Lessons learned from automated vehicle trials in Australia

December 2020

Research report

National Transport Commission

Report outline

Title	Lessons learned from automated vehicle trials in Australia
Type of report	Research report
Purpose	Present and analyse consultation outcomes
Abstract	This research report is a condensed version of a report developed for infrastructure and transport ministers to collect learnings from four years of automated vehicle trials in Australia. The report was informed by engaging with government and industry involved in the trials. Lessons are presented about the trials framework, which consists of importation, trial application and national trial guidelines; the operation and outcomes of trials themselves; and how trials are chosen and evaluated. To move to a next stage of trials in Australia the report notes a number of areas that the NTC, Commonwealth and state and territory governments and Austroads can focus on. There is also an opportunity to build on the learnings in this report to take a holistic look across trials, regulation, infrastructure and public attitudes to assess Australia's readiness for automated vehicles when they become ready for commercial deployment.
Attribution	This work should be attributed as follows, Source: National Transport Commission 2020, *Lessons learned from automated vehicle trials in Australia: research report*, NTC, Melbourne. If you have adapted, modified or transformed this work in anyway, please use the following, Source: based on National Transport Commission 2020, *Lessons learned from automated vehicle trials in Australia: research report*, NTC, Melbourne.
Key words	Automated vehicles, trials, lessons learned, safety management, traffic management, importation, disengagements, evaluation, automated shuttle bus, human factors, human operator
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Report summary

This research report presents lessons learned from four years of automated vehicle trials in Australia. Thirty-two automated vehicle trials have taken place since 2016, and in every state and territory. These trials have provided many lessons for government decision making about future trials and deployment. Creating a national picture of trialling in Australia provides an opportunity to consolidate these learnings and move to a next stage of trials and improve our readiness for the commercial deployment of automated vehicles.

Context

Automated vehicles promise to deliver significant improvements to Australian society across road safety, mobility, accessibility, productivity, traffic flow, fuel efficiency and reduced carbon emissions.

The National Transport Commission (NTC) is working with other government agencies to develop an end-to-end regulatory system to support the safe, commercial deployment of automated vehicles in Australia. Trials are important to ensure automated vehicles can be used safely in Australian conditions before they are deployed commercially.

The NTC recently reviewed the *Guidelines for trials of automated vehicles in Australia* for the first time since they were released in 2017. During the scoping and targeted consultation phase of the review, it became evident that there would be benefits in consulting more broadly to gather lessons learned from trials to date in Australia at the same time.

This research report presents some of the findings from these trials and puts forward lessons for Australian governments. This report is a condensed version of a more detailed report provided to government infrastructure and transport ministers in November 2020.

Topics

The framework for automated vehicle trials in Australia consists of the importation process administered by the Commonwealth Government, the trial application process administered by state and territory governments, and the *Guidelines for trials of automated vehicles in Australia*. There are ways that this process can be clarified, streamlined and proactively communicated to continue to attract companies to trial automated vehicles in Australia.

The trials themselves have provided useful lessons about the state of the technology, how trials are operated, how automated vehicles interact with those inside and outside the vehicles, data provision, public acceptance, infrastructure and accessibility. Governments can use these learnings to improve future trials.

Governments can further evaluate and share learnings to carry on creating a national picture of trials. This will help governments to make more strategic decisions to prepare for the trials that we may see here in the future.

Overall we have found that Australia is ready for a next stage of trialling.

Next steps

We have identified a number of areas from these lessons that the NTC, Commonwealth and state and territory governments and Austroads can focus on to further develop the trials framework and prepare for the next stage of trialling in Australia.

1 About this project

Key points

The project collates lessons from automated vehicle trials in Australia to inform decisions by infrastructure and transport ministers on future trials and preparedness for automated vehicles. Trials have taken place in every state and territory, and this research report aims to provide a national picture of the state of trialling. Governments and industries involved in the trials were consulted to inform this research report.

1.1 Background

Automated vehicles promise to deliver significant improvements to Australian society across road safety, mobility, accessibility, productivity, traffic flow, fuel efficiency and reduced carbon emissions.

The National Transport Commission (NTC) is working with other government agencies to develop an end-to-end regulatory system to support the safe, commercial deployment of automated vehicles in Australia. Trials are an important step to ensure automated vehicles can be used safely in Australian conditions before they are deployed commercially.

Thirty-two automated vehicle trials have taken place in Australia over the past four years, in every state and territory. There have been many valuable lessons from these trials, but often these lessons have not been shared across jurisdictions. Without a national view of findings from automated vehicle trials, Australia risks ignoring the national lessons that can be learned from the insights already collected at the local level.

1.2 Approach

The NTC recently reviewed the *Guidelines for trials of automated vehicles in Australia* for the first time since they were released in 2017. During the scoping and targeted consultation phase of the review, it became evident that there would be benefits in consulting more broadly to gather lessons learned from trials to date in Australia at the same time.

From May to June 2020 the NTC held 34 engagements with more than 80 stakeholders. Stakeholders came from the following sectors: Commonwealth and state and territory government; local government; technology providers; transport operators; infrastructure providers; insurance companies; automobile clubs; road user groups; transport accessibility groups; safety risk and transport consulting; academia; and industry bodies. Feedback and learnings in this report are not attributed to individuals or organisations.

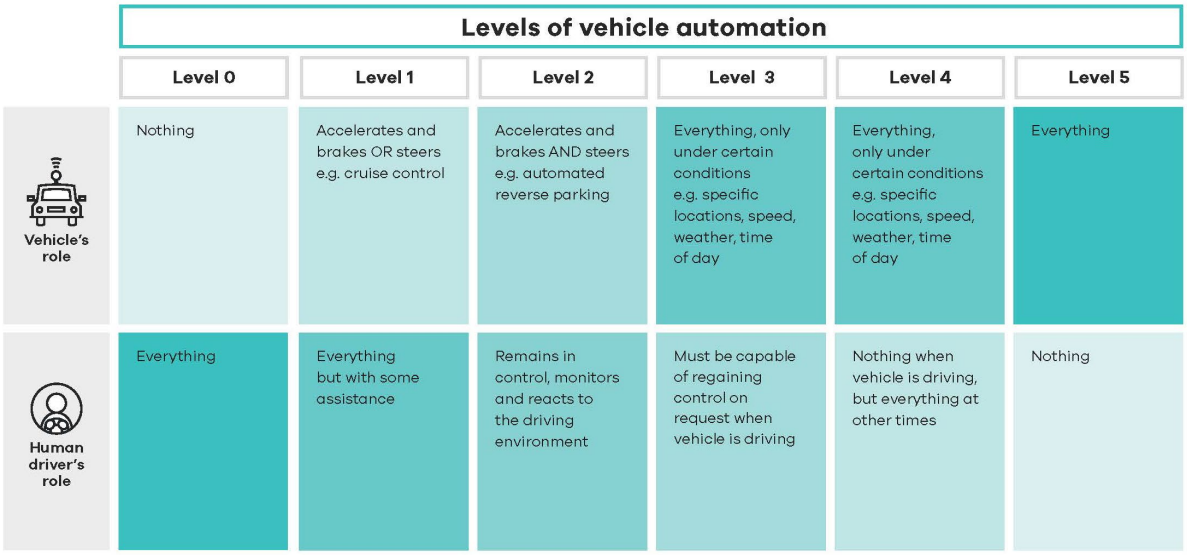
This report was also informed by published trial reports and by reports and other information provided to the NTC by stakeholders.

1.3 Key terms and concepts

This section outlines key terms and concepts used in this report. These are largely based on definitions from the Society of Automotive Engineers (SAE) International Standard J3016.

Figure 1 shows that SAE defines six levels of vehicle automation.

Figure 1: Levels of vehicle automation



The term **automated vehicle** refers to vehicles that can operate at SAE level 3 (conditional automation), 4 (high automation) or 5 (full automation) capability. Reference to 'automated vehicles' in this report is to these types of vehicles. The NTC's automated vehicle reform program also centres on level 3–5 vehicles.

These vehicles can operate with this capability because they are fitted with an **automated driving system (ADS)**. An ADS is the hardware and software collectively capable of performing the entire dynamic driving task on a sustained basis.

Vehicles with level 1 or 2 capability contain **advanced driver-assistance systems (ADAS)** rather than an ADS.

The **dynamic driving task** refers to all the tactical functions required to operate a vehicle on a road or road-related area including among on-road traffic. At level 0, the entire dynamic driving task is performed by the human driver, while at level 5, all aspects of the dynamic driving task can be undertaken by the ADS on all roads at any time and no human driver is required.

Vehicles with level 4 and 5 capability may not have traditional driver controls such as a steering wheel.

The **operational design domain** refers to the set of conditions under which an ADS is intended to function and can safely operate. This includes, but is not limited to, road types (highway, low-speed public streets, etc.), geographic area, speed and environmental conditions (weather, time of day, etc.).

For the purposes of this report, a **trial** of an automated vehicle only includes instances where a vehicle has been trialled in precincts or on public roads with the approval of a state or territory government (or at least close engagement with them). Demonstrations and initial tests – for example, where an automated vehicle has been displayed for a conference, operated in a small precinct for a few days or less, or tested only on a test track without progressing to trial – are not included in this definition. These demonstrations and tests are unlikely to produce substantive findings that can inform this report. Off-road trials of automated vehicles, such as on mining sites, are also not included.

In this report a **trialling organisation** is any organisation that is a partner in a trial. This could be the technology provider, the operator, a council or any other funding partner.

Vehicles cannot operate in automated driving mode on public roads due to existing legal barriers. Organisations seeking to run automated vehicle trials require state or territory road transport agencies to provide **permits or exemptions** from legislative obligations in the Australian Road Rules and other road transport legislation. States and territories can impose conditions on these permits and exemptions to ensure safety.

The NTC and Austroads developed the ***Guidelines for trials of automated vehicles in Australia*** (the NTC/Austroads guidelines) to ensure a level of national consistency for these conditions. The guidelines are pitched at a high level to accommodate any type of automated vehicle. They cover the management of trials, safety assurance, insurance and data requirements. To apply for a permit or exemption, trialling organisations must address conditions set by the relevant state or territory government. These conditions are often based on the criteria in the guidelines[1] but also including conditions tailored for local conditions, legislative requirements and individual trials.

[1] Victoria has its own set of guidelines based on the NTC/Austroads guidelines.

2 Australian automated vehicle trials to date

Key points

There have been 32 automated vehicle trials in Australia to date, in every state and territory. The majority of trials have involved low-speed automated shuttle buses operating on set routes.

There have been 32 trials of automated vehicles in Australia to date. Twenty-two trials have involved automated shuttle buses, two trials have involved automated pods, six trials have involved an automated car, one trial has involved a research vehicle, and one trial has involved an automated ute. Trials have taken place in every state and territory.

Automated vehicles have been tested as first- and last-mile solutions, operated around pedestrianised precincts such as waterfronts and campuses, and to understand their capability in different environments such as CBDs, regional roads and urban motorways. Often trials are completed without an immediate intention to progress to a limited commercial deployment.

Automated shuttle buses are electric vehicles with no steering wheel that can operate at SAE level 4. Their maximum passenger capacity is approximately 15 people (less if seated) and their maximum speed is approximately 25 km/h. Trials to date have all used safety drivers or chaperones (referred to as 'human operators' in this report), who can take back control of the vehicle with a joystick controller, as a condition of their trial exemption or permit. Trials are often operated at speeds lower than the maximum possible speed.

Each automated shuttle bus trial generally progresses through phases – for example:

- Phase 1: safety testing, not open to the public
- Phase 2: testing on a public road in a small operating domain, in limited mixed traffic with passengers (for example, servicing a retirement village or waterfront precinct)
- Phase 3: testing on a public road in a larger operating domain, in more complex mixed traffic, for passengers (for example, providing a first/last-mile solution between a public transit station to the CBD).

Table 1 provides a list of trials conducted so far. Up-to-date information on trials occurring in Australia is collated by Austroads.[2] Lessons learned from these trials are covered in chapters 3 to 5.

[2] See https://austroads.com.au/drivers-and-vehicles/future-vehicles-and-technology/trials.

Table 1: Automated vehicle trials in Australia as at November 2020[3]

State	Location	Vehicle classification	No. of vehicles	Vehicle manufacturer	Main trial partners	Operating domain during most complex phase	Status	Years active[4]	State/ territory government funding contribution
Australian Capital Territory	Belconnen	Automated shuttle bus, level 4	1	EasyMile	EasyMile, Illawarra Retirement Trust Group	Precinct (retirement village), mixed traffic	Complete	May 2019	No
New South Wales	Olympic Park, Sydney	Automated shuttle bus, level 4	2	Navya	NRMA, HMI Technologies, Telstra, Sydney Olympic Park Authority, IAG	Public road in precinct, mixed traffic, traffic signal integration	Complete	Aug 2017 – Apr 2020	Yes
	Armidale	Automated shuttle bus, level 4	1	EasyMile	Armidale Regional Council, EasyMile, The University of New England, Edwards Coaches, Transdev, WSP	Public road in CBD, mixed traffic	Complete	Feb 2019 – Feb 2020	Yes
	Coffs Harbour	Automated shuttle bus, level 4	1	EasyMile	Busways, Coffs Harbour City Council, EasyMile, Via	Public road in precinct, mixed traffic	Ongoing	Dec 2018 – tbc	Yes

[3] Information collected from state and territory road transport agencies.

[4] From the start (or expected start) of road-testing to the end (or expected end) of the last trialling phase. Note that significant development time takes place before on-road testing. Some states and territories have included trials that are in progress though not yet on-road.

State	Location	Vehicle classification	No. of vehicles	Vehicle manufacturer	Main trial partners	Operating domain during most complex phase	Status	Years active[4]	State/ territory government funding contribution
	Newcastle	Automated shuttle bus, level 4	1	Navya	Keolis Downer, Newcastle City Council	Public road, mixed traffic	Ongoing	Jul 2020 – tbc	No[5]
	Dubbo	Automated ute (retrofit), level 3	1	Conigital (ADS), Ford (ute)	Conigital, Dubbo Regional Council, NRMA, Dubbo Buslines, Liftango, Taronga Zoo, QBE, Live Better	Public road, mixed traffic	Ongoing (not yet on-road)	In develop-ment	Yes
	Sydney University	Automated research vehicle, level 4	2	Sydney University – Australian Centre for Field Robotics (ADS), AEV (vehicle)	Sydney University – Australian Centre for Field Robotics, iMove CRC	Public road in precinct, mixed traffic	Ongoing (not yet on-road)	May 2020 – (2023)	Yes
Northern Territory	Darwin	Automated shuttle bus, level 4	1	EasyMile	EasyMile, Darwin Waterfront Corporation, Department of Infrastructure, Planning and Logistics	Public road, mixed traffic	Complete	Feb–Sep 2017	Yes

[5] Lead trial partner City of Newcastle provided funding through its Newcastle Smart City Strategy. The strategy received funding from the Commonwealth Government's Smart Cities and Suburbs program.

State	Location	Vehicle classification	No. of vehicles	Vehicle manufacturer	Main trial partners	Operating domain during most complex phase	Status	Years active[4]	State/ territory government funding contribution
Queensland	Karragarra Island, Moreton Bay	Automated shuttle bus, level 4	1	EasyMile	Redland City Council, RACQ	Public road, mixed traffic	Complete	Nov 2019 – Mar 2020	No
	Raby Bay, Cleveland	Automated shuttle bus, level 4	1	EasyMile	Redland City Council, RACQ	Public road, mixed traffic	Ongoing	Nov 2020 – ongoing	No
	Cairns, Sunshine Coast, Ipswich, Cleveland	Automated shuttle bus, level 4	1	EasyMile	EasyMile	Public road, mixed traffic	Complete	Nov 2017 – Mar 2018	No
	Shailer Park, Logan and Bundamba, Ipswich	Automated car, level 4	1[6]	VEDECOM	Department of Transport and Main Roads, Queensland University of Technology, iMove Cooperative Research Centre	Public road, mixed traffic	Complete	Aug 2019 – Mar 2020	Yes
South Australia	Playford, Adelaide	Automated shuttle bus, level 4	1	EasyMile	EasyMile, City of Playford, SAGE Automation, Department for Infrastructure and Transport (DIT)	Public road, mixed traffic	Complete	Sep 2018 – Jun 2019	Yes

[6] A car with ADAS technology was also used for a prior phase of the trial.

State	Location	Vehicle classification	No. of vehicles	Vehicle manufacturer	Main trial partners	Operating domain during most complex phase	Status	Years active[4]	State/ territory government funding contribution
	Munno Para, Adelaide	Automated shuttle bus, level 4	1	EasyMile	EasyMile, City of Playford, SAGE Automation, DIT	Public road, mixed traffic	Complete	May–Dec 2019	Yes
	Renmark	Automated shuttle bus, level 4	1	EasyMile	EasyMile, Renmark Paringa Council, SAGE Automation, Flinders University, DIT	Public road, mixed traffic	Ongoing	Jul 2018 – Oct 2020	Yes
	Tonsley, Adelaide	Automated shuttle bus, level 4	1	Navya	Flinders University, RAA, Renewal SA, Marion City Council, DIT	Public road, mixed traffic	Ongoing	Apr 2018 – Feb 2022	Yes
	Glenelg, Adelaide	Automated shuttle bus, level 4	1	Local Motors	Local Motors, SAGE Automation, City of Holdfast, DIT	Foreshore walkway	Complete	Oct 2018 – Jun 2019	Yes
	Tonsley, Adelaide	Automated pod, level 4	3	Aurrigo	Aurrigo, RenewalSA, DIT	Precinct (innovation park)	Complete	Feb 2018 – Sep 2019	Yes
	Port Elliot	Automated pod, level 4	1	Aurrigo	Aurrigo, Elliot Gardens retirement living village, DIT	Precinct (retirement village), mixed traffic	Complete	Mar–May 2019	Yes
	Adelaide CBD	Automated car, level 3	2	Cohda (ADS) Lincoln (car)	Cohda, Adelaide City Council and DIT	Closed CBD block	Complete	Sep–Oct 2018	Yes

State	Location	Vehicle classification	No. of vehicles	Vehicle manufacturer	Main trial partners	Operating domain during most complex phase	Status	Years active[4]	State/ territory government funding contribution
Tasmania	Hobart	Automated shuttle bus, level 4	1	Navya	RACT, City of Hobart, Tasmanian Climate Change Office	Public road, mixed traffic (residential)	Complete	Dec 2019	Yes
Victoria	La Trobe University, Melbourne	Automated shuttle bus, level 4	1	Navya	VicRoads, Keolis Downer, La Trobe University, HMI, RACV, ARRB	Precinct (university campus), mixed traffic	Complete	Oct 2017 – Jul 2018	Yes
	Victorian highway rural roads	Automated car, level 3	1	Bosch, Tesla donor vehicle (Car)	Department of Transport, Bosch	Highway rural roads, mixed traffic	Ongoing	Sep 2019 – present	Yes
	AIMES testbed, Melbourne	Automated shuttle bus, level 4	1	EasyMile	The University of Melbourne	Public road, mixed traffic	Ongoing	Sep 2018	Yes
	CityLink, Melbourne	Automated car, level 3	1	Bosch, Tesla donor vehicle (car)	Transurban, Bosch, VicRoads, RACV	Motorway, mixed traffic	Complete	Feb–Apr 2018	No
	Altona North, Melbourne	Automated car, level 3	1	Japanese Corporation, imported vehicle (car)	Japanese Corporation	Public road (industrial area), minimal traffic	Complete	Nov–Dec 2018	No
	Peninsula Link, Melbourne	Automated car, level 3	1	Bosch, Tesla donor vehicle (car)	Bosch, TAC, VicRoads	Motorway, mixed traffic	Complete	Feb–Aug 2018	Yes

State	Location	Vehicle classification	No. of vehicles	Vehicle manufacturer	Main trial partners	Operating domain during most complex phase	Status	Years active[4]	State/ territory government funding contribution
Western Australia	South Perth	Automated shuttle bus, level 4	2	Navya	RAC WA, City of South Perth, WA Government	Public road, mixed traffic	Ongoing	Aug 2016 – tbc	No[7]
	Busselton	Automated shuttle bus, level 4	1	Navya	RAC WA, City of Busselton, WA Government	Public road, mixed traffic	Complete	May–Jun 2019	No
	Geraldton	Automated shuttle bus, level 4	1	Navya	RAC WA, City of Greater Geraldton, WA Government	Public road, mixed traffic	Ongoing	Sep–Dec 2020	
	Curtin University	Automated shuttle bus, level 4	1	Navya	Curtin University	Public road, mixed traffic	Ongoing	Apr 2017 – tbc	No
	The University of Western Australia	Automated shuttle bus, level 4	1	EasyMile	UWA, EasyMile, Telstra	Precinct (university campus)	Complete	Jul–Aug 2018	No

[7] Lead trial partner RAC WA received some funding from the Commonwealth Government's Smart Cities and Suburbs program.

3 Applying for trials

Key points

Applying for a trial consists of:

- an importation application to the Commonwealth to import the vehicle(s)
- a trial application to the state or territory government to approve a trial on public roads.

Stakeholder experiences of the process varied. Trialling organisations found the process lengthy and at times iterative and unclear as they worked with government agencies to have their applications approved. However, this is most likely due in part to the technology being new and testing frameworks that were designed for traditional vehicles. Trialling organisations and governments are growing in their capability to apply for trials and assess applications respectively.

There is an opportunity for government to improve communications about the trials framework for potential trial applicants and to collaborate to improve the trials framework to make it a more efficient process. There is also a potential role for government to provide more support for trials to continue to incentivise companies to trial in Australia and foster local industry.

3.1 Importation

3.1.1 Importation process

The Department of Infrastructure, Transport, Regional Development and Communications (DITRDC) administers the vehicle import approval process. A company wishing to import a vehicle that does not meet current vehicle standards must submit an application to DITRDC for an exemption. State and territory road transport agencies provide a letter of in-principle support to show they support the vehicle being trialled on their public roads.

Some trialling organisations considered the importation process straightforward, finding the information on the DITRDC website sufficient. Other trialling organisations found the importation process challenging and sometimes more time consuming than expected.

In particular, stakeholders noted the challenges of importing automated vehicles under a framework designed for traditional vehicles and vehicle manufacturers. Automated shuttle buses, for example, do not comply with Australian Design Rules and as such are non-standard vehicles that must be imported and approved through a discretionary approval pathway. For many trialling organisations, this was their first time engaging in this process and it could be challenging at first to understand how to document a vehicle's compliance or noncompliance with Australian Design Rules. Organisations often outsourced preparation of the import application to an external agent, either from the start or in the middle of the application process when they realised its complexity. In some cases, state and territory road transport agencies assisted trialling organisations to document how their vehicles matched Australian Design Rules.

3.1.2 State and territory role in importation

State and territory road transport agencies were familiar with their role to provide a letter of support because they already do this for importing traditional vehicles. The letter of support is provided once the agency reviews the safety case for the trial. It was noted that different agencies or units within a jurisdiction at times disagree about whether to support importation, and will provide separate responses. Regardless, once approved by the Commonwealth it is assumed that any further risks are managed through the trial process at the state and territory level.

One road transport agency noted that there was potentially duplication in what trialling organisations needed to provide to receive import approval, with information requested sometimes relating to 'in-service' issues, which are the domain of states and territories and part of the trial application process.

3.1.3 Luxury car tax

Some stakeholders noted that application of the luxury car tax had been unclear. The luxury car tax is a tax on cars (of less than two tonnes and seating fewer than nine passengers) with a value above a threshold. For 2020–21, the threshold is $77,565 for fuel-efficient vehicles and $68,749 for other vehicles. The tax is imposed at the rate of 33 per cent on the amount above the threshold. This could add significant costs to import vehicles fitted with advanced sensor systems; for example, a lidar system could be $70,000 on its own.

3.2 Trial applications

3.2.1 Length and nature of the process

There were varied views about the trial application process. Some found the process smooth, while others found it long, complicated and iterative. The iterative process itself was described as both a negative (unclear requirements at the start, additional time and cost each time more information was required) and a positive (collaboratively working towards a successful application).

Often applicants were not familiar with the technology or with assessing risk for vehicles, and this could contribute to difficulties submitting trial applications. Often applicants required assistance from third parties.

It has also been a learning curve for road transport agencies. Some agencies noted that they had refined their processes to provide more guidance as they gained more experience assessing applications.

Good relationships between trialling partners and between trialling organisations and the state or territory government were noted as key to a successful process. Trialling organisations appreciated the close working relationships they were able to foster with individuals within some states and territory road transport agencies, citing this support as aiding their experience from application to completion.

3.2.2 Harmonisation

Many trialling organisations sought closer harmonisation of trial requirements between states and territories. Standards about what is safe varies from state to state, and some trialling organisations considered road transport agencies had different risk appetites. Application

processes were also very different across jurisdictions. Some states and territories were seen to have more streamlined approvals processes than others.

3.2.3 Pre-trial tests

Some trialling organisations that had trialled multiple times in Australia noted concern at the need to undertake new pre-trial tests of vehicles for each trial. These duplicated successful pre-trial tests undertaken for previous similar trials in another jurisdiction. We also heard that pre-trial testing will increasingly be done internationally and that local requirements to undertake similar tests were, again, duplicative. It was suggested that road transport agencies should collaborate to share the results of pre-trial tests across states and territories, and that this would save time for all parties. However, we also heard the opposing view that states and territories should be able to require pre-trial testing again, even where similar tests had already been taken, and that this was not too onerous a task for trialling organisations.

3.2.4 Stakeholder engagement

Trialling organisations considered it important to engage with a broad range of relevant stakeholders. Some trialling organisations found stakeholder engagement straightforward because of existing working relationships or processes for consultation. Some state and territory governments actively facilitated contact between trialling organisations and the appropriate stakeholders.

One challenge noted was the timing of community consultation. Councils are used to consulting the community at the outset of a project; however, with the outcome of a trial application being so unknown at the outset, it could be unreasonable to run a consultation process for a project that might not eventuate. By the time an application is approved a trial route is already locked in, making consultation of limited value.

Some stakeholders noted that there had been good engagement between trialling organisations and law enforcement. Benefits of close police involvement included both having law enforcement understand the risks and share their knowledge and also encouraging members of the community to participate in a trial if they saw police had confidence in it.

3.2.5 Registration

State and territory governments differed in whether or not they registered automated vehicles. Benefits of registration included making compulsory third-party insurance coverage clearer and giving law enforcement greater visibility of responsible parties in an incident. Some road transport agencies noted that registration of automated vehicles is currently a manual process. This is manageable for now, but as numbers and the scale of trials increase, this approach would not cope.

3.3 Insurance

Some trialling organisations noted a lack of clarity about who should insure what among trialling partners, particularly if they had not been involved in an automated vehicle trial before. There are a number of roles often played by different parties, including the manufacturer, owner and operator. Each trial partner might need to obtain a different type of insurance or multiple insurance policies for different aspects of the trial. States and territories also had different insurance requirements.

Insurers calculate risk based on historical data. This data does not exist for automated vehicles in Australia. Trials in Australia were considered important both to build up this data source and to understand the data that could potentially be accessed for this purpose in the future.

3.4 Funding

Some states and territories contribute funding for trials. Both trialling organisations and road transport agencies noted the importance of government funding to incentivise international companies to bring their technology to Australia.

Trialling organisations often underestimated trial costs. Delays from the application process and unexpected issues could drive up costs and sometimes affected the operation of the trial (for example, only operating on certain days or holding a shorter day).

3.5 NTC/Austroads trial guidelines

The trial guidelines were noted as high level, which has positives and negatives. The guidelines needed to remain high level to allow states and territories to implement requirements for local conditions. Some said this local context should be reflected in the guidelines. However, some prescription was considered useful. Many stakeholders considered the guidelines helpful.

There were many specific comments and suggestions made about the guidelines. These have been considered in the review of the guidelines, which took place at the same time.[8]

3.6 Lessons learned

3.6.1 Improved information for potential trial applicants

Australia has now had a framework for trialling automated vehicles in place for three years.

The importation process designed for traditional vehicles has had to accommodate the importation of automated vehicles before automated vehicle-specific standards are in place. To make going through this process more efficient, it is important that trialling organisations select an applicant with the competency to demonstrate how vehicles do and do not meet Australian Design Rules, or engage a third party early to lead this process for them. There is also the opportunity for governments to clarify the process by providing more tailored information about the importation pathway for trials, requirements and potential taxes that can apply from the outset.

The trial application process can be complex. However, trialling organisations and state and territory governments have shown a great willingness to work together to ensure the eventual success of applications. Again, it is important that trial applicants have the capability to undertake complex tasks such as risk assessments, or to engage a third party to assist early on. As with the importation process, there is also an opportunity for governments to provide more clarity to trialling organisations about the requirements for receiving a permit or exemption as well as the additional steps that must be taken such as

[8] See the NTC's policy paper on the review of the trial guidelines and the updated guidelines: https://www.ntc.gov.au/transport-reform/ntc-projects/review-guidelines-trials-automated-vehicles.

obtaining insurance, engaging relevant stakeholders and meeting particular legislative standards.

The insurance industry will continue to gain experience with how to cover automated vehicle trials. It is expected that this will provide greater clarity on cover for trials.

The NTC considers the suggestions above for governments to clarify the importation process and trial application process lend themselves to creating a centralised online portal, where potential trial applicants can see in one place what the process is for initiating a trial, from start to finish. Currently, trial applicants need to visit at least the DITRDC website, state or territory road agency website and the NTC website to collate the key pieces of information. As such, the NTC will work with governments to create a dedicated website that will set out the holistic process at a high level and provide relevant links to other websites (where necessary), house relevant documents and provide relevant contact details.

3.6.2 Role of government in supporting trials and local industry

Funding is an important incentive for international companies to invest in trials in Australia. Because Australia is largely a 'taker' of automated vehicle technology, it is important that governments show commitment to continuing trials. It may also be important to consider how to grow local industry in the sector.

3.6.3 Improving the process for approving trials

The NTC/Austroads trial guidelines have been useful, but there are a number of areas where they can provide further clarification and prescription to assist trialling organisations when applying for automated vehicle trials. The NTC has recently reviewed the guidelines and incorporated stakeholder feedback. The guidelines will continue to be reviewed every two years.

There are ways that states and territories can collaborate to ensure more efficient outcomes both for trialling organisations and for themselves. States and territories have already committed to working together more closely, and the NTC will facilitate this over the course of 2021.

4 Trial findings

Key points

This chapter brings together findings from trials across the country. There have been many valuable lessons from automated vehicle trials – about the technology, safety, project operation, road users, occupants, reporting and infrastructure. It is important to remember that automated vehicle trials test many more things than the technology itself. Recognising this, governments should take forward these lessons to inform decisions about future trials.

4.1 The technology is still a work in progress

There was a sense among some governments and trialling organisations that the technology was more limited than they had expected it to be.

Trial vehicles experienced a number of real-world challenges, providing learnings about practical issues like interactions at roundabouts, the sensitiveness of lidars, emergency stops (e-stops) and dealing with changing road environments.

Some issues were found due to the unique Australian road environment. For example, automated shuttle buses were often trialled on flat European roads, which are very different from the hilly suburban streets found in Australia.

These learnings about the technology show the importance of trialling automated vehicles in Australia in order to ensure the technology will be safe in our unique road environment.

4.2 Choice of trial location and risk

Choosing the trial location and route was an extremely important decision. The process to choose a location and undertake site assessments could be lengthy.

For some trialling organisations and road transport agencies it was important to explore a real use case for the automated vehicle – for example, to undertake a trial that addressed a first- and last-mile transport disadvantage.

Generally, there was a risk-based approach to route selection. There is a balance to be struck between trialling in low-complexity environments to reduce the risk of safety issues, versus choosing a higher complexity environment to challenge the technology more to further improve it. Often that balance was in favour of the former, safer option, which was considered by some to be appropriate at this early stage of trialling.

Another influencing factor on trial location selection was the amount of additional infrastructure required. There was not much appetite from both trialling organisations and governments for trials that would require significant additional infrastructure to be installed.

4.3 The importance of good project management

Some trialling organisations noted the challenge of having vehicle manufacturers based overseas. This affected the ability to make changes quickly if safety issues arose. Even where this action was not necessary, it could still be a challenge engaging with overseas officers in different time zones.

One road transport agency noted there were different levels of capability in terms of managing project operations. For some the focus was largely on the technology, without enough focus on operational issues such as knowing who the customer is and managing their expectations of the transport experience.

4.4 Behaviour of other road users around automated vehicles

There was overwhelming feedback about risky behaviour by other road users around automated shuttle buses in particular, which are low-speed vehicles. Pedestrians would walk in front of the vehicles. Drivers of conventional vehicles displayed increased risk taking, often unsafely overtaking. There were also incidents where vehicle drivers would cut in too close to a shuttle bus, drive directly towards a shuttle bus and swerve before contact, or pull in between the shuttle bus and a traffic control vehicle. Drivers of conventional buses were also noted as displaying risky behaviour. One trialling organisation noted that the behaviour of other road users became worse over time as they became used to the automated vehicle on their roads.

4.5 Safety learnings

Most trialling organisations and road transport agencies noted they had not had any serious safety incidents in their trials while noting the challenges with other road users raised above. Safety learnings from trials included learnings about:

- interactions at roundabouts
- sensitiveness of lidars
- e-stops
- dealing with changing road environments
- interaction with the built environment
- risky road user behaviour
- human operator safety.

When a safety incident occurred, the common procedure was for the automated vehicle to be taken off the road. All trial partners and the road transport agency would assess the risk and confirm the appropriate risk mitigation measure before the vehicle was approved to return to the road.

Often there were potential safety issues that did not result in an actual incident in the trial because the human operator would take over if they could see a potential risk. Therefore, whether the vehicle would have stopped on its own was not known.

Most governments require reporting on incidents and near-misses regularly and reporting on serious incidents within 24 hours.

4.6 Human operators and passengers

It was a requirement of most permits that automated shuttle buses use human operators. These human operators could take back control from the ADS with joystick controls. Stakeholders noted the need to assess how the role of the human operator is designed and how they are supported to be the 'fallback-ready user'.

States and territories differed on whether human operators must sit or stand. Some trialling organisation considered it safer for human operators to stand, to help ensure that they remained alert. Some road transport agencies considered it would be safer for the human operators themselves if they were seated. Seatbelts were sometimes mandatory. States and territories also took different approaches to whether passengers should sit or stand and whether seatbelts should be mandatory.

Human operators had to focus on the road but also be aware of other things in the road environment that might be sensed by the lidars, such as falling leaves. Human operators might also have a dual role as both the fallback for vehicle operation but also to speak to passengers who have questions.

Potential human operators often had to undertake training and assessment. It was noted that the skillset for this role could be suited to more than just traditional drivers such as bus drivers – for example, individuals with technology or engineering backgrounds.

One stakeholder noted that as trials move to higher speeds, occupant safety will become an increasingly important consideration.

4.7 Data and reporting

Automated vehicles collect a lot of data, but trialling organisations and some road transport agencies noted that it was important for governments to have clear purposes and use cases for accessing data.

There was substantial feedback about the need to report on disengagements. A disengagement is any instance where a human operator takes back control from the ADS. Some road transport agencies require (or required) reporting on any disengagement. However, there was a strong view from trialling organisations that there are different categories of disengagements. Disengagements that should be reported include unexpected disengagements initiated by the ADS. Disengagements initiated by the human operator, if they are unsure of an ADS' ability to navigate a potential risk, could potentially be reportable. However, disengagements that are routine and initiated by the human operator should not be required to be reported – for example, where the human operator needs to move the vehicle outside of the set route temporarily.

Reporting required by governments varied. Some road transport agencies had clear requirements for regular reporting, while others only required an end-of-trial report. End-of-trial reporting was variable depending on the trialling organisations and governments involved. Topics covered generally included passenger use, technical information (such as kilometres travelled in automated mode) and safety incidents.

4.8 Public acceptance

Stakeholders noted the importance of public acceptance. The future uptake of automated vehicle technology will rely on bringing the public along for the journey.

Most trials held pre- and post-trial surveys. The consistent feedback from these surveys was that passenger acceptance of the technology improved once they had ridden in an automated vehicle.

One trialling organisation noted that maximising response rates was important. A road transport agency observed that onsite surveys were important – they had had a low response rate to a survey emailed after the trial.

One trialling organisation noted that the level of public acceptance would most likely depend on the use case. For example, if a trial was addressing a transport disadvantage (such as operating in an area without public transport), it would be more likely to gain acceptance within the community.

4.9 Infrastructure and road environment

Trialling organisations and governments generally sought to trial in locations that would not require significant additional infrastructure investment. Some road transport agencies expected that this would remain the case in the future. There did not seem to be an appetite for dedicated roadways or separate lanes, for example. One road transport agency noted that there are not many low-speed environments for automated shuttle buses, and it was not envisaged that network design would change.

There were some learnings about the road environment – for example, about the need for maintenance of vegetation at the roadside, the ability for automated vehicles to recognise the intention of other road users in some instances, and the differences between the operation of lidar sensors in built-up areas and outside of built-up areas.

4.10 The need to consider accessibility

The level of engagement with disability groups depended on the trial. Automated vehicles are often touted as being able to provide independence to people with disabilities and the elderly. However, stakeholders noted that for this to be the case, their whole-of-journey needs must be taken into account – for example, including buying a ticket, hailing a vehicle, and entering, riding and exiting a vehicle. Removing a human operator from a vehicle could mean removing the person who is able to recognise that a person is hailing the vehicle, assist them to board and to sell them a ticket. One stakeholder noted that automated trains in Sydney worked well because there were still staff members available at platforms to assist.

One trial that included an interactive bus stop catered well to people with disabilities. The bus stop could speak to users, providing information on when the bus was coming and what seat they should sit on.

There were questions raised about whether automated shuttle buses were compliant with disability standards. It was noted that these are mandatory requirements.

4.11 Lessons learned

4.11.1 There are many potential lessons from trials

It is important to remember that automated vehicle trials test many more things than just the technology itself. They can test infrastructure, business models, their viability as a transport

solution and public acceptance, for example. Governments and trialling organisations should consider at the outset what learnings and outcomes they want to gain from running these trials in their jurisdictions. These learnings can help to guide decision making across many areas in the future.

4.11.2 It is important to move forward with these lessons in mind

The majority of automated vehicle trials have been of automated shuttle buses. These trials have provided similar findings across a number of areas, including the safety of technology itself, the behaviour of other road users, safety issues for human operators, reporting, public acceptance and interaction with infrastructure and the road environment. However, despite the high number of this type of trial, it is not clear what the path to commercialisation is. For the technology providers, they will seek to progress their trials to larger, more complex phases and test commercial business models.

Trials of automated shuttle buses represent the bulk of real-world experience that the Australian public has with automated vehicle technology. It is important to increase public acceptance of this technology if Australians are to take up the technology once it becomes ready for commercial deployment. These trials have shown that passengers have had overwhelmingly positive experiences to date.

Sharing learnings from these trials among governments would be useful for a number of reasons. Lessons about the technology, safety incidents (including those involving human operators) and interaction with infrastructure and the road environment could be shared to avoid potential safety incidents in other jurisdictions. Sharing learnings about trial locations could help to avoid governments duplicating similar trials across jurisdictions, which could be a particular concern where public investment is involved.

4.11.3 The benefits of automated vehicles should not be assumed

Finally, there is an opportunity to be more inclusive of more segments of the community. Other road users and pedestrians will share the road environment with automated vehicles, and there would be value in involving and educating them while we are still in the trial phase with this technology. Groups representing vulnerable people such as people with disabilities and the elderly have a number of insights to help improve the technology's accessibility. If the accessibility benefits of automated vehicles are to be realised, it is important that these groups are also involved at the trial stage.

5 Reasons for trialling, how trials are evaluated, sharing findings

Key points

There are a number of reasons why governments and trialling organisations become involved in trials. It is important that governments are clear about the objectives they are trying to achieve through trials in their jurisdiction and to evaluate them in light of those objectives. There is an opportunity to place Australia in a better position to be ready for the commercial deployment of automated vehicles through sharing learnings across jurisdictions.

5.1 Reasons for involvement in trials

The perceived inevitability of automated vehicles entering the road transport mix seemed to be the spur for many stakeholders (outside of the technology providers themselves) to be involved in trials.

5.1.1 State and territory governments

Given this perceived inevitability, some state and territory governments were very active in encouraging automated vehicle trials and had clear objectives for being involved. These included:

- wanting to understand the readiness, benefits of the technology and its commercial viability
- identifying the infrastructure and systems needed to interact with this technology
- wanting to know how the community would respond to the technology and how barriers to their acceptance could be removed
- giving local businesses opportunities to be involved in trials.

Governments falling into this category often provided funding for trials. There was a keenness to be on the front foot to understand how to support automated vehicles should their benefits be proven.

Some state and territory governments played a more responsive, facilitative role. The criteria for trial approval was submission of an application that could meet the government's safety and operational requirements. These requirements were sometimes formalised, but trials did not necessarily need to meet a specific objective, fill a gap or meet strategic criteria in order to be approved.

5.1.2 Technology providers

Technology providers with overseas head offices chose to trial in Australia for reasons including our:

- historically high technology penetration and advancement
- variety of testing environments (for example, road types and weather conditions)

- academic network, particularly for research and investigation into robotics
- strong existing relationships with government (for companies already with Australian offices prior to a decision to trial automated vehicles here)
- regulatory development
- diverse population.

State and territory governments having a clear goal about what they wanted to achieve from a trial was considered important. Technology providers could then propose a use case that met that purpose. Technology providers also noted the importance of governments having a long-term vision for the technology that extended beyond the completion of trial.

5.1.3 Trial partners

Transport and infrastructure stakeholders noted the importance of understanding and being prepared for any potential transport disruption, rather than ignoring it.

The importance of understanding market impacts of this disruptive technology was noted. In particular, for insurance companies there was a need to understand the nature of the risk and how to price it. Data from trials is key to that understanding. An infrastructure stakeholder noted that investment in infrastructure was a long-term activity, so it was necessary to be a part of testing use cases to have informed views on traffic movements over the long term. There was also a desire to build knowledge and capability through trials. For some, this was in order to be able to provide advice to their own stakeholder communities about the technology and how it interacts with infrastructure and other vehicles.

Councils saw trials as an opportunity to explore whether automated vehicles could provide a transport solution for a particular community. There was also a general interest in being involved in innovation for infrastructure planning purposes and to attract industry.

5.2 Objectives for individual trials

Information about the objectives for individual trials was gathered from the stakeholder meetings as well as trial reports, which were either public or shared with the NTC. Objectives included:

- test as a transport solution for an area (for example, for a first- or last-mile journey)
- increase understanding about the potential impact and opportunities of the technology
- increase community awareness and acceptance of the technology
- understand the potential benefits for road safety and the potential risks
- improve accessibility for transport users with disabilities and improve the user experience
- identify how road infrastructure could be improved for automated vehicles.

Stakeholders noted the importance of having clear trial objectives at the outset. As noted in previous chapters, having clear objectives meant trialling organisations could design trials around specific use cases that would meet these objectives, leading to a more efficient application process and allocation of resources.

5.3 Evaluation

One of the main reasons for having clear trial objectives is to provide a benchmark against which to evaluate a trial. Without an understanding of what is trying to be achieved, there is no way to measure success.

We found great discrepancies in how trials are evaluated by governments across states and territories, with some comprehensively evaluating them and some not evaluating them at all. This could be indicative of whether the government was a trial partner or not.

Evaluation by trialling organisations often focused on public acceptance of the technology. While it is important to know this, similar findings have been found multiple times across similar trials. Some stakeholders emphasised the need to move past this type of research to try to answer more substantive questions. Some stakeholders noted the value of using an independent body to evaluate trials, to reduce the introduction of bias into results.

State and territory governments considered that a standardised evaluation framework could be useful. Having a baseline of standard evaluation requirements will make it easier to assess and compare trial findings.

5.4 Sharing learnings across government and publicly

Some state and territory governments have shared trial learnings publicly. However, other road transport agencies tended to share learnings across relevant government agencies in their jurisdiction, but not across jurisdictions.

Keeping trial learnings within a jurisdiction was seen as a missed opportunity. Road transport agencies were open to further sharing of trial learnings across jurisdictions. The work of Austroads was noted, in particular its Research Communities of Practice and its project to develop a lessons learned database for future vehicle and technology trials. Some stakeholders also noted the value of sharing outcomes at the international level.

Stakeholders noted that shared learnings would need to be limited to information that was not commercially confidential. However, it was noted that there was plenty of non-confidential information that could provide useful lessons across government, and there were also ways to collate and de-identify learnings.

Sharing learnings publicly would have the benefit of raising public awareness of the technology. However, one stakeholder noted the potential to cause public and media concern about the technology could be detrimental at this early stage of the industry's development.

5.5 Lessons learned

5.5.1 There can be clearer objectives for trialling

State and territory governments have a range of reasons for being involved in automated vehicle trials generally. Some governments actively pursue opportunities for automated vehicle trials and join trialling organisations as a funding partners, while others play a more facilitative role of creating a 'safe space' for trials in their jurisdictions.

Trialling organisations will have different objectives for trialling, depending on the type of organisation. Trialling organisations will want to test the safety of the technology; councils

may want to encourage industry and address transport disadvantage. Governments could consider the range of objectives for trialling that lie outside the reasons given by industry, and consider their own objectives, even if they are not funding partners.

Selecting trials more aligned with strategic objectives could reduce duplication in trials and start to address knowledge gaps.

5.5.2 Clear objectives can lead to better evaluation, and better evaluation can lead to improved sharing

Clear objectives for a trial are key to evaluating the success of a trial. Though governments may not want to place objectives on a trial that they are not a partner in, they still set the reporting requirements for the trial. In doing so, these reporting requirements could be set in accordance with their own government objectives to aid evaluation.

Evaluation and shared learnings have not been a priority for state and territory governments to date. However, there is a willingness to be more open. Work being led by Austroads will facilitate this, but the NTC is also in a position facilitate government collaboration. In an emerging industry, it is important for governments to learn from each other, with the goal of ensuring that Australia is ready for automated vehicles once they become ready for commercial deployment here.

6 The state of trialling in Australia and a way forward

Key points

We are ready for a next stage of trials in Australia. There are a number of areas that governments can focus on to encourage this next stage. There is also an opportunity to look holistically across trials, regulation, infrastructure and public attitudes to assess Australia's overall readiness for the commercial deployment of automated vehicles.

6.1 The state of trialling in Australia

Automated vehicle trials in Australia have now been operating for nearly five years. In that time, there has been great progress in developing regulatory arrangements to support trials, encouraging international companies to bring their technology here, and creating an environment where different parties are able to come together as trial partners to test this new technology against a number of different objectives. State and territory governments have actively supported or facilitated the trials of automated vehicles in every jurisdiction.

Valuable lessons learned from trials to date include lessons about safety, public acceptance, interaction with road users, the road environment and infrastructure.

However, there is a sense among trialling organisations of a slowing of government interest in automated vehicle trials. This is reflected in the availability of funding, the lack of complexity in trials, and the absence of a clear path to commercial business models.

6.2 The state of trialling internationally

In Australia, the scale, number and automated vehicle technology testing levels are less than in countries with large automotive and IT industries. Noting this, Australia ranked 15th in the KPMG 2020 Automated Vehicle Readiness Index.[9] Canada, with similar automated vehicle policies to Australia, but some automotive manufacturing, as well as national and provincial government support and testbeds, ranked 12th. In arriving at its rankings, KPMG made assessments against the policy and regulatory environment, level of technology and innovation, infrastructure readiness and consumer acceptance.

Internationally, the United States is the leading automated vehicle developer and has the largest trials in terms of scale and numbers. While there are national policies, trial regulation is undertaken by states and many encourage and compete for trials. Technology developers have undertaken broad-scale trials over the past few years, with California (large IT industry), Arizona (conducive regulatory environment) and Michigan (automotive manufacturing, state facilitation and test facilities) among the leading states.

[9] See the KPMG Automated Vehicles Readiness Index 2020: https://home.kpmg/au/en/home/insights/2020/07/autonomous-vehicles-readiness-index-2020.html.

The European Union supports cross-border trialling of national endeavours, with strong collaboration with manufacturers in Germany (a number of test beds) and Sweden (strength in heavy vehicles). Japan and South Korea also undertake testing, including on-road automated vehicles, ‘last mile’ mobility and heavy-vehicle platooning.

6.3 A next stage of trials in Australia

There are several opportunities for government to encourage a next stage of automated vehicle trials in Australia.

6.3.1 More complex trials

Technology providers have been trialling automated shuttle buses in Australia since 2016. All trials have taken passengers on relatively small, mapped routes at low speeds.

To test the limits of the technology and trial how the vehicles might operate when they are ready for deployment, there is a need to trial the vehicles in more complex environments. Provided a safety case can be met, these vehicles could be approved to trial within an operational design domain rather than a set route, on a much larger set route, or in a busier precinct like a CBD or shopping area.

6.3.2 Moving towards commercialisation

Routes should be chosen in areas where there is a genuine view to use these vehicles as a transport solution in the future. For example, in Monheim, Germany, EasyMile runs a fleet of five automated shuttle buses from a bus station to the old town centre. The buses run every 15 minutes seven days a week.

In Phoenix, Arizona, Waymo operates its Waymo One ride-hailing service. The fleet consists of level 4 automated cars that can be hailed for a journey and paid for through an app.

It will be some years before the commercial framework for automated vehicles is in place. In the intervening period, to keep and attract investment from these types of companies, these organisations will want to see a viable pathway to commercialisation in Australia.

6.3.3 Different types of vehicles and applications

Automated shuttle buses have been the first starter for automated vehicles in Australia but there are many other types of vehicles and applications that we can expect to see in the future.

Waymo One shows how a ridesharing service can be provided using automated cars. We are aware that manufacturers are moving towards fleet models for commercialisation, and it is possible that ‘robotaxi’ fleets of this kind will be at the forefront.

COVID-19 has seen a pivot in the industry towards more automated delivery vehicles. These are more likely to be automated pods or small footpath-based vehicles.

There may be interest in heavy vehicle applications, as progress is made in automated heavy vehicles and connectivity. Taking the cab off a vehicle presents huge productivity gains, and once this technology is ready there is likely to be huge demand.

6.3.4 Removing the human operator

All automated vehicle trials in Australia have had human operators on board, operating as fallback-ready users. The level 4 technology in these vehicles will, however, become mature enough to warrant trials without a human operator in the near term. To fully test the limits of the technology, it is necessary for human intervention to be removed. Waymo is running its Waymo One service in Arizona without human operators on board.

6.3.5 Cross-border trials

There have been no trials across state borders in Australia. Cross-border trials are an important test case for transition to commercial deployment. At deployment, automated vehicles may have access to the entire road network so will need the ability to deal with different road rules and infrastructure found in different states and territories. Cross-border trials may also be an important use case for automated heavy vehicle applications.

State and territory road agencies have already noted their willingness to collaborate to make application processes for cross-border trials smoother. The NTC will facilitate this collaboration among states and territories.

6.3.6 Regulation

The trials framework consists of the importation and trial application framework, plus the NTC/Austroads guidelines, outlined in chapter 3. We have suggested improvements that can be made to clarify the application process and present it more holistically to potential trialling organisations. We have also recently reviewed and updated the NTC/Austroads guidelines. Governments are committed to working together to share learnings to improve the process for trialling, including harmonising where possible.

The NTC is also leading development of the commercial deployment framework for automated vehicles. In conjunction with the Commonwealth and states and territories, we are developing a regulatory framework for safety assurance, insurance and data.

We are ahead of other countries in terms of our regulatory readiness for automated vehicles.[10] The NTC will continue to engage with industry on our regulatory reform proposals.

6.3.7 Infrastructure readiness

Automated vehicle trials have shown a number of infrastructure learnings specific to automated shuttle buses in particular. C-ITS testbeds have trialled the connected infrastructure that automated vehicles will interact with. Austroads has done significant work to understand how infrastructure like lines and signs and freeways and highways will need to be improved to accommodate automated vehicles.

There is a potential need to bring together a holistic picture of Australia's readiness for automated vehicles from an infrastructure perspective. From this, a roadmap of guidance on infrastructure development could be assessed.

[10] Australia was one of four countries given the highest rating for automated vehicle regulation in KPMG's '2020 Autonomous Vehicles Readiness Index': https://assets.kpmg/content/dam/kpmg/xx/pdf/2020/07/2020-autonomous-vehicles-readiness-index.pdf.

6.3.8 Investment and industry

Investment in automated vehicle trials is necessary to keep companies trialling in Australia and to attract new companies to bring their technology here. Companies will want to be able to see a viable business opportunity to enter a relatively small market like Australia.

Australia no longer has its own vehicle manufacturing industry for traditional vehicles, but there is the opportunity to grow local industry for automated vehicle technology. For example:

- SAGE Automation is an Australian company that has been involved in several automated vehicle trials, including a trial in Holdfast Bay where it developed a smart transit hub to integrate an automated shuttle bus service. This 'interactive bus stop' allowed passengers to book the shuttle bus and receive information about the service and other local activities.
- Seeing Machines is an Australian company that develops safety technology driven by artificial intelligence. Its driver monitoring technology was used in vehicles in the CAN Drive trial in Canberra to test how quickly a driver can be ready to resume control of an automated vehicle.
- Cohda Wireless, Bosch and EasyMile are examples of international companies that have Australian offices from which they manage their engagement and operations for automated vehicle trials.

6.3.9 Public acceptance

It is necessary to bring the public along on the journey if they are to embrace automated vehicle technology in the future. There has been research about community attitudes conducted by academics, transport bodies and trialling organisations. To date, however, there has not been a discussion among governments about what to do with this information. With the knowledge that public acceptance of the technology is important to uptake, there is a need for government to consider if it has a role in education and facilitating this acceptance.

6.4 The way forward

The current trials framework consisting of the importation process, the trial application process and the NTC/Austroads guidelines can manage more complex, commercial and cross-border trials.

It is clear that there are opportunities for government to play a role in encouraging a next stage of trials in Australia. Collating and publicising messaging about the complete trials framework can show potential trialling organisations the process for applying for a trial in Australia. Close collaboration between state and territory governments can smooth the process for running more advanced trials. Sharing learnings between state and territory governments about safety can help to ensure trials remain safe. And action in the areas outlined in section 6.3 can pave the way for the eventual commercial deployment of automated vehicles as well. We recommend the NTC, the Commonwealth, state and territory governments and Austroads work together to progress this work.

We also consider there is a need to look holistically at Australia's overall readiness for automated vehicles, across trials, regulation, infrastructure and public attitudes. This goes beyond encouraging trials. In 2021, the NTC, in conjunction with the Commonwealth, states and territories and Austroads, will develop a scope and costs of reviewing Australia's overall readiness for the commercial deployment of automated vehicles.