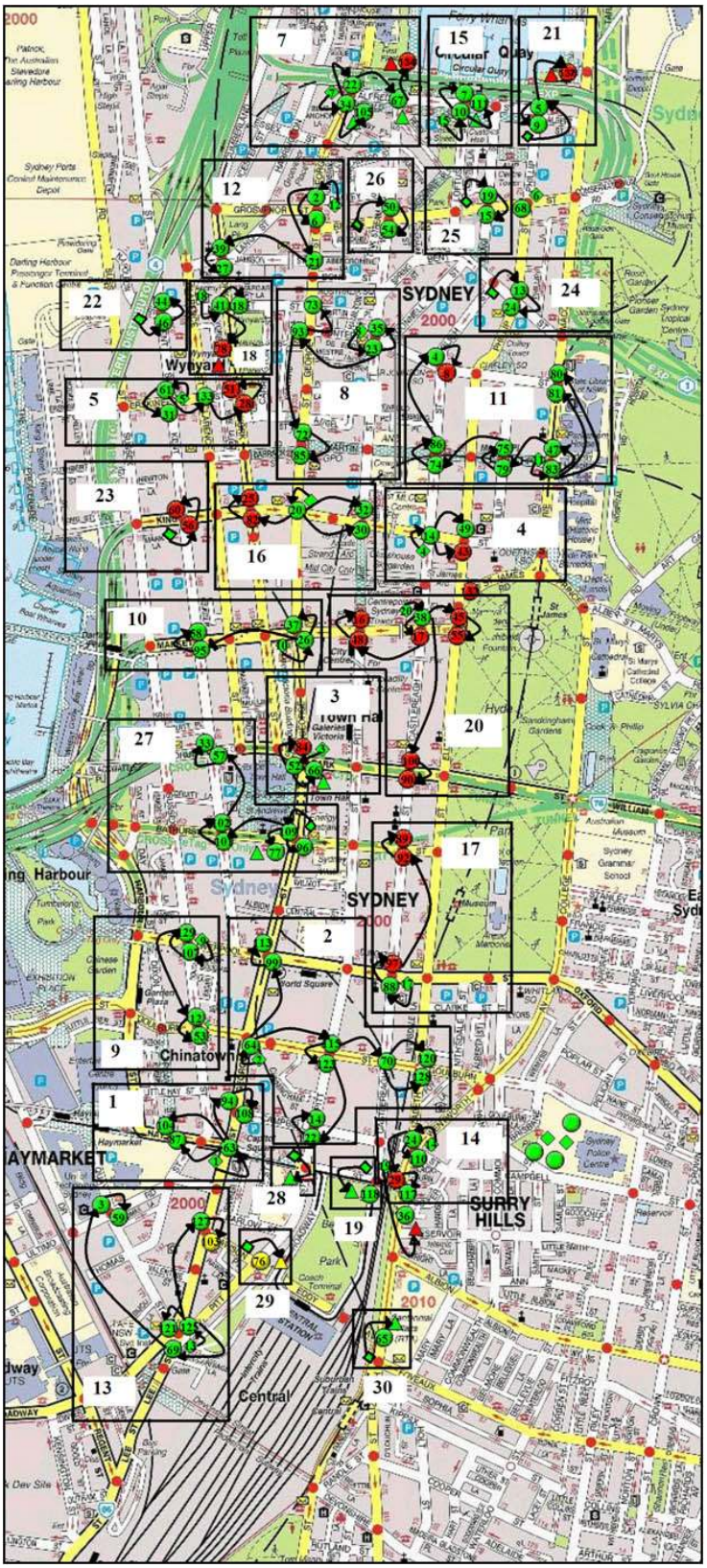

Figure 8 - CBD Nodes and Control Points

As stated, it was initially envisioned that only 3 control points would be required, however as the system matured and unplanned 'blockages' became apparent, to deliver the system's stated capability cabling to the 29 Nodes became paramount.

A Node is a group of units configured in such a way that data/instructions are relayed from the NAP (Network Access Point) via direct cable to the first wireless speaker unit then via wireless technology to the next unit in the chain and then to the next.

CBD Sirens utilise the NSW RTA Computer Network to communicate with the system up to the beginning of each Network Access Point (NAP). Beyond this point the system makes use of direct connection and wireless technology to communicate with the rest of the speaker units and VMS's on that Node.

The map shows the Node groupings and their respective NAP's

Wireless Speaker Unit is represented by a circle.
Variable Message Sign is represented by a triangle.
Network Access Point is represented by a diamond.

Note. Cabling to the Nodes also ensures there is no 'blockage' should a Node be within the incident/event location and is destroyed. The system will still continue to operate using the remaining Nodes.

11.1 Node 7 interconnections

Node 7 is located in the area bounded by George/Pitt/Alfred Streets and First Fleet Park at Circular Quay and has 10 speakers (5 x 2) and 3 VM Signs within the node.

The Network Access Point (NAP) of Node 7 is located in the traffic signal controller cabinet of the respective Node intersection, the NAP is a DSL Router.

Direct cable Ethernet connection is used to link the Router in the controller cabinet to the first Wireless Speaker Unit. For Node 7 this is designated as Wireless Gateway Unit (WGU) 34.

A wireless connection is then used to connect WGU 34 to WGU 22 and WGU 105.

Unit WGU 22 then connects to WGU 67 wirelessly then WGU 134.

A VM Sign is connected to its respective wireless unit (WGU) via direct cross-over Ethernet cable, some wireless units such as repeaters and units associated with VM Signs do not include speakers, as they are used solely for connection and not playback. Examples of these units are; WGU 105, WGU 67 and WGU 134 within this node.

The following is an interconnection example for Node 7:

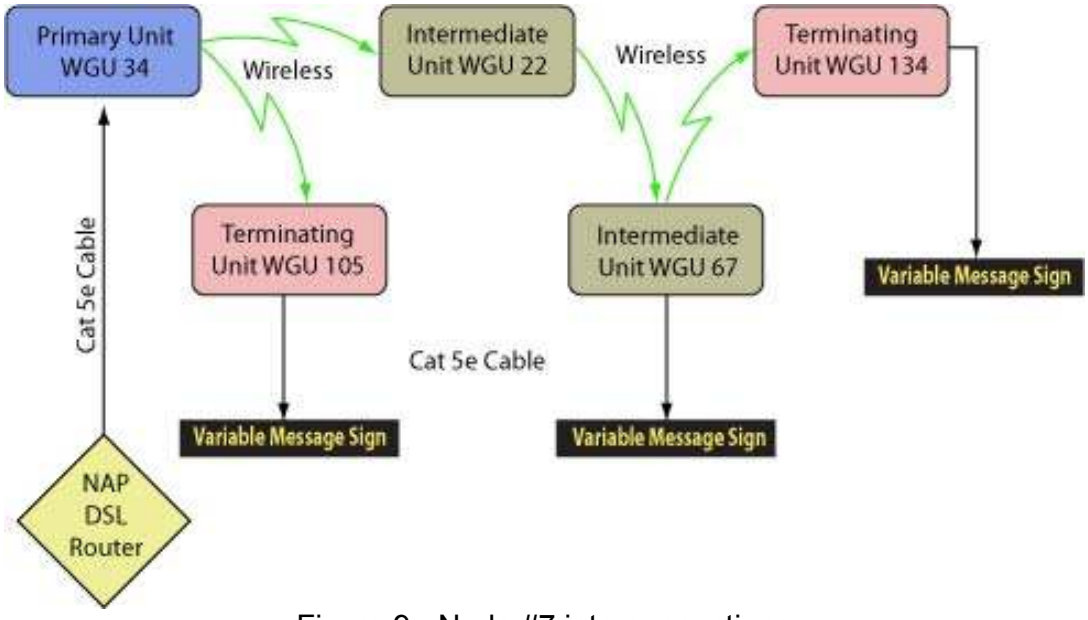

Figure 9 - Node #7 interconnections

12. INSTALLATION/COMMISSIONING

Whilst installation planning was a combined effort between the agencies involved, ITS Manufacturing was tasked with the installation, testing and commissioning of all speakers, radios, antennas and signage. To ensure minimum disruption, all work was conducted between 10:30PM and 5:00AM.

13. SYSTEM OPERATION/CONTROL

The entire system when 'live' is under the control of the NSW Police.

13.1 Audio Alerts

In the event of an emergency the NSW Police Emergency Control Centre has the responsibility of immediately notifying the CBD via the alarm/speaker system. Messages can be either pre-recorded (eg; system testing) or 'live' transmissions alerting the CBD to a specific emergency. The NSW Police would also coordinate the evacuation routes/exits for the particular zone where the event occurred via messages and emergency services personnel.

In addition as each node has a discrete IP address, alerts/messages would also be transmitted to the other zones to alert the public of the event and to advise those zones of the potential impact, current status and if required evacuation routes and timings.

13.2 Variable Message Signs (VMS)

The main controlling hardware/software for the VMS's is located with NSW State Rail at Central Station. As the controlling authority, the NSW Police will advise the appropriate message(s) to be displayed on the VMS's and will coordinate both the audio and visual systems in each zone.

In addition, the NSW Government's fleet of larger VMS's within metropolitan areas would also be used to alert motorists and the public not to approach the CBD due to an event or emergency.

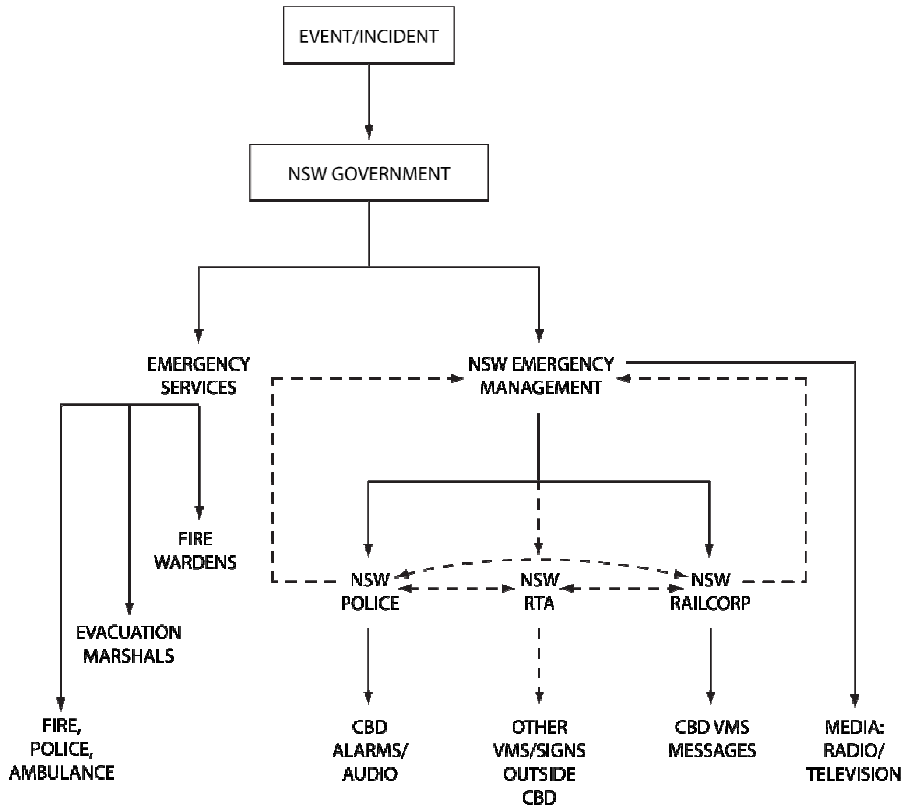

Figure 10 - Emergency Management NSW operational control

14. SYSTEM UPGRADES

The CBD has a maximum elevation of 46 metres above sea-level [10], the use of radio did overcome elevation concerns, however changed CBD conditions have necessitated a review of the system, particularly within the lower elevation areas where the radios have been seriously impacted/degraded by construction works blocking thoroughfares and the safety equipment which is required for pedestrians and vehicles. In addition, LIPD interference has increased within the CBD since commissioning. This has had a combined impact which could not be foreseen, nor compensated by either an increase in transmission power, nor directional aerials.

As the system is proven and is now a component of the NSW Emergency Management System, it is anticipated as the CBD changes into the future, all the devices will be upgraded and it has been suggested permanent cable allocations be installed to enable the system to 'grow' to accommodate the CBD's requirements.

15. DISCUSSION

- A dedicated public information campaign was conducted in the lead-up to the system commissioning, including training of building fire wardens, fire and evacuation marshals. Anecdotal evidence from tests, trials and drills does suggest that the system will be an emergency asset and will perform as required.

- The VMS's within the system are tested weekly and the entire system is routinely tested each month. CBD users and visitors acknowledge the testing but human nature will always be a major component of any critical response or emergency situation and whilst the system has proven effective during commissioning, testing and live drills (including the visit to Sydney by US President George W. Bush in 2007) it has never been proven in 'live' event/emergency conditions.

  Whilst it is hoped the system never has to be proven 'live', until an incident or event occurs no definitive results can be offered within this paper. However, in 2007 television stations did interview members of the public who were in the CBD when the system went live - All stated that the system had gained their attention Note 4.

  Panic is always a concern [7]. and should the system ever be required during a major social or public gathering within the CBD, for example New Year's Eve, the current expectation relies again on anecdotal evidence and assumptions gained during tests and drills.

- The issue of cable versus RF has delivered a rethink of the communications medium and it has been assessed that changes in the CBD will have a continued impact upon radio as a controlling medium, in addition, it has been assessed that cable could prolong system life.

- The system is in place and operational, technology changes however could mean a radical rethink of system control and as technology improves, the system may benefit from a complete overhaul/revamp to ensure continued effectiveness into the longer term.

16. SUMMARY

Irrespective of the model used, it is in a city's best interest to gain the maximum media coverage it can to have in place system's capable of warning and alerting the public to reduce panic [7].

As stated, this is the first emergency information system designed and installed in Australia and the project's processes and strategic analysis to achieve immediate use combined with long term reliability will provide an efficient knowledge base for projects requiring comparable outcomes in equipment and solutions, both in Australia and internationally.

Figure 11 - Circular Quay VMS/radio and speakers/radio

17. NOTES

1. Relevant to this submission.
2. Given the number of entities trading, the author is unable to list all citations/references. It is requested the reader refer to the major commercial chains and financial institutions located within the CBD for operational hours.
3. For the purpose of this document within the confines of the CBD, interference is defined as any new substantial structure, large vehicle/container, or changed traffic conditions after system commissioning which allows blockage/height within the propagation path.
4. Material is copyright and can be viewed by contacting Channels 7, 9, 10 and SBS.

18. REFERENCES

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11. Australian Communications and Media Authority (ACMA), Low Interference potential Devices, http://www.acma.gov.au/WEB/STANDARD/1001/pc=PC_1278
12. Verbal advice, ITS Manufacturing installation and maintenance Engineer Mr. G. Sladden
13. 3D modelling was undertaken by ITS Manufacturing staff – 3D modelling created by Mr. R. Morris