Automated and zero emission vehicle infrastructure advice

Submission to Infrastructure Victoria’s consultation

Public version

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Executive Summary

Telstra welcomes the opportunity to comment on Infrastructure Victoria’s consultation on “Automated and zero emission vehicle infrastructure advice.” We acknowledge the importance of planning now to ensure the right infrastructure is created to facilitate the introduction of automated and zero-emission vehicles while being flexible enough to evolve with these types of vehicles as they are developed and enhanced over the coming decades.

A vital part of the overall infrastructure supporting future autonomous and zero-emission vehicles is nationwide communications infrastructure. 4G-LTE and future 5G networks in Australia provide a solid foundation for relaying large amounts of information from vehicles, road-side infrastructure, sensors and users of our road and public transport systems. These 4G-LTE and 5G networks have the capability to support the connection of large numbers of sensors, roadside infrastructure and vehicles, along with large volumes of aggregate data from vehicles, as well as visual data from CCTV being used to monitor congestion.

While autonomous and zero-emission vehicles don’t need connectivity to function, the ability to tap into and centrally aggregate a wide range of data sources will allow them to choose better routes, thereby minimising congestion and improving the experience for passengers. Better yet, we believe that tangible benefits could be delivered to all road users today through the collection and processing of data from existing sources to create insights that could be used to manage traffic to reduce congestion and provide a better experience to current road users. The development of a communications ecosystem built around mobile connectivity as a key building block is expected to deliver benefits to existing road users, and could pave the way for the connectivity of tomorrow’s autonomous and zero-emission vehicles.
1 Introduction

We welcome the opportunity to comment on Infrastructure Victoria’s consultation on “Automated and zero emission vehicle infrastructure advice.” Through our involvement with the Australian Driverless Vehicle Initiative, the Intelligent Transport Systems World Congress, the 5G Automotive Association, Australia’s state transport agencies and many vendor and stakeholder relationships, we are aware that Connected and Autonomous Vehicles (CAVs) and Electric Vehicles (EVs) will have numerous social and economic benefits for Australia. We believe government and industry should work together to encourage and support the rapid uptake of CAVs and EVs and Infrastructure Victoria applying its resources to this important topic is a valuable step towards achieving this outcome.

We use the term CAVs to describe Connected and Autonomous Vehicles, although in many of the cases we outline below, the benefits are realised through autonomy without the need for the vehicle to be connected to other vehicles around it, to infrastructure (e.g., traffic lights) or to a central system for monitoring. Additional benefits may be realised through the connection of vehicles (autonomous or otherwise) to improve situational awareness for safety applications, such as collision avoidance, or to a central monitoring facility for traffic flow/congestion and safety improvements, which can then be fed back to individual vehicles for journey planning, optimisation and improved driving behaviour. Generally, we refer to Autonomous Vehicles (AVs) throughout our submission, however from time-to-time, we refer to CAVs to highlight instances where additional benefits arise from connectivity.

Our submission is structured as follows:

- In section 2, we describe some areas of technology evolution that we see occurring over the next few years to provide context in the areas of communication, big data and analytics, and the insights that are likely to be gained from artificial intelligence and machine learning.
- In section 3, we respond to each of the ten focus areas covered on the consultation website.
- In section 4, we discuss a number of initiatives Telstra is working on, and describe how these may help inform Infrastructure Victoria’s thinking in relation to CAVs and EVs.

Throughout our submission we make recommendations that Infrastructure Victoria might like to consider. We would be very happy to discuss any of these recommendations further.

2 Technology evolution

CAVs and EVs have the potential to revolutionise transportation of both people and goods. With this revolution will come economic benefits through improved productivity, as well as social benefits through improved safety, a cleaner environment and inclusion for those unable to drive due to age or disability.

However, before CAVs and EVs become ubiquitous, there is a more immediate opportunity to fast-track benefits for our economy and society through greater connectivity and the collection of data. This, coupled with advances in machine learning and artificial intelligence could generate insights for improved real-time traffic management and safety outcomes. We believe that solutions can be rolled out now to achieve tangible benefits today, while also paving the way for CAVs and EVs in the future. Practically speaking, vehicle connectivity to external networks for delivering digital content and services, transmitting telemetry data from the vehicle, enabling remote monitoring and control or managing in-vehicle systems is already here. Ahead of automotive specific communications technologies such as cellular V2X, tens of millions of vehicles are already being shipped with mobile connectivity1, and the pace is only increasing.

Recently completed standards for Cellular Vehicle to Everything communications (C-V2X - see section 3.1) will be rolled out into existing mobile networks providing substantial coverage of Australia’s road network in a short space of time. Car manufacturers are now designing V2X communications systems into the next generation(s) of their vehicles2, 3 that will enable short-range communication between vehicles, and back to central data analysis systems, through cellular V2X. Further, our recently launched Category M1 (CAT-M1) and Narrow-Band Internet-of-Things (NB-

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1 Gartner says connected car production to grow rapidly over the next five years. Gartner, 29 Sept 2016. https://www.gartner.com/newsroom/id/3460018
2 Groupe PSA and Qualcomm advance C-V2X testing for communications between vehicles” https://www.qualcomm.com/news/releases/2018/02/01/groupe-psa-and-qualcomm-advance-c-v2x-testing-communication-between
IoT services could facilitate the deployment of sensors to monitor traffic. Through data aggregation and analysis, and with integration into traffic management systems (e.g., SCATS for traffic light control, CCTV, Bluetooth®, DSRC, MyRo™, Addinsight™ etc.), it is possible to improve the way we use our roads and manage congestion.

As an example, at Telstra we have been developing platforms such as the Telstra Location Insights, which can provide insights for route optimisation via car, public transport, ride share or combinations thereof.

Importantly, these communications, data aggregation and analysis systems will support AVs and EVs. AVs will benefit from connection to cloud-based traffic management systems for real-time route optimisation, and responding to requests to collect additional passengers in autonomous ride-sharing services that will form the passenger collection component of future public transport solutions. Similarly for EVs, electricity grid management systems of the future will require knowledge of where and when EVs require charging to optimise the electricity grid.

It is important that Infrastructure Victoria and industry work together to develop communications systems and data aggregation solutions that deliver tangible benefits to road and public transport users today, and with an eye on the future.

3 Consultation focus areas

Infrastructure Victoria’s consultation website4 outlines ten focus areas to guide submissions. In this part of our submission, we provide our views on each area.

3.1. Technology development

Consultation Guidance: Automated and zero emission vehicle technologies are advancing rapidly, but exactly how rapidly – and in what direction – will have a significant impact on the infrastructure required to support its roll-out. We will also need to look at what might be needed to allow automated and human drivers to exist together on the road, any opportunities or drawbacks to particular technologies, and the specific opportunities for freight.

Communication technology will play a vital role in the success of CAVs and EVs. These roles can be grouped into two categories: 1) direct communication; and 2) network communication. Direct communication is where vehicles talk directly to each other for purposes such as crash avoidance (e.g., messages that communicate vehicle trajectory, which other vehicles will use to support emergency braking decisions), or where vehicles communicate with infrastructure such as traffic lights or other roadside units (RSUs) via short-range communications. Network communication connects vehicles, sensors, road infrastructure (e.g., signs) and other road users (e.g., cyclists) to central systems. This can be used for a variety of purposes from collecting data for traffic optimisation through to providing warnings to vulnerable road users5. Some applications, such as broadcast of traffic-light timing, could be served by either direct or network communications, which may make deployment of these applications less dependent on investment in roadside units and similar infrastructure.

There are two competing standards in the Connected Intelligent Transport Systems (C-ITS) arena. Dedicated Short Range Communications (DSRC) is the older of the two standards, having been adopted in the USA in 20036 by the Federal Communications Commission (FCC) based on the ETSI standard7 for Intelligent Transport Systems, and in December 2017, the Australian Communications and Media Authority (ACMA) updated the Australian ITS class licence8 to adopt this standard. As an alternative to DSRC, in September 2016, the mobile industry Third Generation Partnership Project (3GPP9) completed work on the Cellular Vehicle to Everything (C-V2X) standard10 for inclusion into Release 14 for 4G mobile networks. The Electronic Design paper11 titled “DSRC vs C-V2X: Looking to impress the regulators” provides a short comparison of the two standards.

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9 Third Generation Partnership Project (3GPP). http://www.3gpp.org/about-3gpp/about-3gpp
In our view, there is little difference between the two standards for the purpose of direct communication. Both standards use the 5.9 GHz spectrum band, which means that propagation characteristics are identical, and in all likelihood, we will see vehicles arrive in Australia over the coming years with one or other standard embedded.

However, in the context of network communication, we believe that the 3GPP C-V2X standard offers a significant benefit over its counterpart because it uses pre-existing mobile networks for network communication and identifies the role of network and direct communications as a whole ecosystem. This is in stark contrast to the DSRC standard which uses the 5.9 GHz band for both direct and network communication; the latter 5.9 GHz via short-range RSUs, meaning that entirely new network infrastructure will need to be deployed in the 5.9 GHz band if Australia wants to adopt the DSRC standard. We think this is an impractical and uneconomic approach, especially in regional areas. Our strong recommendation is that Australia align itself with the 3GPP C-V2X standard to utilise the three existing (and soon to be four) mobile networks, which have both the coverage and capacity to provide all forms of V2X communication. Alternately, a “hybrid” approach may be possible which employs DSRC for direct communications, and mobile infrastructure for network communications, although we note that this approach is not well studied nor supported and offers no significant advantage compared to the complete C-V2X standard.

In addition to vehicles, we anticipate an increase in the number and types of connected infrastructure that today is not commonly thought of as part of the road network. Sensors that can monitor everything from the flow of traffic to the health of road infrastructure (for example, vibration sensors on bridges) will become commonplace, as will ‘connected pedestrians’, parking meters and the status of parking bays (occupied/available). The recently launched CAT-M1 and NB-IoT capabilities on the three mobile networks in Australia are well placed to connect this infrastructure to central traffic management systems for analysis and action.

Finally on the topic of communication, and as we noted in our submission to the NTC’s consultation on control and proper control of vehicles, one aspect that will be very important as we journey through the SAE levels of automation is the ability for law enforcement personnel to retrieve data in real time about whether the autonomous system or the human driver was in control of a vehicle at a given time. In that submission, we made the case that mobile networks in Australia provide a solid foundation for relaying information about the status and level of automation engaged in a vehicle at any given time, and providing that to relevant authorities in real time.

**Recommendation 1:** We recommend that as and where appropriate, Infrastructure Victoria look to recommend and use the 3GPP C-V2X standard for network communication. This, coupled with the IoT capabilities currently being introduced into Australia’s mobile networks will provide the best solution to aggregate disparate data from a range of infrastructure to deliver near term improvements for road usage as well as providing the best communication foundation for future CAVs and EVs.

Data will also play many vital roles in the connected intelligent transport systems of the future. As Figure 1 below illustrates, there are a wide variety of sources and recipients of information gathered about road use.

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C-ITS brings a range of new, very broad, granular and real-time data about the location, movement (speed) and direction of vehicles and other users of roads for a range of localised ‘safety’ oriented purposes (V2V, V2X, etc.). This data has a range of potentially valuable uses for existing and future ITS operational control systems such as urban traffic and motorway management systems, integrated multi-modal transport management systems, fleet management systems, traveller journey information systems, etc. Examples include initiatives such as giving green light priority to high priority vehicles, and testing optimal green light timing where the vehicle is informed of the optimal speed to approach a traffic light to facilitate a smoother flow of traffic. To take these initiatives to scale requires integration with existing traffic management systems such as SCATS for traffic light control.

There are many challenges associated with successfully exploiting this new data such as the integration of existing systems to enable flexible exchange of data between C-ITS platforms and other systems which may be closed or proprietary. New application development for a range of applications using C-ITS data will require an understanding of the data, its underlying meaning (via an up-to-date data dictionary) and a secure means to access the data. Traditional software application development paradigms may not be able to rapidly and cost effectively exploit value from collected C-ITS data for the many potential stakeholders.

**Recommendation 2:** We recommend that Infrastructure Victoria promotes the use of open data and APIs that will support interconnection of public and private data, enabling new services within new transport ecosystems. Such an approach will enable new innovative services and approaches to traffic management.

As a concluding observation to this first focus area, we also observe that road ‘maintenance’ in the future will have a digital component alongside traditional maintenance and upkeep activities. Digital road-side infrastructure including traffic lights, signs, sensors and more will require maintenance, and this needs to be accommodated in future infrastructure to support CAVs and EVs.

### 3.2. Levels of sharing and ownership

**Consultation Guidance:** Whether the introduction of automated vehicles leads to no one owning their own vehicle – or to everyone having their own, fully automated car – will have significant implications for what and when infrastructure is needed. We will also be looking to understand the potential market and commercial models for fleets, and how these might impact on how we are likely to use our transport infrastructure in the future.
The future of mobility is about configuring a host of on-demand transportation options to get around more easily and economically, offering scalability and on-demand choices for people who have transport needs that don’t align with mainstream public transport options. Today, public transport routes and schedules are optimised for majority scenarios such as to and from the CBD for commuters travelling to and from work, or to major shopping hubs. This results in the need to schedule a journey involving multiple stages for anyone using public transport outside the main scenarios, for example, elderly people accessing a health specialist a few short suburbs away that is not on a direct public transport route.

If the infrastructure exists to create compelling shared mobility solutions, it will be possible to make it cheaper and more convenient for people to move away from individual vehicle ownership. On-demand is fundamentally more efficient as well as more convenient. The ability for governments to scale public transport options to small groups (on-demand) on customised routes will increase the utilisation of public transport (as a result of increased utility) and simultaneously reduce cost (no half-empty buses at non-peak times, and driver costs). Further, AVs are being considered for the “last mile” of public transport - providing door to railway station transport which vastly improves “catchment” and the economic case for heavy rail in low density sprawl typical of Australian major cities. BlaBlaCar and SNCF in France, and Lyft in US are currently exploring such models with rideshare and human drivers.

3.3. Interface with physical infrastructure

Consultation Guidance: What might the roads of the future look like without drivers or emissions? That is a question we will be asking through this advice. We will consider issues such as road markings, signage, road quality, drop-off and pick-up areas, dedicated lanes, charging and fuelling infrastructure, and parking. We will also look at how the infrastructure needs for automated vehicles could change over time, from introduction to full roll-out, and what the implications could be for future infrastructure projects.

In responding to this focus area, we note that others will be better placed to comment on the requirements for road markings and signage for AVs. That said, we observe from our interactions with transport agencies and vendors in the AV space that it seems vehicle manufacturers will not rely on infrastructure upgrades for their products to work, and will design vehicles to cope with existing infrastructure. We also think there may be benefit in separating private passenger AVs from public transport AVs like shuttles. Future AV shuttle services would benefit greatly from dedicated marked lanes which separate them from general traffic while permitting easy access to collect passengers. A strategy here would be to develop a network of bus lanes in a city as infrastructure for future AV deployments that could be useful for buses today.

As we noted in section 3.1, we predict a large increase in the number and type of ‘things’ that will become part of an overall connected transport ecosystem, which will increase the number of digital interfaces. An important aspect of future transport ecosystems is the centralisation of collected data to gain insights. For example, data from sensors that monitor vibration in bridges could be correlated with data from heavy vehicles that know the weight of the load they are carrying and their location to identify loads that causes vibration to exceed tolerance. Once this is determined, other vehicles exceeding the load can be redirected to another route. Other examples include parking meters that can communicate when a bay is empty, when a meter is running low or time limit has been exceeded. Cyclists and pedestrians will become part of the ecosystem and future smart transport networks will need to interface with them also.

3.4. Digital infrastructure

Consultation Guidance: To fully reap the benefits of automation, driverless cars will need to be connected. But how connected do they need to be and to what? Their exact communication and data needs, including mapping accuracy, will determine what digital infrastructure might be needed to support their operation. Cybersecurity also needs to be addressed to build confidence and protect consumer privacy.

We have already highlighted the communications needs of future connected transport ecosystems. Connectivity must be underpinned by a robust security framework in order to achieve the safety levels expected by users of CAVs, and the privacy required for community acceptance.

There are many communications activities in the context of AVs that will require embedded security. Obviously, there will be continuous communication associated with vehicles (V2X), but in addition there will be other forms of

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13 https://en.wikipedia.org/wiki/BlaBlaCar
communication such as over-the-air software and firmware updates for vehicles, updating of cached map data, payment transactions (shared autonomous vehicles may need to pay for parking while not in use), to mention a few. There are many elements of a future security framework capable of addressing all future communications activities. Elements include authentication/authorisation, encryption, security of storage of data and overall governance. The Alliance for Telecommunications Industry Solutions (ATIS)\(^\text{16}\) has an insightful report\(^\text{17}\) on the security requirements for connected vehicles that addresses the various communication activities and the elements of a security framework. They recommend a two-layer approach that operates at the communication transport layer and at the application/access/data layer to tackle end-to-end security across all communications activities. In that report, they highlight the experience of telecommunications network operators in delivering secure connections to their customers; “telecommunications carriers, are already protecting end-point customers in enterprises, residences, mobile handsets, and vehicles by securing their networks, and in many cases the end device itself” (page 4).

In line with this report, we note the well-established credentials of mobile networks for maintaining security of communications. Authentication of users connected to a mobile network through the subscriber identity module (SIM), and the inherent transport security capabilities of mobile networks (based on 3GPP security standards) creates a communications network where it is very difficult for malicious actors to tamper with the communications.

**Recommendation 3:** We recommend that mobile networks offer the best communications solutions from a cyber security perspective because of their inherent security features such as end user authentication and security of communications between the end points.

Realistically however, mobile networks will not be the only communications network involved in the communications between and with connected vehicles, and other communications networks such as DSRC (or direct V2V communication), Wi-Fi, Bluetooth\(^\text{8}\) and others will play a role. Internationally\(^\text{18, 19}\), it is recognised that some form of security credentials management system is required to authenticate the various actors communicating with each other in the transport ecosystem. We draw to Infrastructure Victoria’s attention Transport Certification Australia’s January 2018 report\(^\text{20}\) on the key decision factors for a Security Credentials Management System.

We think it is also important to support emerging transport ecosystems that can combine public and private data sources and services to create new transport solutions. A key part of this is exposing data and services via well-defined APIs. For example, traffic signal timings from SCATS could be provided to third parties in near real-time allowing nimble innovators to develop apps that increase transport efficiency.

A final factor is the need for precision location systems that operate well in urban conditions. GPS is unreliable in urban settings and Telstra is actively exploring alternatives that may be used by AVs when GPS fails.

### 3.5. Changes to travel and land use

**Consultation Guidance:** The introduction of automated vehicles could dramatically change the way we interact with all forms of transport, particularly if the potential of “Mobility as a Service” is fully realised – or not. The potential impacts that these changes could have on how and where we want to travel will have implications for the infrastructure that we need as a state, in both urban and regional areas. Active transport and how this will be integrated with new types of vehicles is also an important area for us to investigate. Urban planning and infrastructure requirements may change if people live and work in different places or ways due to use of automated vehicles.

Digital connectivity will underpin future intelligent transport systems which the automotive industry will transform through the electrification and automation of vehicles. We foresee the emergence of a sharing economy where vehicles become a shared resource, eventually integrated with other forms of connected transport such as trains, trams and buses.

In order to make the sharing economy approach work seamlessly, publicly accessible AVs will require connectivity to centralised administration to provide a real time view of their availability and location giving consumers choice for both short local urban trips and longer trips involving regional origins/destinations. Future consumers are likely to want to choose between the most time-efficient, cost effective and/or environmentally friendly alternatives which will

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\(^{16}\) [http://www.atis.org/](http://www.atis.org/)


be delivered using a combination of an autonomous EV and public transport, all booked and paid for as a single transaction via their smart phone.

The connection of all transport options and hosting platforms will give rise to mobility-as-a-service that can securely present options to commuters to deliver greener, safer, less congested transport systems in the future. In addition to reducing car ownership, we see benefits for social inclusion, which we discuss further in section 3.10.

Additionally, AVs do not need permanent parking spaces, are likely to be shared so there won’t be as many, and can move away from the urban core when needed. This will drastically reduce the need for car parks and driveways, giving us scope to redevelop these areas for greater social amenity and economic benefit. McKinsey\textsuperscript{21} suggests that AVs combined with ridesharing could take 4 out of 5 cars off the road, meaning we may need fewer roads as well, further unlocking precious land in our urban areas.

3.6. Energy supply and charging capacity

\textbf{Consultation Guidance: The type of zero emission technologies that fuel our future vehicles will have specific infrastructure requirements and impacts across the state’s energy network. If all vehicles are electric, the implications for the grid, the need for charging stations and how batteries engage with the network all have flow-on effects for infrastructure. Hydrogen fuel cell vehicles, on the other hand, could have a different set of implications. We also need to consider when and how our behaviour might change as a result of the introduction of these vehicles. Will we still charge or fuel up at stations, or will this be done at home or work? And can our cars act as batteries to provide energy for our homes? The implications of these decisions will help to determine what infrastructure we need to build or change to accommodate a future with zero emissions vehicles.}

In responding to this focus area, we note that others will be better placed to comment on aspects such as future charging scenarios (centralised charging locations versus charging at home or at work) and the implications for electricity grids.

One observation we can make is that the supply and demand for electricity for EVs can be optimised through the availability and processing of real-time data about demand at various points on the electricity grid and the amount of power remaining in the storage system in single EVs and in the wider fleet. For example, topping up the charge on an EV that is already at 80% capacity on a hot summer day can perhaps be deferred to when demand for electricity has reduced. Similarly, with autonomous EVs, if demand for electricity is high at a particular location (sub-station), it may be possible to redirect to autonomous EVs a few kilometres away to where demand is lower. Centralised management using grid demand data and the needs for individual vehicles can provide solutions where charging can be prioritised, deferred or redirected as appropriate.

As an aside, it is interesting to contemplate what role inductive charging might play as shared autonomous EVs become more prevalent. It could be possible in years to come that AVs will be able to recharge themselves without the need for an attendant simply by visiting an inductive charging carpark while not in use.

3.7. Public acceptance and government policy

\textbf{Consultation Guidance: Drivers today are wary of travelling in a fully automated vehicle, car or ride sharing in Victoria is not very common, and we are lagging behind some other countries in adopting zero emissions vehicles. Public attitudes could affect uptake levels, so it is important that we consider how behaviour might change – and when. Whether the government has a role in encouraging the use of automated or zero emission vehicles could have implications for infrastructure, particularly if it affects adoption rates. The rate of uptake also has implications for how the government funds future infrastructure maintenance and investments, and how the economy reacts to these technologies more broadly.}

As noted in our submission\textsuperscript{22} to the Federal Parliament’s 2017 inquiry into the social issues relating to driverless vehicles, Telstra appreciates that there are concerns about the reliability, privacy and security of CAVs. To achieve the required level of social acceptance, reliability needs to be demonstrated through pilots and public participation. Policies and incentives are required to facilitate trials, gain community acceptance and to adapt the legal and regulatory framework to support and accelerate the introduction of AVs into Australia. One step forward in this space is the recent legislation


\textsuperscript{22} \url{https://www.aph.gov.au/DocumentStore.aspx?id=c23e5e10-00ec-484d-9681-2d8304f62a23&subId=463445}
passed by the Victorian Parliament which will allow AVs to be trialled across Victoria\textsuperscript{23}. There is a role for Government in educating the public on the benefits of CAVs, and in facilitating pilots to enable public acceptance and this requires engagement with the broader community. Security and privacy concerns can be addressed through implementation of legislation, industry codes and standards, with strong input from the community.

The community looks to government for the creation and implementation of appropriate safety standards, road rules and legislation. It is essential for social acceptance of AVs that the community is confident in the design and implementation of safety standards for, and certification of, AVs to ensure safe access to our road and transport system for all users.

Telstra supports policy moves such as the Transport and Infrastructure Council (TIC) National Policy Framework for Land Transport Technology\textsuperscript{24} (“the Framework”) and the National Transport Commission (NTC) policy paper\textsuperscript{25} on Regulatory Reforms for Automated Road Vehicles. We agree with the Framework where it outlines the four main roles for government related to the development of new transport technology and a principles based approach to guide government decision making. We also support the recommendations in the NTC policy paper for activities required to progress the introduction of AVs in Australia, and would emphasise the need for community and industry collaboration in the development of guidelines and standards.

3.8. Environmental and human health aspects

**Consultation Guidance:** Zero emission vehicles can make a contribution to achieving carbon emission reduction targets. But what will be the extent of this contribution, what will be the source of the generated electricity and will it be stored in batteries or hydrogen fuel cells? The environmental impacts of automated and zero emission vehicles over their entire lifecycle, with different possible uses and technologies, requires consideration. Automated vehicles have the potential to reduce road injuries and deaths. But to what level and what transitional safety issues might we face with a mixed fleet of vehicles? As air and noise pollution from vehicles have effects on human health, the contribution that zero emission vehicles can make to improving health may be important.

The introduction of AVs are expected to contribute to a significant reduction in Australia’s road toll. Road accidents are primarily caused by human errors (distraction, failure to obey rules, fatigue etc.) which are preventable in a world of software controlled vehicles. CAVs also have situational awareness augmented by direct wireless connection to other vehicles and roadside infrastructure, as well as additional perception systems such as radar, LIDAR, ultrasونics and infrared imaging. Even basic types of autonomy like electronic stability control (ESC) can have a large safety impact.

During 2017, 1227 people died due to injuries in motor vehicle accidents in Australia\textsuperscript{26}. Australian Institute of Health and Wellbeing (AIHW) data covering the period 2001 to 2010 further suggests that each year around 35,000\textsuperscript{27} Australians suffer serious injury in road accidents which require hospitalisation. The Australian and New Zealand Driverless Vehicle Initiative (ADV)\textsuperscript{28} notes that there are huge potential benefits in reducing road deaths and trauma, which costs the Australian economy $27B per annum\textsuperscript{29}. Reducing deaths and serious injury caused by vehicle accidents will have positive and far-reaching economic benefits to Australian society as well as relieving thousands of individuals of the personal pain and grief associated with the death or injury of a loved one.

In the future, CAVs will typically be Electric Vehicles (EVs) and ideally 100 per cent renewable energy could be used in conjunction with Connected EVs. Even semi-autonomous systems for internal combustion engine vehicles (C-ITS) AVs in the Transport & Logistics sector can take advantage of techniques like truck platooning (where C-ITS assists a truck to travel close enough behind another to benefit from the wind break created by the leader), or vehicle to infrastructure (V2I) communication which can provide green light priority for heavy vehicles, to reduce carbon emissions from both fuel burn and reduced congestion. Connected vehicles and associated traffic optimisation will lower emissions from vehicles, currently contributing 19 per cent\textsuperscript{20} of Australia’s emissions profile. Telstra’s research

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\textsuperscript{25} https://www.ntc.gov.au/Media/Reports/132685218-7895-0E7C-ECF6-551177684E71.pdf
\textsuperscript{27} http://www.aihw.gov.au/publication-detail/?id=60129554605
\textsuperscript{28} http://adv.org.au/2016/05/30/position-paper-economics-impacts-of-automated-vehicles-on-jobs-and-investment/
indicates Smart Logistics and Traffic, Control & Optimisation use cases have the potential to deliver carbon emissions reductions of 18 million tonnes a year by 2030 in Australia20.

AVs can potentially take efficiencies to a new level. AVs across an entire metropolitan area could conceivably operate as a single fleet, continuously optimising operations and responding in a way that human drivers are unable to do. Further, AVs can drive closer to one another and coordinate perfectly across intersections, again in ways that no human could achieve, leading to high road utilisation. These approaches would be especially effective when AVs are separated from human drivers and such “fleets” are operated by single organisations such as a public transport provider. IEEE Spectrum reports31 that CAVs at high penetration could improve highway capacity by a factor of 3.7. Combining AVs with Mobility-as-a-Service models has potential for vastly better use of our road assets, offsetting the need for major capital funds otherwise required to build new roads.

3.9. Economic Impacts

Consultation Guidance: Automated and zero emission vehicles, and the infrastructure provided to support their deployment, are likely to have different economic impacts depending on how and when they are rolled out and used. We will seek to understand these economic impacts to inform investment choices and other policy decisions.

As we noted in section 3.2 above, the uptake of AVs should support increased efficiency and productivity through a reduction in road congestion, reduction in car ownership and better utilisation of the time that is currently required for driving. These will deliver gains to the Australian economy as well as environmental benefits. We expand on these concepts here in the context of economic benefits.

AVs can do the work of private cars, taxis, buses, light rail and trucks. Since there is no driver cost, there is no imperative for public transport to be based around the use of large vehicles like buses and trams. This provides a completely new set of possibilities for public transport that is highly configurable.

Traffic congestion costs the Australian economy, not only environmentally, but also through lost productivity and decreases in the quality of life. C-ITS and AVs have a major role to play in alleviating or avoiding congestion. At the simplest level, GPS navigation and phone-based navigation apps that are connected can help drivers make better route and time of travel decisions, though these are in vendor specific silos rather than holding a single view of the road and traffic situation. This can be further enhanced where C-ITS is used to connect vehicles to each other and roadside infrastructure. Coupled with powerful optimisation and machine learning algorithms, this level of connectivity could provide a vehicle with a set of real-time instructions to optimise the journey and overall traffic performance, leading to faster and more reliable trips. AVs across an entire metropolitan area could conceivably go even further, operating as a single fleet, continuously optimising operations and responding in a way that human drivers are unable to do. A higher road utilisation, enabled by these advances, could improve highway capacity and lead to better use of our road assets, offsetting the need for major capital funds otherwise required to build new roads.

Telstra’s SMARTer 2030 report32 estimates that ICT could deliver substantial cost savings across Australia by 2030 including $USD 3.85 billion ($AUD 5 billion) from increased flexibility and efficiency of road, air, train and marine freight due to Smart Logistics solutions.

3.10. Social consequences and opportunities

Consultation Guidance: Victoria’s ageing population and those living with a disability are potentially beneficiaries of automated vehicles, which promise increased access to mobility, services and employment. Our work will consider how infrastructure investments and policies can help harness these opportunities while mitigating potential negative consequences.

There are numerous potential social and economic benefits for Australia related to the use of AVs. Properly introduced, AVs are expected to bring new transport options to those unable to drive, making possible new levels of

22 SMARTer2030, The Australian opportunity for ICT enabled emission reductions.
social equity, access and inclusion, as well as allowing for mass-customisation of public transport to individual users’ needs, as mentioned above.

In our submission\(^{32}\) to the Federal Parliament we encouraged the Federal Government to ensure that AV policy specifically accounts for inclusion (for more detail, refer to the submission). We see a number of benefits for people who cannot drive or readily access public transport, including affordability, personal and community empowerment and accessibility.

We also observe that AVs are expected to take many forms, and can be expected to operate on infrastructure other than public roads, such as public paths, shopping centres and other public spaces. Autonomous wheelchairs\(^{34}\)\(^{35}\), which are being developed to give greater mobility to people with disabilities, and autonomous delivery vehicles, such as the Nuro R1\(^{36}\) currently under development, and Domino’s DRU\(^{37}\), need to be considered when investment and social planning for community infrastructure such as roads and footpaths is undertaken.

As existing transport industries are disrupted, the reality is that there will be job reductions in the transport and logistics industries. We believe that Government should work with industry to develop a long-term roadmap that can help ensure adequate provision of education and training required to transition affected employees to new, high growth industries and lines of work. New job roles will emerge in technology industries and potentially in vehicle manufacture of CAVs and their components. There is also a role for government to work with industry to tune start-up and innovation ecosystems towards areas that will foster the creation of new jobs.

4 Telstra’s Connected and Autonomous Vehicle activities

Telstra has been exploring Connected intelligent transport systems (ITS) for several years and in October 2016, in partnership with Cohda Wireless, it successfully trialled Vehicle-to-Infrastructure (V2I) technology over Telstra’s 4G network in South Australia, an important first step in developing Cellular Vehicle-to-Everything (C-V2X)\(^{37}\) technology.

Applications of this technology included alerting a driver of roadworks ahead, giving green light priority to high priority vehicles, and testing optimal green light timing where the vehicle is informed of the optimal speed to approach a traffic light so that that they get a green light when they arrive.

Trials\(^{38}\) of Vehicle-to-Vulnerable (bicycles and pedestrians) technology were conducted in 2017, where testing demonstrated sending of standardised intelligent transport system messages over the 4G network to enable interaction of vehicles with smartphone-equipped bicycles to alert vehicles to the presence of vulnerable users.

Telstra also partnered with US-based automated and connected vehicle Technology Company Peloton Technology and the ADVI, supported by the Western Australian Road Transport Association and the WA Government, to explore the safety and fuel efficiency benefits of truck platooning for Australia.

Telstra is a member of a consortium exploring use of AV shuttles for first and last mile, using Navya technology. This trial is well-advanced and includes TNSW, RMS, IAG, NRMA, Sydney Olympic Park Authority and Telstra.

More broadly, Telstra is closely engaged with the global 4G and 5G community through standards bodies such as the Third Generation Partnership Project (3GPP\(^{39}\)) which is evolving special automotive capabilities for mobile networks and the 5G Automotive Association (5GAA) which is brings automotive, technology and telecommunications industries together to define and develop connected mobility and automated vehicle solutions. These build on existing uses such as vehicle telematics to include vehicle to vehicle and vehicle to infrastructure communications with low latency and extended range.

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\(^{32}\) https://www.aph.gov.au/DocumentStore.ashx?id=c23e5e10-00ec-484d-9681-2d8304f62a38&subId=463445
\(^{38}\) https://www.3gpp.org/news-events/3gpp-news/1798-v2x_r14

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5 Closing remarks

Australia as a global leader: The driverless vehicle revolution is with us and Australia has much to gain. Governments, industry, businesses and the community need to be the catalyst for the emergence of new mobility systems, which needs to be done through cross-sector collaboration (transport, telecommunications, and universities/research sector) and partnership. The Australian geography and environment lends itself to testing and piloting such technologies, but Australia is currently lagging globally, and policies and incentives are urgently required. Australia has been a global leader in establishing today’s ITS technologies such as SCATS and STREAMS and has a rich heritage in vehicle and component design, as well as vehicle safety standards, for instance leading the world in legislation for compulsory seat belts. These advantages could help us build a significant CAV technology development capability locally as well as Australians being enthusiastic adopters.

We look forward to continued engagement with Infrastructure Victoria on the introduction of CAVs and EVs to expedite the benefits to be gained from these vehicles.