Submission to the House Standing Committee on Infrastructure, Transport and Cities Consultation into "The Automation of Mass Transit"

Centre for Disaster Management and Public Safety, & Centre for Spatial Data Infrastructure and Land Administration,

University of Melbourne

&

Australian Radio Communications Industry Association

7 December 2018

Lead Author: Mr Ged Griffin Senior Industry Adviser Centre for Disaster Management and Public Safety

Contributing Authors:

Professor Abbas Rajabifard: Director Centre for Disaster Management and Public Safety

Mr Geoff Spring: Senior Industry Adviser Centre for Disaster Management and Public Safety

Mr David Williams: Senior Industry Adviser Centre for Disaster Management and Public Safety

Mr Hamish Duff: Chairman Australian Radio Communications Industry Association

Mr Ian Miller: Executive Officer Australian Radio Communications Industry Association

Table of Contents

Glossary

ACMA	Australian Communications and Media Authority
ANZLIC	Australian New Zealand Land Information Council
ARCIA	Australian Radio Communications Industry Association
ATC	Australian Transport Council
CDMPS	Centre for Disaster Management and Public Safety
CE	Computer Engineering
C-ITS	Cooperative Intelligent Transport Systems
COAG	Council of Australian Governments
CSDILA	Centre for Spatial Data Infrastructure and Land Administration
DSRC	Dedicated Short Range Communications
ECP	Emergency Call Person
ECS	Emergency Call Services
EEE	Electrical and Electronic Engineering
FSDF	Foundation Spatial Data Framework
FSS	Fixed-Satellite Service
GRN	Government Radio Network
ICT	Information and Communications Technology
iDDSS	Intelligent Disaster Decision Support Simulation Platform
IE	Infrastructure Engineering
ITS	Intelligent Transport Systems
LIPD	Low Interference Potential Devices
NG000	Next Generation Triple Zero
NRSS	National Road Safety Strategy
OBU	On Board Unit
OGC	Open Geospatial Consortium
PMR	Private Mobile Radio Network
PPDR	Public Protection and Disaster Relief
PSA	Public Safety Agency
PSAP	Public Safety Answering Point
PSMB	Public Safety Mobile Broadband
PSTN	Public Switched Telephone Network
PU	Personal Unit
RLAN	Radio Local Area Network
RSU	Road Side Units
SCoTI	Standing Council on Transport and Infrastructure
SDO	Standards Development Organisations
SWE	Sensor Web Enablement
TISOC	Transport and Infrastructure Senior Officials' Committee
UPD	Urban Planning and Design
3GPP	Third Generation Partnership

Executive Summary

The House Standing Committee on Infrastructure, Transport and Cities should be complimented on its public consultation into the automation of mass transit systems in Australia.

The University of Melbourne's Centre for Disaster Management and Public Safety (CDMPS) strategic intent is to support multi-disciplinary collaboration between researchers, government, industry, agencies and the community in delivering exceptional public safety outcomes.

Any discussions on autonomous mass transit systems must consider the context of the broader transportation services which comprise a complex multi-modal network. This network is always at risk of the disruptive impact of natural disasters as well as other types of emergencies like a collision or targeted attack (DoIRD 2016; DTMR 2018). These risks can be reduced through an increased level of cooperation between the transport sector, law enforcement and emergency services. This cooperation should extend to enhancing the level of interoperability of operational responses and information and communications systems.

Advances in modern Information and Communications Technologies (ICT) have the potential to revolutionise our world in ways that we can only imagine. The only thing that we can be sure of is that this technology will be defined by mobility and connectivity. A key challenge to our future world is the convergence of skills and knowledge associated with Infrastructure Engineering (IE), Computer Engineering (CE), Urban Planning and Design (UPD) and Electrical and Electronic Engineering (EEE). This convergence has led to the development of concepts like the "Internet of Things' and 'Smart Cities'. These developments include significant advances in Cooperative Intelligent Transport Systems (C-ITS). Connected and Autonomous Vehicles (CAVs) including autonomous mass transit systems are an element of these C-ITS.

The CDMPS views C-ITS as a critical component of the 'smart cities concept' and the associated sensor networks, On Board Units (OBUs), Personal Units (PUs) and Road Side Units (RSUs) are a key subset of the 'Internet of Things' or more precisely the 'Internet of Public Safety Things'. In this context the CDMPS also anticipates that C-ITS will be a key component of the Next Generation Triple Zero (NG000) and Public Safety Mobile Broadband (PSMB) systems.

The CDMPS argues that the harmonisation of technology, standards, spectrum and devices at both a national and international level should be a fundamental aspect of Australia's national C-ITS strategy. It appears that the Australian Communications and Media Authority (ACMA) is adopting this type of approach as it finalises the arrangements of C-ITS in the 5.9 GHz band. Rail Industry (RI) has been assigned spectrum by the ACMA in the 400 MHz band (ACMA 2016a). The Australian Rail Association (ARA) coordinates applications from prospective users seeking access to the RI spectrum. At this stage it is unknown if the RI will have access to the C-ITS spectrum allocation.

It is essential that the House Standing Committee on Infrastructure, Transport and Cities, ARA and the ACMA work in partnership to ensure that the critical underpinning radio communications infrastructure is established to support investment into C-ITS generally and autonomous mass transit systems specifically.

When discussing any autonomous mass transit investment consideration needs to be given to the full range of modal choice options including Rapid Transit Systems (RTS) and existing public transport networks (Bus Industry Confederation 2014).

The introduction of C-ITS will potentially impact the labour market in both a negative and positive manner. It has been estimated that 650,000 Australians are employed in the transport sector performing a range of roles (Stanford & Grudnoff 2018).

Executive Summary (Continued :)

Job losses will be associated with the automation of traditional jobs and roles; however, there will be significant job creation opportunities as well.

Supporting the ongoing skills development of the Australian radio communications industry through both vocational and higher education will ensure that Australia has a workforce that is positioned to actually design, construct and maintain this infrastructure. Similarly, a strategy needs to be developed to support the transition of traditional jobs within the transport and mass transit industry into this new C-ITS environment. The establishment of an Office of Future Transport Technologies within the Department of Infrastructure, Transport and Regional Development should enable the Australian Government to work with industry and State and Territory Governments to ensure Australia is ready to manage the challenges and opportunities flowing from C-ITS and autonomous mass transit systems.

The CDMPS anticipates the emergence of a hybrid C-ITS approach that interfaces the 5.9 GHz band with both the 4.9 GHz band and other communications technologies, especially Long Term Evolution (LTE) based communications technology. LTE technology is especially relevant to mass transit systems as it will help to enhance services supplied to passengers and improve their traveling experience.

The ACMA has expressed a view that *'ITS are intended to improve travel safety, minimise environmental impact, improve traffic management and maximise the benefits of transportation for commercial users and the public'* (ACMA 2016:4). The CDMPS supports this position and believes that C-ITS and autonomous transit systems have a significant potential to enhance road safety outcomes and reduce the national road toll. Given the average national road toll is 1,230 fatalities[1], C-ITS and autonomous transit systems will provide government, road authorities, law enforcement and other public safety officials significant opportunities to enhance the everyday safety of communities around Australia (DIRD 2016:2).

This outcome is a shared responsibility and a high level of collaboration will be required to maximise the public safety benefits arising out of the development and deployment of C-ITS and autonomous transit systems.

The carriage of mission critical data for autonomous transit systems will be at risk of malicious interference so there is a critical need to consider cyber security and operational responses, procedures and mechanisms for any potential attack. Any autonomous transit system should be considered for its potential to be classified as critical infrastructure and advice from the Department of Home Affairs Critical Infrastructure Centre should be engaged to ensure that any cyber security and operational responses procedures and mechanisms are adequate.

The Australian New Zealand Land Information Council (ANZLIC) is the peak national spatial governance body in Australia and New Zealand and has developed the Foundation Spatial Data Framework (FSDF) to provide easy access to authoritative government spatial data. Transport is a key theme within the FSDF and there is an opportunity to engage with ANZLIC to ensure that this theme captures the location of fixed C-ITS infrastructure. It is essential that the FSDF has spatial data sets with a degree of accuracy that will support the operation of CAVs.

Control Rooms are a critical element of any mass transit ecosystem; however an optimal model for the design and operation of an autonomous mass transit system is yet to emerge. Within Australia it is unclear if a standalone control room will be required for any new mass transit system or if an integrated approach will be required to expand the function of existing control rooms.

---

[1] This figure is based on the average from 2112 to 2116 with a minimum of 1151 (2114) and maximum of 1,292 (2116). (Source DIRD 2016)

Executive Summary (Continued :)

Key Recommendations arising from this Submission:

1. Recognise in the national conversation about the future mission critical public safety communications ecosystem supporting Australia's Law Enforcement, Emergency Management and Transport Sectors the potential collective contribution of C-ITS and autonomous mass transit systems.

2. Recognise in the national conversation about C-ITS and autonomous mass transit systems the potential use of wireless infrastructure including mobile broadband and low powered wide area networks.

3. Recognise in the national conversation about the Internet of Things the need for spectrum allocation, radio communications standards and regulation to support the integration of the Internet of Things in the mission critical public safety communications ecosystem, C-ITS and autonomous mass transit systems.

4. Recognise and facilitate through the Department of Home Affairs Critical Infrastructure Centre the classification of the mission critical public safety communications ecosystem, C-ITS and autonomous mass transit systems as *critical infrastructure* and ensure that consistent with this classification national cyber security arrangements support entire ecosystem reliability and resilience.

5. Recognise and embed in C-ITS and autonomous mass transit systems research the role of Standards Development Organisations (SDOs), such as the 3GPP and the Open Geospatial Consortium, in the development and use of open standards to ensure interoperability within and between respective technologies and their ecosystems.

6. Recognise the need for engagement between government and specific industry sectors and industry associations to ensure Australia has the capabilities to effectively manage the challenges and capture opportunities from C-ITS and autonomous mass transit systems and in particular the transitional education and training requirements and the employment arrangements associated with future operational environments.

7. Recognise the need for research into the use of the 4.9 GHz band to allow C-ITS to become an integral component of the mission critical public safety communications ecosystem allowing direct contact and information sharing with Public Safety Agencies.

8. Develop a national policy framework integrating intelligent transport systems into the public safety communications ecosystem to maximise the return on investment in C-ITS from both an economic and social wellbeing perspective.

9. Develop a national research framework for C-ITS and autonomous mass transport systems supported by a robust education, training and skills development capability to support the adoption and operation of C-ITS and autonomous mass transport systems in Australia.

Introduction

This Submission provides a response to the House Standing Committee on Infrastructure, Transport and Cities inquiry on the automation of mass transit systems in Australia.

This Submission is made on behalf of the following organisations:

- **The University of Melbourne Centre for Disaster Management and Public Safety (CDMPS)**

  The CDMPS is a Centre established by the University of Melbourne in November 2013 to specifically focus on research associated with disaster management and public safety. Mission critical communications infrastructure essential to the management of major emergencies and disasters is a specific component of the Centre's Research Agenda. (www.cdmps.org.au).

- **The University of Melbourne Centre for Spatial Data Infrastructure and Land Administration (CSDILA)**

  The CSDILA is a Centre established by the University of Melbourne in 2001 to undertake world-class research supporting sustainable development into the broad areas of spatial data infrastructures, spatial enablement and land administration (www.csdila.unimelb.edu.au).

- **Australian Radio Communications Industry Association (ARCIA)**

  ARCIA is the peak national industry body representing the two-way and associated wireless radio communications industry in Australia. ARCIA is a not-for-profit, incorporated Association that seeks to promote issues such as the protection and better utilisation of the radio communications sections of the spectrum (http://www.arcia.org.au/).

Context

The primary objective of this Submission is to have C-ITS and mass transit systems recognised and included in the national conversation about mission critical public safety communications infrastructure.

The CDMPS has been actively involved in researching and influencing the development of the future mission critical public safety communications ecosystem to support Australia's Law Enforcement and Emergency Management Sectors. This ecosystem should be a key national policy priority as it is the link between the transport sector, community, law enforcement and emergency services.

To provide evidence of the conversation between governments, bureaucracies and industry regarding the need for the holistic development of the future mission critical public safety communications ecosystem within Australia the House Standing Committee's attention is drawn to previous Submissions responding to a range of papers released by Australian Government Departments addressing individual components of the ecosystem i.e. :

- October 2018 – ACMA Review of the Telecommunications (Emergency Call Service) Determination 2009;
- February 2017 – Response to the Request for Information for Australia's Public Safety Mobile Broadband Capability;
- July 2016 – DOCA - Consultation Paper on the proposed Radio Communications Bill 2016;
- July 2015 - Submission to the House of Representatives Standing Committee on Infrastructure and Communications Inquiry into "The role of smart ICT in the Design and Planning of Infrastructure";
- June 2015 - Submission to the Australian Government Productivity Commission's Issues Paper "Public Safety Mobile Broadband";
- August 2014 – Department of Communications Triple Zero Review;

- February 2013 - ACMA "The 803-960 MHz band – exploring options for future change"; and
- December 2011 – DBCDE Review of the Integrated Public Number Database.

Location based services, data and data analytics will be key elements of this emerging ecosystem and the Productivity Commission's inquiry into data availability and use should also be considered alongside the afore mentioned papers released by Australian Government Departments addressing individual components of the ecosystem (PC 2016).

Public Safety Communications Systems Background

Australia's complex public safety communications systems and arrangements provide a critical national capability in protecting and servicing Australian communities to ensure their day to day safety as well as supporting them when disasters strike. Every day the transport sector is at risk of the disruptive impact of natural disasters as well as other types of emergencies like a collision or targeted attack (DoIRD 2016; DTMR 2018). Mass transit systems have also been the focus of both criminal and anti-social behaviour. Thankfully when events occur they are normally at the lower level of intensity, but the potential frequency of their occurrence underpins the need for a close working relationship between the transport sector, community, law enforcement and emergency services.

The Australian radio communications industry contributes to both the economic prosperity and social wellbeing of all Australians. Research into the economic value of the Australian radio communications industry has found that it contributes $3.5 billion per annum[2] to the Australian economy. More broadly public safety communications systems significantly enhance Australia's resilience. These systems have been transitioning from analogue to digital technologies and with the advent of mobile broadband technology they are set to transform to the next generation of public safety communications capability.

The Australian government therefore has a unique opportunity to make strategic policy and technological investment decisions to ensure that there is a balance between establishing a new national public safety communications capability and the achievement of broader community benefits including the enhancement of community resilience. To fully understand and appreciate interoperability, public safety communications needs to be conceptualised as an ecosystem that enables public safety officials to deliver a critical service to the community (DHS 2014).

Australia's law enforcement and emergency response systems are based around the centralised management of Triple Zero calls via the Emergency Call Person (ECP)[3]. The existing public safety communications system key entry point is the Public Switched Telephone Network (PSTN) which was developed based on the fixed telephony network using a dedicated triple digit telephone number i.e. Triple Zero (ACMA 2015). The use of Triple Zero[4] in Australia as the primary emergency telephone number is consistent with current international practice. Two additional emergency service numbers are also in operation in Australia, namely 112 (to support the international standard emergency number) and 106 (to support text-based requests for assistance for people who are hearing or speech impaired) (ACMA 2015:16). Triple Zero telephone calls are then routed to the relevant state/territory and agency via the Emergency Call Services (ECS) or a Public Safety Answering Point (PSAP).

There are a number of legislative instruments impacting on the ECS including:

- Telecommunications Act 1997 (Cth);

[2] Australian Radio Communications Industry Association Study 2014

[3] Telstra is currently performing the role of the ECP.

[4] The Department of Communications Triple Zero Review examined the development of the next generation Triple Zero service (NG000). It is anticipated that the NG000 service will greatly support the ability to capture and use a broad range of multi-media data and expand the quality and versatility of the current Triple Zero service.

- Part 8 Telecommunications (Consumer Protection and Service Standards) Act 1999 (Cth);
- Telecommunications (Emergency Call Service) Determination 2009[5]; and
- Telecommunications (Emergency Call Persons) Determination 1999.

The ECS/PSAP assigns tasks to relevant Public Safety Agencies according to agreed business rules. The wireless interface to law enforcement and emergency services is a state and territory responsibility and has traditionally been supported by a range of Government Radio Networks (GRNs) and Private Mobile Radio Networks (PMRs). The ACMA is responsible for managing the national policy and spectrum allocation for these networks under the Public Protection and Disaster Relief (PPDR) communications policy agenda. More recently there has been a focus on developing PPDR networks based on mobile broadband technologies to facilitate enhanced service delivery. This development will permit PPDR options to move from a primary reliance on voice-only communications to one based upon data[6] which may in the future also have a voice capability.

It is anticipated that the Rail Industry (RI) will be a key beneficiary of investment in autonomous mass transit systems. The RI has been assigned spectrum by the ACMA in the 400 MHz band (ACMA 2016a). The Australian Rail Association (ARA) coordinates applications from prospective users seeking access to this RI spectrum. Further research will be required to identify how the wireless communication requirements for a mass transit system for the RI can be supported within this spectrum allocation or if a different approach will be required. The concept of a connected train service was originally based around the offering of the internet to train passengers and the tailoring of on-board digital services (Kontron 2017). The personalisation of passenger experience has been identified as a key requirement within the RI and it appears that smartphone technology will be a key enabler in this regard (RSSB 2018). This concept has now been expanded to connecting sensor devices and sensor networks that support the operation of trains. These sensors can be physically connected via an Ethernet device or through the use of a wireless mechanism, for example Low-Power-Wide-Area Networks (LPWANs) (Kontron2017). As a result wireless infrastructure using mobile broadband and LPWANs should be considered within the discussions on autonomous mass transit systems.

The ‘Internet of Things’ (IoT) is a term used internationally to describe hardware and software technologies that provide connectivity between people and machines. It has a very broad definition and links to other emerging technologies such as autonomous systems, robotics, data analytics and artificial intelligence (GOfS 2015). Whilst the ‘Internet of Things’ will impact different industry sectors and communities at different rates, it is anticipated that a subset of these emerging technologies (termed the ‘Internet of Public Safety Things’) will deliver significant productivity gains and public safety outcomes for Public Safety Agencies.

The ‘Internet of Things’ is also enabling the development of an area of study, named ‘Smart Cities’ which seeks to use Smart ICT to support the optimisation of resources and the efficient operation of city infrastructure. This approach enhances the quality and performance of urban services, reduces costs and resource consumption and allows officials to engage with the community in a more effective manner (Gupta 2015). Emerging IoT technologies will help support a more efficient and proactive management of mass transit infrastructure. Some have used the term Industrial Internet of Things (IIoT) to focus how these technologies can be used in connection with data analytics to improve enterprise asset management and operations (Trapeze Group 2017). These technologies include digitised signalling, digital automated train control, railway track crack detection, rolling stock component health monitoring and smart decision support tools (Di Claudio et al 2014; Kumar, Titus, Ganesh & Devi 2016; Sujay 2017; Trapeze Group 2017).

[5] ACMA is currently conducting a review of the Telecommunications (Emergency Call Service) Determination 2009.
[6] Data services include text and video data formats.

It is anticipated that the Internet of Things will require spectrum allocation and a range of radio communications standards and class licences, for example the radio communications (Short Range Devices) Standard and Low Interference Potential Devices (LIPD) Class Licence.

Intelligent Transport Systems (ITS) involve stand-alone infrastructure, mobile devices and sensors, traffic management systems and cooperative applications involving telematics and a range of communication modalities[7] (SCOTI 2012). As expressed by the ACMA 'ITS are intended to improve travel safety, minimise environmental impact, improve traffic management and maximise the benefits of transportation for commercial users and the public' (ACMA 2016:4). The development of C-ITS initiatives like eCall[8] systems will need to be integrated into the Next Generation Triple Zero service (SCoTI 2012).

The 2016 ACMA consultation paper and the associated draft Radio Communications (Cooperative Intelligent Transport Systems) Class Licence 2016 focus on securing Dedicated Short Range Communications (DSRC) spectrum within the 5.9 GHz band to support the development of C-ITS. The DSRC within the 5.9 band will help to establish C-ITS across Australia; however both of these documents are silent on the potential role of ITS using LTE technology.

Research by Huawei has been focusing on a cellular-assisted communications technology termed LTE-V to provide an alternative approach to DSRC enabled C-ITS (Moyer 2016; Shi 2015). Whilst there are outstanding technical concerns relating to performance and latency of a LTE-V approach, there are some indications that a multi-protocol wireless solution has a key place within a comprehensive C-ITS approach (Moyer 2016).

The ACMA has previously announced a multi-band layering approach to meet the communications requirements of Public Safety Agencies based on the three key bands of 400 MHz (for wide area narrowband mission critical voice and narrowband data), 4.9 GHz (for localised on-demand coverage extremely fast broadband sensor linking and meshing and other services) and 800 MHz (for cellular mobile broadband and associated services) (ACMA 2013).

The consultation paper is silent on the potential for C-ITS to integrate into the activities of Public Safety Agencies using the 4.9 GHz band allocation. It may be possible for future C-ITS systems to also transmit on the Public Safety Agencies Wi-Fi band (4.9 GHz band) to provide direct contact and information to these Agencies. This is an area of research that should be further explored as the CDMPS anticipates the emergence of a hybrid C-ITS approach that interfaces the 5.9 GHz band with both the 4.9 GHz band and other communications technologies, especially LTE based communications technology.

When viewed from a systems perspective, C-ITS can be considered as a key component of the broader Smart Cities concept. The system of systems used to establish C-ITS should also be considered as a key component of the Internet of Public Safety Things. Figure 1 provides a simplified representation of how C-ITS fits within the emerging public safety communications ecosystem.

The development of a policy framework for integrating intelligent transport systems into the public safety communications ecosystem would help to ensure that the Commonwealth, State/Territory Governments and New Zealand maximise the return on investment in C-ITS.

[7] Communication modalities can include Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I), Vehicle-to-Person (V2P) and Communication outside of network coverage area (V2X).
[8] The European Parliament voted in favour of eCall regulation which requires all new cars be equipped with eCall technology from April 2018. In the event of a serious accident, eCall automatically dials 112 - Europe's single emergency number.

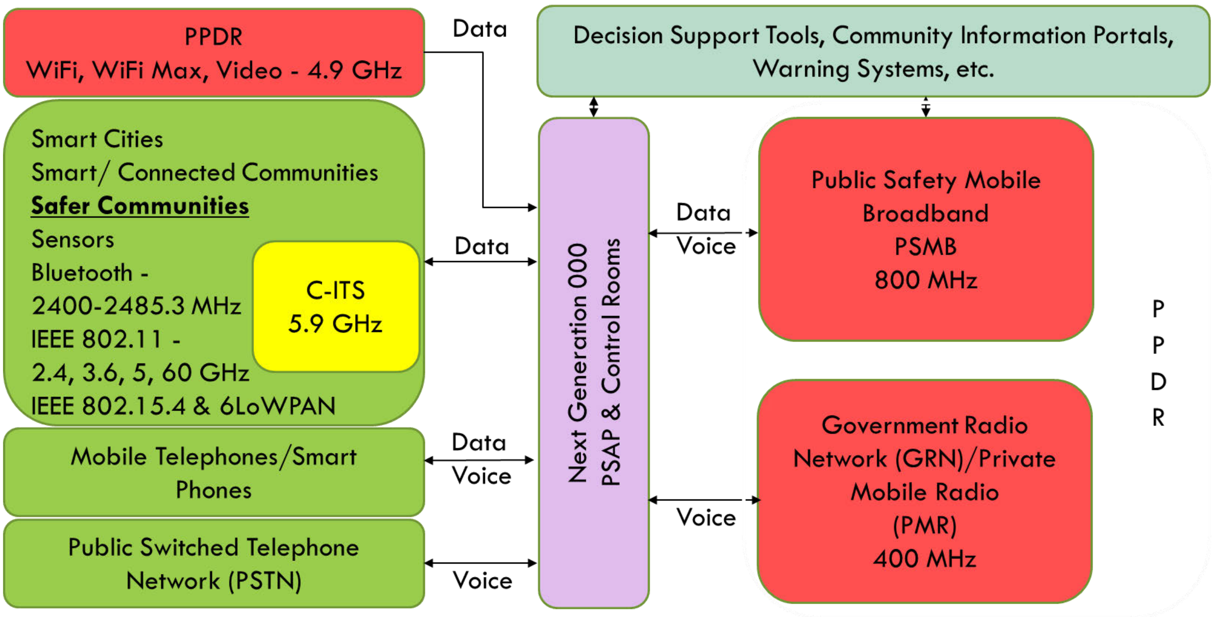

Figure 1: Simplified emerging public safety communications ecosystem.

C-ITS Governance

The Council of Australian Governments (COAG) has established the Standing Council on Transport and Infrastructure (SCoTI) to bring together Ministers that have responsibility for transport and infrastructure issues across the Commonwealth, State/Territory Governments and New Zealand (SCoTI 2016).

SCoTI is advised and assisted by the Transport and Infrastructure Senior Officials' Committee (TISOC). A robust governance structure has been established to ensure that SCoTI is able to provide COAG with high quality advice on transport and infrastructure issues. This governance structure is shown in figure 2.

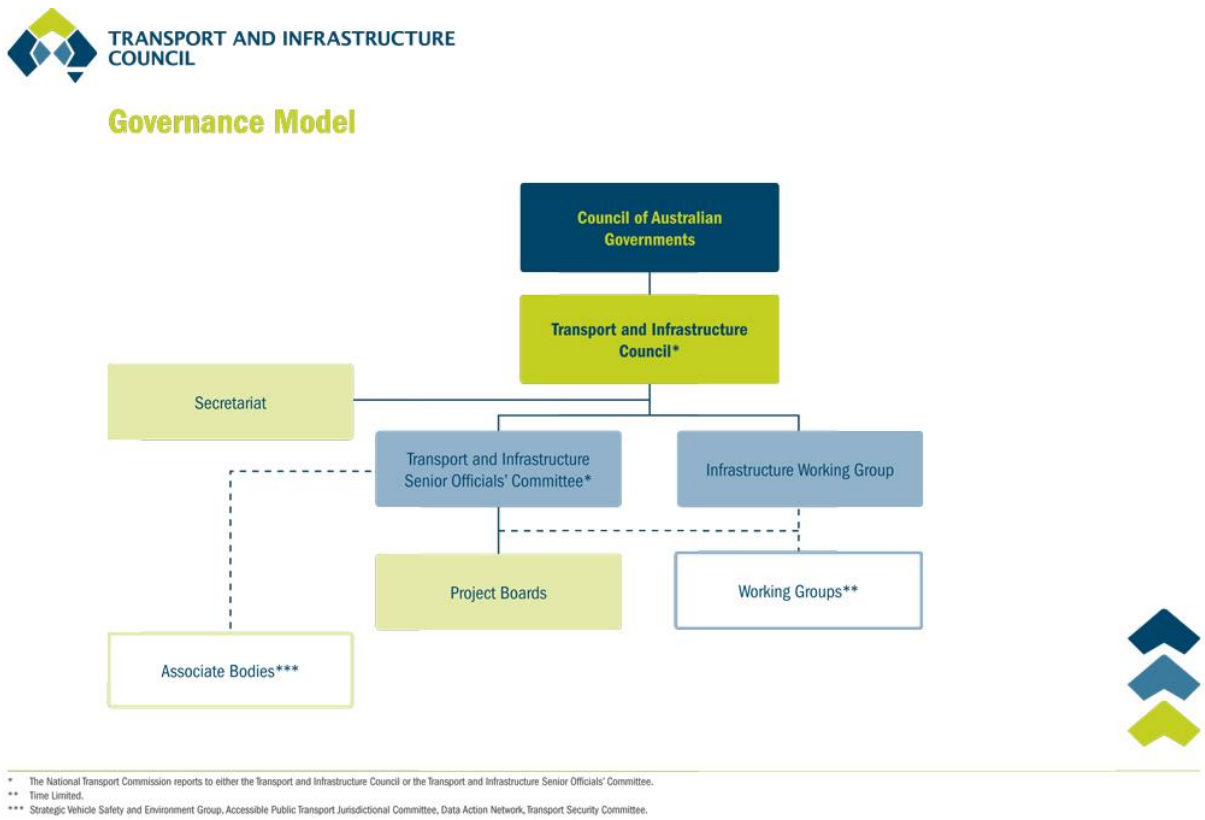

Figure 2: SCoTI Governance Model (Source SCoTI 2016).

The Office of Future Transport Technologies (OFTT) has been established within the Department of Infrastructure, Transport and Regional Development and it is anticipated that OFTT will play a key role within SCoTI especially with regards to supporting the introduction of new C-ITS and autonomous mass transit systems.

SCoTI has developed two key documents in relation to C-ITS namely the Policy Framework for Intelligent Transport Systems in Australia (SCoTI 2012) and the National Road Safety Action Plan 2015-2017 (SCoTI 2014). The National Road Safety Strategy 2011–2020 (NRSS) was approved and released by the former Australian Transport Council (ATC 2011). The National Road Safety Action Plan 2015-2017 supports the NRSS and it details a range of priority national actions to be taken by governments in support of the long-term plan.

The establishment of the former Australian Transport Council, SCoTI and these key policy/strategy documents demonstrate Australia's approach towards national collaboration on road safety improvement. This approach also reflects the shared responsibility and a high level of collaboration required to maximise the public safety benefits of road safety initiatives.

In addition to SCoTI, consideration needs to be given to the key role of Austroads in respect to C-ITS and road safety more generally. Austroads is the association of Australasian road transport and traffic agencies. Austroads (2016) outlines its purpose as being to improve Australian and New Zealand transport outcomes by:

- providing expert technical input to national road and transport policy development.
- improving the practices and capability of road agencies
- promoting operational consistency by road agencies.

Austroads has established the Safety Task Force which has representatives from state and territory road agencies, the National Transport Commission, the Commonwealth Department of Infrastructure and Regional Development, and the Australian Local Government Association.

The Safety Task Force's research program relates to each of the four cornerstones of the safe system: safe roads and roadsides, safe vehicles, safe speeds and safe road users. The program has been designed to support the delivery of the Advancing Safe Systems agenda within the National Road Safety Action Plan (SCoTI 2014).

The Policy Framework for Intelligent Transport Systems in Australia highlights the importance of research into ITS and the ability of Australia's research and development capabilities. The development of a national research agenda for C-ITS generally and autonomous mass transport systems is a priority issue that needs to be highlighted as a critical issue by the Committee.

Ideally this issue should be combined with a need to develop a robust education and skills development system to support the ongoing development of C-ITS autonomous mass transport systems in Australia. ARCIA should be included in this process to provide expert advice on the how to develop the Australian radio communications industry to ensure that it is able to design, construct and maintain the radio communications infrastructure to support any future C-ITS.

Applications and Benefits of C-ITS

The ACMA has expressed a view that *'ITS are intended to improve travel safety, minimise environmental impact, improve traffic management and maximise the benefits of transportation for commercial users and the public'* (ACMA 2016:4). The Policy Framework for Intelligent Transport Systems in Australia provides details of the broad range of challenges and applications of C-ITS (SCoTI 2012).

The CDMPS supports these positions and believes that C-ITS have a significant potential to enhance road safety outcomes and reduce the national road toll. Given that the average national road toll is 1,230 fatalities, C-ITS will provide government, road authorities, law enforcement and other public safety officials significant opportunities to enhance the everyday safety of communities around Australia (DIRD 2016:2).

It is anticipated that significant data will be captured by C-ITS and the broader management of this data (ITS Big Data) and the associated data analytics will be a key area of research going forward. In the public safety context the Public Safety Communications Research Program (PSCR) located in Bolder Colorado is leading the way in research and develop and it has produced Research Roadmaps for Location Based Services[9], Data Analytics and User Interface – User Experience.[10]

The investment in particular technologies is often contextual in nature and the consideration of broader benefits, especially unanticipated benefits is often unclear (ACMA 2015). Whilst ACMA, SCoTI, TISOC and Austroads provide significant leadership in developing the policy framework and operational usage of C-ITS for the safe management of transport and infrastructure issues associated with the broader applications and benefits of C-ITS are less clear. The CDMPS has identified a number of key opportunities where the inclusion of data from C-ITS into decision support and incident management systems has the potential to provide significant benefits. From a disaster management and public safety perspective there are three key areas of interest for the CDMPS, namely emergency management, road safety and crime/intelligence applications.

Emergency Management applications include:

- eCall and eReporting capabilities, which involves the autonomous reporting of incidents based on the vehicle's sensor network for example the detection of a major impact would autonomously report the vehicles location and details of the event to a PSAP/ECS (SCoTI 2012);
- evacuation management support, which can involve a range of activities including the optimisation of evacuation routes and the placement of traffic control points, monitoring the flow of traffic being evacuated from an area as well as dynamically rerouting traffic around an incident and damage within the road network;
- emergency messaging, which can involve displaying messages on smart signs and the interruption of other communications services;
- emergency response, which can involve the integration of a broad range of dynamic sensor data into an incident management or decision support application using the SWE standards.

Road Safety applications include:

- offence detection, which can involve the analysis of data captured by C-ITS sensors or the use of specific sensors on recidivist offenders or their vehicles;
- analysis and use of ITS Big Data and road safety informatics to support enforcement decisions, which can target responses using fixed and mobile RSUs devices;
- response activities, which can be initiated where an event is detected by C-ITS sensors. Developments like Mercedes-Benz's new augmented reality application Rescue Assist will help first responders rescue people trapped within a vehicle more quickly and in a safer manner (Edelstein 2016); and
- medical injury index from vehicle telemetry[11].

---

[9] http://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.1883.pdf
[10] http://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.1917.pdf
[11] For a world leading example see the University of Michigan study of GM OnStar's injury prediction service at http://media.gm.com/media/us/en/gm/news.detail.html/content/Pages/news/us/en/2015/jun/0611-onstar.html

Crime and Intelligence applications include:

- real time monitoring, which can involve using C-ITS infrastructure to supplement monitoring a given area using other technologies and infrastructures, for example local government CCTV systems;
- investigation support, which could involve using data captured by the C-ITS infrastructure to support an investigation into an incident or person; and
- desktop surveillance, which could involve using C-ITS infrastructure to monitor a vehicle travelling on the road network.

Disruptive Technology

Technological developments in the communications industry and within C-ITS are a disruptive force that provides a range of benefits. Stanford & Grudnoff (2018:8) argue that the artificial intelligence and related technologies have a range of major applications within the transport industry including:

- Position, localisation, and mapping capacities and functions;
- Monitoring and surveillance technologies to track vehicle and staff locations;
- Assisted driving, sensing, and perception supports; partial automation of driving task (SAE Tiers 0-1); Increasing automation of driving task (SAE Tiers 2-5);
- Connected vehicle technology allowing better coordination/communication across fleets;
- Big data analytics, deep learning, use of algorithms (in planning routes, service, and customer contacts);
- Extensive computerisation in data management, including by drivers (e.g. paperless document systems); and
- Advanced data systems to enhance security and privacy standards in transportation.

As shown in Table No 1 Stanford & Grudnoff (2018:9) believe that the transition to autonomous operation within the transport sector has a number of benefits but it will be subject to incremental progress depending upon a number of prevailing constrained.

Constraints	Benefits
• Infrastructure. • Proof of safety. • Security. • Social acceptance. • Regional impacts. • Capital investment. • Management adequacy. • Lag times to phase in new equipment. • Insurance.	• Improved safety. • Greater fuel efficiency. • Efficient traffic management. • Reduced greenhouse gas emissions. • General transportation cost reductions. • Enhanced mobility for people with disabilities. • Potential improvements in job quality.

Table 1: Constraints and Benefits of New Technology in Transportation (Source: Stanford & Grudnoff 2018:9).

Control Rooms and Decision Support

Control Rooms are a critical element of any mass transit ecosystem; however, an optimal model for the design and operation of an autonomous mass transit system is yet to emerge. Within Australia it is unclear if a standalone control room will be required for any new mass transit system or if an integrated approach will be required to expand the function of existing control rooms.

Law enforcement and Emergency Service Organisations use a range of decision support tools for example incident maps and prediction/simulation software to enhance their situational awareness and understand the potential impact of unfolding events.

These Agencies also have access to a range of tools like emergency warning systems and community information portals to engage with and warn the community in relation to a particular event. Access to relevant data and sensors networks provide key inputs into these tools.

The CDMPS has been actively involved with the Open Geospatial Consortium (OGC) in researching and developing Sensor Web Enablement (SWE) standards which will enable developers to make all types of sensors, transducers and sensor data repositories discoverable, accessible and useable via the Web. SWE will become increasingly important to mass transit systems and autonomous mass transit systems. It is anticipated that new sensor networks will result in the development of advanced and innovative decision support tools.

The CDMPS has developed an Intelligent Disaster Decision Support System (iDDSS) platform based on the previous investment in the Australian Urban Research Infrastructure Network[12] and the Australian Data Service[13] (AURIN/ANDS) project.

As shown in Figures 3a and 3b the iDDSS enables the incorporation and assimilation of various complex data bases into an easily understood visual medium to assist in emergency event simulation and planning, for example fire and flood simulations. The modelling, simulation and visualisation are configurable to the user requirements as required.

Figure 3a: Intelligent Disaster Decision Support System

Figure 3b: Intelligent Disaster Decision Support System

[12] https://aurin.org.au/
[13] http://www.ands.org.au/

The CDMPS has been actively involved in researching the integration of a broad range of sensor data into the iDDSS platform using the SWE standard. This research includes a number of current research projects focusing on the management of the transport network during a disaster.

A system has been developed to establish user configurable enquiries and alerts based on particular variables, for example tidal/river heights and traffic flow. When these limits are reached an alert notification will be initiated. The integration of C-ITS into this type of system will assist road management authorities to discover events that have the potential to cause major interruption into mass transit systems and the road network.

Interference and Security of C-ITS

The carriage of mission data for autonomous transit systems will be at risk of malicious interference so there is a critical need to consider cyber security and operational responses procedures/mechanisms for any potential attack.

The National Institute of Standards and Technology (NIST) (NSIT as cited in Rockwell Collins 2017:5) has identified that industrial control systems (ICS) are at risk of a range of attacks including:

- Blocked or delayed flow of information through ICS networks, which could disrupt ICS operation;
- Unauthorized changes to instructions, commands, or alarm thresholds, which could damage, disable, or shut down equipment, create environmental impacts and/or endanger human life;
- Inaccurate information sent to system operators, either to disguise unauthorized changes or to cause the operators to initiate inappropriate actions, which could have various negative effects;
- ICS software or configurations settings modified, or ICS software infected with malware, which could have various negative effects;
- Interference with the operation of equipment protection systems, which could endanger costly and difficult-to-replace equipment; and
- Interference with the operation of safety systems, which could endanger human life.

Any autonomous transit system should be considered for its potential to be classified as *critical infrastructure* and advice from the Department of Home Affairs Critical Infrastructure Centre should be engaged to ensure that cyber security and operational responses procedures/mechanisms are consistent with this classification and support entire ecosystem reliability and resilience.

Interference between radio networks can occur and as a result the ACMA has developed a range of co-existence measures to manage anticipated interference. When developing any autonomous mass transit system the ACMA will be a key partner in allocating the required spectrum to support the wireless operation of the system and ensure that that system is able to coexist with other radio operators.

Skills and Education

Job losses will be associated with the automation of traditional jobs and roles; however, there will be significant job creation opportunities as well. Supporting the ongoing skills development of the Australian radio communications industry through both vocational and higher education will ensure that Australia has a workforce that is positioned to design, construct and maintain this infrastructure. Similarly, a strategy needs to be developed to support the transition of traditional jobs within the transport and mass transit industry into this new C-ITS environment.

The establishment of an Office of Future Transport Technologies within the Department of Infrastructure, Transport and Regional Development should enable the Australian Government to work with industry and State and Territory Governments to ensure Australia is ready to manage the challenges and opportunities flowing on from C-ITS and autonomous mass transit systems.

Conclusion

The CDMPS and ARCIA acknowledge the significant commitment of the House Standing Committee on Infrastructure, Transport and Cities, the ACMA and other key stakeholders in supporting the development and introduction of C-ITS in Australia. It is hoped that any C-ITS will be developed using a strategic approach to establish a multilayered flexible framework meeting the future needs of Australia's transport sector, radio communications industry and Public Safety Agencies.

Balancing the economic and broader social impacts associated with spectrum allocation in Australia is an incredibly complex task that requires multi-disciplinary collaboration between researchers, government, industry, agencies and the community.

The CDMPS and ARCIA look forward to supporting the House Standing Committee on Infrastructure, Transport and Cities and key stakeholders in developing Australia's future public safety communications ecosystem including the integration of C-ITS into that ecosystem.

Further Reading

In preparing this Submission the following documents have been identified as being useful reference guides to support the Committee:

- Institution of Engineering and Technology (2017,) Autonomous Vehicles a railway Perspective https://www.theiet.org/sectors/transport/topics/autonomous-vehicles/articles/av-railway.cfm
- NCHRP (2017), Advancing Automated and Connected Vehicles: Policy and Planning Strategies for State and Local Transpiration Agencies https://www.nap.edu/catalog/24872/advancing-automated-and-connected-vehicles-policy-and-planning-strategies-for-state-and-local-transportation-agencies
- NCHRP (2018), Updating Regional Transportation Planning and Modelling Tools to Address Impacts of Connected and Automated Vehicles Volume 2: Guidance https://www.nap.edu/catalog/25332/updating-regional-transportation-planning-and-modeling-tools-to-address-impacts-of-connected-and-automated-vehicles-volume-2-guidance
- Rail Safety and Standards Board Limited (RSSB), (2018), Rail Technical Strategy Capability Delivery Plan, https://www.rssb.co.uk/rts/Documents/2017-01-27-rail-technical-strategy-capability-delivery-plan-brochure.pdf

Contact Regarding This Submission

Contact regarding this Submission should initially be directed to:

Geoff Spring: CDMPS Senior Industry Advisor
E-Mail:
Mob:

References

ANZLIC—the Spatial Information Council (ANZLIC), (2014), The Australian and New Zealand Foundation Spatial Data Framework, (2nd Ed), Department of Communications, Canberra, ACT, Australia.

Australian Communications and Media Authority (ACMA), (2009), IFC 27/2009 - Planning for Intelligent Transport Systems, (Online) http://www.acma.gov.au/theACMA/~/link.aspx?_id=70BC6CFBE79F4412847E4AF0B29F747E&_z=z [Accessed 24/8/16].

Australian Communications and Media Authority (ACMA), (2013), New Spectrum for Emergency Services, (Online) http://www.acma.gov.au/theACMA/new-spectrum-for-emergency-services [Accessed20/9/16].

Australian Communications and Media Authority (ACMA), (2016), Proposed Regulatory Measures for the Introduction of C-ITS in Australia, (Online) http://www.acma.gov.au/theACMA/proposed-regulatory-measures-for-the-introduction-of-c-its-in-australia [Accessed 24/8/16].

Australian Communications and Media Authority (ACMA), (2016a), 400MHz Latest Developments (Online) https://www.acma.gov.au/theACMA/latest-developments-1 [Accessed 5/12/18].

Australian Transport Council (2011), The National Road Safety Strategy 2011–2020, (Online) http://roadsafety.gov.au/nrss/files/NRSS_2011_2020.pdf [Accessed 31/8/16].

Austroads (2016), About Austroads, (Online) http://www.austroads.com.au/about-austroads/about-austroads [Accessed 31/8/16].

Bus Industry Confederation (BIC) (2014), Rapid Transit, Investing in Australia's Transport Future, (Online) https://infrastructureaustralia.gov.au/policy-publications/publications/files/Rapid_Transit_Report_BIC_2014.pdf [Accessed 5/12/18].

Department of Homeland Security (DHS), (2014), National Emergency Communications Plan, Department of Homeland Security (Online) http://www.dhs.gov/necp [Accessed 24/8/16].

Department of Infrastructure and Regional Development (DIRD), (2016), Road Deaths Australia July 2016, (Online) https://bitre.gov.au/publications/ongoing/rda/files/RDA_July_2016.pdf [Accessed 24/8/16].

Department of Infrastructure and Regional Development (DIRD), (2016), Trends: Transport and Australia's Development to 2040, (Online) https://infrastructure.gov.au/infrastructure/publications/files/Trends_to_2040.pdf [Accessed 6/12/18].

Department of Transport and Main Roads (DTMR) (2018), Transport Network Security and Resilience, (Online) https://www.tmr.qld.gov.au/Safety/Transport-security-and-safety.aspx/ [Accessed 5/12/18].

Di Claudio, M., Fantechi, A., Martelli, G., Menabeni, S & Nesi, P., (2014) Model-Based Development of an Automatic Train Operation Component for Communication Based Train Controls, 17th International IEEE Conference on Intelligent Transportation Systems, 8-11 Oct 2014, Qingdao, China.

Edelstein, S., (2016), Mercedes-Benz's new augmented reality app will aid first responders, Digital Trends (Online) http://www.digitaltrends.com/cars/mercedes-benz-rescue-assist-app/ [Accessed 31/8/16].

Government Office for Science (GOfS), (2014), The Internet of Things: Making the Most of the Second Digital Revolution, (Online) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/409774/14-1230-internet-of-things-review.pdf [Accessed 24/8/16].

Gupta, A., (2015), Smart GIS: A Gateway to Smart City Using 3D GIS Maps of Cities, LiDAR Magazine, Vol. 5 No. 4, Spatial Media, www.lidarenews.com

Kumar, S., Titus, T., Ganesh, V., & Devi, S. (2016), Automotive Crack Detection for Railway Track Using Ultrasonic Sensors, International Journal of Engineering Technology and Computer Research (IJETR), **(4)**, 6, pp 34-37.

Kontron S&T (2017), LoRaWAN Connectivity: How LoRaWAN Wireless Connectivity Benefits the Transportation Industry, Kontron S&T, Augsburg, Germany.

Moyer, B., (2016), A Four-way Vehicular Radio Module, Electronic Engineering Journal, August 8, 2016 (Online), http://www.eejournal.com/archives/articles/20160808-redpine/ [Accessed 31/8/16].

Productivity Commission (PC), (2016), Data Availability and Use, (Online) http://www.pc.gov.au/inquiries/current/data-access#draft [Accessed 24/8/16].

Rail Safety and Standards Board Limited (RSSB), (2018), Rail Technical Strategy Capability Delivery Plan, (Online) https://www.rssb.co.uk/rts/Documents/2017-01-27-rail-technical-strategy-capability-delivery-plan-brochure.pdf [Accessed 6/12/18].

Rockwell Collins (2017), The State of Cybersecurity in the Rail Industry, (Online) https://www.rockwellcollins.com/-/media/files/rc2016/marketing/c/cybersecurity-solutions/the-state-of-cybersecurity-in-the-rail-industry-white-paper.pdf?lastupdate=20171215210046 [Accessed 7/12/18].

Shi, Y., (2015), LTE-V: A Cellular-Assisted V2X Communication Technology, ITU Workshop, July 28-29 2015, Beijing China, (Online) https://www.itu.int/en/ITU-T/extcoop/cits/Documents/ITS%20Events-201507-Beijing/Presentations/S3P2-Yi-Shi.pdf [Accessed 31/8/16].

Sujay (2017), Digital ATC System – Fundamental Change, Rail Engineering Digest, (Online) http://railengdigest.com/technical-articles/signalling-control/digital-atc-system-fundamental-change/ [Accessed 7/12/18].

Stanford, J. & Grudnoff, M., (2018) The Future of Transportation Work: A Summary Report, TWU Super, (Online) https://www.twusuper.com.au/employers/employer-services/the-future-of-transportation-work/ [Accessed 4/12/18].

Standing Council on Transport and Infrastructure (SCoTI), (2012), Policy Framework for Intelligent Transport Systems in Australia, Transport and Infrastructure Council, Department of Infrastructure and Transport, Canberra, ACT, Australia.

Standing Council on Transport and Infrastructure (SCoTI), (2014), the National Road Safety Action Plan 2015-2017, Department of Infrastructure and Regional Development, Canberra, ACT, Australia.

Standing Council on Transport and Infrastructure (SCoTI), (2016), Transport and Infrastructure Council, (Online) http://transportinfrastructurecouncil.gov.au/ [Accessed31/8/16].

Trapeze Group (2017), Future Rail: Emerging Technologies to Effectively Manage Growing Rail Networks, (Online) https://www.trapezegroup.com.au/resources/whitepaper-future-rail-eam [Accessed 6/12/18].

Vipond, J.A., (2009), Optus Submission to Australian Communications and Media Authority on Planning for intelligent transport systems, (Online) http://www.acma.gov.au/~/media/Spectrum%20Transformation%20and%20Government/Issue%20for%20comment/pdf/Submission%20on%20IFC%20272009%20Optus.PDF [Accessed 31/8/16].