SAFETY ASSURANCE FOR AUTOMATED DRIVING SYSTEMS
DECISION REGULATION IMPACT STATEMENT

November 2018

National Transport Commission

Report outline

Title	Safety Assurance for Automated Driving Systems: Decision Regulation Impact Statement
Type of report	Council of Australian Governments Decision Regulation Impact Statement
Purpose	The purpose of this decision Regulation Impact Statement is to analyse options for the safety assurance of automated driving systems. This analysis is intended to inform a Transport and Infrastructure Council decision on a safety assurance approach.
Abstract	This decision RIS uses a multi-criteria analysis to assess options for the safety assurance of automated driving systems (ADSs). The baseline option (option 1) does not develop a new safety assurance system. The reform options (2, 3 and 4) all introduce safety assurance systems based on mandatory self-certification by automated driving system entities. These options have increasing levels of government oversight. Following consultation on the options we recommend an approach that incorporates self-certification against safety criteria for ADSs into Australian Design Rules (option 2) to manage safety at first supply. We recommend further work to consider the most appropriate way to manage the safety of ADSs while they are in-service. This work will consider safety duties and the parties they should apply to, and the institutional arrangements that should govern the in-service framework.
Key words	automated driving systems, automated driving system entities, automated vehicles, cost-benefit analysis, multi-criteria analysis, primary safety duty, regulation impact statement, safety assurance system, Statement of Compliance, compliance and enforcement
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Foreword

Australian transport and infrastructure ministers have recognised that automated vehicles offer the possibility of fundamentally changing how transport is provided and unlocking a range of safety, productivity, environmental and mobility benefits.

The National Transport Commission is working with state, territory and the Commonwealth governments on a program of regulatory reform to ensure the Australian community can gain the potential benefits of automated vehicles. Our aim is to develop a flexible and responsive regulatory environment for the commercial deployment of automated vehicles that supports both safety and innovation.

This decision Regulation Impact Statement delivers a key aspect of this reform agenda. Ministers have agreed to a mandatory self-certification approach to safety to provide assurance to the community and government that companies developing automated driving technology are managing safety risks appropriately. This approach also allows for ongoing innovation by enabling different business models and mixes of technology to be brought to Australia.

The development of a safety assurance system based on mandatory self-certification is a significant step in preparing Australia for the commercial deployment of automated vehicles. It will give the Australian public and manufacturers clarity, certainty and consistency, and ensure Australia is able to align with developments in the international regulatory landscape.

I would like to acknowledge the valuable input provided by stakeholders in informing this decision Regulation Impact Statement. I encourage government, industry and the wider community to continue to work with us on the next steps in our automated vehicle regulatory reform agenda to ensure Australians can gain the benefits of this technology.

Carolyn Walsh
Chair and Commissioner

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Introduction

Automated vehicles are vehicles that include an automated driving system (ADS) that is capable of monitoring the driving environment and controlling the dynamic driving task (steering, acceleration and breaking) with limited or no human input. Automated vehicles promise significant safety and mobility benefits but potentially introduce new road safety risks.

Australia's existing laws and regulations do not recognise automated vehicles or provide assurances of their safe design or operation. Overseas, governments are considering automated vehicle safety assurance, but there is not currently an international consensus.

The purpose of this decision Regulation Impact Statement (RIS) is to examine the potential problem of automated vehicle safety and assess any government response. The decision RIS seeks to answer two key questions:

- What is the role of the Australian Government in assuring the safety of ADSs?
- What is the form of the regulatory system (if any) that underpins this role (the 'safety assurance system')?

Decisions made to date on safety for automated vehicles

In 2017 we consulted on high-level approaches to safety for automated vehicles. Government and industry stakeholders indicated broad support for a safety assurance system based on mandatory self-certification by the entity that is looking to bring the technology to the Australian market (the automated driving system entity or 'ADSE'). In November 2017 transport ministers asked us to develop a RIS to assess the costs and benefits of a mandatory self-certification approach.

Automated vehicle safety – what is the problem?

Under our current regulatory environment, there are risks that when automated vehicles become ready for deployment:

- Unsafe ADSs will be deployed.
- A lack of consumer confidence in the safety of ADSs will reduce or delay their uptake.
- ADSEs will face inconsistent and/or uncertain regulatory barriers at the national and international levels when supplying ADSs to the Australian market.

These risks may need to be addressed to support the uptake and safe operation of automated vehicles on Australian roads and unlock their broader benefits.

Options to address the problem

This decision RIS assesses four options to address the problem statement, which relate to the future role of the Australian Government in assuring the safety of ADSs. They are:

- Option 1: Baseline approach – Using existing legislation and regulatory instruments with no explicit safety assurance of ADSs.
- Option 2: Safety assurance system in existing frameworks – A safety assurance system based on mandatory self-certification that relies on the existing vehicle certification framework.

- Option 3: New safety assurance system – A safety assurance system based on mandatory self-certification. This would include new or amended legislation to allow for the inclusion of specific offences and compliance and enforcement options against noncompliant ADSEs.
- Option 4: New safety assurance system + primary safety duty – A safety assurance system that includes all of the elements of option 3, plus a primary safety duty on ADSEs to address risks not identified at first supply. The primary safety duty would place an overarching and positive general safety duty on ADSEs to ensure the safety of their ADSs so far as reasonably practicable.

Safety assessment criteria

Options 2, 3 and 4 require companies to self-certify their ADSs. We are recommending 11 safety criteria that the applicant must self-certify against to demonstrate its processes for managing safety risks before their ADS can be supplied in the Australian market:

1. Safe system design and validation processes
2. Operational design domain
3. Human–machine interface
4. Compliance with relevant road traffic laws
5. Interaction with enforcement and other emergency services
6. Minimal risk condition
7. On-road behavioural competency
8. Installation of system upgrades
9. Verifying for the Australian road environment
10. Cybersecurity
11. Education and training.

We are recommending three other obligations on ADSEs to manage liability for events such as road traffic law breaches and crashes:

1. Data recording and sharing
2. Corporate presence in Australia
3. Minimum financial requirements.

Assessing the reform options

There is uncertainty around:

- the level and nature of the risks posed by automated vehicles
- the future world in which the regulatory framework will operate
- the impacts of the options themselves.

Given the degree of uncertainty and lack of relevant information, a quantitative cost-benefit analysis was not possible. Instead, the assessment is based on qualitative information around key impact categories and assessment criteria. The options were assessed against five impact categories:

- Road safety

- Uptake of automated vehicles
- Regulatory costs to industry
- Costs to governments
- Flexibility and responsiveness

Consultation

Prior to this decision RIS, we released a consultation RIS on 14 May 2018. We held information sessions on the consultation RIS around the country and received 62 written submissions. The majority of submitters that expressed a preferred option supported option 4, but there was a clear minority who identified and preferred a modified version of option 2. Stakeholders were largely supportive of the safety criteria and obligations.

Results of multi-criteria assessment are subject to uncertainty

As noted above, our assessment was undertaken in the context of a number of uncertainties, largely due to the emergent nature of the technology. We did not receive significant new data and evidence through the consultation process.

Within this context, our assessment concludes that:

- Option 4 could provide the greatest benefits, in particular because it is the only option to address all assessment criteria under the road safety impact category. The assessment also shows it could provide large improvements to flexibility and responsiveness, and moderate improvements to the uptake of automated vehicles.
- Option 3 exhibits similar results but with somewhat lesser improvements to road safety compared with option 4. Option 3 does, however, present greater certainty around regulatory costs than option 4.
- Option 2 exhibits similar impacts to option 3 but with somewhat lesser improvements to road safety and flexibility and responsiveness impacts.
- Options 2, 3 and 4 all result in an overall benefit relative to option 1.

Recommended approach and implementation

Our RIS analysis shows that option 4 exhibits the most positive impacts over the life of the ADS, particularly regarding road safety. While the majority of submitters showed a preference for option 4, we also recognise that:

- A number of submitters sought further detail on the extent and application of a primary safety duty and how such a duty would align with other obligations on an ADSE or on other parties.
- Automotive manufacturers strongly supported using existing regulatory frameworks as providing a practical way to manage the safety of ADSs at first supply, maintain a single regulator for industry and allow transition to international standards as they develop.

After considering all submissions and holding further discussions between Commonwealth, state and territory governments, we consider it appropriate to recommend a composite approach to address the safety of ADSs. We recommend an approach to safety at first supply but do not recommend an approach for in-service safety at this time. Instead, we recommend a further stage of work on in-service safety.

At first supply, we recommend the approach outlined in option 2. This approach incorporates the recommended safety criteria and obligations into the existing vehicle

certification framework (Australian Design Rules) administered by the Commonwealth government.

For in-service safety, we recommend further work to develop an appropriate approach. This is in order to better assess the costs and benefits of potential approaches to in-service safety, including the safety benefits and regulatory costs. The work will cover three key areas: the appropriate in-service safety duties, the parties they should apply to, and the institutional arrangements to govern in-service safety.

This further work on in-service safety will also allow the outcomes of the RIS to be incorporated into what is currently a separate reform on changes to driving laws to support automated vehicles. This will mean broad in-service safety duties and specific obligations currently in the Road Rules are examined together to ensure there is a holistic approach, and that we do not place prescriptive obligations (relating to the dynamic driving task) onto an ADSE that would be covered by a primary safety duty.

1 Context

Key points

- Vehicles with automated driving systems will soon be available for commercial deployment in Australia.
- Automated vehicle technology is new and emerging, with significant uncertainties and potential risks.
- Automated vehicle technology has the potential to deliver significant road safety and other benefits.
- Australia's existing laws and regulations do not recognise automated vehicles or ensure their safety or safe operation.
- Automated driving system safety assurance is being considered in markets around the world, but there is no international consensus.

This chapter details some of the expected benefits and risks of automated vehicles, outlines the national approach to creating a regulatory framework and introduces the policy work to date to develop a safety assurance system for automated vehicles. The chapter ends with information about this decision Regulation Impact Statement (RIS) and some key terms and concepts that will feature in the document.

1.1 Introduction – what are automated vehicles?

Automated vehicles are vehicles that include an automated driving system (ADS) that is capable of monitoring the driving environment and controlling the dynamic driving task (steering, acceleration and braking) with limited or no human input.

This could include:

- vehicles based on existing models, with automated functions
- new vehicle types with automated functions
- aftermarket devices or software upgrades that add automated driving functions to existing vehicles.

New vehicles with high levels of automation are expected to arrive on our roads from around 2020. These vehicles will increasingly take control of the driving task away from human drivers in certain circumstances and environments.

Automated vehicles promise major safety and community benefits and offer the possibility of fundamentally changing transport and mobility. However, the supply and use of automated vehicles also raises new risks.

Australia's transport ministers, through the Transport and Infrastructure Council,[1] have 'agreed that Australian governments will aim to have end-to-end regulation in place by 2020 to support the safe deployment of automated vehicles' (Transport and Infrastructure Council, 2017, p. 3).

[1] The Transport and Infrastructure Council brings together Commonwealth, state and territory and New Zealand ministers with responsibility for transport and infrastructure issues, as well as the Australian Local Government Association.

1.2 Background

1.2.1 Road crashes in Australia

Human error and dangerous human choices cause up to 94 per cent of serious crashes (National Highway Traffic Safety Administration, 2015, p. 1),[2] with causes including speeding, drink-driving and distracted driving (Pettigrew, 2016).

In 2017 there were 1,225 deaths on Australian roads from 1,131 road crashes (BITRE, 2018, p. 1). There is currently no nationally consistent road crash injury data in Australia due to state/territory methodological differences. However, a 2017 research report estimated that there were 32,300 serious injuries that resulted in hospitalisation and 224,104 minor injuries sustained from road crashes in 2016. There were also an additional 453,552 crashes that resulted in only property damage (Litchfield, 2017, p. 19).

Road crashes have a major impact on Australians. They result in a number of costs for individuals and society including:

- costs to individuals and their families associated with death or rehabilitation and care
- costs on other road users associated with clean-up and any resulting delays
- costs for society more broadly from death and injury of members of the public
- costs to productivity from lost workforce participation due to death or injury.

The total social cost of road crashes in Australia for 2016 was estimated at $33.16 billion. This estimate includes:

- $10.2 billion in fatality costs (based on an average cost per fatality of $7.8 million)
- $13.58 billion in injury costs (based on an average cost per serious injury of $310,094 and $3,057 per minor injury)
- $9.38 billion in property damage costs (inclusive of $5.54 billion in vehicle repair costs, $2.29 billion in insurance administrative costs, $1.55 billion in travel delay costs) (Litchfield, 2017, p. 22).

All Australian governments have committed to reduce fatal and serious injury crashes on Australian roads. This commitment is expressed through the *National Road Safety Strategy*, which identifies 'improving the safety of our vehicle fleet' as a key activity (Transport and Infrastructure Council, 2014, p. 5). In May 2018 the Transport and Infrastructure Council approved the *National Road Safety Plan 2018–2020*. Supporting the strategy, the plan 'is centred on a shared commitment from all jurisdictions to the vision that no person should be killed or seriously injured on Australia's roads' (Transport and Infrastructure Council, 2018b).

1.2.2 Benefits and risks of automated vehicles

While the quantification of the benefits and risks of automated vehicles is fundamentally uncertain, research suggests that, overall, automated vehicles are expected to improve road safety, travel times, highway and intersection capacity, fuel efficiency, emissions per kilometre, travel choices, mobility, accessibility and opportunities for sharing (Milakis, et al., 2017, p. 324).

[2] Data from the United States in the National Motor Vehicle Crash Causation Survey.

The most significant anticipated benefit of increasing vehicle automation is improved safety. These benefits are already being realised, with automated driving applications such as Lane Keeping Assist and Auto Emergency Braking demonstrating reductions in crashes of up to 50 per cent (Austroads, 2017b). Research suggests automated vehicles can reduce human errors or potentially eliminate them completely, translating to savings of $16 billion per year (Pettigrew, 2016).

A report prepared for the NSW State Insurance Regulatory Authority (Finity Consulting, 2016) estimates that adopting automated vehicles in Australia will reduce the likelihood of injuries for:

- car driver and passenger injuries by 80 per cent
- cyclist injuries by 70 per cent
- motorcyclists by 40 per cent
- pedestrians by 45 per cent.

It is estimated that the uptake of automated vehicles in the United States will cause vehicle crashes to fall from second to ninth place in terms of leading causes of death (Bertoncello & Wee, 2015). As such, the uptake of increasingly automated vehicles is widely considered an emerging opportunity to improve the safety of the Australian vehicle fleet (see Appendix I for evidence of the expected benefits of automated vehicles).

Automation of the vehicle fleet is also expected to affect ways in which products and services are offered, delivering more compelling products, better applications for consumers and new revenue streams for companies. Commercial operators may save on fuel costs by switching to ADS vehicles (Fagnant & Kockelman, 2015). Additionally, increasingly automated vehicles could facilitate the anticipated switch from traditional car ownership models to a shared driverless model, which could reduce the costs of travel by up to 78 per cent on a per mile basis (based on US modelling) (Accenture Digital, 2014, p. 4).

However, these expected benefits will be predicated on consumer uptake of automated vehicles, which is currently uncertain. The uptake for automated vehicles will be driven by:

- how safe they are
- cost
- the extent that they provide other benefits such as enhanced mobility and more productive road networks
- the flexibility of regulatory regimes
- the evolution of innovative mobility business models
- the uptake of complementary innovations such as connectivity, electrification and sharing mobility.

The supply and use of automated vehicles also raises new risks, and these are heightened due to the new and emerging nature of the technology. Software failure has been recognised as a risk for automated vehicles (Noy, et al., 2018). Safety engineers anticipate that systemic technical errors, or failure to properly maintain and service the ADS, could become significant hazards akin to human error (Kira, 2017, pp. 7, 17).

Many identified impacts – such as impacts on fixed vehicle costs, congestion, travel comfort, transport infrastructure, overall energy consumption, air pollution, public health and jobs and investment – are uncertain (Milakis, et al., 2017, p. 325).

The automotive industry has noted that 'before the safety and environmental benefits of automated and connected vehicles can be realised a number of matters need to be considered – one of the most important of which is the regulatory environment' (Federal Chamber of Automotive Industries, 2017, p. 4). The overarching regulatory approach in Australia is discussed below.

1.2.3 Regulatory environment

Governments currently regulate road transport to ensure safety and security outcomes. Current transport regulations cover vehicle standards, the operation and roadworthiness of vehicles and driver licensing. General consumer and product liability laws provide additional consumer protections.

Commonwealth and state and territory governments share responsibility for motor vehicle safety laws and their enforcement. The Commonwealth government administers the *Motor Vehicle Standards Act 1989*[3] and the Australian Design Rules (ADRs) to control the safety of new and imported vehicles at the point of first supply. State and territory governments administer licensing, registration and roadworthiness (via in-service vehicle standards). Finally, the National Heavy Vehicle Regulator administers the Heavy Vehicle National Law (HVNL) and is responsible for regulating the in-service heavy vehicle standards.[4] These laws and regulations are described further in Appendix F.

Current Australian transport legislation assumes there is a human driver. It does not provide for an ADS to be in control of the vehicle, rather than a human driver.

1.2.4 National reform program for automated vehicles

To unlock the benefits and manage the risks associated with introducing automated vehicles, Australian governments will aim to have end-to-end regulation in place by 2020. Such regulation will provide 'a flexible approach while automated technology continues to progress and international standards are being developed' (Transport and Infrastructure Council, 2017, p. 3).

The Transport and Infrastructure Council has agreed to a phased national regulatory reform program led by the National Transport Commission (NTC) to facilitate the introduction of light and heavy vehicles with greater levels of automation onto Australian roads. Completed projects include developing guidelines to support automated vehicle trials (National Transport Commission, 2017a) and enforcement guidelines that clarify the regulatory concepts of 'control' and 'proper control' for automated vehicles (National Transport Commission, 2017d). Current work focuses on four reforms:

- **Safety assurance system for automated vehicles:** The subject of this RIS.
- **Changing driving laws to support automated vehicles:** Developing legislative reform options to clarify the application of current driving laws to vehicles with automated functions and to establish legal obligations for automated driving system entities (ADSEs).
- **Motor accident injury insurance review:** Identifying barriers to accessing compensation under current motor accident injury insurance schemes for personal injuries and deaths caused by an ADS. Developing options with the aim of ensuring that

[3] The Road Vehicle Standards Bill 2018 is currently before the Senate (as at publication). The bill would replace the *Motor Vehicle Standards Act 1989*. It includes, among other things, to enable the minister to determine national road vehicle standards for road vehicles.

[4] With the exception of the Northern Territory and Western Australia.

crash victims are no worse off in accidents involving automated vehicles than those injured by a vehicle controlled by a human driver.

- **Regulating government access to C-ITS and automated vehicle data:** Developing options to manage government access to cooperative intelligent transport systems (C-ITS) and automated vehicle data.

We are also supporting state and territory governments to review current exemption powers to ensure legislation can support on-road trials.

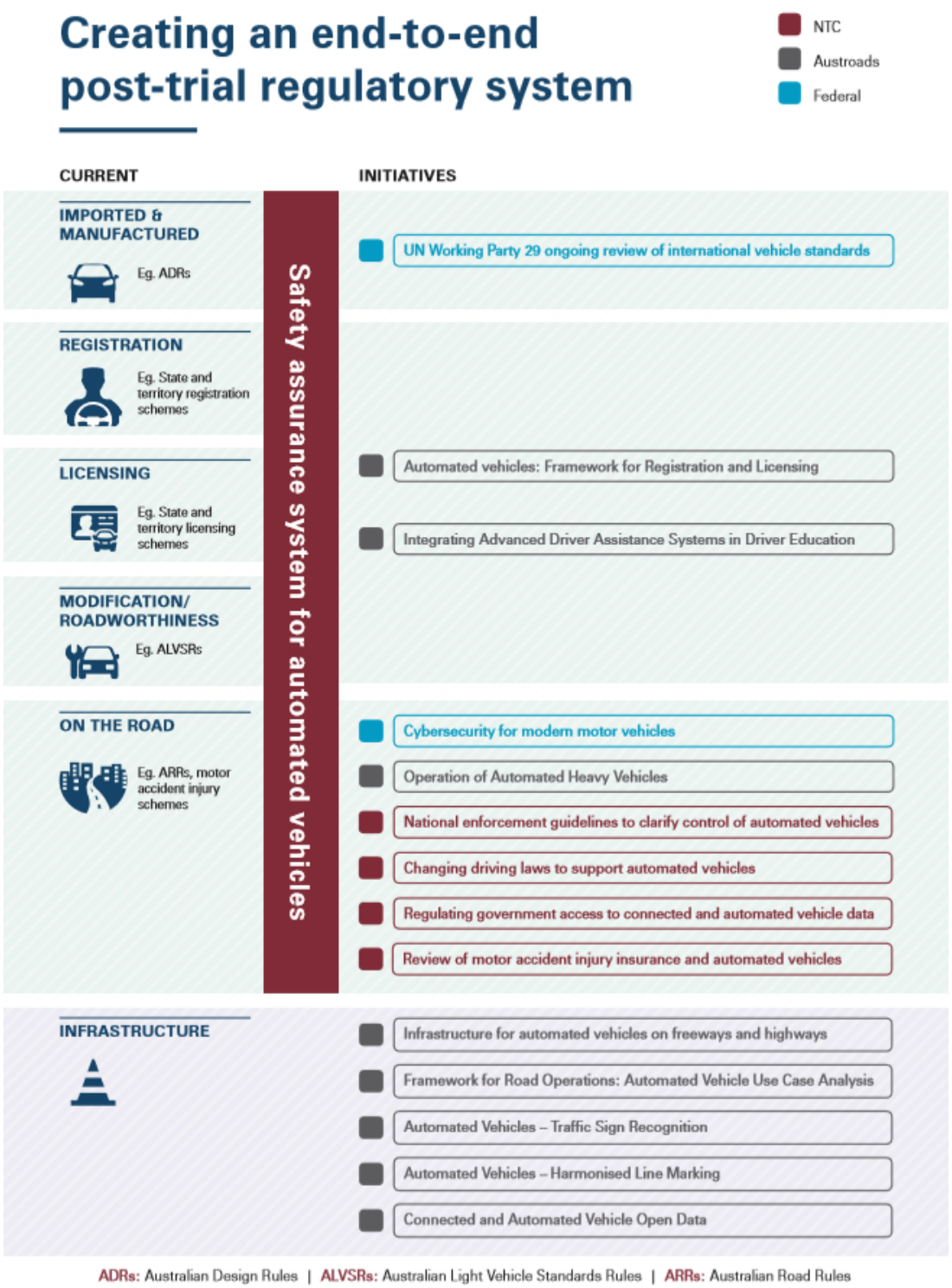
In addition to these NTC projects, the following work is being undertaken by other agencies:

- The Commonwealth Department of Infrastructure, Regional Development and Cities (DIRDC) continues to participate in developing new and updated United Nations vehicle standards and is a participant in United Nations Working Party 29 (WP.29) on the harmonisation of vehicle regulations.
- Austroads is undertaking a project to assess how registration and licensing operations can best be aligned with a safety assurance system. Austroads' assessment suggests that the impacts on registration and licensing are likely to be minimal, given that the safety assurance system will operate nationally and not through registration processes. A national registration working group will undertake further work in 2019 to assess the extent of refinements needed to current business practices. For example, new registration fields could be added to registration databases (including information available on the National Exchange of Vehicle and Driver Information System) to capture essential information about the ADS.
- Every state and territory in Australia is supporting and is involved in trials and demonstrations of connected and automated vehicles (Austroads, 2017a).

We continue to collaborate closely with the Commonwealth, state and territory governments, local governments and Austroads to deliver an integrated regulatory system for deploying vehicles with ADSs.

Figure 1 shows the existing end-to-end regulatory process and the projects underway at each stage to prepare for more vehicles with automated functions. The safety assurance system will bind all projects across the regulatory system (with the exception of infrastructure) into a nationally consistent framework.

Figure 1. End-to-end regulatory process and projects



These initiatives focus on ensuring Australia can maximise the potential opportunities and benefits that come with more automated vehicles. A nationally consistent approach will also reduce costs, provide certainty to industry, promote innovation and competition and ensure that Australians have early access to the newest technologies.

1.2.5 Safety assurance for automated driving systems

The safety assurance for ADSs reform will examine the role of governments in automated vehicle safety. In November 2016 transport ministers agreed that the NTC should 'develop a national performance-based assurance regime designed to ensure the safe operation of automated vehicles' (National Transport Commission, 2016, p. 12). Ensuring that automated vehicles can operate safely on Australian roads under Australian conditions is a key step in allowing greater numbers of these vehicles.

In June 2017 we published a discussion paper, *Regulatory options to assure automated vehicle safety in Australia*. We consulted on four regulatory options for safety assurance (Figure 2):

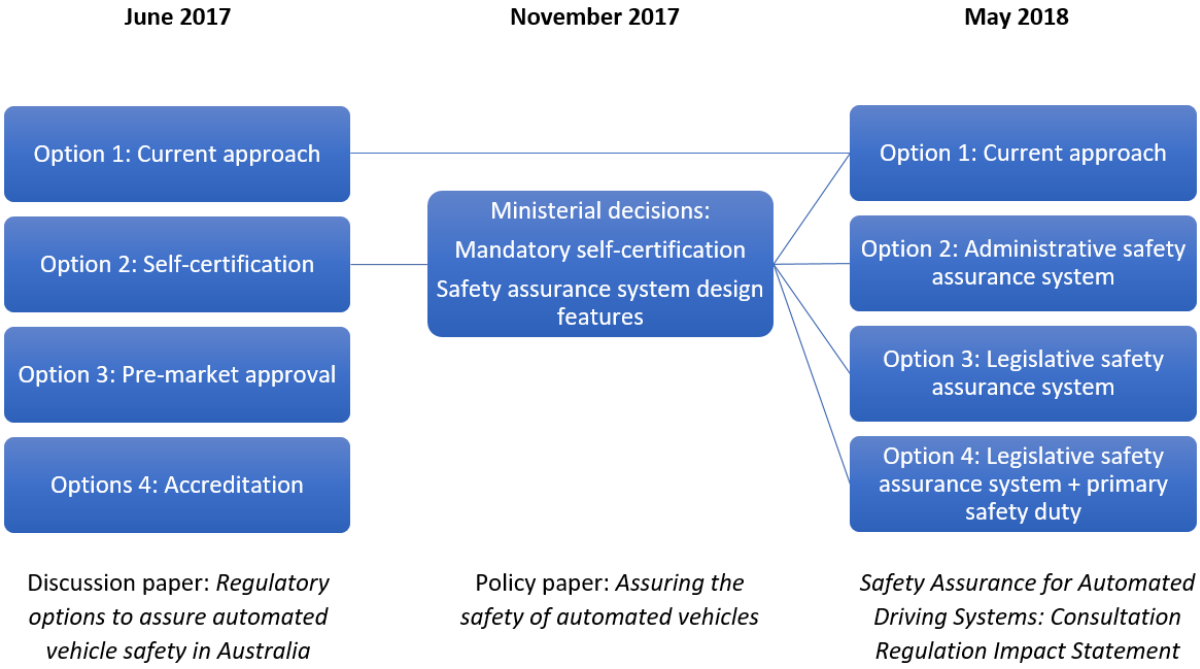
- continuing the current approach
- self-certification by ADSEs
- pre-market approval of ADSs
- accreditation of ADSEs.

We received 27 submissions to the discussion paper including submissions from road and transport agencies, manufacturers, automobile clubs, insurers and law firms.[5] Submissions clearly indicated that the community expects governments to have a role in ensuring automated vehicles are safe. There was also strong support for a mandatory self-certification approach.

Following consultation and after considering the various policy complexities, ministers agreed to the recommendations in the paper *Assuring the safety of automated vehicles* in November 2017, subject to an assessment of costs and benefits. This paper recommended a mandatory self-certification approach to ensuring automated vehicle safety, with consideration of a primary safety duty (National Transport Commission, 2017c, p. 3). The mandatory self-certification model is designed to provide assurance to the government and the community that companies developing ADS technology are managing safety risks appropriately while also allowing for ongoing innovation. The liability/responsibility for safety would still remain with the vehicle manufacturer or the ADSE.

[5] Publicly available submissions on the *Safety assurance for automated driving systems: consultation Regulation Impact Statement* are available on the NTC website.

Figure 2. Safety assurance system for automated vehicles project



The key design features ministers agreed to (subject to an assessment of costs and benefits) are outlined in Table 1 (National Transport Commission, 2017c, p. 2).

Table 1. Design features of the proposed safety assurance system

1. The safety assurance system will be administered by a government authority, preferably on a national basis. Approval decisions may be made on the advice of a single national government panel consisting of the Commonwealth, states and territories, the NTC, the National Heavy Vehicle Regulator and Austroads.
2. The safety assurance system will manage principles-based safety criteria that capture key safety risks associated with automated vehicles. The safety criteria should include matters relating to:
   - the safe operational design domain of the vehicle
   - the human–machine interface
   - on-road behavioural competency, including compliance with traffic law, interaction with vulnerable road users
   - cybersecurity
   - driver training
   - the provision of data, including interaction with enforcement agencies.
3. ADSEs (such as manufacturers) will be required to submit a Statement of Compliance that demonstrates how each of the agreed safety criteria has been managed. A Statement of Compliance must be submitted and approved before the relevant ADS or function can be introduced into the market.
4. The ADSE remains responsible for testing and validating the safety of the ADS or function. The role of government in the safety assurance system is to satisfy itself that the applicant has processes in place to identify and manage the safety risks. It is not

envisaged that the safety assurance process will conduct independent testing or validation activities.

5. To support national consistency and cross-border travel, state and territory road managers will be notified of a safety assurance outcome, but approval of a road manager should not be required for the ADS to operate unless the ADS forms part of a vehicle that would otherwise require a permit or exemption to access the road network. This is consistent with the current arrangements for new light vehicles.
6. All in-service modifications to the ADS that have a significant impact on safety performance or material compliance with the original safety assurance system approval, including over-the-air software updates of the vehicle, are anticipated to require approval by the safety assurance system before that significant modification is introduced into the market.

To meet the design features, the safety assurance system should be based around an initial and continuing safety assurance process of:

- initial safety assurance – which involves the ADSE demonstrating compliance against a set of safety criteria for an ADS type on a case-by-case basis (first supply)
- continuing safety assurance – which involves the ADSE ensuring that the ADS continues to comply with the safety requirements (in-service).

The safety assurance system is intended to apply only to ADSs that are responsible for the dynamic driving task and any significant modifications to ADSs.

The design of the safety assurance system ensures that it does not capture driver assistance technologies such as automated electronic braking and lane-keeping technologies that are already available on the market.

1.2.5.1 Safety Assurance for Automated Driving Systems: Consultation RIS

In May 2018 we published the *Safety Assurance for Automated Driving Systems: Consultation RIS*. It assessed the costs and benefits of four options to implement the safety assurance system agreed in principle by ministers and was released for consultation to gather evidence and facilitate engagement with the community.

We sought feedback on the:

- problem to be addressed
- feasibility of the policy options to mitigate the safety risks associated with deploying vehicles with ADSs
- impacts of policy options on industry, governments and the community
- approaches to measuring these impacts
- conclusions on the most cost-effective solution to the identified problem
- proposed safety criteria and obligations for ADSEs to self-certify against.

The options consulted on were:

- Option 1: Baseline approach – the baseline option, using existing legislation and regulatory instruments, with no explicit safety assurance of ADSs.
- Option 2: Safety assurance system in existing frameworks – a safety assurance system based on mandatory self-certification that relies on existing legislation and regulatory instruments.

- Option 3: New safety assurance system – a safety assurance system based on mandatory self-certification. This would include new or amended legislation to allow for the inclusion of targeted compliance and enforcement options.
- Option 4: New safety assurance system + primary safety duty – a safety assurance system that includes all the elements of option 3 plus a primary safety duty on ADSEs. This was our preferred option in the consultation RIS.

We received 62 submissions to the consultation RIS including submissions from road and transport agencies, manufacturers, automobile clubs, insurers and law firms.[6] The majority of submissions supported option 4, but there was a clear minority preference for a modified option 2 from manufacturers and the DIRDC. This is discussed further in Chapter 3. There was also broad support for the safety criteria and obligations proposed for ADSEs to self-certify against. These are discussed further in Chapter 4.

The safety assurance system is part of the broader national reform program for automated vehicles outlined above. Importantly, the safety assurance system is being developed in conjunction with the changing driving laws reform project that, among other things, will specify the situations in which an ADS may drive a vehicle in place of a human driver.[7] Driving laws will only be changed to allow this when the approach to safety is clear. This will provide certainty that allowing an ADS 'driver' will not result in unsafe vehicles operating on public roads.

1.2.6 International developments

International approaches to regulating the safety of automated vehicles are still in the early stages of development. Our discussion paper *Regulatory options to assure automated vehicle safety in Australia* outlined a range of international developments (National Transport Commission, 2017b, p. 40; National Transport Commission, 2017c, p. 8).

Australia has committed to harmonising its regulations in line with international standards. Regulations are determined internationally under the United Nations Economic Commission for Europe World Forum for Harmonization of Vehicle Regulations (WP.29). WP.29 is the forum dedicated to technical regulations applied to the broad automotive sector. An update to UN Regulation 79 (UN R79), which deals with the technical requirements for systems allowing the driver to undertake secondary activities (nominally Society of Automotive Engineers (SAE) level 3) is expected to be finalised in 2019 and available for adoption by countries in mid-2020. UN R79 will need to be further updated to accommodate automated vehicles above level 3. Timeframes for further development have not been agreed.

Although WP.29 is making progress on developing regulations there is currently no internationally agreed approach. Many national agencies are currently focused on supporting trials and developing technologies. After discussions with a broad range of national governments throughout 2017 and 2018, we have concluded:

- Most national governments agree each jurisdiction must resolve automated vehicle safety regulation at the domestic level. International standards are only expected to address the technical components to be incorporated into any domestic regulatory process.

[6] Publicly available submissions to the safety assurance system are available on the NTC website at https://www.ntc.gov.au/submissions/history/?rid=162799&pid=9404.

[7] Information on the 'Changing the driver laws to support automated vehicles' project is available on the NTC website at http://ntc.gov.au/current-projects/changing-driving-laws-to-support-automated-vehicles/.

- There is no emerging international consensus on how to assure the safety of automated vehicles or the role of government in assuring the safety of automated vehicles.

The Transport and Infrastructure Council have noted 'the importance of not getting ahead of international developments' (Transport and Infrastructure Council, 2018a, p. 3). Different jurisdictions are at different stages of developing safety assurance systems for automated vehicles. The mandatory self-certification approach agreed by Australian transport ministers in November 2017 appears to impose greater regulatory oversight than the approach currently adopted in the US at the federal level (which favours voluntary certification with minimal government oversight) but significantly less regulatory oversight than the direction that Germany, Japan, Korea and some US states are heading towards (who favour a pre-market approval approach). Other national governments – including France and the United Kingdom – are still formulating a policy position.

Critically, the design of the safety assurance system should enable industry to demonstrate safety by referencing approvals, tests or validation processes undertaken by other national governments if the standards and processes are commensurate with the safety expectations and requirements in Australia. In this regard, safety regulation in Australia can align with a diverse range of safety assurance processes in other countries wherever possible.

1.3 About this decision Regulation Impact Statement

A RIS is required for all government decisions that are likely to have a measurable impact on businesses, community organisations or individuals. A RIS involves analysing the potential impacts of new policy proposals and regulatory options required for implementation and ultimately presents an evidence base for decision making on regulatory options.

The Office of Best Practice Regulation advised us that a Council of Australian Governments RIS would need to be completed prior to the Transport and Infrastructure Council deciding the appropriate form of safety assurance for ADSs.

We developed a consultation RIS to consult and engage with the community on the options available. The consultation RIS and the subsequent consultation and feedback we received forms the basis of this decision RIS.

This decision RIS uses a multi-criteria analysis approach because full monetisation of costs and benefits is not appropriate or possible in the case of emerging automated vehicle technology. Where available, quantitative data has been used. This multi-criteria analysis approach is consistent with the Office of Best Practice Regulation's cost-benefit analysis guidelines.

We have considered the views gathered from submissions and other consultation and incorporated these into our analysis to develop this decision RIS. The evidence contained in the decision RIS will assist the Transport and Infrastructure Council to determine the best approach for achieving better community outcomes as well as broader growth and productivity objectives.

1.3.1 Scope

The scope of the decision RIS is to assess regulatory reform options that address identified problems. The reform options present a range of plausible approaches for a safety assurance system based on mandatory self-certification, building on earlier work and public consultations on assuring automated vehicle safety. The decision RIS also recommends safety criteria and obligations for the Statement of Compliance.

The following areas are **outside the scope** of this decision RIS:

- an assessment of existing or new entities that could undertake any required government agency roles in a safety assurance system (this assessment will be dependent on the option chosen and is expected to take place as part of a next phase work looking at institutional arrangements)
- detailed compliance and enforcement options, including sanctions and penalties (the compliance and enforcement approach will be considered after a regulatory approach to safety assurance is agreed)
- a detailed analysis of how a safety assurance system would affect existing vehicle registration and driver licensing regimes (Austroads is examining this issue in parallel with our work)
- detailed project planning and implementation of a safety assurance system (this assessment is expected to take place after a regulatory approach to safety assurance is agreed)
- safety assurance of automated rail vehicles or non-standard road vehicles such as land-based drones.

1.3.2 Structure

The rest of this RIS will follow the below structure:

- a definition of the problem that the safety assurance system is intended to address and the case for government intervention (Chapter 2)
- a description of the options for assessment (Chapter 3)
- a description of the recommended principles-based safety criteria that would form part of the safety assurance system (Chapter 4)
- a description of the methodology used to assess the options (Chapter 5)
- an assessment of the options (Chapter 6)
- a summary of the assessment of the options, testing of the assessment under different deployment scenarios and assessment of relevant factors for government (Chapter 7)
- our recommended approach and next steps (Chapter 8).

1.4 Key terms and concepts

This section outlines the key terms and concepts used in this RIS. These are largely based on the SAE International Standard J3016.

Automated driving system (ADS) means the hardware and software that are collectively capable of performing the entire dynamic driving task on a sustained basis. It is a type of driving automation system used in vehicles operating with conditional (level 3), high (level 4) and full (level 5) automation mode**.**

Automated driving system entity (ADSE) means the legal entity responsible for the ADS. There will only be one ADSE for each ADS type going through a safety assurance system.

Automated vehicles are vehicles that include an ADS capable of performing the entire dynamic driving task including steering, acceleration, braking and monitoring the driving for sustained periods of time (a more expansive definition is provided in the glossary).

Dynamic driving task means all the operational and tactical functions required to operate a vehicle in a road or road-related area including amongst on-road traffic.

The **levels of driving automation**[8] range from 'no automation' (level 0) in which the entire dynamic driving task is performed by the human driver, through to 'full automation' (level 5) in which 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.

Levels 0–3 describe systems that cannot undertake the entire dynamic driving task and require a human driver to perform all or part of the dynamic driving task, although they may include a driving automation system that takes control of parts of the dynamic driving task.

This consultation RIS is concerned specifically with vehicles that have ADSs (levels 3–5). For simplicity, these types of vehicles will be referred to throughout this consultation RIS as 'automated vehicles' unless a more specific clarification is warranted. Table 2 outlines an adaption of levels 3–5 SAE levels of driving automation.

Table 2. Adapted SAE levels of automation: levels 3–5

Level 3: Conditional automation

The ADS undertakes the entire dynamic driving task for sustained periods in defined circumstances. The human driver does not have to monitor the driving environment or the ADS but must be receptive to ADS requests to intervene and any system failures.

Level 4: High automation

The ADS undertakes the entire dynamic driving task for sustained periods in some situations, or all the time in defined places. The human driver does not have to monitor the driving environment and the driving task or to intervene when the ADS is driving the vehicle.

Level 5: Full automation

All aspects of the dynamic driving task and monitoring of the driving environment are undertaken by the ADS. The ADS can operate on all roads at all times. No human driver is required.

Operational design domain (ODD) means 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.).

Safety assurance system is the mechanism through which the ADS is certified by the regulator as being safe to operate on the road network. It will consider criteria such as safe system design, human–machine interface, verifying for the Australian road environment and cybersecurity. Once approved (or licensed) to operate, the ADSE must continue to comply with those standards, including being responsive to certain in-service issues (such as changes to road rules).

The glossary explains other technical terms used.

[8] The levels of driving automation are based on SAE International Standard J3016, *Levels of Driving Automation*. SAE International, initially established as the Society of Automotive Engineers, is a US-based, globally active professional association and standards-developing organisation for engineering professionals in various industries. Principal emphasis is placed on transport industries such as automotive, aerospace and commercial vehicles.

2 Problem statement and need for government intervention

Key points

- There are risks that unsafe ADSs will be deployed.
- Current regulatory barriers are insufficient to manage these risks. Poor-quality systems could be introduced into the market resulting in avoidable crashes, without sufficient regulation.
- Lack of consumer confidence in the safety of automated vehicles may reduce or delay their uptake.
- Inconsistent and/or uncertain regulation could delay manufacturers or ADSE supplying ADSs to the Australian market.
- The presence of these market and regulatory failures, and the expectations of Australian communities and industry to address them, warrant government intervention.

This chapter outlines the problem this decision RIS seeks to address and demonstrates the need for government intervention to address it.

2.1 The problem

We have updated the problem statement below in response to stakeholder feedback on the consultation RIS.[9]

In our current regulatory environment, when automated vehicles become ready for commercial deployment there are risks that:

- **unsafe ADSs will be deployed**
- **a lack of consumer confidence in the safety of ADSs may reduce or delay their uptake**
- **ADSEs may face inconsistent and/or uncertain regulation both at a national and international level when supplying ADSs to the Australian market.**

These risks must be addressed to support the uptake and safe operation of automated vehicles on Australian roads and to unlock their broader benefits.

We consider each of the three parts of the problem in this chapter with an outline of the available evidence.

[9] The problem statement in the consultation RIS was: 'In our current regulatory environment, when automated vehicles become ready for deployment there are risks that: ADSs may fail to deliver reasonable safety outcomes; a lack of consumer confidence in the safety of ADSs may reduce or delay their uptake; and ADSEs may face inconsistent and/or uncertain regulation to supply ADSs to the Australian market.'

2.2 Stakeholder feedback on the problem

Stakeholders largely agreed with the three areas of risk contained in the original problem statement. A number of stakeholders considered the problem was accurately described and did not need further amendment at this point in time. Some stakeholders had differing opinions on the framing or ranking of the three risks. Stakeholders also suggested a number of additional risks.

As a general concern iTech Labs, an enforcement agency and some attendees at our information sessions noted insufficient evidence to justify expectations of automated vehicle safety. The Centre for Accident Research and Road Safety – Queensland (CARRS-Q) noted that ADSs will introduce new safety risks throughout their life cycle.

In the consultation RIS, the first part of the problem statement was 'ADSs may fail to deliver reasonable safety outcomes'. Nova Systems considered this should refer to 'necessary' or 'measurable' safety outcomes rather than 'reasonable' safety outcomes, which is a qualitative descriptor. They noted safety outcomes are measured in quantitative terms and targets. An insurer similarly noted that 'reasonable safety outcomes' required a definition in order to monitor and evaluate the success of the safety assurance system.

Austroads and an enforcement agency also noted that the scope of 'safety' is not defined and that it might mean different things to different ADSEs. Stakeholders also sought clarity about the meaning of 'reasonable safety outcomes' at the information sessions. The Western Australian Government noted that the safety parameters that this encompassed was not specified.

The Victorian Government considered the problem statement should focus on creating a safer road system.

Austroads, the Heavy Vehicle Industry Australia (HVIA), the Truck Industry Council (TIC), the Federal Chamber of Automotive Industries (FCAI) and an enforcement agency had concerns about the safety of aftermarket fitment of ADS to non-automated vehicles.

Nova Systems noted the potential for unsafe ADSs to be approved if the body administering the safety assurance system is not adequately skilled or the technology not independently certified. They also noted that certifications of safety from other countries might not be suitable for the Australian ODD or might not be provided by a competent agency.

A number of stakeholders also considered inadequate infrastructure a key problem, as well as the capability of relevant stakeholders (for example, local councils) to upgrade infrastructure. The Motorcycle Council of NSW, CARRS-Q and Prof. Brian Fildes also noted the importance of the safe systems approach adopted in Australia.

The Western Australian Government noted that the second part of the problem statement should refer to 'community confidence' rather than 'consumer' confidence because the whole community will be exposed to risks from ADSs.

CARRS-Q noted that the costs of deploying ADS technology could be a barrier to their equitable uptake, particularly by those most needing of the technology.

The FCAI considered the main impediment to introducing ADSs is an inconsistent or uncertain regulatory environment in Australia. Toyota noted that a nationally consistent approach was preferable to two layers of potentially inconsistent regulation at the state/territory and federal levels.

The Australian Automobile Association (AAA), FCAI, HVIA, Toyota, Transurban and the Western Australian Government also noted the risk of international inconsistency. The AAA considered that regulation that was not internationally consistent could act as an economic

disincentive to potential ADSEs to bring their technology to Australia, and therefore Australia will miss out on its benefits. The FCAI noted harmonisation with UN standards would result in adopting ADSs at the lowest cost.

An enforcement agency considered that ADSs with different levels of automation (levels 3–5) would need different regulatory frameworks. The HVIA noted that a different regulatory approach may be required for experimental or low-volume ADSs compared with ADSs being commercially deployed.

HVIA noted that it is unlikely that heavy and combination vehicles with ADSs would be available by 2020 due to the complexity of their operation and the public's concerns about their safety. FCAI also noted that commercial deployment of automated vehicles is unlikely to occur by 2020.

2.3 NTC response

In our previous consultations on safety assurance, feedback has been clear that the level of safety expected of automated vehicles by the public is higher than that for traditional vehicles. This is implicit in our work program on automated vehicles and the reason for wanting to encourage their uptake.

As automated vehicle technology is only emerging, we do note the limitations of the evidence base to quantify safety. We reference available research in the previous chapter that does suggest a range of benefits, and in particular, safety benefits. But key to developing appropriate safety assurance processes is acknowledging that automated vehicle technology could introduce new risks. A robust safety assurance system is intended to mitigate these risks. Regarding CARRS-Q's specific point about safety over the life of an ADS, we address this issue further in Chapter 4.

We have decided to address comments on safety by amending the first part of the problem statement to 'unsafe ADSs may be deployed'. This does not address Nova Systems' and an insurer's comments that the safety outcomes should be quantifiable; instead it focuses on the need for ADSs themselves being safe systems. We consider it difficult at this time to provide a standard for measurement and note that though we should expect of ADSs that they provide significantly safer outcomes than human-driven vehicles, incremental improvements should also not be discouraged. We also agree with the objective of creating a safer road system as suggested by the Victorian Government but have tried to focus the full problem statement more specifically on the direct issues a safety assurance system will address. Ultimately, a safety assurance system that addresses the problems set out is expected to contribute to the objective of a safer road system, in conjunction with the suite of other reforms being developed by agencies to prepare for automated vehicles.

We are not recommending a different regulatory framework for ADSs with different levels of automation. We consider that a regulatory framework based on self-certification (as is being considered under all reform options) will be sufficiently flexible to appropriately manage different mixes of technology as well as different business models. Compliance and enforcement tools will also be considered in the next phase of work on safety assurance. We also note with regard to HVIA's comment on low-volume ADSs that the reforms recommended in this phase of work relate specifically to commercial deployment. We released the *Guidelines for trials of automated vehicles in Australia* in May 2017 to provide guidance to applicants seeking to trial automated vehicles in the interim period. We plan to review these guidelines in 2019.

We note concerns about aftermarket fitment of ADS; however, we consider safety risks will be managed under a safety assurance system. Under the self-certification approach in our

reform options, we note that any aftermarket device will need to go through the safety assurance process. To be approved for use, the body administering the safety assurance system will need to be satisfied that the aftermarket ADS will be able to operate safely.

Regarding Nova Systems' concerns about the capability of the body administering the safety assurance system, and the adequacy of approvals in other countries, we note that these issues will be considered in a later phase of work on the institutional arrangements that will govern the safety assurance system. This phase is described further in Chapter 3.

We also agree that a safe systems approach is appropriate, and though not specifically referenced, this approach is reflected in our recommendations and analysis. For example, our multi-criteria assessment considers the range of relevant parties in the road transport system and the safety criteria that an ADSE must self-certify against to ensure ADSs can appropriately interact with all road users and infrastructure. As well, the broader work program to prepare for the commercial deployment of automated vehicles being done by the NTC, DIRDC, Austroads and states and territories covers projects across all vehicle functions as well as infrastructure.

We have not updated the second part of the problem statement to refer to 'community' confidence because this part of the problem statement is meant to particularly relate to the purchasing decisions of consumers. We consider the risks that the whole community is exposed to are addressed in the first part of the problem statement about unsafe ADSs generally.

We have also decided not to update the problem statement to reflect CARRS-Q's concerns about the high cost of ADSs being a barrier to the equitable uptake of ADSs. However, we note that costs to industry of a new safety assurance system are considered in our assessment of options in the RIS, as we acknowledge that higher costs may be passed on to consumers.

We have added international inconsistency to the third part of the problem statement. We take note of concerns that industry may consider this a barrier to entry and also note a direction from transport ministers in May 2018 that automated vehicle reform in Australia should not get ahead of international developments. We also note that international harmonisation is part of three of the assessment criteria we are using in our multi-criteria analysis of the options for safety assurance.[10]

Ministers have agreed a goal of an end-to-end regulatory framework by 2020. This was based on advice from manufacturers that this is when their technology will most likely become available for initial commercial deployment. We recognise that initial deployment will be limited in scope. We have further engaged with industry at an international level in 2018 and confirm that this timeframe remains relevant; however, we continue to review this.

We acknowledge that appropriate infrastructure is a key factor in ensuring automated vehicles operate safely on Australian roads. However, we consider a safety assurance system for ADSs is not the appropriate mechanism to manage infrastructure provision. Austroads are considering infrastructure design changes for connected and automated vehicles as part of a separate program of work. We will remain involved in Austroads' work as this progress.

[10] Uptake of automated vehicles, criterion (b) 'Provides clear and consistent regulatory expectations to facilitate market entry, including national consistency and alignment with international requirements;' Regulatory costs to industry, criterion (c) 'Supports an approach that is consistent across all jurisdictions and is aligned with international requirements;' and Flexibility and responsiveness, criterion (b) 'Allows for transition as international approaches evolve.'

2.4 ADSs may fail to deliver improved road safety outcomes

Automated vehicles are widely expected to improve road safety in the future by reducing human error. However, the safety benefits, or risks, of deploying ADSs are highly uncertain. There are also new risks associated with introducing automated vehicles. Appendix C provides an overview of the three types of safety risks that may arise with the introduction of automated vehicles. These risks include the aftermarket devices that could be used to add automation to existing vehicles.

ADSEs have a commercial incentive to ensure ADSs operate safely. However, there is a risk of a gap between what an ADSE believes is necessary to achieve this (in terms of automation or vehicle design) and what is socially optimal (in terms of reducing crash risk). This could eventuate for the following reasons:

- ADSEs, automated vehicle owners and other relevant aftermarket agents are unlikely to bear the full economic cost of a crash caused by an unsafe automated vehicle. Broader unaccounted for social costs (or externalities) include the cost of traffic congestion (loss of productivity for those caught in a crash), other road users' pain and suffering, emergency responder and clean-up costs, medical treatment costs, lost workforce participation and road asset damage.
- ADSEs, automated vehicles owners and other relevant agents (for example, insurers) may lack the necessary skills and judgement to assess what is safe in Australian-specific road contexts, particularly initially.

Without specific safety regulation and effective deterrent mechanisms (such as insurance premiums and legal liability), there is a risk of market failure to deliver a socially desirable level of safety risk management.

2.4.1 Existing mechanisms to manage safety risks are not fit for purpose

Vehicle safety is currently managed via a range of regulatory tools including the ADRs and driver licensing. These are outlined in Appendix FG.

Automated vehicles do not fit within the current regulatory framework, which assumes a human driver. The ADRs do not yet capture automated functionality. The ADS will drive the vehicle in place of a human driver. For human drivers, driver licensing is a way of ensuring vehicles are driven safely. There is no existing equivalent regulatory mechanism to ensure the ongoing safe performance of an ADS 'driver'.

As well, there are limits on the degree to which existing mechanisms that apply after any event will result in ADSEs and other relevant parties internalising all social costs.[11] For example, it may be difficult to attribute blame for a crash, or an ADSE may perceive penalties to be avoidable such that legal liability may not incentivise appropriate levels of risk management.

[11] Current regulations are supported by product safety laws, legal liability and vehicle supplier self-regulation in a mature market where consumers can make their expectations clear through informed purchasing choices. For traditional vehicle manufacturers, any indication of a poor safety record has the prospect of significant reputational risk to their brands, which may act as a deterrent to risky behaviour. However, it is unclear how effective this reputational risk will be for new or small providers.

2.4.2 Evidence of automated vehicle safety risks that may not be addressed under the existing framework

Many potential automated vehicle safety risks would not be managed effectively under the existing framework.

In automated vehicle trials and in early commercial deployments of vehicles with partial automation, there have been some crashes, including a small number of fatalities.

While most of these crashes have been attributed to 'the other driver' or a third party rather than the ADS, they highlight that there are safety risks. This is particularly true in the early commercial deployment stage as automated vehicles mix with the conventional human-driven vehicle fleet and other road users.

Two high-profile cases of automated vehicle crashes are set out below. These examples demonstrate the safety risks and the need to ensure that an ADS has adequate safeguards. Other manufacturers conducting automated vehicle trials have also had safety incidents. We have selected these examples because they received significant international attention.

Tesla Model S crash – 7 May 2016

The first fatal crash involving a vehicle operating at partial automation occurred in the US state of Florida.[12] The occupant of a Tesla Model S car was killed in a crash with a truck while the car was operating in 'autopilot mode'[13] (Yadron & Tynan, 2016).

The crash occurred when the truck turned in front of the Tesla at an intersection and the car failed to apply the brakes. An investigation by the National Transportation Safety Bureau (NTSB) found that the 'truck driver's failure to yield the right of way and a car driver's inattention due to overreliance on vehicle automation are the probable cause of the fatal … crash' (National Transportation Safety Board, 2017). The NTSB also found that the 'automated vehicle control system was not designed to, and did not, identify the truck crossing the car's path or recognize the impending crash'. The NTSB concluded that:

> *System safeguards, that should have prevented the Tesla's driver from using the car's automation system on certain roadways, were lacking and the combined effects of human error and the lack of sufficient system safeguards resulted in a fatal collision that should not have happened. (National Transportation Safety Board, 2017)*

Uber Technologies Inc. crash – 18 March 2018

A second fatal crash occurred when a Volvo XC90, being operated by Uber, struck a pedestrian wheeling her bicycle across a road in Tempe, Arizona (Yadron & Tynan, 2016). The vehicle was a test vehicle being operated in 'computer control mode', with a human driver at the wheel, at the time of the accident.

According to Uber, the developmental self-driving system relied on an attentive operator to intervene if the system failed to perform appropriately during testing. In addition, the operator was responsible for monitoring diagnostic messages that appear on an interface

[13] Autopilot mode is a driver-assist feature that requires the driver to keep their hands on the steering wheel at all times. It should be noted that the driver in the May 2016 Tesla crash did not have their hands on the wheel before the crash.

in the vehicle and tagging events of interest for subsequent review (National Transportation Safety Board, 2018).

The NTSB's preliminary report stated that the self-driving system first registered radar and LIDAR observations of the pedestrian six seconds before impact. As the vehicle and pedestrian paths converged, the software classified the pedestrian first as an unknown object, then a vehicle, then a bicycle with varying expectations of future travel path.

At 1.3 seconds before impact, the self-driving system determined that an emergency braking manoeuvre was needed to mitigate a collision. According to Uber, emergency braking manoeuvres are not enabled when the vehicle is under computer control to reduce potential for erratic vehicle behaviour – instead the vehicle operator is expected to intervene and take action. The system was not designed to alert the operator.

The self-driving system data showed that the vehicle operator intervened less than a second before impact by engaging the steering wheel, and began braking less than a second after the impact. All aspects of the self-driving system were operating normally at the time of the crash, and there were no faults or diagnostic messages (National Transportation Safety Board, 2018).

2.5 Lack of consumer confidence in ADS safety may reduce or delay their uptake

Consumers can play a role in creating a safer vehicle fleet through their purchasing decisions. However, there is a risk that automated vehicle markets may not operate efficiently if consumers cannot adequately make a judgement about the quality or safety risks of the ADS.

Consumers are likely to look for a trusted independent third party to provide a level of assurance that the systems are safe. Consumers may also assume that an ADS that is available for purchase has passed some kind of safety assessment.

If buyers cannot distinguish between safe and unsafe automated vehicles this could distort market outcomes. In particular, there is a risk it could reduce sales of relatively safer automated vehicles, which may be more expensive. This risk is more likely to be an issue in the short term before ADSEs can show evidence of their safety record, or in some way signal the safety of their products to consumers.

A lack of consumer confidence due to a real or perceived safety risk could undermine the uptake of safe ADSs. This could cause a delay in realising their anticipated benefits. Such a delay could also have flow-on effects to other policy objectives that result in lost opportunities for the Australian economy.

2.5.1 Evidence that a lack of consumer confidence in ADS safety may reduce or delay their uptake

The Australasian New Car Assessment Program (ANCAP) is the leading, independent vehicle safety authority in Australia and New Zealand. Its role is to build consumer confidence through research, testing and promotion of technology. ANCAP told us that 'consumer expectations and understanding are factors that can influence … the uptake of autonomous driving technology' (ANCAP, 2017, p. 4).

There is research indicating that individuals are 'concerned' about using automated vehicles and, in particular, about the safety consequences of equipment or system failure (Schoettle & Sivak, 2014, p. 11–14). In a survey of 505 Australians, the authors found that more than

half of respondents were 'very concerned' (27.9 per cent) or 'moderately concerned' (29.5 per cent) about driving or riding in a vehicle with high automation. More than three-quarters of respondents were 'very concerned' or 'moderately concerned' about the safety consequences of equipment or system failure. Additionally, over 70 per cent were 'very concerned' or 'moderately concerned' about 'legal liability for drivers/owners' and 'self-driving vehicles getting confused by unexpected situations'.

A recent study of more than 1,000 people by car insurer Budget Direct also found that 57 per cent of respondents thought that automated vehicles were dangerous, and only 47 per cent said they would ride in one (Budget Direct Motor Insurance, 2018).

Evidence from the aviation industry shows that public attitudes towards safety are likely to be influenced by the perceived effectiveness of the regulatory regime. A survey of 1,019 people by the Civil Aviation Safety Authority (CASA) found that the public 'generally believe Australia has a good safety record and attribute the low number of aircraft incidents to CASA's efforts and believe there are good regulations in place' (Civil Aviation Safety Authority, 2014, p. 4). Around 80 per cent considered that commercial flights were as safe or safer than five years earlier, and the most common reasons cited for improved safety were more advanced technology, improved airport security/screening and new safety rules.

These surveys suggest that regulation can play a role in influencing the community's perceptions of safety, and therefore potentially affect the community's use of that mode of transport or product/technology.

Market demand is therefore likely to be influenced by how much potential users of automated vehicles are reassured by the presence of a regulatory system.[14]

2.6 ADSEs may face inconsistent and/or uncertain regulation to supply ADSs in the Australian market

Industry, insurers and consumers could face uncertainty if the role of government in assuring the safety of automated vehicles has not been decided by the time these vehicles are commercialised. The realisation of potential benefits could be limited if the supply and uptake of automated vehicles is delayed.

Industry may face unnecessary regulatory costs, and consumers may be prevented from realising the full benefits of automated vehicles if there is no national approach to automated vehicle safety.

There are risks that:

1. regulatory expectations will be uncertain
2. states and territories will adopt their own regulations to manage risks leading to inconsistent regulation of automated vehicles.

1. The requirements for automated vehicle suppliers could still be unclear or uncertain. This uncertainty could result in unnecessary administrative and delay costs. This may be a significant barrier to supply, ultimately denying consumers access to the product.

[14] Uptake may also be limited by other factors such as a lack of awareness about ADS technology. A survey by EastLink of more than 15,000 Victorian motorists showed that the majority of survey respondents had very little or no knowledge about automated vehicles (EastLink, 2017).

Uncertain regulatory expectations in terms of who is being regulated, what they are required to do, and what sanctions and penalties they may be exposed to can impose a burden on regulated entities.

If new automated vehicles are certified for sale as nonstandard vehicles, as required under the existing regulatory approach, prospective owners face additional uncertain registration requirements (see the description of the registration process in section 0 for further detail). This uncertainty could result in unnecessary administrative burden and delay costs for consumers that may affect demand for automated vehicles.

2. Inconsistent regulation will lead to unnecessary costs for ADSEs and potentially for government. The market for automated vehicles will be a national market, and inconsistency between state and territory regulatory arrangements may impose additional and unnecessary costs on ADSEs. These costs could include costs of proving compliance with different technical standards, testing procedures and roadworthiness requirements. Furthermore, unnecessary regulatory costs pose an economic disincentive for the technology and automotive industries to invest in Australia.

Inconsistent regulation could also constrain cross-border activity and potentially obstruct safety innovation.

Inconsistent regulation may also cause unnecessary costs to government through duplication. State- or territory-based road managers may apply different technical standards, testing procedures and roadworthiness requirements.

2.6.1 Evidence of inconsistent and/or uncertain regulation to supply ADSs

In the absence of new automated vehicle-specific regulation, ADSEs face uncertainty over the safety requirements they must meet at the certification stage, as well as uncertainty of their obligations on an ongoing basis while ADSs are in-service.

National consistency was a key objective across many of the submissions to our 2017 discussion paper *Regulatory options to assure automated vehicle safety in Australia*. The Australia & New Zealand Driverless Vehicle Initiative (ADVI) submission provided a concise summary of why national consistency matters:

> *It is important that Australia is an early adopter of AV technology and proactively [implements] and pursues opportunities. This requires a single approval process in place of the current fragmented approach currently provided through the involvement of nine (9) governments. Australia comprises about 1.5% of global vehicle sales and cannot afford this level of complexity if it is to realise the significant benefits that may be achieved. (ADVI submission, p. 7)*

Governments have an incentive to be seen as leaders in facilitating new technologies and industries that will provide jobs and export revenues. Every state and territory in Australia is currently involved in trials of connected and automated vehicles (Austroads, 2017a). Three states have introduced new or amended laws to support these trials. While these trials have been limited in their scope to operations not crossing state or territory borders, it does demonstrate that different approaches are already evolving. There is some risk that these could manifest into inconsistent state- or territory-based regulations if an agreed national approach were not to proceed.

2.7 Need for government intervention

The problem statement outlines both market and regulatory failures that are not adequately addressed by Australia's current regulatory framework, suggesting that government intervention is warranted.

Governments have an existing role regulating vehicle and road safety and therefore there is a public expectation that governments will provide safety assurance in an environment of uncertain outcomes. Governments would be justified in taking a proactive role to provide oversight of automated vehicle safety because the technology is new and the safety performance of these vehicles is uncertain, and it may be difficult for consumers to assess the safety of these products.

Existing safeguards to manage the safety of vehicles with automated functions, including consumer guarantees and vehicle recall powers under the Australian Consumer Law, may not capture all of the new safety risks relating to the ADS. Risks relating to the operational design domain, legal accountability, cybersecurity and human performance requirements, among others, would remain unregulated.

Industry, insurers and consumers could face uncertainty if the role of government in assessing the safety of vehicles with automated functions has not been decided by the time automated vehicles are commercialised.

Submissions to our discussion paper on *Regulatory options to assure automated vehicle safety in Australia* clearly confirm that the community expects governments to have a role in ensuring automated vehicles are safe (National Transport Commission, 2017c, p. 12).[15]

Consultation in 2017 also revealed a general acceptance for industry to manage safety risks and to self-regulate at this early stage with a system of government oversight consistent with the safety assurance design features (see section 1.2.5). Without a regulatory response, governments will not have a mechanism to assure themselves that automated vehicles are safe.

2.8 Stakeholder feedback

We asked stakeholders whether we had provided sufficient evidence to support the case for government intervention in the consultation RIS, and if we should consider anything else. We also asked if we had accurately covered community and industry expectations of a regulatory response.

The majority of stakeholders responding to the question about government intervention considered the case had been made. These stakeholders included state and local governments, enforcement agencies, consultants, lawyers and researchers. One road transport agency considered an unregulated environment unacceptable, as any potential failures early on would be detrimental to achieving the overall potential benefits.

Some stakeholders from industry, including the FCAI, HVIA and TIC, considered the case had not been made for government intervention because there was not enough evidence that the current system would not deliver safe outcomes.

[15] Publicly available submissions to the safety assurance system are available on our website at: https://www.ntc.gov.au/current-projects/safety-assurance-system-for-automated-vehicles/.

Roads Australia considered the case for intervention was made, but only up to option 3. A vehicle manufacturer considered the case for intervention was made only if intervention came in the form of the current regime.

Nova Systems considered the case for intervention could be bolstered by referring to other sectors such as the rail, aviation and heavy vehicle sectors.

Views about whether community and industry expectations had been accurately covered in the consultation RIS were also mixed. Stakeholders that considered expectations had been covered well included state and local governments, consultants, lawyers, industry bodies and enforcement agencies. Nova Systems and an enforcement agency noted that community and industry expectations had also been covered in previous NTC consultations on safety assurance.

The FCAI and TIC stated that industry expectations had not been accurately covered because the consultation RIS did not accurately reflect existing relevant regulation.

CARRS-Q considered the expectations of the research community were not well covered regarding access to data.

The Municipal Association of Victoria and iTech Labs considered that the community would expect safety assurance based on independent testing of ADSs, rather than self-certification. The Motorcycle Council of NSW considered the community will only be confident in the safety of ADSs if Statements of Compliance (as discussed in the next chapter) were made public.

The Queensland Government and an enforcement agency also suggested the need to further engage the community and industry to judge their expectations and gain further input, and the Western Australian Government noted the need to consult in an accessible way on the final scope of safety regulation. The Western Australian Government also noted that a gap may emerge in terms of community and industry expectations of ADS design and the acceptable level of safety.

2.9 NTC response

We consider the strong support for government intervention justifies amending the regulatory framework to assure the safety of ADSs. This support also reflects consultation on the case for government intervention in 2017. The appropriate form for that intervention is discussed later in this decision RIS, as part of multi-criteria analysis of options.

We noted that other transport sectors such as rail and aviation have moved to a safety assurance approach that is flexible and less prescriptive than the approach taken in road transport. These systems are more flexible in terms of the types of technology and means of testing that applicants must demonstrate and, as such, have allowed for the introduction of automated functions more easily than in the road transport sector.

We consulted on the broad safety assurance approach in 2017, as described in the previous chapter. Pre-market approval was one of the options consulted on, but stakeholder feedback showed a clear preference for self-certification, and ministers agreed to this approach in November 2017. We will consider whether Statements of Compliance should be made public in the next phase of work.

We note FCAI and TIC's concerns about the description of existing regulation in the consultation RIS. We discuss changes we have made to the RIS in terms of the proposed Road Vehicle Standards Act and a proposed Australian Design Rule 90/01 in Chapter 3. We also have updated information in Chapters 1 and 3 and Appendix G about existing consumer law obligations.

We also discuss CARRS-Q's and others' concerns about data use in Chapter 4 under our consideration of the data recording and sharing safety criteria.

Finally, we agree that it is important to engage the community and industry as this work progresses. Further consultation will be held across the range of reforms in our work program as we continue to develop the end-to-end regulatory framework for automated vehicles. We will endeavour to consult inclusively and in clear and accessible formats. A description of the consultation undertaken on the consultation RIS is included at Appendix A. This included formal consultation channels such as information sessions and a written submissions period but also included engagement through videos on social media to foster wider participation from the community.

3 Options to address the problem

Key points

- This decision RIS presents four options to address the problem.
- Option 1 is the baseline option. It does not introduce a safety assurance system. It uses existing regulatory processes to manage the safety of automated vehicles. This option has been updated to reflect stakeholder feedback on the consultation RIS.
- Options 2, 3 and 4 introduce a system to ensure automated vehicles are safe and require an ADSE to manage safety risks by self-certifying against principles-based safety criteria. We call this a 'safety assurance system'.
- Option 2 introduces a safety assurance system under the existing regulatory framework. It requires an ADSE to self-certify against principles-based safety criteria. This option has been updated to reflect stakeholder feedback on the consultation RIS.
- Option 3 introduces a safety assurance system that is nationally administered both at first supply and in-service, with specific offences and compliance and enforcement options against noncompliant ADSEs.
- Option 4 includes all the elements of option 3 as well as a general duty on ADSEs to ensure safety ('primary safety duty').

This chapter sets out the key features of the options under consideration in this RIS and how they would work in practice, along with feedback from submissions.

3.1 Introduction

In November 2017 the Transport and Infrastructure Council agreed to the development of a national safety assurance system for automated vehicles based on mandatory self-certification. The council agreed design features of the safety assurance system after we undertook public consultation, but this agreement was subject to completing a RIS.

This RIS considers four main options. Option 1 is the baseline against which we assess the other three options. Option 1 does not provide for a safety assurance system. In contrast, options 2, 3 and 4 all provide for a safety assurance system with differing levels of regulatory oversight.

The safety assurance system applies both at 'first supply' of an ADS and while it is on the roads ('in-service'). The ADSE will be responsible for initial and ongoing adherence to their Statement of Compliance. The enforceability of this adherence varies among the options.

The mandatory self-certification approach makes the ADSE, rather than government, responsible for testing and validating the safety of the ADS. The ADSE must complete a Statement of Compliance explaining how it will address principles-based safety criteria. The role of government is to set the safety criteria, assess the Statement of Compliance and satisfy itself that applicants have adequate processes in place to manage safety risks.

3.2 Stakeholder feedback

Stakeholders were asked whether the four options presented in the consultation RIS were clearly described.

Austroads, Brisbane City Council, Geoffrey Taylor, Maurice Blackburn Lawyers, the Queensland and Western Australian governments, three enforcement agencies, Roads Australia and Transport Certification Australia all considered the options were clearly described.

A number of stakeholders requested further clarity on features of the options, and iTech Labs considered the differences between the options could be better described. RAC WA considered the responsibilities for industry under each option were not comprehensively covered.

Calibre noted that option 1 would be the most unsafe option and considered the descriptions of options 2 and 3 required more data in order to draw any conclusions.

Toyota noted that framing option 2 as an 'Administrative safety assurance system' (the title given to option 2 in the consultation RIS) was misleading given it would be supported and enforceable under the existing regulatory framework.

The Australian Road Research Board (ARRB) noted that to prepare for technology that delivers increased mobility outcomes, the safety assurance approach chosen needs to embrace regulatory responses within relevant operational frameworks (for example, urban, regional and remote) and business models for such mobility services.

A vehicle manufacturer noted that it was unclear to what extent states and territories would maintain control over laws under each of the options and cited the importance of national consistency aligned with international best practice.

There were a number of stakeholders who sought further detail about the primary safety duty in option 4. The AAA, DIRDC and the FCAI wanted further information about how a primary safety duty would differ from existing regulatory frameworks such as product safety laws and recall powers under Australian Consumer Law. DIRDC also sought information about why a general duty as found in work health and safety regulation would be a 'good fit' for regulating ADSs. CARRS-Q and DIRDC requested further clarification about how the primary safety duty would be 'triggered' when a near-miss or other unsafe behaviour occurs, and CARRS-Q and the Queensland Government were also unsure how national bodies would be notified of these events. The AAA also sought clarification about whether a primary safety duty is being considered in other countries.

ADVI, the Motor Trades Association Queensland, PricewaterhouseCoopers, a number of road transport agencies and an industry association recommended that the primary safety duty be extended to parties other than the ADSE.

A government agency and Austroads noted that aftermarket fitment of ADSs should not be allowed. Austroads noted that aftermarket ADSs should have to go through the safety assurance system.

A number of stakeholders, including those from the vehicle manufacturing industry, considered that creating a new agency to administer a safety assurance system was an unjustified cost to both government and industry. This view was largely given in light of a preference for a modified option 2, on the assumption that options 3 and 4 would require a new agency. One government agency noted the cost of new national bodies generally and suggested that we explore the extent to which safety assurance functions could be performed by an existing entity. This issue is discussed in a new section on institutional arrangements later in this chapter.

The FCAI noted that the compliance and enforcement shortcomings in the current system could be addressed without creating a new agency. Both the FCAI and DIRDC also noted

the increased compliance and enforcement tools that will be available should the Road Vehicle Standards Bill be passed.

Other options

The FCAI, TIC and AAA and a number of vehicle manufacturers considered option 2 (and option 1) was not described correctly and put forward a modified option 2 based on advice received separately from DIRDC about the regulatory framework. DIRDC also proposed this modified option in its submission. This option would share attributes of both the consultation options 2 and 3. This modified option 2 is discussed later in this chapter, and the option is further assessed in the multi-criteria analysis in Chapter 6.

Both DIRDC and BMW recommended option 2 as an initial approach, with BMW recommending harmonisation with UN regulations in the long term and DIRDC suggesting a long-term approach consistent with option 3 or 4, developed in parallel to implementing a modified option 2.

Transurban considered leaving the primary safety duty as a final overlay was a missed opportunity because it could instead be used earlier in the evolution of a regulatory framework if an iterative or phased approach was taken. Transurban considered using the primary safety duty alongside option 2 would provide 'a superior near-term option, with the flexibility to respond to changes in technology and process as they emerge'.

3.3 NTC response

To address requests for further clarity about differences between the options and the responsibilities of industry, we have added a diagram showing how an ADSE would go through a safety assurance system under each option.

Regarding Toyota's comments about the title for option 2, we agree that the term 'administrative' does not accurately reflect the features of the option; this is even more so given the changes to option 2 described further in the chapter. We have therefore changed the title of option 2 to 'Safety assurance system in existing frameworks'. We have also changed the titles of options 3 and 4 to differentiate them more clearly from option 2.

A safety assurance approach based on self-certification will encompass outcomes-based safety criteria, as discussed in the previous chapter, and should therefore be able to accommodate different operational frameworks and business models, as noted by ARRB.

We have provided further information about the primary safety duty and its crossovers with other regulatory frameworks in the description of option 4.

We note that safety duties are a feature of not just the work health and safety sector but safety regimes across all transport modes in Australia. As well as safety duties in the rail, aviation and maritime sectors, there are also instances of safety duties within the road transport sector. For example, safety duties are placed on parties within the heavy vehicle chain of responsibility, and in New South Wales, on parties involved in the provision of point-to-point transport. Uber Advanced Technologies Group confirmed in its submission that they are subject to duties as a ridesharing operator in Australia. A 'general safety provision' for product safety under the Australian Consumer Law was also a proposal in a review of the law by Consumer Affairs Australia and New Zealand last year.[16]

[16] Consumer Affairs Australia and New Zealand, *Australia Consumer Law Review Final Report,* 2017 https://cdn.tspace.gov.au/uploads/sites/86/2017/04/ACL_Review_Final_Report.pdf.

In regard to the 'triggering' of the primary safety duty we have recommended removing references to 'near-misses' from the safety criteria because it is a subjective metric and potentially unclear. This is discussed in the next chapter on safety criteria (Chapter 4). We propose to cover notifications to regulatory bodies in subsequent work.

A primary safety duty has not been introduced in any other country, and at this stage we are not aware of other countries that are considering it. However, it is worth noting that regulatory frameworks for the safety assurance of automated vehicles are in the early stages of development in most countries, and there is no clear consensus approach.

In consultation with Commonwealth, state and territory governments, we have considered again whether other parties should be covered by the primary safety duty. We have recommended the description of option 4 as per the consultation RIS, meaning that the primary safety duty applies only to ADSEs. However, we also recommend further consideration of duties on ADSEs and other parties in a subsequent phase of work on in-service safety, as described in Chapter 8.

The consultation RIS makes clear that all ADSs must go through the safety assurance system, not just those fitted to a vehicle at first supply. Therefore, ADSs that are fitted to a vehicle 'aftermarket' must go through the safety assurance system. The consultation RIS also noted that this applied to significant modifications to an already approved ADS. We have clarified this in the decision RIS.

Regarding Transurban's view that the primary safety duty could be overlaid on option 2, we note the merits of this approach. The combination of existing regulatory frameworks and in-service duties will be considered further in the discussion of our recommended approach in Chapter 8.

3.3.1 Significant changes in the decision RIS

3.3.1.1 Road Vehicle Standards Bill

The *Motor Vehicle Standards Act 1989* (MVSA) forms an important part of the existing regulatory framework. It requires all vehicles to comply with the ADRs when first supplied to the Australian market. The options in the consultation RIS are formed in light of the MVSA.

As noted in the consultation RIS and by a number of stakeholders, the MVSA is expected to be repealed and replaced by a new Road Vehicle Standards Act (RVSA), which at the time of writing was in Bill form before parliament. Since release of the consultation RIS, there have been two key developments. First, the Road Vehicle Standards Bill has progressed through the Australian House of Representatives and as at June 2018 had been moved for second reading before the Senate. As a result, the passage of the Bill is now more certain than previously, although the legislative process is not complete. Second, our understanding of the relevant amendments in the Bill has progressed since the consultation RIS. DIRDC has advised that the Bill will provide a greater range of compliance and enforcement tools to enforce vehicle certifications they approve. These include the issue of infringement notices, enforceable undertakings, civil penalty orders and the ability issue recalls for road vehicles and components. This would affect the operation of the options, and our assessment of them would therefore change.

We therefore consider it appropriate to update the options to reflect how they would operate under the RVSA. The descriptions of the options have changed where relevant in this chapter and our multi-criteria analysis updated accordingly in Chapters 6 and 7.

We have updated the decision RIS to reflect our best assessment of what the regulatory framework will be when automated vehicles are expected to become available for

commercial deployment. We note that should the Bill not pass, the options we describe will operate differently with respect to compliance and enforcement, and the outcomes of our multi-criteria analysis will be different in that respect.

3.3.1.2 Australian Design Rules – ADR 90/01

At the time of the consultation RIS, DIRDC advised that ADR 90/01 could parallel existing road rule limitations on the use of an ADS. In this respect, the ADR would (at least to begin with) prevent vehicles fitted with an ADS from being supplied to the market as a standard vehicle (for vehicles that would otherwise meet the full requirements of the ADRs). This would be in line with the current state of international regulations, in particular UN R79, which do not yet allow for the mainstream approval of an ADS.

However, and to facilitate early adopters of innovative ADS, DIRDC advised that a vehicle fitted with an ADS could instead be certified as nonstandard, at the discretion of the responsible minister. With this approach, automated vehicles would be able to be certified outside of the standard vehicle arrangements, under the condition that they meet specified requirements for the ADS. State and territory agencies would then decide if such vehicles could be used on their road network (with or without any additional jurisdictional conditions). In the consultation RIS, option 2 adopted the proposed safety criteria as being the specified requirements, for the conditions of a nonstandard certification approval.

Since the release of the consultation RIS, DIRDC has advised option 2 could be evolved to respond to state and territory concerns about how easily nonstandard vehicles could be administered in the road registration system. A modified proposal is to instead develop ADR 90/01 to allow automated vehicles with an ADS to be certified as standard vehicles if they: meet the requirements of UN R79 (as and when R79 is updated to recognise the approval of ADSs, and as it moves to allow higher levels of automation – this is described in Chapter 3); and/or if a Statement of Compliance that directly addresses the proposed safety criteria is made by the manufacturer. Development of this proposed ADR 90/01 is progressing. We are engaging with DIRDC as this process continues.

As such, we have updated the assumptions behind the options assessed in this decision RIS to reflect the new content of the proposed ADR 90/01. The description has been changed in this chapter and our multi-criteria analysis updated accordingly in Chapters 6 and 7.

3.4 Options

The options we assess in this RIS are:

Options

1. **Baseline approach –** does not introduce a safety assurance system. It uses existing regulatory processes to manage safety, with no explicit safety assurance of ADSs.
2. **Safety assurance system in existing frameworks –** introduces a safety assurance system using the existing vehicle certification framework. It requires an ADSE to self-certify against principles-based safety criteria. We also assess a modified option 2 where relevant.
3. **New safety assurance system –** introduces a safety assurance system with a dedicated national agency for automated vehicle safety. It requires an ADSE to self-certify against principles-based safety criteria. It includes offences and compliance and enforcement tools that are specific to safety assurance.

4. **New safety assurance system + primary safety duty –** introduces a safety assurance system with a dedicated national agency for automated vehicle safety. It requires an ADSE to self-certify against principles-based safety criteria. It includes offences and compliance and enforcement tools that are specific to safety assurance and a general duty on ADSEs to ensure safety ('primary safety duty').

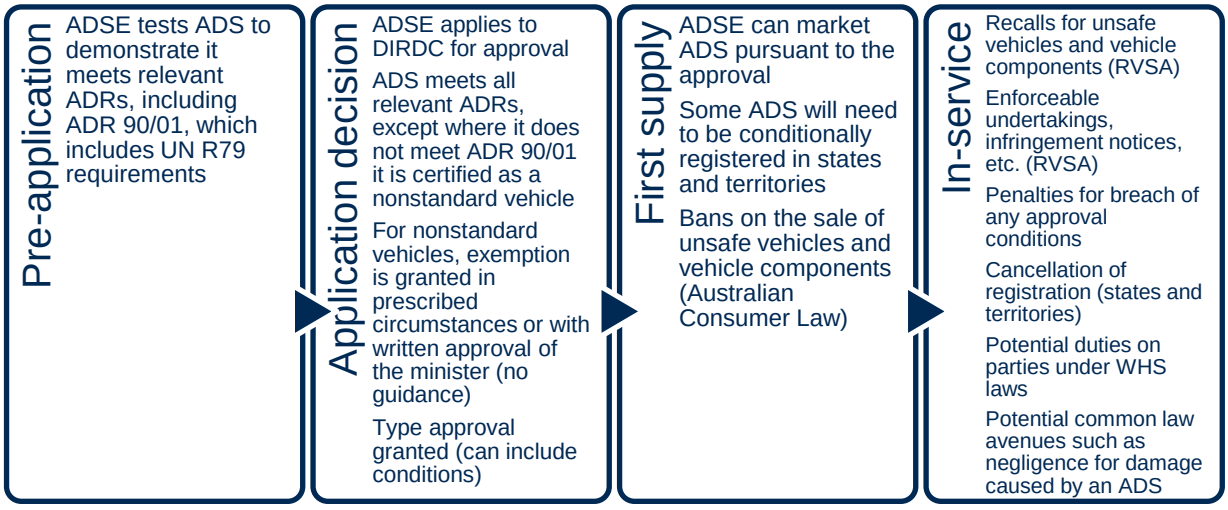
Table 3 identifies the RIS options to be assessed and the key regulatory features they aim to provide.

Table 3. Key regulatory features of the decision RIS options

	Option 1: Baseline approach	Option 2: Safety assurance system in existing frameworks	Option 3: New safety assurance system	Option 4: New safety assurance system + primary safety duty
Regulatory controls at first supply	✓ (but conditions for certification unclear)	✓	✓	✓
Regulatory controls for registration	× (conditions for registration unclear)	✓	✓	✓
Regulatory controls for in-service performance	× (not specifically for automated vehicle functionality)	✓ (but compliance and enforcement tools to enforce controls lesser than options 3 and 4)	✓	✓
Safety assurance system-specific offences and compliance and enforcement tools	×	×	✓	✓
Primary safety duty	×	×	×	✓

The rest of this chapter will describe the key features of each option in detail.

3.4.1 Option 1: Baseline approach



Description of the option

Option 1 does not introduce a safety assurance system specific to automated vehicles. It uses existing regulatory processes to manage the safety of automated vehicles.

The current version of international regulation UN R79 (UN R79/01) contains technical regulations on steering equipment. It limits the approval of automated systems to functions that operate at vehicle speeds at or below 10 km/hr (for example, 'traffic jam assist' or 'parking assist'), as well as defined automated lane-keeping functions (where it requires the driver to remain in control of the vehicle and limits the lateral acceleration of the vehicle to 3 m/s^2). Although UN R79 is not specific to ADSs, by limiting automated steering functions to the above constraints, it has the effect of ensuring vehicles with ADSs would be noncompliant.

DIRDC has advised that a new ADR 90/00 has recently been approved, which begins to harmonise existing Australian steering requirements with UN R79. This measure alone will not prevent an ADS from being fitted and so will not have a direct impact on this option; it will facilitate the subsequent introduction of ADR 90/01. ADR 90/01 will then limit automated steering to those allowed under UN R79.

Further in the future, an update to UN R79 (such as UN R79/02 or 03) internationally will then expand the scope of that regulation to allow drivers to undertake secondary activities while the vehicle is in motion (for example, taking hands off the steering wheel, using a phone). This will open the way for international approval of ADSs that meet certain technical requirements. DIRDC advises that this update is expected to be finalised in 2019 and available for adoption by countries in mid-2020.

DIRDC have advised that they would then propose to update ADR 90/01 (possibly through an ADR 90/02) to fully harmonise with the updated UN R79. If approved by ministers, the effect of this will be that most ADS, up to nominal SAE level 3, will be able to be compliant with the ADRs by meeting the technical requirements of the updated UN R79.

Under option 1, the current system for managing new and imported vehicles and their in-service performance would continue. The safety of ADSs would be managed through existing safeguards (such as ADRs, road rules and the proposed RVSA).

This option is *the starting point for comparison.* Under this option:

- Most ADS that are only capable of operating up to level 3 (nominally) could be approved under the ADRs as a standard vehicle by meeting the technical requirements in UN R79 (Commonwealth role).
- Level 4 and 5 ADSs would require a nonstandard approval until UN R79 was developed further to cover them, with an exemption from the ADS requirements of ADR 90 without clarity about what the conditions would be[17] (Commonwealth role)
- This would require assessment of individual level 4 and 5 vehicles under current state/territory-based registration processes (state and territory role)
- Beyond the enforcement powers of the RVSA for vehicles and their components, there would be a lack of specific mechanisms targeted at ADSs and ADSEs for regulating in-service performance.
- The role of an ADSE would not be defined and hence there would be limited offences or compliance and enforcement tools for the ADSE rather than the vehicle manufacturer.
- ADSs may not be adequately captured regarding software upgrades or use of aftermarket devices.

How it would work

Regulatory controls at first supply

Level 3 ADSs would need to meet the technical requirements in ADR 90/01 (UN R79). These would specify many of the safety aspects covered by the safety criteria outlined in Chapter 4. However, the criteria may not include requirements specific to the Australian road environment, or of a less technical nature (for example, education and training).

If a level 3 ADS met the ADR 90/01 requirements (and all other relevant ADRs), it would be certified as a standard vehicle without the need for conditions.

Until the international standards evolved further, vehicles with a level 4 or 5 ADS are likely to be categorised as nonstandard vehicles.[18] A nonstandard vehicle may not be supplied to the market (120 penalty units) unless it has gone through the exemption process. This process allows a nonstandard vehicle to be supplied to the market in prescribed circumstances or with the written approval of the relevant minister.[19]

Under option 1 there would be no 'prescribed circumstances' that would apply to an ADS. This means the requirements for an exemption would not be clear or certain.

Regulatory controls for in-service performance

[17] In the longer term it is likely that certainty would increase. Exemptions may no longer be required because the ADRs could be updated with ADS standards to align with any international standards that are developed. DIRDC's view is that the UN's timetable for developing a comprehensive suite of standards for automated vehicles may be shortening, with timing more likely to be in parallel with this project's milestones. This means a transition to international standards will need to be a consideration for all options in this decision RIS. UN standards will be largely centred around pre-market requirements and some limited in-service requirements, with countries left to cover all other aspects of automated vehicle use on a national basis.

[18] Section 5 of the MVSA provides that **nonstandard**, in relation to a road vehicle or a vehicle component, means not complying with the national standards and not taken to comply with the national standards by virtue of an approval given under subsection 10A(2).

[19] MVSA, s. 14

A nonstandard vehicle would need to be individually registered by states and territories. State and territory registration systems and processes vary. Registration requirements for a nonstandard automated vehicle would most likely need to include additional conditions. These conditions may differ from jurisdiction to jurisdiction.

States and territories could advise DIRDC whether they would grant conditional registration to nonstandard vehicles with an ADS. Registration could be subject to conditions requiring that the registered vehicle operator does not make unauthorised modifications to the ADS and accepts ADS updates.

The varying and uncertain registration processes would cause significant regulatory uncertainty for ADSEs and ADS consumers. There would also be administrative burdens in obtaining exemptions and registration from state or territory road managers, which are not designed for large-scale, commercial deployments.

Regulation of in-service safety performance for any nonstandard systems may not be covered by existing in-service regulations, which do not specifically consider an ADS.[20]

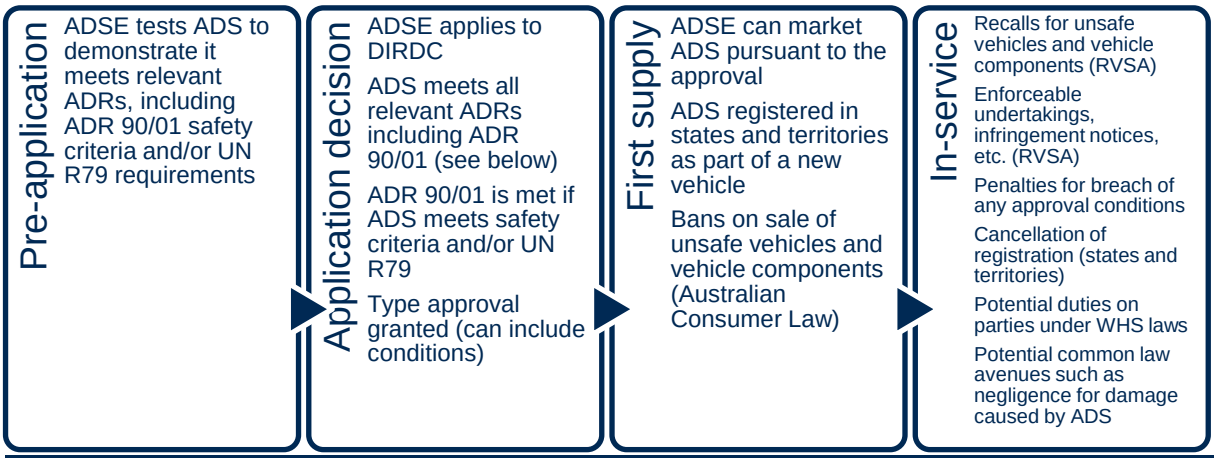
Compliance and enforcement

This option would not create safety assurance system specific offences and any additional compliance and enforcement measures. It would not clearly define the role of the ADSE separate to the vehicle manufacturer.

Sanctions and penalties under the RVSA could be applied to manufacturers for systemic failures to meet pre-market technical requirements. These include vehicle recalls, the withdrawal of approval to supply vehicles to the market, infringement notices, enforceable undertakings and civil penalty orders.

In-service sanctions and penalties, enacted by states and territories for noncompliance with conditional registration requirements, such as withdrawal of registration, would affect the registered owner or operator rather than the ADSE.[21] This could lead to private owners of vehicles being penalised (for example, through removing a vehicle's registration) for system issues that are beyond their control.

3.4.2 Option 2: Safety assurance system in existing frameworks



[20] For example, the Australian Light Vehicle Standards Rules 2015, and the Heavy Vehicle (Vehicle Standards) National Regulation.

[21] In some cases, the registered operator or owner and the ADSE may be the same, such as fleet operators.

Option 2 introduces a safety assurance system (as outlined in Table 3) using existing regulatory processes to manage the safety of automated vehicles.

The Commonwealth government will set safety criteria and obligations for ADSEs to self-certify against. These are outlined in Chapter 4.

Under option 2, DIRDC's proposed ADR 90/01 would include UN R79, as well as the proposed safety criteria in the form of a Statement of Compliance (SOC). The SOC would include the majority of the safety criteria outlined in Chapter 4, giving them legislative standing.

An ADS will be able to satisfy ADR 90/01 by meeting the requirements of UN R79 and/or the safety criteria in the Statement of Compliance[22]. The effect of this will be that ADSs would be able to be compliant with ADRs, and the ADSE would be recognised and treated as equivalent to a component manufacturer.

Under this option:

- a vehicle that meets all other applicable ADRs, would be issued with a standard approval where the ADSE is able to satisfy the requirements of ADR 90/01, which would involve either self-certifying against principles-based safety criteria (in the Statement of Compliance) and/or meeting UN R79 requirements (Commonwealth role). This would include:
    - ADS steering systems up to a nominal SAE level 3, which would likely be able to meet the technical requirements of an updated UN R79; and/or
    - All other systems and levels of ADS steering systems, which would be able to be self-certified against the Statement of Compliance.
- existing compliance and enforcement measures would be used, which would not be able to cover all safety criteria whilst the ADS is in-service
- the ADS could be recognised and regulated as a component (steering system) separate to the vehicle (but towards the construction of a new vehicle).

How it would work

Regulatory controls at first supply

ADSs would need to meet the UN R79 technical requirements and/or the safety criteria in the Statement of Compliance. Some safety criteria may overlap with UN R79 requirements, and as such, DIRDC may determine certain criteria to be met if a corresponding UN requirement has been met. The criteria covered by UN R79 would be expected to gradually expand as UN R79 is developed further internationally. This would result in the applicable requirements under the Statement of Compliance gradually reducing.

If an ADS met the ADR 90/01 requirements (and all other relevant ADRs), it would be certified as a standard vehicle without the need for conditions[23]. Conditions would only be needed under the nonstandard approval discussed under Option 1.

[22] The UN R79 requirements and safety criteria may overlap. By meeting UN R79 requirements, DIRDC may determine some safety criteria have been met. We expect overlap to continue to increase as UN requirements further develop to accommodate higher levels of automation.

[23] There may still be a need for conditions to be imposed on a standard approval. This is already done under both the current MVSA and a future RVSA, and as such would be business as usual and not specifically for ADS.

Regulatory controls for in-service performance

Approvals under the RVSA may be able to include conditions for ongoing compliance for a steering system meeting the requirements of ADR 90/01. This would include requirements for cybersecurity, software updates and complex electrical systems, all of which are expected to be included in, or linked to, UN R79. Alternative provisions, such as an ADSE demonstrating compliance with other standards, may satisfy some of the in-service criteria of the safety criteria under a Statement of Compliance.

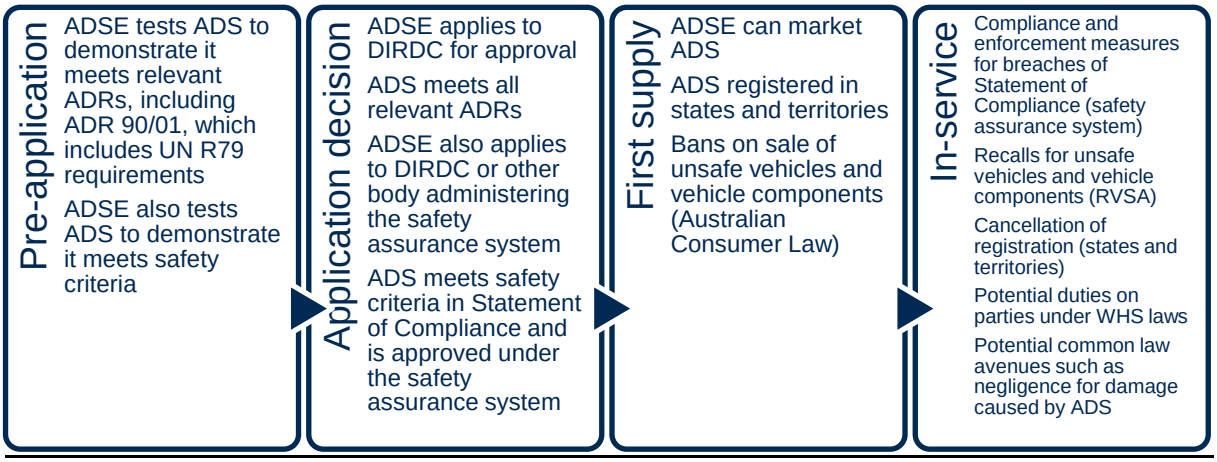
However, not all safety criteria would be able to be included in an RVSA approval whilst an ADS is in-service. For example, compliance with relevant road traffic laws, installation of system upgrades by owners or operators, some aspects of education and training and data recording and sharing may need to be managed elsewhere.

Compliance and enforcement

Existing sanctions and penalties could be applied to manufacturers for systemic failures to meet pre-market technical requirements. They could also be applied for breaches of any aspect of an ADR 90/01 approval, including any of the safety criteria covered by the Statement of Compliance in the approval. These sanctions include vehicle recalls, the withdrawal of approval to supply vehicles to the market, infringement notices, enforceable undertakings and civil penalty orders.

As per Option 1, this option does not create safety assurance system specific offences and compliance and enforcement measures. This could make it difficult to target all possible responsible parties in all scenarios.

3.4.3 Option 3: New safety assurance system



Description of the option

Option 3 introduces a nationally administered safety assurance system under new legislation specific to ADSs. The system would include specific offences and compliance and enforcement measures.

The agency responsible for administering the safety assurance system (whether the Commonwealth government or another agency) will set safety criteria and obligations for ADSEs to self-certify against.

Under option 3, ADR 90/01 would include the requirements of UN R79 but would not include the safety criteria.

Under this option:

- an ADSE would self-certify against principles-based safety criteria (these are set out in Chapter 4)
- new offences and compliance and enforcement measures would be introduced that are specific to safety assurance to enforce compliance with the safety assurance system (through new or amended legislation)
- a national function would be established to administer the safety assurance system
- the ADS (and the ADSE) would be recognised and regulated separately from the vehicle.

The ability to regulate the vehicle and the ADS separately would ensure each ADS goes through a safety assurance process. For example, if an aftermarket ADS fitment is added to an already certified vehicle, without the ability to regulate the ADS separately from the vehicle the ADS would not necessarily go through the safety assurance process. The ADS will be driving the vehicle in place of a human driver so a regulatory system that does not provide an ability to ensure it is safe presents a significant safety risk.

This ability to regulate the ADS separately from the vehicle also means there is a better ability to target the correct party if an ADS is unsafe. For example, if the ADS and vehicle are regulated as a whole and the ADS is faulty, the vehicle might be deregistered or recalled, which may be a disproportionately unfair consequence for the vehicle owner. Separate regulation would allow a vehicle with manual controls to still be operated by the owner, with the ADS disengaged instead.

There would need to be relevant offences and compliance and enforcement measures to ensure the ADS remains disabled if it has not been approved under the safety assurance system.

How it would work

New or amended legislation would recognise an ADSE as being responsible for:

- submitting a Statement of Compliance for an ADS
- in-service safety of the ADS, where appropriate.

This option is likely to include a legislative mechanism for states and territories to identify and refer intelligence (for example, breaches of road traffic laws) to the national agency responsible for the safety assurance system. Such advice would be relevant to the responsible agency's consideration of sanctions and penalties, including whether approval of the ADS should be removed. This option could also include a mechanism for the national body to provide information back to the states and territories to assist with managing road safety.

Regulatory controls at first supply

Vehicle type approval would continue to be required. However, ADR 90/01 would not include the safety criteria. Instead, ADSEs with ADSs would need to submit a Statement of Compliance to the agency responsible for the safety assurance system, demonstrating they have met the safety criteria. If approved under this safety assurance system, the ADS would be classified as a standard vehicle by DIRDC's Vehicle Safety Standards Branch provided they meet other relevant ADRs.

This would simplify the registration process for states and territories and create certainty for ADS vehicle owners. The vehicle would be registered as a standard vehicle without the need for conditions.

Regulatory controls for registration and in-service performance

ADR-compliant automated vehicle models with an approved Statement of Compliance would be classified as standard automated vehicles and could be registered using standard registration processes.

The new or amended legislation would allow a national body to regulate the ADSE and the in-service performance of the ADS. It could require that the ADSE maintains ongoing compliance with its Statement of Compliance and report safety-critical events such as breaches of the road rules, crash data, near-miss data and cybersecurity vulnerabilities and other related events to the national body.

Specific offences and compliance and enforcement measures

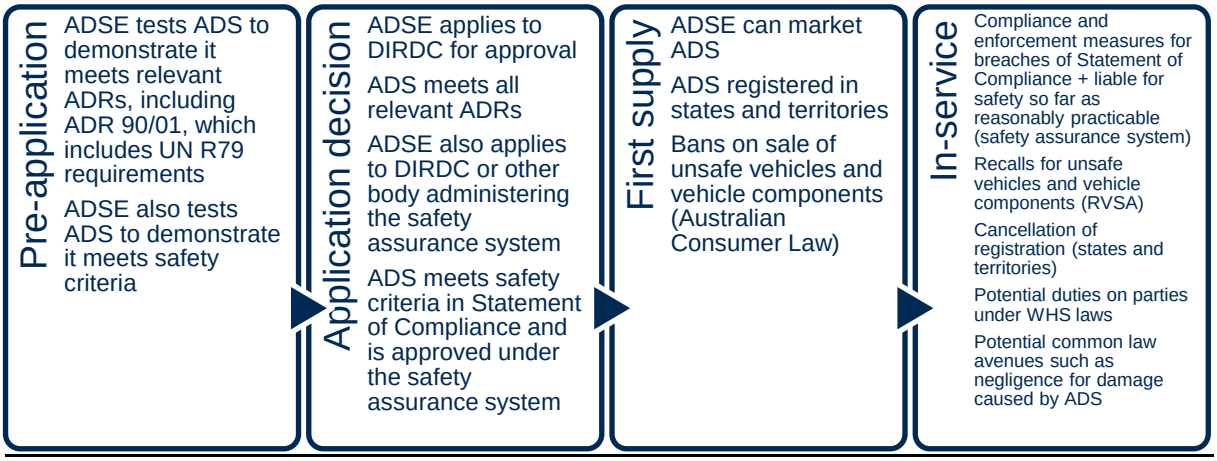
To support the effectiveness of the safety assurance system, the legislation would provide specific offences and compliance and enforcement measures.

The legislation would create a range of offences to underpin the mandatory features of the safety assurance system (see Appendix D for indicative sanctions and penalties). These could include but are not limited to:

- failure to lodge a Statement of Compliance to the relevant agency before introducing an ADS to market
- false or misleading information provided in the Statement of Compliance
- failure to lodge a Statement of Compliance to the relevant agency of an in-service modification that results in a vehicle operating at a higher level of automation
- failure to inform the relevant agency of a significant safety risk or issue related to the ADS
- failure to follow a legal direction of the relevant agency in relation to the ADS
- failure to maintain ongoing adherence to the Statement of Compliance
- failure to provide data or meet reporting requirements.

Specific offences and compliance and enforcement measures allow the regulatory agency to target the appropriate parties and behaviours. Governments would otherwise need to rely on existing mechanisms such as vehicle recalls or withdrawal of registration. These may not target the appropriate parties or provide the appropriate level of response to a safety breach.

3.4.4 Option 4: New safety assurance system + primary safety duty



Description of the option

Option 4 introduces a nationally administered safety assurance system under new legislation specific to ADSs.

This option incorporates all the design elements of option 3 but also includes a primary safety duty relating to ADSs while they are in-service. This option captures additional safety risks and unsafe behaviours to those addressed in option 3 through additional regulatory obligations on parties.

Under this option:

- an ADSE would self-certify against principles-based safety criteria (these are set out in Chapter 4)
- new offences and compliance and enforcement measures would be introduced that are specific to safety assurance to enforce compliance with the safety assurance system (through new or amended legislation)
- a national function would be established to administer the safety assurance system
- the ADS (and the ADSE) would be recognised and regulated separately from the vehicle
- ADSEs would be subject to a primary safety duty, which would include coverage of in-service performance of the ADS.

Primary safety duty

A primary safety duty would provide an overarching and positive general safety duty on the ADSE to ensure the safety of the ADS so far as reasonably practicable.

This duty would support the mandatory self-certification approach as an ongoing duty throughout the life cycle of the ADS. It would aim to ensure that in-service safety risks and hazards that are not identified through the safety assurance system process are managed and that unsafe behaviours that are not otherwise captured by prescribed offences are prevented.

A primary safety duty would not be prescriptive and would therefore accommodate significant advances in safety technology. It would also provide industry with flexibility in how they manage risks compared with more prescriptive requirements. As well, it could allow the avoidance or removal of prescriptive requirements on an ADS as a driver.

In addition, a primary safety duty allows for more proactive enforcement because risk-related behaviour can be addressed before an incident occurs.

A primary safety duty to ensure automated vehicle safety could be based on a number of existing models. In this consultation RIS, the high-level principles of the primary safety duty are based on the model work health and safety (WHS) law.

The model WHS law applies a 'primary duty of care' requiring a person conducting a business or undertaking to, so far as is reasonably practicable, ensure the health and safety of workers and others who may be affected by the carrying out of work (Safe Work Australia, 2016).

Primary duty of care – *Work Health and Safety Act 2011*

The primary duty of care is imposed on persons conducting business or undertakings (PCBUs). PCBUs have a primary duty of care towards workers and other persons like visitors and volunteers.

Under s 19 of the WHS Act, a PCBU must ensure, **so far as is reasonably practicable**, the health and safety of:

- workers engaged, or caused to be engaged, by the person
- workers whose activities in carrying out work are influenced or directed by the person while the workers are at work in the business or undertaking.

PCBUs must also ensure, so far as is reasonably practicable, the health and safety of others is not put at risk from work done as part of the business.

'Reasonably practicable' means what is reasonably able to be done to ensure health and safety, taking into account and weighing up all relevant matters. These matters include:

- the likelihood of the hazard or risk occurring
- the degree of harm that might result from the hazard or the risk
- what the person concerned knows, or ought reasonably to know, about the hazard or risk, and ways of eliminating or minimising the risk
- the availability and suitability of ways to eliminate or minimise the risk
- after assessing the extent of the risk and the available ways of eliminating or minimising the risk, the cost associated with available ways of eliminating or minimising the risk, including whether the cost is grossly disproportionate to the risk.

The duties under the WHS Act cannot be transferred. A person can have more than one duty, and more than one person can concurrently have the same duty.

A similar duty could be applied to automated vehicles to require the ADSE to ensure so far as is reasonably practicable the safety of an ADS. Sanctions and penalties would apply to the ADSE if it breaches the duty. This approach would most likely result in better road safety outcomes because it would:

- be consistent with proven approaches in other safety laws
- provide a strong focus on safety beyond simple self-certification
- ensure a risk-based approach to safety rather than a checklist approach that could be encouraged if reliance is placed on more specific obligations
- provide a 'catch all' if new safety risks are identified that were not part of the original safety assessment criteria
- ensure that safety standards increase over time as technology and practice improve

- allow for a proactive approach to compliance rather than waiting for a breach of the self-certification (which could involve a fatality) before addressing a safety concern.

For industry, this approach would provide flexibility as to how they address safety risks and allow the removal of more prescriptive obligations that would otherwise need to apply to cover specific risks or scenarios. A duties approach can thus reduce red tape. For example, because an ADS will undertake parts of the dynamic driving task, it will need to comply with certain relevant road rules that currently apply to humans. A primary safety duty could remove the need to prescribe specific obligations, for example, not allowing a hazard to be caused to other people or vehicles by opening a vehicle door.[24] These kind of prescriptive requirements that currently apply to human drivers would similarly need to be specified as offences applying to an ADSE in the absence of a primary safety duty.

For ADSEs whose operations are already covered by WHS duties, which would at least include those operating their own vehicles, there would be no additional regulatory burden. However, a specific duty related to the operation of an ADS would allow appropriate powers for a specialised regulator.

Compliance and enforcement powers could include options such as formal warnings, improvement notices, enforceable undertakings and prohibition orders, along with fines and imprisonment. The compliance and enforcement options would be commensurate with the risk and the ability of the duty holder to address that risk. Penalties could be similar to those for breaches of WHS or HVNL laws. More detail on compliance and enforcement measures, along with penalties from other schemes, are set out in Appendix D. Detailed consideration of sanctions and penalties, including their magnitude, will be undertaken once an option for safety assurance has been agreed.

How it would work

A primary safety duty would be administered by a national body and triggered by an incident, near-miss or other behaviour indicating a risk involving an ADS. In such events, the national body could investigate the causes of the incident, near-miss or unsafe behaviour to determine responsibility.

The national body would then determine whether the risk could reasonably have been managed and whether the duty holder knows, or ought to reasonably know, about:

- ADS hazards or risks and ways of eliminating or minimising them
- the availability of suitable ways to eliminate or minimise the hazards or risks.

The national body could apply specific and targeted sanctions or penalties to the relevant duty holder.

Parties covered by the primary safety duty

In the consultation RIS we proposed that the primary safety duty should only cover ADSEs – that is, the party seeking to bring the technology to market in Australia. This means that the in-service safety risks of bringing a particular ADS type to market are borne by only one party in the new safety assurance system. We considered that the ADSE should have the best understanding of and most control over the safety risks. As they are a new party, they are also not well covered by existing legislation.

In developing the consultation RIS we considered whether other parties should also be covered by the primary safety duty. Our view was that vehicle manufacturers (where this is

[24] For example, in the Victorian Road Safety Rules 2017, Ref 269.

different from the ADSE), commercial operators, registered operators/owners and vehicle repairers would not need to be covered for the following reasons:

- The vehicle manufacturer is covered by existing recall powers for faults that they have responsibility for and may have no ability to control the operation of the ADS.
- Commercial operators of vehicles are commonly covered by their own legislation (taxi or point-to-point and heavy vehicle legislation) and are also covered by WHS law because the vehicle is being used as a workplace (a primary safety duty already applies through WHS law).
- The registered operator/owner of the vehicle has limited ability to manage risks created by an ADS other than to follow the ADSE's instructions, including applying software updates as required.
- Vehicle repairers are covered by existing consumer laws.

As noted above, for the purposes of this decision RIS we continue to recommend the primary safety duty applies to ADSEs but will further assess this in the next phase of work.

Gaps in the existing regulatory environment

The Australian Consumer Law provides consumer guarantees that products will be safe, free from defects and fit for purpose. Product recalls can occur under Australian Consumer Law where there is a risk that a product will or may cause injury, or if there is an awareness of a death, serious injury or illness associated with a product.[25] However, the overall legislative framework is weighted towards post-market controls (requiring consumers and regulators to take action after a safety incident has occurred) rather than pre-market controls (requiring traders to take more proactive steps before introducing products into the Australian market).[26]

Consumer law may also not recognise an ADS distinct from a vehicle, requiring the recall of the entire vehicle rather than just the ADS (it would not allow an owner to drive a level 3 or 4 vehicle with the ADS turned off). Australian Consumer Law would also not apply to all types of ADS such as those used exclusively for passenger transport including buses and other commercial and heavy vehicles not protected by consumer guarantees.[27]

The application of obligations under WHS laws on ADSEs is uncertain. ADSEs that operate fleets of ADS vehicles are likely to owe a duty of care to ensure the health and safety of their workers, passengers and the public. In other situations, such as where an ADSE leases its ADSs to a commercial operator, or where its ADSs are sold to individuals for private use, the extent of a duty and the conditions in which they would apply are less clear. WHS laws may impose duties, but they may not be sufficiently clear or comprehensive to meet the policy objectives.

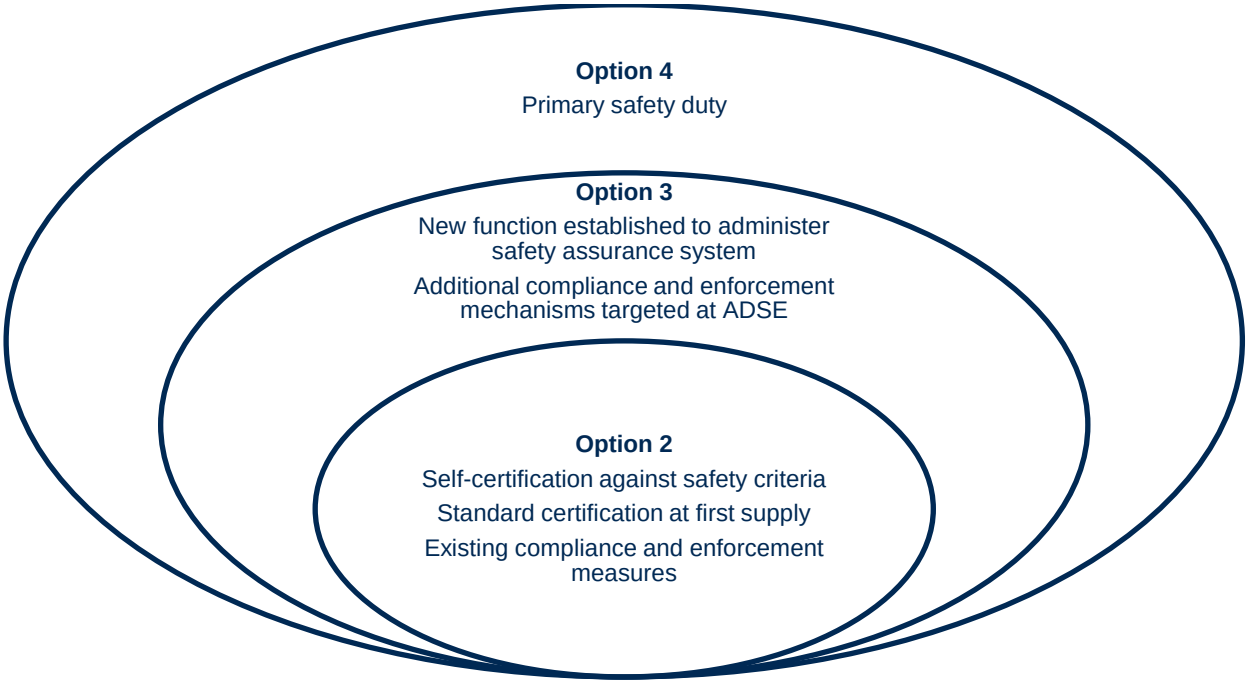
Figure 3 summarises the reform options.

[25] Recalls of road vehicles will be managed under the RVSA if passed, rather than the Australian Consumer Law.

[26] Consumer Affairs Australia and New Zealand, *Australia Consumer Law Review Final Report,* 2017 https://cdn.tspace.gov.au/uploads/sites/86/2017/04/ACL_Review_Final_Report.pdf.

[27] Australian Consumer Law currently covers all road vehicles valued under $40,000. It also covers vehicles valued over $40,000 where the vehicle is primarily used for personal purposes. If the vehicle is used mainly to transport goods on public roads regardless of how much the goods cost it is also covered by Australian Consumer Law.

Figure 3. Summary of reform options



3.5 Further work on institutional arrangements

A number of stakeholders cited the creation a new national agency (for example, FCAI and TIC) as one reason for not preferring options 3 or 4. Reasons for opposing a new agency were cost and potential duplication of roles that existed within DIRDC.

The description of the governance of options 3 and 4 in the consultation RIS used language that implied the creation of a new agency to administer the safety assurance system. However, the consultation RIS also noted that an assessment of existing or new entities that could undertake any roles in a safety assurance system would be a part of separate work looking at institutional arrangements once an approach to safety assurance has been chosen by ministers. This further work is described further in Chapter 8.

We have changed the wording in the RIS to make clear that the options do not imply an institutional structure at this point in time. There are many ways that the options, in particular options 3 and 4, could be administered. These include (and are not limited to) establishing:

- a new function for safety assurance of ADSs within DIRDC's Vehicle Safety Standards Branch
- a new function for safety assurance of ADSs within another existing national agency
- a new function for safety assurance of ADSs within an existing non-government entity
- a new function for safety assurance of ADSs in state and territory government agencies, overseen by a national function
- a new independent entity for safety assurance of ADSs
- a new government agency for safety assurance of ADSs
- a new advisory panel to advise the agency responsible for safety assurance of ADSs.

3.6 Alignment with international standards and transition to pre-market approval

A number of stakeholders sought clarity on the process for aligning safety assurance in Australia with international standards being developed by the UN.

In November 2017 the Transport and Infrastructure Council agreed to the 'development of a national safety assurance system for automated vehicles, based on mandatory self-certification, transitioning to pre-market approval when international standards for ADSs are developed and incorporated into the ADRs' (National Transport Commission, 2017c, p. 31). Though this approach has been agreed, the detail of the process for this transition has not yet been decided.

As noted in Chapter 3, Australia has committed to harmonising its regulations in line with international standards. The UNECE World Forum for Harmonization of Vehicle Regulations Working Party 29 (WP.29) is developing the technical standards for the steering functions of automated vehicles, which will be incorporated into UN R79. At this stage, the standards under initial development will most likely accommodate ADSs that are able to operate up to a nominal SAE level 3.[28] DIRDC has advised that this update is expected to be adopted in mid-2020 and could be harmonised at that point into the ADRs. UN R79 will need to be further updated to accommodate the technical standards for level 4 and 5 automated vehicles. Timeframes for further development are unclear.

A potential process for transitioning to pre-market approval is for the future development of UN regulations and ADRs to accommodate new technical standards covering ADSs. The safety criteria in the safety assurance system (described in the next chapter) will be subject to review and could be satisfied by meeting the requirements of these new technical standards. If there is duplication of these safety criteria in UN regulations and ADRs incorporating these new standards, the relevant criteria could either be directly met by the new standards or taken out of the safety assurance system where the criteria are sufficiently covered by these new standards. This process could work under options 2, 3 and 4.

The safety criteria, primary safety duty (if option 4 is chosen) and national safety assurance function could then be reviewed once UN R79 and ADRs include all technical specifications that cover automated vehicles up to and including level 5.

This RIS also proposes that the safety assurance system allow ADSEs to demonstrate safety by referencing approvals, tests or validation processes undertaken by other national governments if the standards and processes are commensurate with safety expectations and requirements in Australia.

The details of a final transition process will be further developed in the next phase of work.

[28] WP.29 does not refer to SAE levels in UN R79. The next major series of amendments to UN R79 will incorporate technical specifications for automatically commanded steering functions of Category B2 and C (approximately SAE level 2). After that, systems that allow the driver to perform secondary activities (approximately SAE level 3) will be considered.

4 Safety criteria for automated driving systems

Key points

- We recommend 11 principles-based safety criteria and three other obligations as part of a safety assurance system.
- ADSEs must self-certify that they comply with these safety criteria in a Statement of Compliance.
- The criteria are principles-based to balance safety and innovation.
- Under options 3 and 4, compliance with criteria could be managed over the life of the ADS by the body administering the safety assurance system. Under option 2, not all criteria could be managed by the Commonwealth.

This chapter sets out the recommended safety criteria and other obligations for a safety assurance system based on mandatory self-certification. These would apply under options 2, 3 and 4.

As noted in the previous chapter, option 2 would enable the Commonwealth to manage these safety criteria at first supply, but certain criteria have ongoing elements that the Commonwealth would not be able to manage effectively while an ADS was in-service. We have identified these criteria in the chapter.

4.1 Overview

Options 2, 3 and 4 outlined in the previous chapter all require an ADSE to self-certify against safety criteria in a Statement of Compliance.

This chapter outlines the recommended safety criteria against which the ADSE will be required to submit a Statement of Compliance for approval before an ADS or function, or significant modification, can be introduced into the market. The ADSE, rather than government, will be responsible for testing and validating the safety of the ADS or function and documenting these processes. The role of government is to satisfy itself that the applicant has processes in place to identify and manage the safety risks.

We recommend 11 safety criteria that require the applicant to demonstrate its processes for managing safety risks. We also recommend three other obligations on ADSEs to assist relevant parties to appropriately assign criminal and civil liability for events such as road traffic law breaches and crashes.

These criteria were developed with the aim of balancing safety and innovation. As such, the criteria are generally outcomes-based rather than prescriptive.

Not all safety criteria are necessarily relevant to each ADS, function or significant modification. If the applicant considers that a safety criterion or other obligation is not relevant (in whole or in part), the applicant should explain why.

This chapter outlines only the information an ADSE must provide in its Statement of Compliance to meet safety criteria and other obligations. Full descriptions of the safety criteria and obligations, information about how they were developed and potential criteria and obligations that were considered but are not recommended, are at Appendix E.

Based on stakeholder feedback, these criteria have been updated from safety criteria proposed in the consultation RIS. For some criteria we have amended the description of the criterion or obligation, rather than its requirements. In these cases, the amendments are reflected in Appendix E, rather than this chapter.

4.2 Safety criteria and other obligations for the Statement of Compliance: general feedback

In this section, we discuss the general stakeholder feedback received about the safety criteria and other obligations. More specific feedback about each criterion is then discussed in the sections that follow.

4.2.1 Stakeholder feedback

Stakeholder feedback generally supported the safety criteria and other obligations outlined in the consultation RIS, with several government and industry stakeholders stating that the criteria provide reasonably comprehensive coverage while allowing automated vehicle technology to continue to advance.

The Western Australian Government submitted that the safety criteria should be outcomes-based rather than issues or processes to ensure safety outcomes.

Transurban and Nova Systems emphasised the importance of maintaining flexibility to adapt the criteria and obligations, including aligning them with international approaches as these evolve.

A government agency submitted that the proposed criteria may not appropriately address the risks of conditional automation.

The TIC submitted that basing Australian safety criteria on US guidelines is not appropriate because there are no equivalent UNECE criteria and obligations, and therefore Australia may not be complying with its international obligations under the UNECE 1958 Agreement. ADVI and a government agency questioned our reliance on the US criteria and suggested referring to performance criteria for automated vehicles developed by the Association of British Insurers and Thatcham Research. QBE similarly suggested referring to this joint research.

The Municipal Association of Victoria (MAV), iTech Labs, Calibre and Geoffrey Taylor submitted it is necessary for appropriate infrastructure to be in place to support automated vehicle safety, including mobile communications coverage.

4.2.2 NTC response

We agree it is important for the safety criteria and other obligations to remain flexible and adaptable as international approaches evolve. As UNECE standards for automated vehicles develop and inform new ADRs, elements of the safety criteria may be removed from the Statement of Compliance requirements. Because these standards have not yet been developed, it is appropriate to consider other international approaches to shape the criteria for the Statement of Compliance. While the criteria are broadly based on those in the National Highway Traffic Safety Administration's (NHTSA) automated vehicle policy, the criteria have also been informed by draft resolutions and recommendations of UNECE WP.1 and WP.29, as well as the approach to automated vehicle regulation in Germany. Based on stakeholder feedback, we have also considered the performance criteria developed by the Association of British Insurers and Thatcham Research. The international approaches we relied on in developing the criteria are detailed in Appendix E.

In response to the Western Australian Government's submission, we have reviewed the safety criteria and updated the 'Requirement for the Statement of Compliance' for some criteria. We note that the overall outcome sought is safety, and each of the safety criteria aims to address different risks to achieve this overall outcome.

In response to concerns that the criteria may not address the risks of conditional automation, we note criteria are expected to cover all levels of automation. The agency assessing an ADSE's Statement of Compliance may require different information to meet the same criterion depending on the ADS's level of automation.[29] However, we consider the core criteria ADSEs must remain the same irrespective of the level of automation.

Infrastructure to support automated vehicles is outside the scope of our work program for automated vehicles. Austroads is considering infrastructure issues across several projects, which are summarised in Figure 1 of Chapter 1. Some states and territories are also working through infrastructure issues relevant to automated vehicles. For example, Infrastructure Victoria recently delivered advice to the Victorian Government on the infrastructure required for highly automated and zero-emissions vehicles.

4.3 Principles-based safety criteria: requirements for the Statement of Compliance

We are recommending 11 safety criteria. While the broad criteria remain the same as in the consultation RIS, they have been amended based on stakeholder feedback. Analysis of stakeholder feedback is detailed under each criterion below.

4.3.1 Safe system design and validation processes

Stakeholder feedback

Several stakeholders, including government, police, insurers and consultants, submitted that the safety criteria omit references to monitoring and maintaining ADS safety over the life of the ADS (in-service and end-of-life) and do not include a process to monitor the ADSE's compliance with its self-certification statements or after-sale enforcement measures. A government agency similarly submitted that the safety criteria do not cover automated vehicle end-of-life scenarios.

Some stakeholders commented on the end-of-life of an ADS.

- BMW submitted that there is currently no common understanding of what represents a reasonable amount of time for supporting the ADS.
- During the RIS information sessions, we received feedback that the ADSE should set the ADS 'life' and how long it will support updates.

ADVI and a government agency submitted that we should include a new safety criterion requiring back-up system safeguards to be in place if the system fails. This is based on performance criteria developed by the Association of British Insurers and Thatcham Research.

[29] For example, for the human–machine interface criterion (see section 4.3.3), sufficient time for the human driver to respond may differ depending on whether or not the ADS can come to a safe stop without human intervention (that is, whether the ADS is operating at conditional automation or high automation). If the ADS cannot come to a safe stop without human intervention, ensuring a safe outcome could mean giving the human driver more time to respond to a request to take back control (when compared with the response time given to the human driver if the ADS can come to a safe stop without human intervention).

The Victorian Government and a police agency submitted that we should include aftermarket ADSs in this criterion, which should include compatibility considerations (which vehicles could have the ADS installed). The Western Australian Government submitted that interoperability standards should be an additional safety criterion (for example, interoperability between the ADS and alcohol interlocks).

Nova Systems submitted that the wording of this criterion should focus on design basis, assurance and compliance and should not refer to 'testing' because testing is only one verification method.

A government agency submitted that the Statement of Compliance should require ADSEs to comment on whether vehicle components comply with the ADRs and, where they may not comply, to explain why.

NTC response

In response to submissions that in-service ADS safety is omitted from the safety criteria, we note that, under options 2, 3 and 4, an ADSE would need to maintain ongoing compliance with its Statement of Compliance while its ADS is in-service. As such, the ADS must operate in compliance with its self-certification statements in-service, and not just make these statements at first supply. We will consider a process to monitor compliance and relevant enforcement measures once the policy option for assuring automated vehicle safety is decided. Under option 4, the in-service performance of the ADS would be further captured by the primary safety duty on the ADSE.

To build on in-service safety over the life of the ADS, we have updated this safety criterion to explicitly refer to the life of the ADS as set by the applicant. We understand there is no common approach internationally about how long the ADSE should support the ADS. As such, at this stage, the life of the ADS should represent the amount of time the applicant proposes to support the ADS. The criterion now also requires the applicant's system design and verification processes to take account of the ADS life cycle, including end-of-life. Based on ADVI's and a government's agency's submission, we have also updated the criterion to include back-up systems for system failures as a relevant system design element.

Based on feedback from the Victorian Government and a police agency, we have updated the criterion to include compatibility as a relevant system design element.

We consider the criterion sufficiently covers interoperability standards and have therefore not added a new criterion as suggested by the Western Australian Government. We consider the criterion's requirement for ADSEs to cover all safety-critical issues will also address how the ADSs can operate safely when other devices in a vehicle interact with it.

In response to suggested updates to wording by Nova Systems, we have replaced 'testing' with 'verification' but have kept the reference to 'system design process' because this is sufficiently broad.

In relation to compliance with ADRs, we note that this is considered separately under the MVSA and is not something an ADSE needs to submit as part of its Statement of Compliance.

Requirement for the Statement of Compliance

The applicant must explain why it chose particular design, validation and verification processes and how these ensure a safe technology is developed and maintained for the life of the ADS. The life of the ADS should be set by the applicant and represent the amount of time the applicant proposes to support the ADS, including by way of software

upgrades. The applicant's design and verification processes should cover all safety-critical issues, such as unsafe maintenance, repairs, physical modifications and other system failure, as well as the ADS reaching the end of its life and no longer being supported by the applicant. For example, the applicant could design the ADS to disengage (temporarily or permanently) or for back-up systems to take over where safety-critical issues arise or the system otherwise fails.

Where the ADS is supplied as an aftermarket device (rather than a device already fitted to the vehicle), compatibility (the vehicle types the ADS can be fitted to) should be specified as an element of system design.

The applicant should document decisions relating to the choice of design, validation and verification processes and include empirical evidence or research to support the safety assertions made. Such documentation could explain why particular processes were chosen. Where applicable, the applicant should use guidance, industry best practices, design principles and standards developed by established standards organisations.

4.3.2 Operational design domain

Stakeholder feedback

iTech Labs identified many environmental conditions that can hinder the correct operation of the ADS, including night conditions and precipitation. iTech Labs submitted that the RIS does not consider and evaluate these risks.

QBE submitted that 'a level of consistency in the required information about the ODD across automated vehicle manufacturers would offer a number of benefits' and suggested we refer to research by the Association of British Insurers and Thatcham Research.

A government agency sought clarification about whether an ADS that can operate in all environments would have an ODD.

Nova Systems suggested clarification of the ODD criterion by specifying that it includes all aspects of the vehicle configuration, role and environment. Nova Systems gave the examples of configuration changes like extra sensors or improved software being able to expand the ODD.

NTC response

We note that many of the environmental condition risks identified by iTech Labs are relevant to the ODD identified by the applicant. For example, if the ADS cannot safely operate at night or in certain weather conditions, then these should be outside the scope of its defined ODD, and the ADS should be incapable of operating in such conditions. Based on QBE's feedback, we have updated the description of conditions relevant to the ODD in Appendix E.

Where an ADS operates at full automation, it would most likely still have an ODD, but its ODD will not have any limitations.

Regarding Nova Systems' point about the configuration, role and environment model, we note that the requirement specifies that major changes to the ODD are likely to be significant modifications, which would require a new Statement of Compliance to be submitted for approval first. We consider this language sufficiently broad to cover any ADS change significantly affecting the ODD.

We also note that under option 2 the Commonwealth may not be able to effectively manage all aspects of in-service safety related to the ODD.

Requirement for the Statement of Compliance

The applicant must identify the ODD of the ADS and demonstrate how it will ensure the ADS is:

- able to operate safely within its defined ODD
- incapable of operating in areas outside of its defined ODD
- able to transition to a minimal risk condition when outside its defined ODD.

This could include documentation outlining the process for assessing and verifying the ADS's functionality both within and outside the defined ODD.

The applicant should also outline how it will review and manage changes to the defined ODD. Major changes to the ODD are likely to be significant modifications requiring the applicant to submit a new Statement of Compliance for approval before introducing the change into the market.

4.3.3 Human–machine interface

Stakeholder feedback

The University of New South Wales Research Centre for Integrated Transport Innovation (rCITI) submitted that the human–machine interface (HMI) criterion is not sufficient and outlined 12 principles relevant to HMI design. These principles cover the ADS's automated capability, including its ODD, the level of automation engaged and the ADS's current and intended actions.

The Victorian Government submitted that the HMI criterion should also incorporate the activation of the ADS. This would require the HMI to inform the human driver when it is safe for the human driver to engage the ADS. ADVI and another government agency similarly submitted the importance of clear processes for handover (to the ADS) and handback (to the human driver), including where there is an emerging hazard, in line with the performance criteria developed by the Association of British Insurers and Thatcham Research. ADVI also submitted that the ADS should monitor the safety and competency of the driver.

The Queensland Government submitted that the HMI must provide adequate notice for the human driver to take control of the vehicle, and the ADS should stop safely or take other evasive action if the human driver does not take back control.

The Queensland Government submitted that an external HMI is necessary, with the Motorcycle Council of NSW submitting that the external HMI should extend to communication not just with pedestrians and cyclists but also motorcyclists in high-speed environments.

The Western Australian Government submitted that, for accessibility purposes, HMI communication should include auditory and haptic feedback mechanisms. The government and Nova Systems also submitted that elements of the HMI criterion may differ depending on the level of automation and the automated vehicle function (for example, to carry freight). BMW similarly submitted that HMI communications should be limited to situations where communication is needed.

Nova Systems also suggested noting the relationship between the HMI criterion and the education and training criterion and focusing on design assurance and compliance processes rather than assessment and testing.

NTC response

Many of the principles outlined by rCITI are already captured either under the HMI criterion or under the education and training criterion. The main gap is informing vehicle occupants of the ADS's current and intended actions. This allows occupants to predict the vehicle behaviour and ensures occupants are not surprised or frightened by the vehicle's actions. We have updated the criterion to capture this principle.

We agree with the Victorian Government's submission that the HMI should incorporate communication with the driver about when it is safe for the driver to engage the ADS and have updated the criterion to capture this.

In response to stakeholder feedback about the process for handing control back to the human driver, we note that:

- this process is already captured by the criterion, including requiring sufficient time for the human driver to respond to a handback request
- at conditional automation, the ADS is not required to bring the vehicle to a minimal risk condition without human intervention. The HMI criterion does, however, require the applicant to outline safeguards to ensure the fallback-ready user is actually ready to take back control (such as monitoring of human readiness to take back control). At higher levels of automation, the action required of the ADS if the human driver does not take back control is captured by the minimal risk condition criterion rather than the HMI criterion.
- the criterion has been updated to cover handback requests in emerging hazard situations.

In response to stakeholder feedback about including an externally facing HMI, we note this is already captured by the criterion. The externally facing HMI should communicate information with all parties external to the vehicle. As such, the description of the criterion in Appendix E has been updated to include motorcyclists and to note that the external parties specifically named in the description are examples only.

We are not mandating a specific communication interface for HMI communication. References to relevant signage and an external screen in the description and requirements are examples only, and the criterion has been updated to clarify this. The criterion does not require ADSEs to include auditory and haptic feedback mechanisms but also does not preclude it.

We agree that not all elements of the HMI criterion are relevant to all ADSs. For example, at full automation many of the internal HMI communications outlined in the criterion may not apply. However, these HMI communications are important for other levels of automation. As outlined in Appendix E, if an applicant considers that a safety criterion is not relevant, the applicant must explain why. This description has been amended to note that a criterion may not be relevant in whole or in part.

Based on feedback from Nova Systems, we have updated the criterion to link with the education and training criterion and moved away from referring to testing of the HMI.

Requirement for the Statement of Compliance

The applicant must outline how the HMI will facilitate interaction between the ADS and relevant parties (both internal and external to the vehicle) that allows the vehicle to operate safely.

In relation to human drivers and occupants, elements of the HMI interaction link with the education and training criterion. The information communicated by the HMI should include, but is not limited to:

- communicating to the human driver when it is safe for the driver to engage the ADS
- informing the human driver if the ADS is engaged and the level of automation engaged
- requesting the human driver or fallback-ready user take back control of the vehicle with sufficient time for the human driver or fallback-ready user to respond, including in an emerging hazard situation. In addition, the applicant should outline the safeguards to ensure a fallback-ready user is actually ready to take back control. This could include monitoring by the ADS of human readiness to take back control and alert systems where such readiness is not apparent
- drawing attention to potential safety risks related to human monitoring and readiness to re-engage with the driving task
- informing vehicle occupants of the ADS's current and intended actions to allow occupants to predict vehicle behaviour
- indicating whether the ADS is functioning properly or experiencing a malfunction.

In relation to parties external to the vehicle, information such as the ADS's state of operation should be communicated by the HMI via an external communication interface. This could, for example, take the form of an external screen.

The applicant must also outline how it designed and verified the HMI and reference any appropriate international standards or agreed guidelines for HMIs.

4.3.4 Compliance with relevant road traffic laws

Stakeholder feedback

Calibre and Nova Systems questioned which road traffic laws apply to the ADS, with Nova Systems submitting that 'many existing road rules will not be suitable for ADS'. Nova Systems also submitted that compliance with relevant road traffic laws is a subset of safe system design and the ODD and therefore does not need to be a separate criterion.

A police agency questioned how an ADS could demonstrate compliance with road traffic laws in practice, particularly where there is a new law that has not been tested by the ADS.

BMW submitted that we should harmonise local and state traffic laws to minimise variations in those laws.

NTC response

There are currently no road traffic laws that apply to the ADS. We will work with states, territories and industry to develop dynamic driving obligations for the ADS, which will most likely require the ADS to operate consistently with obligations in the Australian Roads Rules (model law that forms the basis of the current road rules for human drivers in each state and territory). We are aiming to harmonise road traffic laws for the ADS across the states and territories where possible and have already recognised that not all existing road rules are

relevant for an ADS.[30] We have amended the description of this criterion in Appendix E to clarify these points.

We are not prescribing a set approach for an ADSE to demonstrate that its ADS complies with road traffic laws. This safety criterion requires the applicant to document its own assessment and verification of the ADS's compliance with relevant road traffic laws. The applicant also needs to explain its process for updating the ADS to account for new or amended road traffic laws. This is because the applicant cannot have verified the ADS's compliance with the new laws at the time of providing its Statement of Compliance.

In response to Nova Systems' submission, we consider that requiring compliance with road traffic laws is a key component that is separate to the other safety criteria. As detailed in Appendix E, it is included in other relevant regulatory systems in both the US and Europe.

We also note that under option 2 the Commonwealth may not be able to effectively manage all aspects of in-service safety related to compliance with road traffic laws.

Requirement for the Statement of Compliance

The applicant must demonstrate how it will ensure the vehicle operates in compliance with relevant road traffic laws when the ADS is engaged. In particular, how the ADS will comply with:

- relevant road traffic laws, including any variations in each state and territory
- amendments to the relevant road traffic laws when they come into force.

This could include documentation outlining the process for assessing and verifying the ADS's compliance with relevant road traffic laws and the process for updating the ADS to comply with amendments to those laws.

The applicant must also demonstrate how the ADS will respond in a safe way where strict compliance with relevant road traffic laws is not possible. This requirement closely links with the on-road behavioural competency criterion.

4.3.5 Interaction with enforcement and emergency services

Stakeholder feedback

The Western Australian Government submitted that the criterion only covers the level of automation engaged, and this can already be ascertained by law enforcement from the external HMI.

Nova Systems submitted that the criterion should specify it is limited to accident investigation; otherwise, it is not clear how it contributes to the safe operation of the ADS.

A police agency submitted that emergency services more broadly, and not just police, should be defined in the criterion.

The Queensland Government, another government agency and a police agency suggested that a broader range of interactions should be considered as part of this criterion, including enabling police and emergency services to directly control automated vehicles (such as directing an ADS to stop) and for automated vehicles to receive safety messages.

[30] In *Changing driving laws to support automated vehicles: Policy paper*, May 2018.

NTC response

Based on feedback from stakeholders, we have updated the criterion (predominantly the description in Appendix E) to:

- refer to a broader range of interactions between the ADS and enforcement and emergency services
- include interactions more specifically related to the safe operation of the ADS
- explain why the interaction is likely to be broader than information communicated by an external HMI
- provide greater clarity around entities providing emergency services.

Requirement for the Statement of Compliance

The applicant must demonstrate how it will ensure that police can access accurate information about whether the ADS is engaged at a given time, the level of automation engaged and any handover of control requests. The applicant should also demonstrate how it may facilitate access by police to this information in real time at the roadside.

The applicant must demonstrate how it will ensure safe interaction with emergency services (including but not limited to police, fire and ambulance services) more broadly when the ADS is engaged. This includes interactions on-road and at the roadside.

4.3.6 Minimal risk condition

Stakeholder feedback

BMW submitted that the criterion does not distinguish between different levels of automation because at conditional automation the ADS may not be able to meet a minimal risk condition in all circumstances, and the human driver will need to take back control. Conversely, ADVI and a government agency submitted that the ADS must execute a safe stop if the driver fails to take back control.

Transport Certification Australia (TCA) suggested including malfunction and intrusion, data breach or physical tampering as scenarios where the ADS cannot operate safely, rather than just referring to external environment constraints.

Calibre recommended referring to ‘so far as is reasonably practicable’ when defining minimal risk. Nova Systems suggested that the minimal risk condition include a ‘minimum equipment list outlining which systems need to be operating correctly in order to achieve safe autonomous modes’.

A stakeholder at a RIS information session noted that the minimal risk condition will need to be appropriate for the circumstances; for example, it would not be safe to bring an ADS to a controlled stop on an outside lane of a freeway.

NTC response

Irrespective of the level of automation, the ADS must take steps to bring the vehicle to a minimal risk condition where the ADS cannot operate safely. However, the criterion distinguishes between the steps the ADS should take at conditional automation and the steps the ADS should take at high and full automation. At conditional automation, notifying the human driver to take back control in accordance with the HMI criterion would most likely constitute sufficient steps to achieve the minimal risk condition. This is because the ADS can

rely on the fallback-ready user to take control to bring the vehicle to a minimal risk condition. At high and full automation, the ADS performs this fallback function and may therefore need to achieve a minimal risk condition without human intervention. We have updated the criterion to clarify this.

In response to TCA's submission, we note that the criterion refers to system faults and deterioration of vehicle hardware (in addition to where the ADS is outside its ODD) as scenarios where the ADS may not be able to operate safely. We have updated the description of the criterion in Appendix E to cover physical tampering. We have not specifically included intrusion because it is more closely linked to the cybersecurity criterion.

We consider Calibre's recommendation of referring to 'so far as reasonably practicable' is more relevant to the primary safety duty outlined in option 4 because it is an overall safe system obligation. Achieving a minimal risk condition is an operational requirement where the ADS cannot operate safely at a point in time.

The inclusion of a minimum equipment list suggested by Nova Systems is probably too prescriptive for the safety criteria, noting that different ADSEs may rely on different equipment and technology for the ADS.

We agree that the appropriate steps to achieve a minimal risk condition will depend on the circumstances and surroundings the ADS is in at the time it becomes unsafe. We have clarified this intention in the criterion and in the description of the criterion in Appendix E. Specifically, we note that the impact on other traffic and road users must be considered.

Requirement for the Statement of Compliance

The applicant must demonstrate how the ADS will detect that it cannot operate safely and the steps the ADS will take to bring the vehicle to a minimal risk condition.

This could include documentation outlining the process for verifying the ability of the ADS to detect and respond to such circumstances. The steps the ADS must take to bring the vehicle to a minimal risk condition are likely to vary depending on the reason why the ADS cannot operate safely, other traffic and road users present, and on the level of automation engaged. Therefore, a range of approaches to bring the vehicle to a minimal risk condition may need to be considered.

4.3.7 On-road behavioural competency

Stakeholder feedback

The Victorian Government, Calibre and TCA submitted that we should include predictable and safe interaction with other road users (such as drivers of non-automated vehicles and non-vehicular road users) into the criterion. The Motorcycle Council of NSW submitted that the ADS's ability to recognise and respond to vulnerable road users, particularly motorcyclists, is key.

ADVI and a government agency suggested we should also include a crash intervention criterion requiring the ADS to perform a minimal risk manoeuvre in an unforeseen dangerous situation.

iTech Labs identified many dynamic external hazards (for example, objects that can disrupt vehicle motion, other vehicles violating traffic laws or moving erratically and debris from previous crashes) and environmental conditions that can hinder the correct operation of the ADS. iTech Labs submitted that the RIS does not consider and evaluate these risks.

Nova Systems submitted that on-road behavioural competency does not need to be a separate criterion but instead should be part of the safe system design and validation processes criterion because it is a key design aspect.

NTC response

We agree that predictable and safe interaction with other road users is a relevant component of this criterion and have updated the criterion to reflect this. We have also updated the description of the criterion in Appendix E to explicitly refer to motorcyclists as vulnerable road users.

We consider that a separate crash intervention criterion is not required because it is already captured by this criterion. Where there is an unforeseen dangerous situation, the ADS must detect and appropriately respond by, for example, the ADS disengaging or bringing the vehicle to a safe stop.

As discussed in section 4.3.2, many of the environmental conditions risks identified by iTech Labs are relevant to the ODD identified by the applicant. Other environmental conditions risks and the dynamic external hazard risks identified by iTech Labs are generally covered by this criterion.

In response to Nova Systems' submission, we consider that on road behavioural competency is a key operational component that links with, but is separate to, the other safety criteria. As detailed in Appendix E, it is included in other relevant regulatory systems in both the US and Europe.

Requirement for the Statement of Compliance

The applicant must demonstrate how the ADS will appropriately respond to foreseeable and unusual conditions that may affect its safe operation and interact in a predictable and safe way with other road users. This could include documentation outlining the process for verifying the ADS's:

- object and event detection and response capabilities
- crash avoidance capabilities
- ability to respond to unusual events within its ODD
- on road interaction with other road users, including vulnerable road users.

4.3.8 Installation of system upgrades

Stakeholder feedback

The Queensland Government suggested a distinction be made between safety-critical upgrades and those that do not impact on safe operation, and for the ADS to monitor installation of the safety critical upgrades. Conversely, QBE suggested that non-safety-critical upgrades should also be incorporated where cumulative failures to install such upgrades may generate risk.

Maurice Blackburn Lawyers submitted that the vehicle owner should not be able to choose whether to install a system upgrade, and the system should be tested for errors after an upgrade has been installed.

The Western Australian Government submitted that, due to issues with sufficient data network coverage in some areas of Australia, this criterion should consider whether to specify a timeframe during which the ADS can operate before it installs an update.

Calibre submitted that dynamic software updates (updates while the automated vehicle is moving) should not occur because it could cause accidents if the updates were incorrectly installed.

NTC response

We agree with the Queensland Government's submission and note that this criterion specifically references safety-critical upgrades. We have updated some parts of this criterion to make this more explicit. While the we understand that cumulative failures to install non-safety-critical upgrades may generate risks, this is more appropriately covered under the safe system design and validation processes criterion, which more broadly requires system design to cover safety-critical issues. It may not be appropriate to impose the same requirements as those outlined in this criterion on cumulative failures to install non-safety-critical updates.

In response to Maurice Blackburn's submission:

- We note the criterion requires the applicant to demonstrate how system failures will be detected once upgrades are installed. Error testing may be one such method.
- We do not agree that software upgrades must be installed without the vehicle owner's consent. This is something the ADSE may choose to implement provided it complies with other laws. However, if a vehicle owner chooses not to install a safety-critical system upgrade, the criterion requires the ADS to be disengaged so the vehicle owner would not be able to operate the vehicle in automated mode.

We consider there may be safety risks in allowing an ADS to operate where a safety-critical upgrade has not been installed. As such, where the ADS cannot receive or install an over-the-air software update because of insufficient data network coverage, stipulating a timeframe during which the ADS can continue to operate may not be feasible. We have updated the criterion to refer to failures in receipt of over-the-air software updates as an additional 'failure to install upgrades' scenario. It may, however, be difficult for an ADSE to detect a failure by the ADS to receive an over-the-air software update. One way the ADSE could meet this element of the criterion is by restricting the ADS's ODD to areas where there is sufficient data network coverage.

We note concerns raised by Calibre regarding dynamic software updates, but we are ot proposing to prohibit such updates because this may be too prescriptive or even cause safety issues. For example, there may be circumstances when not installing the update at a given time introduces greater risk.

We also note that under option 2 the Commonwealth may not be able to manage all aspects of in-service safety related to the installation of system upgrades by owners and operators.

Requirement for the Statement of Compliance

The applicant must demonstrate how it will manage system upgrade risks. This includes ensuring safety-critical system upgrades to the ADS are installed and do not result in the operation of an unsafe ADS.

The applicant must explain how it will notify registered owners/operators that a safety-critical upgrade has been installed, or is available and needs to be installed. For such safety-critical upgrades, the applicant must also demonstrate how it will:

- detect failures to install upgrades (including failures of automatic updates, failures by registered owners/operators to take action when an upgrade is available or failures in receipt of over-the-air software updates)
- detect system failures once upgrades are installed
- ensure the ADS is safely disengaged if such failures occur.

This could include documentation outlining the process for verifying the ADS's ability to:

- update automatically and notify the registered owner/operator of the update
- notify the registered owner/operator of available system upgrades
- detect and respond to failures to install upgrades
- detect and respond to any system failures following the installation of upgrades.

4.3.9 Verifying for the Australian road environment

Stakeholder feedback

Nova Systems recommended changing the name of the criterion to refer to 'designing' rather than 'testing' because testing is just one method of verification.

Calibre questioned whether the criterion covers state or national roads and, together with a government agency, recommended there be a standard set of Australian environment criteria ADSEs need to comply with.

Insurance Australia Group (IAG) submitted that a process to independently test the safety of the ADS should be created in Australia because there are examples where automated vehicle technology is tested as safe in the US or Europe but is not safe in Australia.

A government agency suggested merging this criterion with the on-road behavioural competency criterion.

NTC response

We agree with Nova Systems' feedback that referring to testing may be too narrow. However, referring to designing may also be problematic because the ADSE could design the ADS for an overseas road environment and then adapt it to the Australian one. As such, we have updated the title to 'verifying' because it is broader than 'testing'.

In response to Calibre's query, this criterion requires the applicant to consider the Australian road environment including any variations between states and territories. Therefore, the criterion covers all Australian roads, not just roads in some jurisdictions. Our aim is to keep the criteria performance-based. Noting that there may be changes to the Australian road environment, requiring ADSEs to comply with a standard prescriptive set of Australian environment criteria may not be feasible.

We note that we included this criterion, which requires applicants to consider the Australian road environment when verifying the ADS, aiming to address concerns (such as those raised by IAG) about an ADS being safe overseas but not in Australia. Therefore, we consider it is not appropriate to merge this criterion with the on-road behavioural competency criterion.

Requirement for the Statement of Compliance

The applicant must demonstrate how it has considered the Australian road environment in designing, developing and verifying the ADS, including its forward planning processes to ensure compliance with changes to the road environment (such as changes to road infrastructure).

This could include documentation outlining the process for verifying the response of the ADS to the Australian road environment such as interaction with road signs in various states and territories and interaction with Australian flora and fauna.

4.3.10 Cybersecurity

Stakeholder feedback

Several stakeholders submitted that we should include greater guidance in the criterion.

- The Queensland and Western Australian governments submitted that the criterion should be drafted with a greater focus on cybersecurity outcomes, including throughout the life cycle of the ADS.
- Calibre, QBE and the Western Australian Government submitted that the criterion should reference specific cybersecurity standards in existence or in progress.
- The South Australian Freight Council and a government agency submitted that the NTC or another agency should develop a more detailed cybersecurity regulatory regime for automated vehicles.

The Queensland Office of the Information Commissioner (OIC) and the Office of the Victorian Information Commissioner (OVIC) submitted that limiting the criterion to risks of cyber intrusion is too narrow. Another privacy commission submitted that ADSEs should demonstrate how they will manage any data breaches caused by cybersecurity attacks and the consequences of these on individual privacy.

An enforcement agency and QBE submitted that we should consider requiring ADSEs to include a manual override mechanism to deal with instances of cyber intrusion.

NTC response

Based on feedback from stakeholders, we have substantially updated the criterion to:

- refer to minimisation of cybersecurity threats and vulnerabilities, including data security breaches (not just cyber intrusion)
- focus on cybersecurity outcomes over the life of the ADS, rather than just referring to the design and development of the ADS
- explicitly refer to the consequences of cyber attacks on individual privacy
- note than ADSEs can reduce the safety consequences of cyber intrusions by including a manual override mechanism.

We note that cybersecurity initiatives and standards for new vehicles are already being developed both in Australia and internationally. In Australia, DIRDC is leading work on a project considering cybersecurity for modern motor vehicles. As such, we do not propose to develop a detailed cybersecurity regime for automated vehicles. Noting also that such initiatives and standards continue to evolve, we have not referenced any specific standards

ADSEs should follow but require the applicant to refer to relevant legislation and industry standards, not just best practice guidance.

Requirement for the Statement of Compliance

The applicant must demonstrate:

- the capacity and competency of the ADS to minimise cybersecurity threats and vulnerabilities, including risks of cyber intrusion and other data security breaches
- the ADS's ability to detect and minimise the consequences of cyber intrusions and data security breaches that occur. Relevant consequences include those on road user safety and consequences for individual privacy following a data breach. One way to minimise negative effects on safety could be to include a manual override mechanism
- the applicant's processes for maintaining the ADS's capacity and competency to minimise cybersecurity threats, vulnerabilities and consequences of intrusions and breaches over the life of the ADS.

The applicant should refer to relevant legislation, industry standards and guidance for vehicle cybersecurity (domestic and international) and explain how it has incorporated these into its processes for designing, developing and maintaining the ADS.

4.3.11 Education and training

Stakeholder feedback

ADVI, the Queensland Government and two other government agencies submitted that the ADSE should provide detailed information about the ADS's automated capability.

- The Queensland Government stated this could include level of automation, ODD, use limitations and restrictions on modifications.
- A government agency stated there is benefit in consumers purchasing a vehicle where the ADS's ODD suits their needs.

Several stakeholders commented on the interaction of this criterion with the registration and licensing functions of states and territories.

- The Victorian Government submitted that education and training should be ongoing and cover changes following system upgrades. The Victorian Government also submitted that education and training should improve the community's understanding of automated vehicles and be available to jurisdictions for their registration and licensing functions.
- A government agency questioned the implications of the criterion on states and territories, including on delivery of education and training for human drivers of automated vehicles and driving licensing.
- Another government agency submitted we should remove this criterion and instead have it covered by Austroads in its registration and licensing work.
- rCITI submitted we should review past Austroads work to frame the criterion for driver licensing.

The Western Australian Government submitted that the criterion should be broadened to include retraining and testing, cover parties such as designers and suppliers (not just the ADSE), and require a feedback mechanism to entities in the automated vehicle industry. Calibre recommended the criterion include broader public and emergency service training.

NTC response

We agree that the ADSE should inform consumers of the ADS's automated capability and other factors such as its ODD. We have updated the reference to the ADS's capabilities in this criterion to more clearly capture these factors.

We note that ongoing education as required is already included in the criterion.

We propose that this criterion not cover education and training broadly, or replicate or replace the registration and licensing functions of states and territories. Like the other safety criteria, education and training should cover information relevant to the ADS the applicant is seeking to bring to market. We have updated the criterion to clarify this. We do not consider the criterion should cover the following:

- *Human driver competency and licensing*. Delivery of registration and licensing functions remains with the states and territories. Austroads is currently working through a registration and licensing framework for automated vehicles and is considering how to integrate ADSs into driver education.
- *Broader education and training of the community, emergency services and road agencies*. The education and training prepared by the ADSE could serve these broader purposes, but its primary purpose is to provide adequate information to users and parties responsible for maintaining the ADS. This is to ensure the applicant's ADS is safely deployed and operates safely in-service.
- *Information sharing between entities in the automated vehicle industry*. We consider ADSEs could choose to do so (provided they comply with relevant privacy regulation), but requiring such information sharing under the safety criteria could impose a large burden and the benefits are not yet tested.

We also note that under option 2 the Commonwealth may not be able to manage all aspects of in-service safety related to education and training, particularly related to registration and licensing.

Requirement for the Statement of Compliance

The applicant must outline the education and training it will provide to relevant parties about its ADS and how this will minimise the safety risks of using and operating the ADS. Education and training should consider different types of vehicles (including light and heavy vehicles) and different types of vehicle users. Without limiting the education and training to be provided, such education and training should consider:

- training human drivers and fallback-ready users to safely disengage and re-engage the ADS and the driving task
- informing human drivers of their obligations and responsibilities, particularly any fallback-ready user obligations
- informing consumers of the ADS's capabilities by clearly describing its automated capability, its level of automation, use limitations, restrictions on modifications and any restrictions of the automated technology such as the ODD
- facilitating the maintenance and repair of the ADS, including post-crash, before it is put back in service

- facilitating employee, dealer and distributor understanding of the technology and operation so relevant information can be accurately conveyed to consumers and purchasers
- ongoing education as required, including education and training to end users who are not the original vehicle owner and to communicate the impact of upgrades.

The development of education and training should be well documented. Such documentation could explain the reasons for the education and training chosen and how it will facilitate proper and safe use of the applicant's ADS. The ADSE should also make use of best practice or standards.

4.4 Other obligations on ADSEs: requirements for the Statement of Compliance

We are recommending three other obligations on ADSEs. These are the three other obligations outlined in the consultation RIS. While the broad obligations were broadly supported and remain the same, they have been amended based on stakeholder feedback.

Analysis of stakeholder feedback received for each obligation is detailed below.

4.4.1 Data recording and sharing

Stakeholder feedback

BMW, a police agency and the Western Australian Government submitted that what constitutes a 'near-miss' is unclear and would be interpreted subjectively. These stakeholders suggested either elaborating on the meaning of the term or removing it. Similar concerns were raised by stakeholders during the RIS information sessions.

A government agency, a police agency and Steven Shladover submitted that the criterion should introduce more specific data recording and sharing requirements on ADSEs. These include:

- specific instructions about where and for how long to store data
- specific instructions about how relevant parties will access the data (including access to data at the roadside and access to data held outside of the jurisdiction where an incident occurs)
- the form the data will take
- the minimum set of data elements to be recorded.

Conversely, Transurban submitted that overly prescriptive requirements may become barriers to entry if they are more onerous than in international markets. BMW and another manufacturer similarly submitted that requirements should align with international markets. BMW further submitted that data recording and storage requirements should align with UNECE work covering the data storage system for automated driving.

CARRS-Q, the MAV and the Western Australian Government submitted that automated vehicle data should be recorded and shared for broader purposes than those outlined in the criterion. These include recording and sharing data for community research, community education and machine learning, and to promote a safety culture within the broader automated vehicle industry.

The OIC, OVIC, another privacy commission, the Queensland Government and Calibre submitted that privacy is a key consideration for this criterion.

- The OIC and OVIC submitted that we should clarify the phrase 'without limiting the data to be recorded and shared' by highlighting that the *Privacy Act 1988* places limits on the data that can be recorded and shared.
- The OVIC and another privacy commission suggested highlighting specific privacy requirements in this criterion, including appropriate handling of data and consumer consent to data collection.
- The Queensland Government submitted that ADSEs will be subject to the Privacy Act and that we need to include further information about how the privacy of individuals will be appropriately protected while also allowing for data to be collected and disclosed.
- Calibre questioned whether the data recording and sharing requirements apply nationally and submitted that standard data protection laws should be enforced because there are variations in privacy protections between different states.

QBE and the Law Institute of Victoria (LIV) submitted that insurers should receive incident-related data to determine liability, with QBE submitting that insurers also need safety-related data to understand risk. The LIV and the AAA submitted that consumers should have access to relevant automated vehicle data to determine liability for a collision or traffic accident.

BMW and another manufacturer submitted they will need to store data generated by automated vehicles worldwide in one place (generally the country where the manufacturer's global headquarters are) to continually improve the ADS. These manufacturers therefore raised concerns about requirements to store data in Australia (or exclusively in Australia).

The Queensland Government submitted that the criterion should require ADSEs to provide data in a consumable format. Another government agency submitted that requirements on ADSEs to collect, store and retain relevant data and to provide it to relevant parties should be legislated.

The Australian Trucking Association (ATA) submitted that data should also be shared with the Australian Transport Safety Bureau (ATSB).

NTC response

We agree with stakeholder feedback that the term 'near-miss' is subjective and potentially unclear. Certain metrics such as hard braking, or requests by the ADS that the human driver take back control (in circumstances other than the ADS reaching the limits of its ODD) could indicate a near-miss situation. However, these are likely to be subjective metrics. Near-misses are also not covered in data recording and sharing requirements of other relevant regulatory systems (see Appendix E). As such, we have removed references to recording and sharing near-miss data from the criteria. We note that an ADSE would likely still need to examine near-misses as part of its general risk management, particularly if it is subject to a primary safety duty under option 4.

We acknowledge feedback from some stakeholders that the criterion should introduce more specific data recording and sharing requirements on ADSEs and that these requirements should be legislated. We note that the criterion covers many of the specific issues raised by stakeholders but does not require ADSEs to collect a specific set of data elements or to provide access to data in a specific way. This aims to ensure that requirements are not more onerous than in international markets and provides flexibility to ADSEs to innovate and align with international requirements. There are not currently clear international standards, but we anticipate they will be incorporated into ADRs as they are finalised. This includes

requirements being developed by the UNECE to cover the data storage system for automated driving. We are addressing other elements of stakeholder feedback as follows:

- We recommend that legislative obligations to report safety-critical events be imposed on ADSEs (see section E.1.7)
- New powers (for entities such as police) to collect data generated by automated vehicle technology will be considered as part of our subsequent compliance and enforcement approach to automated vehicles.

The purposes of the current data recording and sharing requirements relate to law enforcement, civil liability and relevant data for road agencies. We consider that extending these purposes out more broadly based on stakeholder feedback could go well beyond government's safety role, particularly because it touches on commercial decisions. Where use or disclosure of information complies with relevant privacy regulation, it may be open to the ADSE to use and share the data more broadly (for example, provision of safety-related data to insurers to assess risk); however, our view is that government should not mandate this use and disclosure. This issue is being considered further in our motor accident injury insurance reform.

We agree that ADSEs should consider privacy when addressing this criterion. In relation to submissions about privacy, we note the following:

- The reference to 'without limiting the data recorded and shared' is still included because the requirements outlined in the criterion do not represent an exhaustive list. We have updated the criterion to clarify the relationship with privacy law.
- Information about how the privacy of individuals will be appropriately protected, and specific privacy requirements are not outlined because the criterion now refers to requirements in the Privacy Act more broadly.
- Collection, use and disclosure of personal information by ADSEs are covered under the Privacy Act rather than the privacy regulation in the states and territories. State and territory privacy regulation covers public sector entities such as police and road agencies. We are currently assessing the privacy risks of government access to automated vehicle data and whether these are sufficiently addressed under existing legislation. This assessment is considering the differences in privacy regulation between the various states and territories.

In response to submissions about consumer access to data, we have updated the criterion to include liability for crashes in addition to defending road traffic infringements.

In response to submissions from BMW and another manufacturer, we consider it is important for ADSEs to store data relevant to the enforcement of road traffic laws and the general safe operation of the ADS (including data relevant to crashes) in Australia so this data can be accessed by police or other regulatory agencies as necessary. We have updated the criterion to clarify which data the ADSE should store in Australia. This criterion does not require the data to be stored exclusively in Australia and therefore ADSEs could also store the data in another country (provided this complies with relevant privacy regulations).

In response to the Queensland Government's submission, we note that the criterion already requires ADSEs to provide data in a standardised, readable and accessible format.

In response to ATA's submission, we note that the ATSB covers aviation, marine and rail modes of transport and its role does not currently extend to road transport.

We also note that under option 2 the Commonwealth may not be able to manage all aspects of in-service safety related to data recording and sharing.

Requirement for the Statement of Compliance

The applicant must outline the ADS data it will record and how it will provide the data to relevant parties. Without limiting the data to be recorded and shared, the applicant must explain how it will ensure:

- the vehicle has real-time monitoring of driving performance and incidents, including event data records in the lead-up to any crash that identifies which party was in control of the vehicle at the relevant time
- the vehicle can provide road agencies and insurers with crash data
- relevant parties (including police) receive information about the level of automation engaged at a point in time if required
- individuals receive data to dispute liability (for example, data showing which party was in control to defend road traffic infringements and dispute liability for crashes) when the individual makes a reasonable request
- data is provided in a standardised, readable and accessible format when relevant
- data is retained to the extent necessary to provide it to relevant parties (the amount of time data is retained for may depend on the purpose(s) the information could be used for – for example, law enforcement, insurance)
- data relevant to the enforcement of road traffic laws and the general safe operation of the ADS (including data relevant to crashes) is stored in Australia. This does not require the applicant to store the data exclusively in Australia.

In responding to this criterion, the applicant should note that the *Privacy Act 1988* places limits on the collection, use and disclosure of personal information, which may limit the data the applicant can record and share.

4.4.2 Corporate presence in Australia

Stakeholder feedback

ADVI agreed that an ADSE should be criminally and civilly liable under Australian law but submitted that it is not clear whether a corporate presence in Australia or some other mechanism is necessary to achieve this.

The LIV and Maurice Blackburn submitted that corporate presence in Australia must be an ongoing requirement for ADSEs.

NTC response

We agree that corporate presence alone would not be sufficient to ensure the ADSE is criminally and civilly liable where appropriate. As discussed in section E.5.1, the three obligations on ADSEs (data recording and sharing, corporate presence in Australia and minimum financial requirements) together assist with appropriately assigning criminal and civil liability.

In response to the LIV's and Maurice Blackburn's feedback, we have updated the description of the criterion in Appendix E to make it explicit that corporate presence in Australia is an ongoing requirement for the life of the ADS. How this ongoing obligation would be enforced could be provided for in legislation as part of the compliance and enforcement approach for automated vehicles.

Requirement for the Statement of Compliance

The applicant must provide evidence of its corporate presence in Australia.

4.4.3 Minimum financial requirements

Stakeholder feedback

The LIV and Maurice Blackburn submitted that minimum financial requirements must be ongoing obligations for ADSEs.

The Queensland Government submitted that prescribing a minimum financial requirement could pose a barrier to entry and protection for owners and operators of automated vehicles against an ADSE becoming insolvent is more important.

The Western Australian Government submitted that price signals through risk-rated insurance products for ADSEs should be considered as part of this criterion. This is because the insurer may require more information relevant to the ADSE's risk profile than what the ADSE needs to provide in its Statement of Compliance.

The South Australian Freight Council submitted that we need to ensure that ADSEs are not shell companies without any financial backing.

NTC response

In response to the LIV's and Maurice Blackburn's feedback, we have updated the description of the criterion in Appendix E to make it explicit that minimum financial requirements is an ongoing obligation for the life of the ADS. How this ongoing obligation would be enforced could be provided for in legislation as part of the compliance and enforcement approach for automated vehicles.

In response to the Queensland Government's submission, the description of the criterion in Appendix E notes that we are not seeking to prescribe a minimum annual turnover or other numerical financial measure to ensure these requirements do not prevent safe ADSs from entering Australia. Protections the ADSE may have in place against going into insolvency may, depending on the circumstances, be sufficient to meet this criterion.

We note that the safety criteria for the Statement of Compliance represent the relevant requirements an applicant needs to meet to bring its product to the Australian market. We consider the criteria used by insurers to assess insurance risk may differ from the safety criteria.

In response to the South Australian Freight Council's submission, we note that the aim of the minimum financial requirements criterion is to ensure that ADSEs are not just shell companies without any financial backing.

Requirement for the Statement of Compliance

The applicant must provide evidence of its current financial position, its grounds for claiming it will have a strong financial position in the future and the level of insurance held.

4.5 First supply and in-service safety compliance

Option 2 would enable the Commonwealth to manage compliance with safety criteria and obligations at first supply, but certain of them will have ongoing elements that the Commonwealth may not be able to manage effectively while an ADS was in-service. The first supply and in-service elements of the safety criteria and obligations are noted above and collated in Table 4.

Table 4. First supply and in-service elements of the safety criteria and obligations

First supply	In-service
Safety criteria	
1. Safe system design and validation processes	
2. Operational design domain	2. Operational design domain
3. Human–machine interface	
4. Compliance with relevant road traffic laws	4. Compliance with relevant road traffic laws
5. Interaction with enforcement and other emergency services	
6. Minimal risk condition	
7. On-road behavioural competency	
8. Installation of system upgrades (ADSE)	8. Installation of system upgrades (owner/operator)
9. Testing for the Australian road environment	
10. Cybersecurity	
11. Education and training (for example, requirement to provide material)	11. Education and training (registration and licensing conditions)
Obligations	
1. Data recording and sharing	1. Data recording and sharing
2. Corporate presence in Australia	
3. Minimum financial requirements	

4.6 Criteria and other obligations that have not been included

4.6.1 Ethical considerations

This criterion was discussed in the consultation RIS but was specifically excluded.

Stakeholder feedback

Prof. Robert Sparrow and Dr Mark Howard submitted that ‘ethics is inherent to the concept of safety’ and crash scenarios are unavoidable; therefore, ethical considerations need to be included in the discussion.

The Motorcycle Council of NSW submitted that other safety criteria would only sufficiently capture ethical implications ‘if testing with vulnerable road users – particularly motorcyclists – is as vigorous as that for other roads users’. The Motorcycle Council of NSW submitted that if this is not the case, then an ethical decision to treat vulnerable road user safety as less important has been made.

Steven Shladover submitted that we should not necessarily follow the NHTSA's approach in excluding ethical considerations and cautioned that the level of ADS design capability detailed in a Swedish paper (outlined in Appendix E) will not be achieved in practice.

NTC response

As detailed in Appendix E, we acknowledge that ADSs may face safety dilemmas with ethical implications; therefore, we have not excluded ethical considerations from the discussion.

Rather, we do not consider a separate ethical considerations criterion is necessary because ethical considerations are already largely captured by other safety criteria (especially following updates based on stakeholder feedback to the consultation RIS). For example, the compliance with relevant road traffic laws criterion requires an applicant to prioritise safety over strict compliance with road laws where necessary. Similarly, the on-road behavioural competency criterion requires an ADS to respond to foreseeable and unusual conditions that may affect its safe operation and to interact in a predictable and safe way with other road users. Road users explicitly include vulnerable road users such as motorcyclists.

These criteria, together with others, create a framework for addressing safety dilemmas with ethical implications. We recognise that crashes may still occur; however, the criteria are designed to minimise such occurrences and to minimise the consequences of such occurrences without needing to prioritise one road user over another. At this stage, including a separate ethical considerations criterion may create significant overlap and potentially contradict other safety criteria. It is also not clear what is understood to be acceptable ethical decision making by an ADS internationally beyond what is captured by other safety criteria.

Therefore, we recommend that an ethical considerations criterion not be included. We note that it is also not used in other safety regimes. A more detailed description and reasons for exclusion are contained in section E.2.1.

4.6.2 Crashworthiness

This criterion was discussed in the consultation RIS but was specifically excluded.

Stakeholder feedback

Prof. Brian Fildes submitted that crashworthiness is a critical criterion and not including it risks creating a substantial safety loss for society.

NTC response

As discussed in Appendix E, crashworthiness focuses on the vehicle rather than the ADS. We agree that automated vehicles should comply with the same crashworthiness requirements as conventional vehicles. However, a crashworthiness criterion is not needed for an ADS because crashworthiness ADRs would already apply to automated vehicles.

A more detailed description and reasons for exclusion are contained in section 0.

4.6.3 C-ITS capability

This criterion was not specifically discussed in the consultation RIS but has been raised by some stakeholders in their feedback on the RIS.

Stakeholder feedback

TCA submitted that a criterion requiring the ADS to interact safely with the C-ITS ecosystem should be included to facilitate interaction between the ADS and connected infrastructure, vehicles and other road users. ADVI similarly submitted that all automated vehicles should have C-ITS capability.

NTC response

We understand that automated vehicles can operate independently of the C-ITS ecosystem and therefore do not consider that they must have C-ITS capability and interact with the C-ITS ecosystem. While interaction with the C-ITS ecosystem could enhance the safety of automated vehicles, a lack of C-ITS capability does not on its own make an ADS unsafe.

Some automated vehicles may have C-ITS capability, and an ADSE may use this capability as one reason to support certain safety claims made in its Statement of Compliance.

4.6.4 Privacy

This criterion was discussed in the consultation RIS but was specifically excluded.

Stakeholder feedback

The Queensland Government, OIC, OVIC and another privacy commission submitted that an ADSE should demonstrate its ability to comply with the Privacy Act in its Statement of Compliance.

- The OVIC suggested the criteria could require ADSEs to complete a Privacy Impact Assessment to achieve this.
- A privacy commission suggested that the NHTSA's policy, which we relied on to exclude privacy, is inconsistent with the European Union's General Data Protection Regulation (GDPR), which applies to data generated by ADSs. The OIC similarly referred to the GDPR.

Steven Shladover submitted that privacy should be included in the safety criteria and gave the example of the California Department of Motor Vehicles' (DMV) regulations, which include requirements covering non-safety-critical personal information to protect the privacy of automated vehicle users.

The IoT Alliance Australia submitted that privacy requirements may be necessary to limit access and protect citizens.

The OIC and the South Australian Freight Council submitted that there are genuine domestic and family violence safety risks because data generated by automated vehicles provides location and behaviour pattern data. The South Australian Freight Council also contended that the use of information from the ADS should be limited to specific purposes.

NTC response

We agree that privacy is a relevant consideration for ADSEs. As discussed in sections 4.3.10 and 4.4.1, we have updated the cybersecurity and data recording and sharing criteria to specifically refer to the protection of personal information and to the limits on collection, use and disclosure of personal information in the Privacy Act.

The privacy of personal information collected and held by ADSEs is already broadly covered by the Australian Privacy Principles (APPs) in the Privacy Act. While the GDPR applies to data generated by ADSs and may offer stronger privacy protections than the APPs, it does

not apply exclusively to ADSs. It provides for privacy protection generally, in the same way as the APPs and other privacy regulation in Australia do. A decision to apply a GDPR-like law in Australia is a policy decision broader than automated vehicle policy and would more appropriately be dealt with by privacy authorities. As such, we consider that a decision to exclude privacy from these safety criteria is not inconsistent with the GDPR.

We also consider that the California DMV privacy requirements could be covered by the APPs, which provide individuals with a range of privacy protections when private sector entities collect personal information and sensitive information.

We note that European companies looking to bring an ADS to the Australian market may be required to comply with the GDPR, which may affect their ability to comply with other criteria (such as data recording and sharing). The ADSE may wish to raise this when submitting its Statement of Compliance.

We recognise location data and other personal information collected by automated technology could be personal information, the disclosure of which could have safety implications for victims of family and domestic violence. However, these are broad safety issues beyond the road safety issues the safety assurance system is looking to mitigate.

We note that the entity responsible for assessing an applicant's Statement of Compliance should focus primarily on road safety issues – a focus beyond road safety issues may be outside its mandate and expertise. Similarly, requiring ADSEs to complete a Privacy Impact Assessment may create barriers to entry and may not be necessary from a safety assurance perspective.

We recognise that privacy is an important consideration and are currently assessing the privacy risks of government access to automated vehicle data and the purposes for which this data should be used. However, we consider that it falls outside the scope of the criteria for the Statement of Compliance.

This issue is also discussed in Appendix E.

4.7 Provisions that could be captured in legislation

The consultation RIS proposed that obligations on ADSEs to report safety-critical events to the agency responsible for the safety assurance system be included in legislation. A description of these obligations is contained in Appendix E.

4.7.1 Stakeholder feedback

The OVIC and OIC submitted that the reporting obligations should extend to ADSEs reporting secondary uses of personal information generated by automated vehicles. The OVIC also suggested that ADSEs should report privacy breaches in addition to cybersecurity vulnerabilities.

The Queensland Government submitted that ADSEs should report any incidents that occur when the ADS is engaged as well as information about automated vehicle-related injuries and fatalities to evaluate the impact and effectiveness of automated vehicles.

4.7.2 NTC response

The reporting obligations outlined in Appendix E require the ADSE to report breaches of the road rules, crash data, cybersecurity vulnerabilities and other safety-critical events. This is likely to capture the Queensland Government's suggestions that ADSEs report incidents, injuries and fatalities. However, we have updated the description in Appendix E to more explicitly refer to injuries and fatalities.

We note that the reporting obligations have been included to assess the ongoing safety of the ADS while it is in-service. As such, requiring ADSEs to report secondary uses of personal information generated by automated vehicles is outside scope. Reporting on cybersecurity vulnerabilities could in some instances capture privacy breaches. In addition, as the OVIC notes in its submission, ADSEs would most likely need to report data breaches to the Office of the Australian Information Commissioner. As such, we consider that the reporting obligations under the safety assurance system do not need to specifically extend to privacy and data breaches.

5 Method for assessing the options

Key points

- We use a multi-criteria analysis to assess the costs and benefits of the four options.
- Our multi-criteria analysis is primarily qualitative because there is a lack of relevant quantitative information.
- Our multi-criteria analysis uses five impact categories that drive the costs and benefits of the different options:
  - road safety
  - uptake of automated vehicles
  - regulatory costs to industry
  - regulatory costs to government
  - flexibility and responsiveness.

5.1 Introduction

The consultation RIS described the methodology used to provide a preliminary assessment of the costs and benefits of the four options described in Chapter 3 as well as identifying a provisionally preferred option. The steps involved in the assessment were:

1. Choosing an assessment approach (multi-criteria analysis)
2. Identifying key impact categories, assessment criteria and high-level weightings of the key impact categories.
3. Identifying individuals or groups who are likely to be affected by the reform options.
4. Defining the assessment period.
5. Assessing options.
6. Testing the validity of the outcomes of this assessment by:
   - Examining the impact of options under different automated vehicle uptake scenarios.
   - Discussing the factors that might lead governments to prefer a different option.

We used the key impact categories and associated assessment criteria (Table 7) to identify and compare the incremental costs and benefits of each of the reform options against option 1 (the baseline option). This allows for a qualitative comparison of the relative effectiveness of the four policy options.

This chapter outlines the stakeholder feedback received on the options assessment method, describes any changes that we made to our approach after considering the feedback and sets out the final method used to assess those options in this decision RIS.

The assessment of the RIS options is set out in Chapter 6.

5.2 Stakeholder feedback and NTC response

Stakeholders generally supported the method of assessment of options as presented in the consultation RIS.

5.2.1 Choosing the multi-criteria analysis approach

Stakeholders generally agreed that the multi-criteria analysis approach for assessment was appropriate given the level of uncertainty about the future and therefore lack of clear quantifiable costs and benefits.

The AAA suggested that a further quantitative cost-benefit analysis should be undertaken to better understand the benefits of the different options. This would be critical when considering the benefits of implementing the primary safety duty.

We believe that a traditional (quantifiable) cost-benefit analysis is not feasible at this time given the extent of uncertainty inherent in the assessment. Instead, we consider the largely qualitative multi-criteria analysis approach best deals with the significant uncertainty around quantifiable costs and benefits. This approach meets the Office of Best Practice Regulation's (OBPR) Council of Australian Governments RIS guidelines (2016) and was approved by the OBPR in May 2018. As such, as have confirmed the use of the multi-criteria analysis approach to the assessment of reform options.

5.2.2 Impact categories, assessment criteria and high-level weightings

Stakeholders generally agreed with the identified impact categories and assessment criteria.

Some stakeholders suggested that the impact categories were somewhat limited because not all potential benefits, or dis-benefits, beyond road safety are captured. For example, one government agency noted that less congestion should be considered a benefit or dis-benefit, depending on the outcome. They considered there could also be a range of other economic and social benefits such as contributing to the landscape of the internet of things.

We acknowledge that automated vehicles will have many wider benefits beyond just road safety (see section J.4) and the extent of these benefits of automated vehicles is highly uncertain (noting that some possible impacts, such as congestion, could be significant costs or significant benefits).

However, it is also difficult to isolate wider impacts that can be clearly attributed to the reform options (as opposed to other forces). Therefore, our approach focuses on whether the reform options would be likely to increase the uptake of automated vehicles, which would in turn drive these wider impacts.

The Heavy Vehicle Industry Association suggested that using the uptake of automated vehicles as an impact category was not appropriate because it relied on an assumption that increased uptake would result in improved road safety and productivity. Their view was that this was as yet unproven.

We acknowledge the uncertainty but contend, on the weight of evidence reviewed (see Appendices I and J), that automated vehicles are expected to make an overall positive contribution to road safety and road transport more broadly. On this basis, we have retained the impact categories as presented in the consultation RIS.

Comments on specific assessment criteria

Various stakeholders suggested additional assessment criteria to be considered in the assessment. Within the impact category, the suggested additional criteria included those listed in Table 5.

Table 5. Suggested additional assessment criteria

Impact category	Suggested additional assessment criteria	NTC response
Road safety	Ensures safety of drivers and of other vulnerable road users (Nova Systems)	Agree with the intent, as this is the goal of the safety assurance system, but assessment against this criterion would be subjective
	Manages vehicle end-of-life (FCAI, TIC)	Agree. Added to existing assessment criteria covering ADS safety over the vehicle life cycle
Uptake of automated vehicles	Significantly contributes to a reduction of the road toll Prevents an initial high incident rate that would halt automated vehicle uptake (Nova Systems)	Agree with the intent, as this is the goal of the safety assurance system, but assessment against these criteria would be subjective
Regulatory costs to industry	International harmonisation to minimise cost to the automotive industry when introducing new ADSs and fulfil Australia's international obligations (FCAI, TIC)	Agree. Already incorporated into assessment criteria: Provides clear and consistent regulatory expectations to facilitate market entry, including national consistency and alignment with international requirements
Flexibility and responsiveness	Has a significant positive impact on the general public (through emergent in-service safety risks and hazards being more well managed) and enforcement and insurance services (through incidents or unsafe behaviours being consistently investigated under primary safety duty powers to identify cause and culpability) (TCA)	Covered under the existing road safety assessment criteria

Nova Systems also recommended amending the 'Regulatory cost to industry' assessment criteria (a) 'Results in low upfront and ongoing compliance, administrative and delay costs' to 'Results in market acceptable upfront and ongoing compliance, administrative and delay

costs,' because costs do not necessarily need to be low from a community perspective as the total cost of technology introduction, including regulatory costs, only need to be less than the total cost savings that result from reduced accident rate. We agree in principle and have interpreted 'low upfront costs' in the context of market acceptability, noting that, if the market did not accept these costs, uptake would minimal. Therefore, we have not changed this criterion.

Bodies representing automotive vehicle manufacturers (FCAI and TIC) suggested that the assessment criteria about allowing for regulation of the ADS separate from the vehicle should be removed from the flexibility and responsiveness impact categories, because they did not support aftermarket fitment of non-approved/supported products to their vehicles – converting traditional vehicles to level 3, 4 or 5 automated vehicles. They considered such modifications were a substantial safety risk. We reiterate that under each of the reform options any such aftermarket device that results in a 'significant' modification to an in-service vehicle's functions (such as introducing level 3, 4 or 5 ADS functionality) would require approval under the safety assurance system, including addressing how the device would interact with the existing in-service vehicle. As such, we have retained this criterion.

A police agency identified problems with some of the assessment criteria on the basis that there was insufficient information to adequately make an assessment against these criteria. Throughout the consultation RIS we did acknowledge issues of uncertainty and insufficient information and included a number of approaches to complement the qualitative assessment under uncertainty, for example, scenario testing and describing specific conditions that may support the preference of different options.

Toyota Australia was of the view that each impact category and assessment criteria ought to be reviewed at regular intervals in consultation with industry.

At the information sessions held around Australia, a number of stakeholders questioned the information-sharing obligations and arrangements relating to ADS safety incidents. These specific obligations and arrangements are currently unclear and require clarity on the institutional arrangements that will be in place to regulate ADS in-service performance. These arrangements will be examined in the next phase of the reform development. As such we have omitted the road safety impact assessment criterion:

> *(i) Supports information sharing between jurisdictions and the national body responsible for ADS safety to allow for a quicker and more targeted response to identified safety issues.*

Comments on the relative weighting of impact categories

Nova Systems provided the following commentary in support of the strong weighting towards the road safety impact category:

> *The concept that the costs of any [safety assurance system] will be significantly less (by orders of magnitude) than the savings from increased road safety is agreed and this thought to be the most important consideration. The lack of fidelity in costs at this point in the RIS process is not crucial as the relative ranking of options is correct.*

Lastly, we have made one further change to the assessment criteria that was not raised by stakeholders. Criterion (h) of the road safety impact category is:

> *(h) Allows for a national body to administer the regulation of ADS safety, including monitoring and responding to in-service ADS safety incidents.*

The above criterion is about the benefits of national consistency on road safety. However, we acknowledge that the benefits of national consistency on road safety are not clear. National consistency is more appropriately dealt with under assessment criteria in other impact categories ('Uptake of automated vehicles' and 'Regulatory costs to industry'). As such we have omitted this criterion.

5.2.3 Affected individuals and groups

Stakeholders generally agreed with the groups and individuals identified as being the most likely to be affected by the reform options. Some stakeholders suggested a more detailed description of affected parties including:

- motorcyclists (Calibre, Motorcycle Council NSW, an enforcement agency, Queensland Government)
- children, people with disabilities and the elderly (an enforcement agency, Queensland Government)
- automotive service provider industry such as mechanics, modifiers of in-service vehicles, auto body technicians, tyre fitters and auto electricians (Queensland Government, an enforcement agency, Nova Systems)
- broader transport sector (Queensland Government)
- people injured or who suffer property damage (Queensland Government)
- enforcement and first responders (two enforcement agencies)
- local councils (an enforcement agency)
- infrastructure providers (Nova Systems).

Some stakeholders suggested that the impact on identified affected parties may be broader than what was noted in the consultation RIS. For example, the FCAI suggested that vehicle manufacturers would also be affected by road safety, uptake and flexibility impacts.

A major manufacturer suggested that consumers and automated vehicle users will be affected by regulatory costs to industry.

We have made adjustments to the identified affected parties to provide for greater comprehensiveness, including adding motorcyclists as vulnerable road users and adding the automotive service provider industry to the uptake impact category.

However, we did not include all suggested additional parties because we consider that a number of these parties are sufficiently captured in the current identification of affected groups and/or are unlikely to be impacted in a significantly different way to others within the identified groupings (see Table 6 for examples).

Table 6. Affected parties already captured

Suggested affected parties	Captured within the following identified groupings
Children, people with disabilities the People injured	Road users group
People who suffer property damage	General public group

Broader transport sector Enforcement and first responders Local councils Infrastructure providers	Public and provide providers of transport, emergency response, infrastructure and insurance services group

As such we have only made minimal changes to the identified groups and individuals who we expect to be affected by the reform options.

5.2.4 Timeframe for assessment

Some stakeholders questioned the 'urgency' of the proposed reform because they considered mass market introduction of levels 4 and 5 was unlikely to eventuate until at least 2030. The FCAI considered that a small number of level 4 or 5 vehicles might be introduced before 2030 but expected that these would be either niche products (for example, a Navya shuttle) and/or in limited numbers as part of a closed fleet.

The Heavy Vehicle Industry Association suggested the RIS should have considered an option that continued the current legislative framework for at least the next five years, then considered the appropriate framework when it was clearer how the market for autonomous vehicles would develop.

We consider that a regulatory framework needs to be in place when automated vehicles are ready for commercial deployment, even if the scope of deployment is small initially. Having a flexible regulatory framework will be important in these early stages when less is known about the technology.

5.2.5 Assessing the options

Many stakeholders (for example, Nova Systems) acknowledged the challenges of assessing the options given the significant amount of uncertainty. Some stakeholders noted that the degree of uncertainty made any assessment of costs and benefits 'unreliable'.

The Heavy Vehicle Industry Association considered that because there is very little certainty about how the technology or market conditions for autonomous vehicles will evolve, the RIS has largely based its analysis on value judgements, not on hard data. They argue that this is not an appropriate basis on which to commit to writing legislation and building a bureaucracy that will operate for at least 10 years.

As noted above, issues of uncertainty and insufficient information were acknowledged throughout the consultation RIS, and we used a number of approaches to complement the qualitative assessment under uncertainty.

5.3 Multi-criteria analysis approach

We used a multi-criteria analysis approach to assess the options for a safety assurance system. This approach allows a combination of quantitative and qualitative information to be assessed against criteria related to expected impacts (costs and benefits) of different policy options.

A multi-criteria analysis approach is commonly used where full monetisation of costs and benefits is not appropriate or possible. Automated vehicles use technology that has not previously been regulated, either in Australia or elsewhere, and their future is uncertain. This means there is a lack of empirical data, making a fully quantitative cost-benefit assessment approach not possible. However, where available, quantitative data has been used. This

multi-criteria analysis approach is consistent with the OBPR's cost-benefit analysis guidelines.

5.4 Impact categories and assessment criteria

We selected five impact categories for the multi-criteria analysis. We selected these five impact categories for the following reasons:

1. **Road safety** – having safe vehicles on Australian roads is a fundamental and accepted standard under existing regulation and will continue to be under any new regime to regulate automated vehicles.[31]
2. **Uptake of automated vehicles** – the potential benefits of automated vehicles such as improved road safety, mobility, freight productivity and reduced road congestion cannot be fully realised without the uptake of automated vehicles into the Australian vehicle fleet.
3. **Regulatory costs to industry** – a safety assurance system will have regulatory costs to ADSEs. If the costs are too high, automated vehicles may not be introduced and used widely in Australia.
4. **Regulatory costs to government** – a safety assurance system will have upfront and ongoing costs to government; these costs need to be proportionate to the benefits.
5. **Flexibility and responsiveness** – ADS technology and international regulatory approaches are still developing. Any regulation needs to be sufficiently flexible to allow for this development.

Table 7 outlines the five impact categories and the assessment criteria for each impact category. Detailed descriptions of these assessment criteria and reasons for choosing them are at Appendix F.

Table 7. Impact categories and assessment criteria

Impact category	Assessment criteria
1. Road safety	(a) Covers ADS safety over the vehicle life cycle including at first supply, in-service and at end-of-life (b) Covers parties that have not sought approval under the safety assurance system but who would be an ADSE if they sought approval (c) Ensures there is always a clearly recognised legal entity responsible for risks associated with automated vehicles (d) Ensures responsibility sits with the party best able to manage the risk (e) Addresses emergent safety risks that may not have been specifically identified or considered at first supply

[31] See, for example, the *National Road Safety Strategy 2011–2020*, which is the commitment of federal, state and territory governments to an agreed set of national goals, objectives and action priorities setting out a path for action to reduce fatal and serious injury crashes on Australian roads. Available at http://roadsafety.gov.au/nrss/.

Impact category	Assessment criteria
	(f) Proactively addresses emerging ADS risks before the safety issue eventuates (g) Enables the introduction of targeted compliance and enforcement options, including sanctions and penalties for noncompliance by the ADSE
2. Uptake of automated vehicles	(a) Provides community assurance that automated vehicle safety risks have been comprehensively addressed (b) Provides clear and consistent regulatory expectations to facilitate market entry, including national consistency and alignment with international requirements
3. Regulatory costs to industry	(a) Results in low upfront and ongoing compliance, administrative and delay costs (b) Provides clear and consistent regulatory expectations to industry about its responsibilities and what is required to comply (c) Supports an approach that is consistent across all jurisdictions and is aligned with international requirements
4. Regulatory costs to government	(a) Minimises upfront structural, organisational and regulatory change to implement the model, including a minimal impact on existing processes and minimal regulatory layers (b) Supports efficient ongoing administrative processes including, if required, mandatory self-certification, safety assurance system assessments, registration and responding to breaches (c) Clearly defines the roles and responsibilities of states, territories and the Commonwealth (and a separate national agency if applicable) for regulating automated vehicle safety
5. Flexibility and responsiveness	(a) Can be implemented by 2020 (b) Allows for transition as international approaches evolve (c) Allows flexibility for industry by focusing on safety outcomes, minimising prescriptive requirements, remaining technology-neutral and allowing innovative solutions (d) Allows flexibility for government in addressing emerging safety risks (e) Allows for regulation of the ADS separate from the vehicle

5.4.1 High-level weighting of impact categories

To assist our analysis, we developed two materiality tests (as detailed in Appendix H) that show that, under a range of plausible assumptions, an effective safety assurance approach will provide:

- significant road safety benefits in terms of reducing the number and severity of road crashes

- significant economic benefits resulting from earlier and higher uptake of automated vehicles.

These benefits should be considered against the quantum of regulatory costs (or cost savings) and the costs to governments imposed by the reform options. Our testing of key materiality benefits in Appendix H notes that, based on current information, the assessment of these costs is highly uncertain. However, even under conservative assumptions on the effectiveness of regulatory safety options, these costs do appear to be a fraction of the value of the benefits that could be realised, in particular the road safety benefits.

As such, if we use these theoretical tests to accept the relative strength of the possible road safety benefits, the overall assessment of options should give a heavier weighting towards those options that deliver the greatest road safety benefits.

While the uptake benefits appear to be significant, there is limited information available to differentiate the options relative to this impact category. As such, no general weighting need be applied.

5.5 Individuals and groups likely to be affected

To assess the costs and benefits of the reform options it is important to identify the individuals and groups affected by the reform.

Table 88 outlines the key groups and individuals that are most likely to be affected by the reform options. We have added some groups based on stakeholder feedback.

Table 8. Groups likely to be affected

Impact category	Affected individuals and groups
1. Road safety	Road users, including vulnerable road users such as cyclists, motorcyclists and pedestrians (who may be injured or killed) General public (through wider costs of crashes) Public and private providers of transport, emergency response, health, infrastructure and insurance services (secondary beneficiaries)
2. Uptake of automated vehicles	Consumers and users of automated vehicles ADSEs Manufacturers (where these are different from the ADSE) Mobility service providers, road managers (secondary beneficiaries) Automotive service industry such as mechanics, modifiers and repairers (potentially disadvantaged) Professional drivers (potentially disadvantaged)
3. Regulatory costs to industry	ADSEs Manufacturers (where these are different from the ADSE)

Impact category	Affected individuals and groups
4. Regulatory costs to government	Commonwealth government State and territory governments and the National Heavy Vehicle Regulator National body responsible for administering the safety assurance system (options 3 and 4 only)
5. Flexibility and responsiveness	ADSEs Manufacturers (where these are different from the ADSE) Commonwealth government State and territory governments and the National Heavy Vehicle Regulator National body responsible for administering the safety assurance system (options 3 and 4 only)

5.6 Timeframe for assessment

The assessment considers the impacts of the options over a 10-year timeframe from 2020 to 2030. The 2020 starting point reflects the Australian Government's aim to have end-to-end regulation in place by 2020 to support the safe deployment of automated vehicles (Transport and Infrastructure Council, 2017, p. 3). The 2030 end date reflects the 'interim' nature of this regulatory proposal.

5.7 Assessing the options

We used a comparative analysis scale to assign each option a rating against each impact category. Table 9 shows the scale we use to indicate an option's comparative advantage or disadvantage compared with the baseline (option 1).

Table 9. Comparative analysis scale

Very negative impact	Negative impact	Neutral	Ambiguous/ uncertain	Improvement	Large improvement
The option would most likely result in a **large decline** compared with the baseline option	The option would most likely result in **some (limited or moderate) decline** compared with the baseline option	The option would most likely have a **negligible impact** compared with the baseline option	The option could result in an **improvement or decline** compared with the baseline option	The option would most likely result in **some (limited or moderate) improvement** compared with the baseline option	The option would most likely result in a **large improvement** compared with the baseline option

5.8 Testing the validity of the outcomes of this assessment

Finally, we tested the validity of the assessment outcomes by:

- examining outcomes against different deployment scenarios
- assessing the factors that would lead to a different preferred option.

Our recommended approach is set out in Chapter 8. This approach may need to be re-assessed, with further stakeholder input, as greater certainty about the future emerges.

6 Assessment of the options

Key points

- Based on our assessment, options 2, 3 and 4 all resulted in an overall benefit relative to the baseline option (option 1).
- Option 4 exhibits the most positive potential impacts, with large improvements to road safety and flexibility and responsiveness impacts, as well as moderate improvements to the uptake of automated vehicles.
- Option 3 presents similar results but somewhat lesser improvements to road safety and flexibility and responsiveness impacts compared with option 4. Option 3 does, however, present somewhat greater certainty around regulatory costs than option 4.
- Option 2 exhibits similar impacts to option 3 but to an equal or lesser extent in all impact categories.

6.1 Introduction

The consultation RIS provided a provisional assessment of the consultation options. This chapter provides an updated assessment of the final options as they are described in Chapter 3 of this decision RIS. As noted in that chapter, we have revised the assumptions underpinning all options to reflect both stakeholder feedback and our best assessment of what the status quo will be when automated vehicles become ready for commercial deployment. This has resulted in changes to our baseline option (option 1) and option 2. We have also refined our assessment method, including the assessment criteria, based on stakeholder feedback received. These changes were detailed in Chapter 5.

In this chapter, we update some of our assessments based on the changes noted above and stakeholder feedback.

6.2 Assessment of the options – general stakeholder feedback

On the whole, most stakeholders broadly agreed with our assessment of impacts of reform options (for example, Brisbane City Council, Maurice Blackburn, Queensland Government, Roads Australia). However, some stakeholders disagreed with aspects of the assessment to an extent that the cumulative disagreements would result in a different preferred option (for example, FCAI and TIC).

These views and our response to them are highlighted in the sections below relating to each of the five impact categories:

1. road safety
2. uptake of automated vehicles
3. regulatory costs to industry
4. regulatory costs to government
5. flexibility and responsiveness.

6.3 Road safety impacts

In any policy option or regulatory approach aimed at improving road safety, government and the community look for whether it reduces, or is likely to reduce, the number or severity of crashes.[32]

Automated vehicles provide an opportunity to improve the safety of the Australian vehicle fleet (see Appendix J for evidence on the expected benefits of automated vehicles). As noted in Chapter 1, the US Department of Transport attributes the cause of 94 per cent of all crashes to 'human choice'. The introduction of automated vehicles into the Australian vehicle fleet has the potential to reduce or remove the risk of human error to improve road safety.

Improving road safety through introducing automated vehicles relies on an option that addresses specific safety risks to:

- prevent ADSs with unacceptable safety risks from entering, or remaining in, the market (a failure to prevent ADSs with an unacceptable safety risk from entering or remaining in the market risks lowering, rather than raising, the safety of the Australian vehicle fleet)
- lower the safety risks of ADSs by raising overall safety standards
- bring forward the uptake of vehicles with ADSs that have acceptably low safety risks to achieve safety benefits earlier.

Each of the options to implement a safety assurance system (options 2, 3 and 4) progressively introduce greater levels of regulatory control that are specifically targeted at reducing safety risks.

6.3.1 Stakeholder feedback

Stakeholder feedback on the effectiveness of options to address road safety risks were divided, mostly around the relative effectiveness of option 4 compared with option 2 in delivering reasonable safety outcomes.

The majority of stakeholders who expressed a preferred option supported option 4 as the most (or only) effective option to address in-service safety issues over the life cycle of the vehicle. These stakeholders included state and territory road transport agencies, enforcement agencies, insurers, laws firms, consultancies and research bodies. Most other stakeholders who expressed a preferred option (for example, manufacturers, the TIC and DIRDC) considered that an option closer to the existing regulatory approach (the modified option 2) would be adequate to address life cycle safety risks without introducing uncertain regulatory requirements and unnecessary new costs.

The Victorian Government argued that the primary safety duty in option 4 applied for the life of the vehicle and, so far as reasonable practicable, to every software update and interaction between the software and hardware. Moreover, what constituted 'reasonably practicable' evolves over time to reflect change in the global market. Option 3, on the other hand, would not address software updates or other changes such as a manufacturer or vehicle owner changing the ADSE providing the software. Furthermore, a general safety duty would ensure

[32] Ideally, if sufficient, reliable data were available, the overall impact of the options on the road safety impacts could be measured by multiplying:

- the number and severity of crashes averted as a result of the option, by
- the average cost of a crash.

While there are a variety of estimates of the costs of different crash severities, it would be extremely challenging to estimate the extent to which the different options avert crashes or reduce their severity.

that safety risks are managed by those best placed to do so. The Victorian Government was particularly firm in its view that 'at a minimum, the only acceptable option for a safe automated vehicles scheme' was one that included general safety duties (among other features).

Nova Systems described how the 'primary safety duty should result in greater hazard identification and far more detailed root cause analysis, where the underlying problem is rectified, rather than just replacing a defective piece of equipment'.

The Queensland Government considered 'the primary safety duty will provide an overriding incentive for the ADSE to ensure that the ADS is designed to monitor vehicle performance and safety, and to take corrective action if issues are identified over the lifecycle of the ADS'.

Other stakeholders provided insights into the types of risks that a primary safety duty may address that would not be adequately addressed by the other options. In particular, a number of stakeholders highlighted that a primary safety duty would be more effective in addressing additional safety risks that are largely unknowable now but would emerge as ADS technology is deployed and further develops (for example, TCA, South Australian Freight Council). The Motorcycle Council of NSW noted that another risk the duty would capture was motorcycle safety.

Conversely, the TIC argued that a non-prescriptive primary safety duty will not address ADS safety risks, and the FCAI argued that they do not expect 'that the introduction of a primary safety duty will address any additional safety risks when the ADSE is a vehicle manufacturer'.

The AAA questioned what additional protections a primary safety duty affords consumers over and above what is required under the Australian Consumer Law. The AAA also argued that option 3 may be able to proactively address emerging ADS risks before the safety issue eventuates where a data sharing code is enforced by government and managed by the national body administering safety assurance.

6.3.2 NTC response

Our assessment shows that ADS safety risks, including those occurring in-service, are addressed to at least some extent by options 2, 3 and 4 via the safety criteria and obligations in the Statement of Compliance. We do not believe that the baseline option (option 1) would provide sufficient regulatory coverage of ADS safety risks.

Option 1 may address technical design risks identified at first supply. Options 2 and 3 would address these technical risks as well as other specific risks identified by the safety assurance system's safety criteria, including addressing known in-service operational safety risks that are identified at first supply. A risk remains that regulations to manage these known risks may not keep up with best emerging practices. Option 4, however, addresses both anticipated risks as well as risks that may not be well understood when the Statement of Compliance is approved. It also provides an incentive to manage new risks so far as reasonably practicable.

An effective regulatory system should be supported by an appropriate set of compliance and enforcement tools. Options 1 and 2 would provide for a suite of compliance and enforcement options set out in in the RVSA Bill (which will replace the current MVSA if passed). These new enforcement options are stronger than those currently available under the current MVSA. We do not believe that option 1 would provide a sufficient level of regulatory coverage because the compliance and enforcement options would not be linked to any ADS-specific safety criteria. Under option 2, the RVSA's compliance and enforcement options

would be directly linked to the safety assurance system's safety criteria at first supply; however, the RVSA's powers would be limited with respect to in-service safety performance.

Both options 3 and 4 provide a more comprehensive, and tailored, suite of compliance and enforcement tools that would be capable of meeting all the safety assurance system's safety criteria and obligations.

DIRDC has advised that, under the proposed ADR90/01, ADSEs will be recognised as the legal entity responsible for automated vehicle safety at first supply. We consider that this legal recognition may be valid for the ADS's in-service operation but may not necessarily be maintained if the original ADSE sells or transfers its operations to another entity.

As such we have updated our assessments of road safety impacts from the consultation RIS regarding criteria:

- (a) Covers ADS safety over the vehicle life cycle including at first supply, in-service and at end-of-life
- (c) Ensures there is always a clearly recognised legal entity responsible for risks associated with automated vehicles
- (g) Enables the introduction of targeted compliance and enforcement options including sanctions and penalties for noncompliance.

For criterion (a) option 2 is now rated green as fully meeting this criterion (previously amber for partially meeting it) to reflect the updated assumptions behind the option (that the RVSA will provide enhanced compliance and enforcement tools that include some in-service coverage) and changes made to the safety criteria.

We note that options 3 and 4 are likely to be more effective at addressing a more comprehensive set of safety risks because they are supported by compliance and enforcement tools targeted to the ADSE and linked to all of the safety assurance system's safety criteria and obligations.

We also note that only option 4 provides comprehensive coverage of in-service safety risks, including emergent risks that were unknown when the Statement of Compliance was approved, and provides incentives to adopt risk management practices so far as reasonably possible.

For criterion (c) we have rated both options 1 and 2 as amber for partially meeting this criterion (previously red) to reflect the improved, but limited, recognition of the ADSE as the responsible legal entity.

For criterion (g) we have rated option 2 as amber for partially meeting the criterion to reflect the improved, but limited compliance and enforcement tools available under the RVSA (that were not considered at the time of the consultation RIS). We did not change the rating of option 1 since it does not incorporate the safety assurance system safety criteria and therefore the improved compliance and enforcement tools would not be linked to addressing ADS-specific risks.

6.3.3 Assessment of options against road safety assessment criteria

Table 10 summarises the extent to which we consider each of the four options addresses the road safety assessment criteria.

Table 10. Assessment of options against road safety assessment criteria

	Option 1	Option 2	Option 3	Option 4
(a) Covers ADS safety over the vehicle life cycle including at first supply, in-service and at end-of-life	×	✓	✓	✓
(b) Covers parties that have not sought approval under the safety assurance system but who would be an ADSE if they sought approval	×	×	✓	✓
(c) Ensures there is always a clearly recognised legal entity responsible for risks associated with automated vehicles	×	✓	✓	✓
(d) Ensures responsibility sits with the party best able to manage the risk	×	×	✓	✓
(e) Addresses emergent safety risks that may not have been specifically identified or considered at first supply	×	×	×	✓
(f) Proactively addresses emerging ADS risks before the safety issue eventuates	×	×	×	✓
(g) Enables the introduction of targeted compliance and enforcement options, including sanctions and penalties for noncompliance	×	✓ Partially met. Compliance and enforcement options available under the new RVSA but may be limited for enforcement of in-service performance	✓	✓

We consider option 4 provides the greatest potential road safety benefits based on the road safety assessment criteria.

Option 1 does not meet any of the seven road safety assessment criteria.

Option 2 fully meets two criteria (a and c) and partially meets another (g). Its key features are that the ADSE would be recognised as the legal entity responsible for ADS safety through the ADR process. It would require ADSEs to demonstrate how they intend to manage in-service safety at first supply to market through the ADR approval process. It is also supported by the compliance and enforcement tools available under the RVSA; however; these may be limited with respect to addressing in-service safety performance failures. Therefore, option 2 may be an appropriate approach for safety at first supply, but it does not effectively address in-service risks.

Option 3 is likely to provide additional road safety improvement outcomes compared with options 1 and 2. Option 3 satisfies most of the road safety assessment criteria; however, it fails to address two road safety assessment criteria we consider are critical to ensuring an ADS is safe. These are:

- (e) Addresses emergent safety risks that may not have been specifically considered at first supply
- (f) Proactively addresses emerging ADS risks before the safety issue eventuates.

Option 4 meets all the road safety assessment criteria. The addition of a primary safety duty on an ADSE would create an overarching and positive general safety duty on the ADSE to ensure the safety of the ADS so far as reasonably practicable. The point of difference with option 3 is that this would require an ADSE to address safety risks that may not have been specifically covered or identified at first supply and to proactively address safety risks before they eventuate. In contrast, option 3 only provides specific and targeted penalties related to risks identified at first supply.

Overall, options 3 and 4 both rate more highly than option 2 because they would both:

- address the risks posed by unapproved aftermarket devices by covering parties that have not sought approval under the safety assurance system but who would be an ADSE if they sought approval (criterion b)
- ensure responsibility sits with the party best able to manage the risk (criterion d)
- enable the introduction of targeted compliance and enforcement options, including sanctions and penalties for noncompliance, that are targeted to addressing ADS specific safety risks (criterion g).

We rate option 4 higher than option 3 because it addresses more of the assessment criteria. Specifically, the primary safety duty is expected to capture and address new or unexpected safety risks that are not addressed in the Statement of Compliance (criterion e) and manage emerging safety risks before an incident occurs (criterion f).

This ensures safety standards increase over time as technology and practice improve and allows for a proactive approach to compliance rather than relying on a breach of the self-certification before addressing a safety concern.

6.4 Uptake impacts

The uptake impact category acknowledges that the potential benefits of automated vehicles (such as improved road safety, mobility, freight productivity, fuel efficiency and reduced road congestion) cannot be fully realised unless automated vehicles are widely used in Australia.[33]

The different regulatory options may provide varying levels of community confidence that automated vehicles are acceptably safe. An option that provides the community with confidence that automated vehicles are safe seems likely to result in automated vehicles

[33] Ideally, if sufficient, reliable data were available, the overall impact of the options on the uptake and penetration of automated vehicles would be measured by multiplying:

- the proportion of the vehicle fleet that has an automated driving system, by
- the average benefit of automated vehicles.

However, this data is not yet available, so we need to consider the logic that explains how the reform options would affect consumer confidence and therefore the uptake and penetration of automated vehicles.

being used in Australia more rapidly and making up a larger share of the Australian vehicle fleet. If this occurs, the safety and other wider benefits of automated vehicles may be greater and realised sooner.[34]

The extent that reform options would affect business and consumer confidence would be influenced by a range of factors including:

- real and perceived safety outcomes
- consumers' understanding of the effectiveness of each option to ensure acceptable safety.[35]

6.4.1 Stakeholder feedback

Stakeholders agreed with our reasoning that the potential benefits of automated vehicles cannot be fully realised unless automated vehicles are widely used in Australia. The AAA noted that 'for these benefits to be realised, both community and industry must be provided assurance that risks or uncertainties have been addressed'. Brisbane City Council also suggested that 'safety assurance will be the highest priority for purchasers of this new technology'.

The Heavy Vehicle Industry Association and an enforcement agency questioned the assumption that automated vehicles would in fact be safer than conventional vehicles, making the uptake impact analysis biased.

A number of stakeholders argued that option 4 would deliver the greatest level of community and industry confidence in the safety of automated vehicles (for example, the AAA, Motorcycle Council of NSW and the TCA) and that this increased confidence would result in an increased uptake of automated vehicles (Motorcycle Council of NSW).

The FCAI and TIC disagreed with the assessment of how options provide community assurance that automated vehicle safety risks have been comprehensively addressed. They noted that the current ADR approach (i.e. option 1) provides community assurance that vehicle safety risks have been comprehensively addressed, and this approach will soon be updated to recognise automated steering devices. The FCAI noted that this approach will 'continue to provide community assurance that the safety risks of the automated driving (steering) systems covered by the ADRs (UN Regulations) have been comprehensively addressed'.

The TIC further argued that option 4 does not provide a clear and consistent regulatory expectation to facilitate market entry, including national consistency and alignment with international requirements, because the regulatory and legal expectations of the primary safety duty are not clear or consistent. Industry have argued that this could delay manufacturers from bringing the technology to Australia and that delay costs could be significant.

6.4.2 NTC response

We acknowledge the nuances of the stakeholder feedback regarding criterion (a) 'Provides community assurance that automated vehicle safety risks have been comprehensively addressed'. We believe that while the current vehicle approvals system provides sufficient levels of consumer and industry confidence for conventional vehicles, a safety assurance

[34] See Appendix J for a discussion of the safety and other benefits of automated vehicles.

[35] Not all consumers are likely to have a comprehensive understanding of this and so there may not be a clear distinction between the levels of consumer confidence that could be attributed to each option.

system with specific safety criteria (options 2, 3 and 4) is required to assess the new technology and provide the community and industry with confidence that automated vehicles are safe.

Based on this logic we strongly believe that options 2, 3 and 4 would deliver superior consumer and industry confidence and therefore greater uptake of automated vehicles than option 1. Each of these options is rated 'green' as likely to result in an improvement.

As outlined in the preceding section on road safety impacts, we believe that option 4 is likely to deliver the most optimal safety outcome. All else being equal, over time, this should result in greater uptake of automated vehicles than would be the case under an option that did not deliver such safety outcomes. While there appears to be some stakeholder support around differentiating the rating of option 4 compared with options 2 and 3 (to reflect a significant improvement in automated vehicle uptake), we are uncertain of the degree to which a future market would react to the differing regulatory approaches and we have therefore adopted a conservative approach to the rating.

Regarding criterion (b) 'Provides clear and consistent regulatory expectations to facilitate market entry, including national consistency and alignment with international requirements', we believe that safety criteria that are a component of options 2, 3 and 4 will progressively be reviewed and aligned with international standards for automated vehicles as these develop (see Chapter 3 for further detail). We do accept, however, that the primary safety duty that is a key component of option 4 would be unique to Australia at this point in time and as a result may introduce uncertain or inconsistent requirements for Australia. A possible outcome is that manufacturers could delay introducing ADS technology into Australia, and that may bring significant delay costs. We have therefore amended the rating of option 4 from green to amber to reflect a partial meeting of this criterion.

6.4.3 Assessment of options against uptake assessment criteria

Table 11 summarises the extent to which we consider each of the four options addresses the uptake assessment criteria.

Table 11. Assessment of options against uptake criteria

	Option 1	Option 2	Option 3	Option 4
(a) Provides community assurance that automated vehicle safety risks have been comprehensively addressed	×	✓	✓	✓
(b) Provides clear and consistent regulatory expectations to facilitate market entry, including national consistency and alignment with international requirements	×	✓	✓	✓ Partially met. Application of a primary safety duty may be unique to Australia

Our uptake impact assessment outcomes show that the three reform options (options 2–4) all represent an overall benefit compared with the baseline option.

Options 2–4 would all provide community assurance that automated vehicle safety risks have been addressed. Of all the options, option 1 would deliver the least consumer assurance because the baseline regulatory systems that we expect to be in place will not address a range of critical automated vehicle in-service safety risks. These risks include compliance with relevant road traffic laws, installation of system upgrades, suitability under Australian-specific conditions, some aspects of education and training and data recording and sharing.

It is difficult to assess the differences in levels of community confidence that automated vehicles are safe between options 2, 3 and 4. While options 2–4 have all been rated similarly, it is likely that options 3 and 4 may provide greater community assurance than option 2. This is because options 3 and 4 provide for specific compliance and enforcement mechanisms, including penalties that are targeted to ADS specific risks. The existence of targeted penalties for failure to comply with compliance requirements could increase community confidence that ADSEs will provide accurate information about safety risks. An increased level of community confidence based on a particular reform option would be reliant on community education about the reform.

Option 1 has a clear administrative process, but there is limited clarity on what is required to satisfy this process. Options 2 and 3 provide clear and consistent regulatory expectations to facilitate market entry including national consistency and alignment with international requirements. Option 4 also provides clear and consistent regulatory expectations, but it introduces a primary safety duty that may be unique to Australia and could potentially result in some manufacturers delaying the introduction of ADS technology in Australia.

6.5 Regulatory costs to industry impacts

The regulatory costs to industry impacts category recognises that a safety assurance system will have regulatory costs for industry. If regulatory costs are too high, automated vehicles may not be introduced and used widely in Australia.[36]

In a RIS, existing regulatory costs are only applicable to the extent that they form the baseline option against which reform options are assessed. Our assessment of regulatory costs to industry is based on costs that would be incurred in direct response to the reform options (options 2–4).

6.5.1 Stakeholder feedback

Stakeholder feedback acknowledged the lack of quantification of regulatory costs in the consultation RIS and therefore the difficulty in assessing the options (for example, CARRS-Q). However, stakeholder feedback did not reveal any quantifiable regulatory costs to be included in the RIS.

Industry stakeholders were particularly concerned about costs associated with the primary safety duty in option 4. The FCAI argued:

[36] Ideally, if sufficient, reliable data were available, the overall impact of the options on the regulatory costs to industry and individuals would be measured by multiplying:

- the number of ADS certification/ safety assurance system applications, and
- the number of ADS registrations, by
- the average compliance, administrative and delay costs per process.

There is currently not sufficient data to calculate reliable regulatory cost estimates. Instead we have used qualitative information to complement assumed quantitative estimates.

> *The introduction of a non-prescriptive primary safety duty may lead to legal proceedings to interpret with inconsistent application across the jurisdictions is expected to delay the commercial deployment of highly automated vehicles by vehicle OEMs.*

Industry stakeholders including the FCAI, Heavy Vehicle Industry Australia and TIC also expressed concern about whether this obligation represents a misalignment with international approaches.

Some industry and government stakeholders acknowledged that, without government support, any regulatory costs imposed on vehicle manufacturers (ADSEs) – including government administrative costs passed on to industry through fees and charges – would most likely be passed on to consumers (BMW, another vehicle manufacturer and the Queensland Government), which may affect the uptake of automated vehicles. Additionally, BMW and the FCAI noted that high unanticipated costs on ADSEs could delay the introduction of automated vehicles into the Australian market.

Nova Systems identified that other regulatory costs to industry will depend on the level of regulatory oversight employed and its maturity. These costs could include: 'additional training, certification and professional membership costs (e.g. CPEng for Engineers)'.

The Western Australian Government, a road transport agency and an enforcement agency identified education and training requirements around developing and working within a self-certification safety assurance regime as likely to be significant costs to the industry, especially when considering the maturity of the industry and the likelihood of new companies entering the market. The Western Australian Government also cautioned that other unforeseen regulatory costs are likely to be present in practice.

6.5.2 NTC response

We acknowledge the feedback received and note that despite the lack of quantifiable costs, stakeholders generally agreed with the types of costs identified and the assessment provided.

The FCAI and the TIC, however, disagreed with the assessment that the ongoing administrative and delay costs of option 1 are uncertain and potentially higher than the other options. They argued that vehicle manufacturers have worked within the current regulatory system since the inception of the MVSA and are well aware of the administrative procedures, expectations, timings and cost structure the current system works. We accept that this system is clear and certain for conventional vehicles, as well as for traditional vehicle manufacturers; however, automated vehicles will certainly face a different set of assessment requirements prior to approval. Option 1 does not provide any clarity on what these requirements would be, whereas options 2, 3 and 4 provide clarity via the safety criteria of the safety assurance system.

The primary safety duty is similar to duties in WHS law, along with duties in the regulation of other modes of transport such as rail. We do not consider it will add a significant burden to ADSEs that already have strong safety systems in place; instead, we consider it will ensure a strong level of safety and dissuade poor operators who may undermine the industry.

Our recommended approach prioritises safety and is flexible enough to incorporate international standards as they are developed (see section 6.7 for more detail).

6.5.3 Assessment of options against regulatory costs to industry assessment criteria

We assessed the regulatory costs to industry against the criteria:

- (a) Results in low upfront and ongoing compliance, administrative and delay costs
- (b) Provides clear and consistent regulatory expectations to industry about its responsibilities and what is required to comply
- (c) Supports an approach that is consistent across all jurisdictions and is aligned with international requirements.

For criterion (a) we assessed compliance costs, administrative costs and delay costs separately.

Compliance costs

We consider that compliance costs may be incurred by industry, specifically manufacturers or ADSEs. These include:

- upfront or ongoing investments into compliance systems beyond what would have been invested in the absence of a safety assurance system
- costs of training employees beyond what would have been incurred in the absence of a safety assurance system.

A RIS is focused on incremental compliance costs that are incurred when affected parties face new additional costs to do what is required by the regulation. Compliance costs are therefore measured against the baseline option (option 1).

Options 2–4 require the industry to build internal systems and capabilities that involve additional compliance costs:

- Option 2 requires the industry to be able to demonstrate that the ADS meets the required standard and prepare a Statement of Compliance. To do this, the industry may need to invest in internal systems (for example, functional structures and governance) and capabilities (for example, employee training).
- Option 3 would include the same compliance costs as option 2 and but may also create some additional costs to develop systems and employee capabilities to ensure compliance with the Statement of Compliance. This additional cost would be driven by the presence of a stronger and more targeted compliance and enforcement regime (as compared with option 2) that covers the whole life cycle of the ADS; however, the magnitude of this additional cost is uncertain.
- Option 4 would include all the compliance costs of options 2 and 3. In addition, it would include costs to develop systems and employee capabilities to ensure compliance with primary safety obligations for those ADSEs not already covered by safety duties in other sectors (for example, fleet operators with a primary duty of care under WHS laws),

Options 2–4 impose compliance costs because they require the industry to build internal systems and capabilities to meet additional regulatory requirements. We expect that total compliance costs for each option would be driven by the magnitude of the additional regulatory burden imposed. Therefore, we would expect option 4 to have the highest compliance costs, followed by option 3 and then option 2. However, the quantum of total compliance costs associated with each option is unclear.

Administrative costs

We consider that administrative costs may be incurred by industry, specifically manufacturers or ADSEs. These include:

- time to prepare relevant documentation for the approval process
- the cost of making an application for approval, including any fees or charges paid
- costs incurred to test the ADS and/or conformity of the production process
- costs of sharing automated vehicle data with government – for example, information about whether an ADS was engaged when a crash occurred or information about ADS failures
- any additional record-keeping costs
- administrative steps necessary to satisfy primary safety duty obligations (option 4 only), where they would differ from the steps needed to meet obligations ADSEs might already owe under safety duties in other sectors.

Each option requires industry to do certain things that incur administrative costs:

- Option 1 only requires that ADSEs participate in the ADR process. While the international regulation UN R79 is expected to provide clarity around technical specifications for ADSs, ADSEs may also be required to meet additional and presently undefined requirements to demonstrate that ADSs are safe to deploy on Australian roads.
- Option 2 similarly only requires that ADSEs participate in the ADR process; however, in contrast with option 1, option 2 has clear and consistent regulatory expectations, as defined in the safety assurance system safety criteria. ADSEs would be required to prepare and submit a Statement of Compliance that addresses the specified safety assurance system safety criteria. Some of these criteria are likely to be consistent with the technical standards outlined in UN R79, while others will be additional.
- Option 3 requires ADSEs to maintain compliance with their Statements of Compliance, which may involve additional activities such as monitoring performance, sharing automated vehicle data with government (in certain circumstances) and/or responding to enforcement directives (sanctions and penalties), compared with option 2. Each of these activities will incur additional administrative costs.
- Option 4 defines ADSEs as the duty holders under the primary safety duty. This obligation introduces new administrative costs in addition to those described in option 3, particularly on ADSEs that are not already covered by safety duties in other sectors.[37] Primary safety duty obligations may differ between ADSEs because a primary safety duty is performance-based and can be tailored to be fit for purpose. Therefore, administrative costs to ADSEs are variable and uncertain across the industry as a whole.

We do not believe that the technical standards defined in UN R79 alone would be sufficient to satisfy a national body responsible for safety assurance that the ADSs were safe for commercial deployment. This means that an ADSE would need to provide an additional level of assurance that the ADS are safe. Under option 1, there would be no standards or specific

[37] For example, option 4 may involve additional costs to maintain risk management records to comply with primary safety duty obligations. Option 4 may also involve further costs associated with sharing information in the event of a primary safety duty investigation.

guidance to support this process. This would make the application process uncertain and potentially costly for industry.

A safety assurance system (options 2–-4) provides an ADSE with the certainty about the regulatory requirements, which option 1 does not.

We expect that option 2 is likely to have the lowest administrative costs of the four options because it has a clear process and regulatory expectations.

Options 3 and 4 introduce additional requirements on the ADSE, such that the ADSE is expected to incur additional administrative costs.

Under option 4, we expect that ADSEs, as duty holders, would incur higher administrative costs than under option 3. However, it is unclear whether the administrative costs under option 4 would be higher or lower than option 1.

Delay costs

Delay costs are expenses and loss of income incurred because of an application and/or approval delay. We consider delay costs may be incurred by the ADSE.

Option 1 provides less certain regulatory requirements than options 2–4, which involve well-defined safety assessment criteria under the safety assurance system. We consider that the increased certainty about what is required, for both the ADSE and those making the assessment, means ADSEs are likely to incur fewer delay costs under options 2–4. There is no reason to believe that delay costs would be significantly different between options 2, 3 and 4.

Table 12 summarises the extent to which we consider each of the four options addresses regulatory cost to industry assessment criteria.

Table 12. Assessment of options against the regulatory costs to industry assessment criteria

	Option 1	Option 2	Option 3	Option 4
a. Results in low upfront and ongoing compliance, administrative and delay costs	✓ (partially meets criterion) Lowest (baseline) upfront compliance costs Uncertain, but potentially higher ongoing administrative and delay costs	✓ (partially meets criterion) Higher upfront compliance costs but lower administrative and delay costs than option 1	✓ (partially meets criterion) Higher upfront compliance costs and potentially lower administrative costs than option 1 Lower delay costs than option 1	× Highest upfront compliance costs Higher administrative costs than option 3 expected, but uncertain as compared against options 1 and 2 Lower delay costs than option 1
b. Provides clear and consistent regulatory expectations to industry about its responsibilities and what is required to comply	✓ (partially meets criterion)	✓	✓	✓ (partially meets criterion)

	Option 1	Option 2	Option 3	Option 4
c. Supports an approach that is consistent across all jurisdictions and is aligned with international requirements	✓ (partially meets criterion)	✓	✓	✓ (partially meets criterion)

6.5.4 Summary of regulatory costs to industry impact assessment

There is significant uncertainty about the upfront and ongoing compliance, administrative and delay costs for each option.

Of the three types of regulatory costs, we anticipate that administrative costs would be the most significant because administrative costs:

- include significant regulatory requirements such as testing the ADS and/or conformity of the production process and preparing relevant documentation
- can be incurred multiple times, whereas the bulk of compliance costs may be dominated by once-off upfront costs.

Our conclusions are based on the qualitative assessment of the options against the relevant assessment criteria and stakeholder feedback. Options 1, 2 and 3 partially meet criterion (a) 'Results in low upfront and ongoing compliance, administrative and delay costs':

- Option 1 has the lowest (baseline) upfront compliance costs; however, the ongoing administrative and delay costs are uncertain and potentially higher compared with the other options.
- Option 2 would have higher upfront compliance costs and possibly lower administrative and delay costs compared with option 1.
- Option 3 introduces new administrative costs driven by the presence of a more targeted compliance and enforcement regime relating to maintaining compliance with the Statement of Compliance.
- Option 4 introduces additional administrative costs relating to the ADSE's role as a duty holder under the primary safety duty. Obligations under this duty are variable, therefore, administrative costs to ADSEs are also variable and uncertain across the industry as a whole. It should be noted, however, that there may be ADSEs who will already be subject to safety duties under other sectors (for example, fleet operators).
- Options 2, 3 and 4 require the industry to build internal systems and capabilities that involve compliance costs. These costs increase with increasing regulatory requirements, with option 4 expected to have the highest compliance costs. Again, it can be noted that some ADSEs may already be subject to compliance costs from meeting safety duties in other sectors.
- There is uncertainty around the significance of delay costs.

Options 2, 3 fully meet criteria (b) 'Provides clear and consistent regulatory expectations to industry about its responsibilities and what is required to comply' and (c) 'Supports an approach that is consistent across all jurisdictions and is aligned with international requirements':

- Options 2 and 3 provide clear and consistent regulatory expectations to industry about its responsibilities and what is required to comply. They also support an approach that is consistent across all jurisdictions and aligned with international requirements.

Options 1 and 4 partially meet criteria (b) and (c):

- Option 1 will have some regulatory certainty surrounding the technical standards contained in international regulations, but other important safety requirements remain undefined. By applying the technical standards contained in UN R79, option 1 has a degree of alignment with international requirements. However, option 1 risks inter-jurisdictional inconsistency, as state and territory government stakeholders have informed us that they are not prepared to rely on international technical standards alone, at least not in the short term.
- Option 4 has similar regulatory expectations to options 2 and 3, except that it introduces a primary safety duty. Some industry stakeholders have argued that this introduces significant uncertainty. We are not aware of any other international ADS market considering a primary safety duty at this stage,

6.6 Regulatory costs to government impacts

The regulatory costs to government impact category recognises that a safety assurance system would have upfront and ongoing costs to government. These costs need to be proportionate to the benefits.[38]

In this impact category we consider regulatory costs to:

- the Commonwealth government and/or a national agency administering the safety assurance system
- state and territory road managers and the National Heavy Vehicle Regulator.

Governments will face a range of ongoing and once-off administrative costs. This includes costs associated with building the necessary systems, capabilities and capacities.

The current vehicle certification process involves fees and charges to recover costs. Government costs for administering the safety assurance system may also be fully, or in part, recovered from the industry through fees and charges.

To the extent that fees and charges cover government costs, these fees and charges become administrative costs to the applicants (the ADSEs). Where costs are not fully recovered, governments bear the cost. More detail is provided on costs at different levels of government in Appendix L.

[38] Ideally, if sufficient, reliable data were available, the overall impact of the options on costs to governments would be measured by multiplying:

- the number of pre-approval applications for automated driving system (by vehicle/system type), and
- the number of for automated driving system registrations (by individual vehicles/systems), by
- the average administrative costs per process.

There is currently not fully sufficient data to calculate reliable regulatory cost estimates. Instead we have used qualitative information to complement assumed quantitative estimates.

6.6.1 Stakeholder feedback

Consulting firm Calibre recommended that administration costs be considered with respect to any safety accident investigation body needing to be set up as part of the regulatory duties to oversee the safety enforcement of the road regulations.

The ATA argued that autonomous vehicle crashes should be investigated by the Australian Transport Safety Bureau (ATSB). Using the ATSB's reported 2016–17 aviation and rail investigations costs, the ATA estimated that autonomous vehicles crash investigation costs could be between $5 and $10 million per year.

The ATA also recommended that ADSEs should be required to report safety critical events to the ATSB as well as the agency responsible for the safety assurance system (if this were different from the ATSB). The ATA argued that 'without independent safety investigations for learning lessons and making recommendations to improve safety such as those conducted by the US National Transportation Safety Board (NTSB), we simply will not understand and cannot ensure the correction of the root causes of safety incidents and crashes'.

The MAV recommended that council costs associated with supporting state road agencies in granting access permits, such as for trials, should also be considered. Brisbane City Council, however, concluded that the reform options would not affect local government.

The Victorian Government argued that option 4 would not introduce any significant additional costs because existing health and safety laws have public safety duties as well as safety duties on designers, manufacturers and suppliers of vehicles to ensure safe operation, so far as is reasonably practicable. As such the primary safety duty would not create a new obligation that results in additional regulatory burden but, in effect, provides sector specific regulators (such as road safety regulators) with the capacity to monitor compliance and enforce these duties.

DIRDC, the FCAI and manufacturers proposed an amended approach to option 2 whereby government costs could be reduced. In our updated assessment of the regulatory costs to government, we have noted how this amended option could reduce costs to governments.

6.6.2 NTC response

We note that the institutional arrangements to govern the safety assurance system have not yet been examined. We expect the role of existing agencies in investigating automated vehicle safety will be part of this upcoming work.

We also note the Victorian Government's point about existing WHS duties. We agree that some ADSEs may be subject to duties under WHS laws, as outlined in Chapter 3, potentially depending on business and ownership models. However, we also noted that the extent of this application to all ADSEs is uncertain and has not been tested.

In our updated assessment of the regulatory costs to government, we have noted how the FCAI's amended option could reduce costs to governments.

6.6.3 Assessment of options against regulatory costs to government assessment criteria

Table 13 summarises the extent to which we consider each of the four options addresses the regulatory costs to government assessment criteria.

Table 13. Assessment of options against the regulatory costs to government assessment criteria

	Option 1	Option 2	Option 3	Option 4
(a) Minimises upfront structural, organisational and regulatory change to implement the model, including a minimal impact on existing processes and minimal regulatory layers	✓	✓	×	×
(b) Supports efficient ongoing administrative processes including mandatory self-certification, safety assurance system assessments, registration and responding to breaches	×	✓ (partial support to respond to breaches of in-service aspects of some safety criteria)	✓	✓
(c) Clearly defines the roles and responsibilities of states, territories and the Commonwealth (and a separate national agency if applicable) for the regulation of automated vehicle safety	×	×	✓	✓

The overall government costs are largely uncertain at this time.

We expect that the most significant cost component would relate to administering the safety assurance system.

There is significant uncertainty around other potentially significant government costs such as monitoring, investigating and enforcing in-service safety incidents.

The significant once-off cost components include upfront investments into administrative systems, the cost of training employees and costs related to regulatory change. Again, there is currently insufficient information to estimate these costs.

Based on current knowledge, the overall comparative costs to government for the reform options (options 2, 3 and 4) are ambiguous compared with the baseline option.

6.7 Flexibility and responsiveness impacts

The flexibility and responsiveness category reflects the high level of uncertainty associated with ADS technology and international regulatory approaches. These are still developing. Any Australian regulation needs to be sufficiently flexible to allow for this uncertainty and for the regulatory system to respond and adapt.[39]

[39] For example, there is uncertainty about the level and nature of the systematic risks posed by automated vehicles, the future world in which the regulatory framework will operate (for example, future automated vehicles market structures, uptake and market penetration rates, future road safety outcomes, technological change and its effectiveness) and the impacts of the options themselves (for example, the behavioural response to reform options and their effectiveness).

In assessing the costs and benefits of any regulatory measure there is always a degree of uncertainty about the future world in which the regulatory framework will operate. The level of uncertainty is higher for anticipatory regulation of emerging technologies such as automated vehicles.

The regulatory approach needs to be flexible enough to provide for the high level of uncertainty. It needs to accommodate:

- a variety of business and operating models[40] – a failure to provide flexibility for future business models could restrict innovation and be costly to the economy
- an unknown technological mix – it is unclear which type of ADS technologies are more likely in the short and medium term.

6.7.1 Stakeholder feedback

The AAA agreed that 'flexibility and responsiveness of a regulatory response will be critical to the take-up of automated vehicles in Australia'. It also argued that 'failure to accommodate for rapid and dynamic changes in the environment could have detrimental economic outcomes by stifling innovation and resulting in a delay of take-up'.

The Western Australian Government agreed that 'providing sufficient flexibility to enable the regulatory framework and an overarching governance structure to cater for a range of technologies is essential'. Given the technology will most likely evolve over time, providing flexibility and the ability to cater for risks that emerge as a consequence of their deployment is a sound approach.

The TCA agreed that 2020 timeframe is highly challenging and therefore advises that Australia looks closely at, learns from and adapts current regulatory assessment frameworks and governance arrangements rather than starting with a blank page. There are aspects we do not need to — and cannot afford the time or cost to — reinvent.

Industry bodies argued that the likelihood of implementation by 2020 was overstated (FCAI, Heavy Vehicle Industry Australia) or will be very challenging (Nova Systems, TCA). Nova Systems also suggested that implementing options 3 and 4 would be extremely difficult if the safety assurance functions were executed using existing government departments. However, the desired implementation timeframe could be achieved if these functions were executed outside existing government departments (Nova Systems).

Toyota Australia explained that:

> *… it is important for Australia to maintain flexibility when considering selection of a reform option until such time that global markets have implemented a comprehensive regime. This will enable the Australian Government to implement international regulatory standards with minimal risk of Australian specific regulatory requirements with associated compliance burdens, which may render automated vehicle technology prohibitively expensive and impact the technology's introduction to the domestic market.*

6.7.2 NTC's response to stakeholder feedback

As noted in the assessment, implementation of options 3 or 4 by 2020 will be challenging. This timeframe will continue to be reviewed as our reforms progress.

[40] For example, solely private ownership, solely commercial fleets or mixed private ownership and commercial fleets.

We believe that all options are flexible enough to incorporate international standards as they are developed.

There is currently no internationally agreed approach to automated vehicle safety. However, as noted earlier in this decision RIS, we understand that the planned update to UN R79 will add technical standards for conditionally automated vehicles (nominally SAE level 3). DIRDC has advised that this update is expected to be adopted in mid-2020 and harmonised at that point into ADRs. UN R79 will need to be further updated to accommodate the technical standards for highly and fully automated vehicles (levels 4 and 5).

We understand that an international approach for standards for highly and fully automated vehicles is unlikely to be in place when some of these types of automated vehicles become available for commercial deployment.

The safety assurance approach is an interim measure until there is international agreement on a regulatory approach for automated vehicles. During this interim period, the safety criteria and safety assurance approach will be subject to review when United Nations regulations are updated to include technical specifications that cover automated vehicles. This ensures that our approach does not get ahead of international developments, yet still achieves progress.

The safety assurance system will enable industry to demonstrate safety by referencing approvals, tests or validation processes undertaken by other national governments. Safety regulation in Australia can align with a diverse range of safety assurance processes in other countries where these are commensurate.

6.7.3 Assessment of options against flexibility and responsiveness assessment criteria

Table 14 summarises the extent to which we consider each of the four options addresses the flexibility and responsiveness assessment criteria.

Table 14. Assessment of options against flexibility and responsiveness criteria

	Option 1	Option 2	Option 3	Option 4
(a) Can be implemented by 2020	✓	✓	✓ (possible but challenging)	✓ (possible but challenging)
(b) Allows for transition as international approaches evolve	✓	✓	✓	✓
(c) Allows flexibility for industry by focusing on safety outcomes, minimising prescriptive requirements, remaining technology-neutral and allowing innovative solutions	×	✓	✓	✓
(d) Allows flexibility for government in addressing emerging safety risks	×	×	×	✓

	Option 1	Option 2	Option 3	Option 4
(e) Allows for regulation of the ADS separate to the vehicle	×	×	✓	✓

The assessment notes that:

- options 3 and 4 will be challenging to implement by 2020
- all options allow for a transition as international approaches evolve
- options 3 and 4 allow flexibility for industry by focusing on safety outcomes, minimising prescriptive requirements, remaining technology-neutral and allowing innovative solutions
- only option 4 allows flexibility for government in addressing emerging safety risks
- options 3 and 4 allows for regulation of the ADS separate to the vehicle.

The flexibility and responsiveness impact assessment outcomes show that each of the three reform options provide an overall benefit as compared with the baseline option with an improvement increasing from options 2 through to 4.

7 Summary of assessment

Key points

- The multi-criteria analysis shows that option 4 is likely to have the most positive road safety impacts.
- This analysis was undertaken in the context of uncertainties about quantifiable costs and benefits, due to the emerging nature of automated vehicle technology.
- Our assessment of the options gives a heavier weighting towards options that deliver greater road safety benefits.
- To test the validity of the outcomes of the multi-criteria analysis we analysed how the options responded to possible future uptake scenarios. Options 3 and 4 performed stronger in high-uptake scenarios, and option 2 performed strongest in low-uptake scenarios.
- Lastly, we considered a range of factors that could be relevant for government in choosing an option.

7.1 Introduction

This chapter summarises the multi-criteria analysis undertaken in the previous chapter.

We have also tested the validity of the outcomes of this analysis by analysing how the options respond to four possible future scenarios. This is to account for a lack of certainty about how many people will use automated vehicles, and future business and ownership models. The scenarios provide for varying levels of uptake and spread across the vehicle fleet of automated vehicles in Australia and for different ownership models.

We then considered the most relevant factors for government in choosing a regulatory approach for automated vehicles and decide which factors are most plausible and persuasive.

Lastly, we used the multi-criteria analysis and scenario testing, and the factors we consider most relevant to choosing a regulatory approach, to come to a conclusion on the option with the greatest net benefit and a preferred approach.

7.2 Summary of multi-criteria analysis

Table 15 summarises the outcomes of the multi-criteria analysis undertaken in Chapter 6.

Table 15. High level multi-criteria analysis

Impact category	Option 1	Option 2	Option 3	Option 4
Road safety	This option represents the baseline option	The option would most likely result in **limited improvement** in road safety outcomes compared with the baseline option	The option would most likely result in a **moderate improvement** in road safety outcomes compared with the baseline option	The option would most likely result in a **large improvement** in road safety outcomes compared with the baseline option
Uptake of automated vehicles	This option represents the baseline option	The option would most likely result in a **moderate improvement** compared with the baseline option	The option would most likely result in a **moderate improvement** compared with the baseline option	The option would most likely result in a **moderate improvement** compared with the baseline option
Regulatory costs to industry	This option represents the baseline option	The option would most likely result in **moderate improvement** (lower costs) compared with the baseline option	The option would most likely result in a **moderate improvement** (lower costs) compared with the baseline option	The option could result in an **improvement or decline** compared with the baseline option
Regulatory costs to government	This option represents the baseline option	The option could result in an **improvement or decline** compared with the baseline option	The option could result in an **improvement or decline** compared with the baseline option	The option could result in an **improvement or decline** compared with the baseline option
Flexibility and responsiveness	This option represents the baseline option	The option would most likely result in **limited improvement** in flexibility and responsiveness outcomes compared with the baseline option	The option would most likely result in a **moderate improvement** in flexibility and responsiveness outcomes compared with the baseline option	The option would most likely result in a **moderate improvement** in flexibility and responsiveness outcomes compared with the baseline option
Summary	This option represents the baseline option	**Overall impacts:** This option would most likely result in moderate improvement compared with the baseline option	**Overall impacts:** This option would most likely result in moderate improvement compared with the baseline option	**Overall impacts:** This option would most likely result in large improvement compared with the baseline option

We acknowledge that the analysis has been conducted with a high degree of uncertainty due to a lack of clear quantitative evidence on which to base a number of these assessments.

Our analysis shows that all of the reform options (options 2–4) resulted in overall benefits compared with option 1 (baseline option).

Option 4 shows the most positive impacts, with large improvements to road safety against the baseline option, moderate improvements to the uptake of automated vehicles and flexibility and responsiveness impacts, and an ambiguous/uncertain impact to regulatory costs and costs to government.

Option 3 has similar results but somewhat lesser improvements to road safety compared with option 4. Option 3 does, however, present somewhat greater certainty around regulatory costs than option 4. Option 2 exhibited similar impacts to option 3 but with somewhat less positive road safety and flexibility and responsiveness impacts.

The options assessment does not explicitly weight the different impact categories; however, consideration was given to the relative potential magnitude, or materiality, of some of the key benefits.

In Appendix H we present our materiality testing of the key benefit categories. The testing drew on a literature review of research into cost of road accidents, causes of accidents and projected take-up rates of ADSs. This testing demonstrated that even under very conservative assumptions on the effectiveness of ADS regulatory safety options, the value of road safety benefits could greatly exceed plausible regulatory costs to industry and government.

Though it has not been possible to the measure regulatory costs to industry and government, at this stage we consider they are unlikely to be more than a fraction of the value of the benefits, particularly road safety benefits, that could be realised with improvements to the safety outcomes of ADSs through an effective safety assurance system.

As such our summary assessment in this decision RIS gives a heavier weighting towards options that deliver the greatest road safety benefits.

The additional regulatory oversight under option 4 has the potential to address road safety in two key areas over and above the other options: it ensures ADSEs remain liable for emergent safety risks that may not have been specifically considered at first supply; and it incentivises ADSEs to proactively address emerging ADS risks before a safety issue eventuates. As noted above, the costs to government and industry of this additional oversight are uncertain, but based on the materiality testing we have been able to do, at this stage we consider the potential additional costs of option 4 over the other options would not exceed its potential benefits.

7.3 Testing the validity of the outcomes of this assessment

As noted the assessment methodology, we tested the validity of the assessment outcomes by:

- examining the impact of options under different automated vehicle uptake scenarios
- discussing the factors that would lead to a different preferred option.

7.3.1 Impacts of options under different automated vehicle uptake scenarios

It is unclear how many people will use automated vehicles. It is also unclear if private vehicle ownership will be common for automated vehicles as is the case with conventional vehicles. Some analysts predict that shared vehicle ownership will become more common and replace private ownership.

To test the validity of the outcomes of the multi-criteria assessment, in this section we analyse which options respond best to four possible future uptake scenarios. The scenarios provide for varying levels of uptake, ownership models and spread across the fleet of automated vehicles in Australia. Each scenario is plausible and might require different features from a regulatory system.[41]

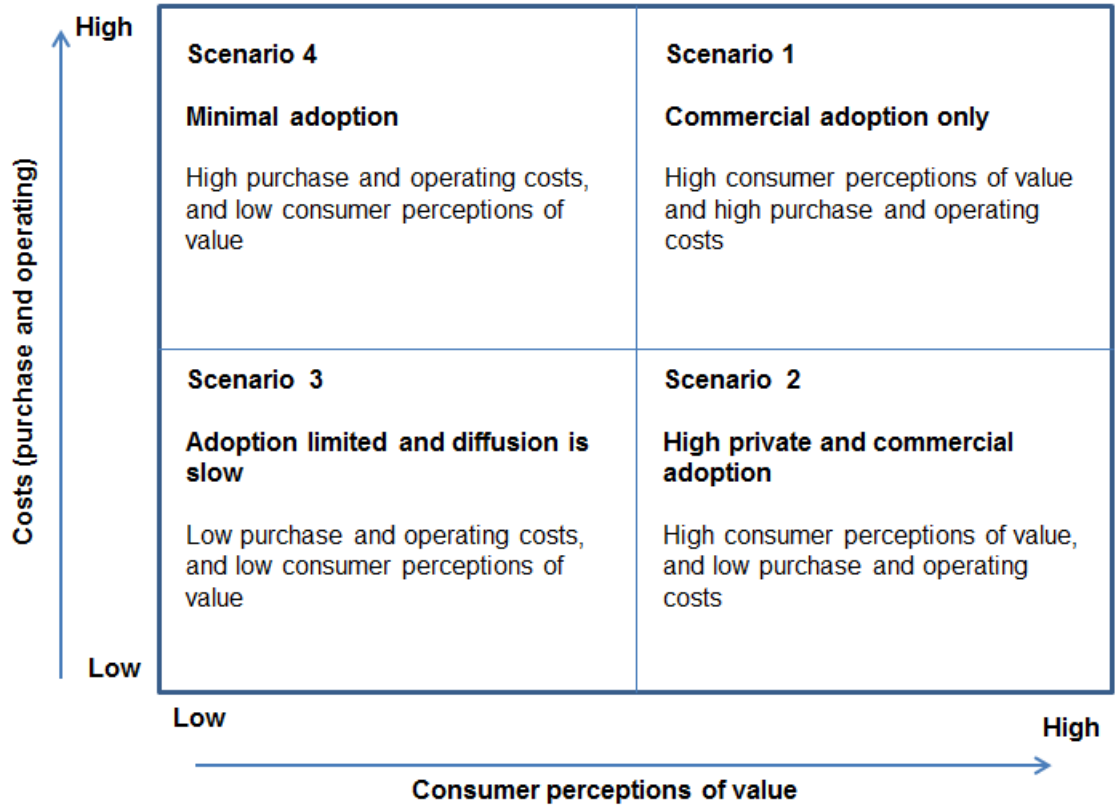
The following scenarios are set out in Figure 4:[42]

- commercial adoption only (top-right quadrant)
- high private and commercial adoption (bottom-right quadrant)
- adoption limited and diffusion is slow (bottom-left quadrant)
- minimal adoption (top-left quadrant).

[41] At this stage, it is difficult to know which scenario would be most likely to eventuate, but we can identify and monitor the factors that would influence consumer perceptions of automated vehicle benefits and costs. Factors influencing consumer perceptions of automated vehicle benefits include the effectiveness of regulations to ensure safety, safety record, enhanced mobility (particularly for people cannot drive or cannot afford to own a vehicle), extent of complementary benefits (for example, increased productive/leisure time and comfort) and ability to overcome technological obstacles. Factors influencing automated vehicle costs include the efficiency of the regulatory environment, global development and demand (product development and market forces), increased vehicle sharing, complementary developments/deployment of connectivity, electrification and sharing.

[42] These scenarios are established using a quadrant framework where four scenarios are established by the relationship of: costs of purchasing and operating automated vehicles, which also captures the technological path (where costs are expected to reduce over time); and consumer perception of value (benefits) of automated vehicles, which also captures the development of business models, such as increased vehicle sharing.

Figure 4. Automated vehicle uptake scenarios



Scenario 1: Commercial adoption only (top-right quadrant)

Upfront purchase costs are high and ownership of automated vehicles is limited to commercial operators.[43] Commercial operators are likely to require similar fleet vehicles (for example, taxi fleets). This means there would only be a moderate level of new automated vehicle applications each year.

Impacts of options

Under this scenario, there might be 100–200 new automated vehicle applications per year.[44]

With an increasingly shared vehicle fleet, the overall number of registered vehicles would fall, but each vehicle would travel more kilometres each year. This could present risks to in-service performance, which is addressed under options 2, 3 and 4 progressively. In-service performance is most comprehensively addressed by option 4 because the primary safety duty requires ADSEs to address emergent risks that were not identified in the Statement of Compliance. However, with most ADSEs being commercial operators under this scenario, it is likely they will be covered already by safety duties under WHS law.

Scenario 2: High private and commercial adoption (bottom-right quadrant)

Private and commercial consumers recognise and value the benefits of automated vehicles and upfront costs fall quickly. Commercial automated vehicle applications are widespread and automated driving functionality is included in all new vehicles suitable for private use (similar to air-bag, electronic stability control and satellite navigation rollouts). Automated

[43] Commercial operators could offset these costs against savings from reduced costs for human drivers.

[44] This is based on the current number of new vehicle applications of around 400 per year.

vehicle saturation of the new vehicle market occurs relatively quickly, within 10–15 years. As the existing vehicle fleet is replaced there is automated vehicle saturation of the in-service vehicle fleet in the subsequent 10–15 years.

Impacts of options

The strong demand for automated vehicles from both commercial operators and private users means there is demand for a wide variety of vehicle types. This will ensure a high level of new automated vehicle applications.

The overall fleet of registered vehicles would remain at similar levels to today, or even increase, as more potential owners realise the benefits of automated vehicles.

Options 2, 3 and 4 would deliver greater regulatory efficiency than option 1 because of the clear and targeted regulatory processes (new vehicle approvals under the safety assurance system).

Depending on the types of safety issues associated with widespread private and commercial automated vehicle uptake, option 4 may provide a necessary additional level of coverage of safety risks. The primary safety duty provides for new risks that were not identified in the Statement of Compliance. As the application of WHS duties of care to all types of ADSEs is not fully tested, the primary safety duty also ensures all ADSEs have duties to ensure safety as far as reasonably practicable given, regardless of whether ADSs are sold to commercial operators or private owners.

Scenario 3: Adoption limited and diffusion is slow (bottom-left quadrant)

Anticipated benefits of automated vehicles do not eventuate, automated vehicles are involved in a number of fatal crashes and consumer confidence in the technology falls. Despite being reasonably affordable, consumer ambivalence leads to limited uptake and demand for human-driven vehicles remains. The fleet becomes increasingly mixed, but automated vehicle replacement of human-driven vehicles does not occur.

Impacts of options

Under this scenario there are significant automated vehicle safety issues, but purchase costs are relatively low.

While demand for automated vehicles would be restrained, the low cost could attract consumers who may not choose to, or be able to, comprehensively assess the safety risks of automated vehicles before purchasing them. This possibility emphasises the need for an effective safety assurance system and a primary safety duty.

An effective safety assurance system that comprehensively addresses in-service safety performance would be imperative to protect public safety and to instil consumer confidence. Only options 3 and 4 would provide this protection.

Depending on the types of safety issues, option 4 may provide a necessary additional level of coverage of safety risks.

Scenario 4: Minimal adoption (top-left quadrant)

The cost of automated vehicles remains high and anticipated benefits do not eventuate. Private consumers remain concerned about high costs and safety risks, and commercial automated vehicle business models are not viable. Commercial and private consumers renew their preference for human-driven vehicles.

Impacts of options

Under this scenario, where automated vehicle purchase costs remain high and significant safety issues are prevalent, demand for automated vehicles is likely to be low. The regulatory costs of options 1 and 2 may be substantially lower than the higher once-off costs associated with options 3 and 4.

Given the identified safety issues in this scenario, some form of safety assurance would be necessary to protect the small number of consumers who choose to buy automated vehicles. Option 2 could provide adequate safety assurance while avoiding additional unnecessary regulation that would be better suited where automated vehicle volumes are higher.

Stakeholder feedback

HVIA suggests that scenarios 1 and 4 are for more likely to happen in the period out to at least 2025. Fatal accidents involving automated vehicles appear to be dampening public expectations on the likely rollout of high levels of automation.

Summary of scenario analysis

Our analysis of the scenarios is that options 2, 3 and 4 perform more strongly than option 1 in situations where there is a significant level of demand for automated vehicles (scenarios 1–3).[45]

Depending on the types of safety issues associated with different levels of demand for automated vehicles and dominant business models (for example, private, fleet or mixed-ownership models), option 4 may provide a necessary additional level of coverage of safety risks.

Where automated vehicle demand is relatively low because costs remain high and consumers perceive benefits to be low (scenario 4), option 2 may provide the most suitable approach. In the short term, automated vehicle demand may also be low because technology and markets are in their infancies. This early phase may exhibit similarities with the minimal uptake scenario.

7.3.2 Relevant factors for government in choosing an option

Different options could be preferred under different conditions. We have compiled a list of possible factors and conditions that could lead decision-makers to different preferred options.

Option 2 would be preferable if governments consider that:

- It is appropriate to take a cautious, incremental approach to regulation because of the uncertainty about the future including international regulatory approaches.
- A more robust Australian regulatory regime could be perceived as a disincentive for suppliers/operators to enter the market.
- The compliance and enforcement options made available under the RVSA are sufficient to mitigate uncertain future risks.

[45] Significant levels of demand are likely to occur if consumers see high benefits in automated vehicles (scenario 1: commercial adoption only, and scenario 2: high private and commercial adoption). It is also likely where consumer perceptions of value are low but purchase costs are also low (scenario 3: limited adoption).

- A self-certification system that includes generic and limited compliance and enforcement measures and limited coverage of in-service safety would be successful in achieving an acceptable level of safety.
- There would be sufficient time to implement additional regulatory measures (for example, options 3 or 4) if needed, once the technology is introduced into the Australian market.
- The public will accept this regime as providing sufficient reassurance about the safety of automated vehicles so as not to undermine the uptake of the technology.

Option 3 would be preferable if governments consider that:

- Self-certification on its own is insufficient to achieve an acceptable level of safety.
- The compliance and enforcement options made available under the RVSA are insufficient to protect all road users.
- Consumer law is insufficient to ensure ADSEs are held to account for safety failures without additional offences and penalties being imposed.
- A suite of appropriately targeted sanctions and penalties would be a sufficient additional factor to change the behaviour of ADSEs to achieve acceptable safety outcomes.
- The additional cost, both in terms of government administration and compliance costs imposed on ADSEs, are outweighed by the additional safety benefits achieved.
- It is possible to formulate requirements, offences and penalties so they do not require ongoing revision and updating as ADS technology and the market for it evolve.
- Implementing penalties to supplement the self-certification system if the need arises would be too slow and unduly risk safety either because technology may evolve very rapidly or because it would take a long time for governments to implement more targeted compliance and enforcement measures as an incremental regulatory step above option 2.
- Additional costs of implementing this regime are likely to be low because it will only need positive action by governments if ADSEs breach legal requirements.
- It is broadly in line with regulatory regimes in key international markets and would not discourage potential suppliers from entering the Australian market.
- It is likely to lead to greater uptake of automated vehicles than option 2 because the public view it as providing better assurance about the safety of automated vehicles.

Option 4 may be preferable where governments consider that:

- The potential and unknown safety risks associated with ADSs are so significant that a primary safety duty is required to provide ADSEs with an additional incentive (over and above options 2 and 3) to manage the safety of the products and services they provide.
- Options 2 and 3 cannot cover all foreseeable future safety risks, and the broad nature and flexibility of a primary safety duty is needed to manage these.
- Additional costs are likely to be relatively low due to the primary safety duty applying to ADSEs only and because general safety duties such as WHS already cover a broad range of potential obligations.
- This option would not be significantly more onerous than regulatory approaches in key international markets and would not discourage potential suppliers from entering the Australian market.

- This option would significantly enhance the public's confidence in automated vehicles (over and above options 2 and 3), and this enhanced confidence would potentially translate into higher uptake rates.

Stakeholder feedback

Stakeholders broadly agreed with the relevant factors and conditions presented in this chapter, but there were some stakeholders that disagreed; these are highlighted below.

Nova Systems and the Western Australian Government highlighted that a cautious, incremental approach would result in uncertainty for the public and manufacturers. This could in turn affect costs and the uptake of automated vehicles, which would see Australia lag behind the rest of the world in realising the vital safety improvements that are promised for automated vehicles.

The FCAI and TIC did not agree with our analysis and views, specifically that:

- Option 2 may not provide adequate means of ensuring that ADSEs ensure safety.
- The use of targeted sanctions and penalties alone in option 3 is also unlikely to result in sufficient safety outcomes because they do not provide sufficient incentive to ADSEs to address emerging safety risks.

The FCAI and TIC consider that the existing regulatory regime provides an adequate means of ensuring that ADSEs ensure safety and there are already sufficient sanctions and penalties to provide an incentive to ADSEs to address emerging safety risks. Furthermore, the new RVSA has been designed to provide greater flexibility for the government's compliance and enforcement regime, including recall provisions. The FCAI and TIC considered that any potential and unknown safety risks with commercial deployment of vehicles fitted with ADS will be best managed via the existing vehicle regulatory system.

Our view on relevant factors for government

Overall, we consider that the factors that would suggest option 4 as the preferable option are more plausible and persuasive than those favouring the other options at this stage. We consider that option 2 may not provide adequate means of ensuring that ADSEs ensure safety because it may not provide adequate means of ensuring safety after first supply. The use of targeted sanctions and penalties alone in option 3 is also unlikely to result in sufficient safety outcomes because they do not provide sufficient incentive to ADSEs to address emerging safety risks.

Option 4 could enhance actual and perceived safety compared with options 2 and 3 via a primary safety duty by providing ADSEs with appropriate incentives to proactively address unknown and emergent safety risks so far as reasonably possible, for the whole life cycle of the ADS. In addition to improving actual safety outcomes, this may also increase the public's confidence in automated vehicles. This enhanced confidence might increase uptake and saturation of automated vehicles in the Australian fleet. It may also reduce the need for frequent legislative amendment to cover newly identified safety risks. Option 4 is more likely to give government sufficiently flexible enforcement and compliance mechanisms to ensure that ADSEs consider and address safety risks that emerge once the automated vehicle is in service.

8 Recommended approach and further work

Key points

- Our analysis in Chapter 7 shows that option 4 could provide the greatest benefit compared with the baseline option and, in particular, would address more of the safety risks identified under the road safety impact category. This was our preferred option in the consultation RIS and received the most support from stakeholders via the consultation process.
- However, we acknowledge the significant uncertainty inherent in this analysis. We did not receive significant new data and evidence from the consultation process to further quantify the analysis.
- As a result, we recommend a composite approach that incorporates a safety assurance system for ADSs into existing frameworks at first supply (option 2), with further work to be undertaken to assess in-service safety duties (as included in option 4) and other relevant in-service matters.

8.1 Stakeholder feedback

The majority of stakeholders who expressed a position in their written submissions agreed with our provisionally preferred option from the consultation RIS, option 4. This preference was expressed by governments, research bodies, consultants, lawyers and some industry bodies.

Some stakeholders supported the option in principle but had some concerns around the clarity of costs for each option (for example, AAA, ARRB, Nova Systems). Some stakeholders (for example, ARRB and a vehicle manufacturer) suggested that our preferred option should remain provisional until we have a better understanding of how automated vehicles may operate, what their needs are (for example, infrastructure and security) and the details of how the safety assurance system would work (clarifying institutional and governance arrangements and legislative approaches).

Some industry stakeholders expressed strong preferences for the modified option 2 (for example, BMW, Mercedes-Benz Australia Pacific, another vehicle manufacturer, FCAI, TIC, ZF Friedrichshafen). DIRDC suggested a staged approach, starting with option 2, with development at the same time of either options 3 or 4 to potentially be added at a later stage once further details on institutional arrangements have been thoroughly investigated.

The Heavy Vehicle Industry Australia noted that it was not necessary to choose an option now and expect that option to be valid for the period 2020–2030. They suggested it would be more sensible to wait until the future market conditions in which ADSs will operate are clearer before choosing the option.

As noted in Chapter 4, there was general support for the safety criteria and obligations that would form the basis for a safety assurance system.

8.2 Results of the assessments are subject to uncertainty

As noted earlier in the RIS, the full monetisation of costs and benefits was not possible due to the emerging nature of automated vehicle technology. The degree of uncertainty made it impractical to carry out a quantitative cost-benefit analysis. Instead, we conducted a multi-

criteria qualitative assessment of the likely benefits and costs of each option, informed by supplementary quantitative information and testing where available. Through the consultation process, we asked stakeholders to provide additional information or data to help us clearly describe or quantify benefits. We did not receive significant new data and evidence through the consultation process.

We developed two materiality tests (detailed in Appendix H) which show that, under a range of plausible assumptions, an effective safety assurance approach will provide significant road safety benefits and economic benefits resulting from earlier and higher uptake of automated vehicles. In these theoretical tests, we demonstrated that even under conservative assumptions on the effectiveness of ADS regulatory safety options, the value of road safety benefits could greatly exceed plausible regulatory costs to industry and government. As such, we consider the option that effectively addresses the most safety risks will exhibit the most positive impacts overall.

However, we also acknowledge the significant uncertainty inherent in this analysis due to the emerging nature of the technology and consequently the lack of quantitative data and evidence about the safety benefits and regulatory costs of the different options. The four options have been assessed in a highly uncertain environment where governments are taking regulatory action in anticipation of an unknown future.

Within this context, our multi-criteria analysis concluded that option 4 exhibits the most positive impacts and, in particular, is the only option to address each of the seven assessment criteria under the road safety impact category. Specifically, the additional regulatory oversight provided by the primary safety duty under option 4 has the potential to address road safety in two key areas over and above the other options: it ensures ADSEs remain liable for emergent safety risks that may not have been specifically considered at first supply (criterion 1(e)); and incentivises ADSEs to proactively address emerging ADS risks before a safety issue eventuates (criterion 1(f)).

We also analysed which options respond best to four possible scenarios. The scenarios provide for varying levels of uptake, ownership models and spread across the vehicle fleet of automated vehicles in Australia. In three of the four scenarios we assessed, options 3 and 4 appear as performing more strongly than options 1 and 2. This was for scenarios where there is a significant level of demand for automated vehicles. Depending on the types of safety issues associated with different levels of demand for automated vehicles and dominant business models (for example, private, fleet or mixed-ownership models), option 4 may provide a necessary additional level of coverage of in-service safety risks by requiring ADSEs to address emergent risks that would otherwise not be addressed under the other options.

There are several factors that governments must consider in choosing a regulatory approach for automated vehicles. They affect which option is considered preferable. We outlined the factors that we considered relevant to each option. Overall, we considered that the factors that would suggest option 4 as the preferable option were more plausible than those favouring the other options. We noted in particular that option 4 was the option most likely to incentivise ADSEs to address safety risks that only emerge after an ADS is in-service.

8.3 Recommended approach and implementation

Our analysis concludes that option 4 is likely to exhibit the most positive impacts over the life of the ADS, particularly in regard to road safety. However, as outlined above, we acknowledge the uncertainties inherent in assessing the impacts of new technologies and the regulatory approaches to those technologies.

While the majority of submitters showed a preference for option 4, we also recognise that:

- a number of submitters sought further detail on the extent and application of a primary safety duty and how such a duty would align with other obligations on an ADSE or on other parties
- automotive manufacturers strongly supported using existing regulatory frameworks as providing a practical way to manage the safety of ADSs at first supply, maintain a single regulator for industry and allow transition to international standards as they develop.

After considering all submissions and holding further discussions between Commonwealth, state and territory governments, we consider it appropriate to recommend a composite approach to address the safety of ADSs. We recommend an approach to safety at first supply but do not recommend an approach for in-service safety at this time. Instead, we recommend a further stage of work on in-service safety.

8.3.1 First supply

At first supply, we recommend the approach outlined in option 2. This approach incorporates the recommended safety criteria and obligations into the existing vehicle certification framework (Australian Design Rules) administered by the Commonwealth government.

Under this approach:

- Australia will adopt a single, national, mandatory self-certification approach to ADSs to ensure the safety of this technology as it enters the Australian market.
- The recommended safety criteria will be incorporated into ADRs to allow for standard certification of ADS vehicles and the transition to international standards as they develop.
- The Commonwealth will take responsibility for regulating first supply of ADSs in consultation with states and territories.

This approach provides legislative certainty to industry and ensures that the ADSE is clearly identified. It will involve the Commonwealth taking responsibility for regulating ADSs at first supply in consultation with states and territories. We will continue to work with DIRDC to inform development of ADR 90/01, which will incorporate the safety criteria and obligations agreed by ministers.

8.3.2 In-service

For in-service safety, we recommend further work to develop an appropriate approach. This is in order to better assess the costs and benefits of potential approaches to in-service safety, including the safety benefits and regulatory costs. The work will cover three key areas: the appropriate in-service safety duties, the parties they should apply to, and the institutional arrangements to govern in-service safety.

We will lead this work in conjunction with Commonwealth and state and territory governments. The work will build on the findings of the RIS, particularly regarding the likely benefits identified under option 4. It will also allow the outcomes of the RIS to be incorporated into what is currently a separate reform on changes to driving laws to support automated vehicles.[46] This will allow broad in-service safety duties and specific obligations currently in the Road Rules to be examined together to ensure that there is a holistic

[46] See https://www.ntc.gov.au/current-projects/changing-driving-laws-to-support-automated-vehicles/.

approach and that we do not place prescriptive obligations (relating to the dynamic driving task) onto an ADSE that would be covered by other safety duties.

Appendix A Overview of consultation

In May 2018 the NTC published the *Safety Assurance for Automated Driving Systems: Consultation Regulation Impact Statement* (Consultation RIS) seeking feedback on how Australia should regulate the safety of automated vehicles. The Consultation RIS outlined the key problem risks that need to be addressed to ensure the safe commercial deployment of automated vehicles in Australia and identified and assessed the relative costs and benefits of the four options to address the key problem risks.

We engaged in a thorough consultation program between 14 May and 9 July 2018. This involved hosting 11 information sessions between 1 and 18 June 2018 with both industry and government stakeholders in every state and territory.

The purpose of the information sessions was to assist industry stakeholders' understanding of the reform options and safety assessment criteria, provide a forum to ask questions and raise issues, seek additional evidence of the costs and benefits of the reform options and gather any initial feedback on the reform options.

We also ran a workshop at the Future Vehicles Summit in Melbourne and presented at an ITS Australia webinar in June. Officials also travelled to the US and Europe to meet with international industry and government stakeholders.

To encourage participation in the consultation process, we also wrote to international original equipment manufacturers inviting them to provide a submission to the consultation RIS. We also released two short videos on our YouTube, LinkedIn and Twitter pages. The first video aimed to raise awareness of our automated vehicle program, and the second video announced the opening of the formal consultation period for the consultation RIS and provided background information.

We received 62 written submissions. These submissions came from transport agencies, manufacturers, automobile clubs, insurers, law firms, consultants and research bodies. A list of the public submissions is in Table 16.

Table 16. Public submissions

Name of organisation	Abbreviation	Description
Audi Australia	–	Automobile manufacturer
Australia and New Zealand Driverless Vehicle Initiative	ADVI	Initiative led by the Australian Road Research Board to support deployment of automated vehicles
Australasian New Car Assessment Program	ANCAP	Independent vehicle safety advocate
Australian Road Research Board	ARRB	Australian research agency that provides independent, applied research and consulting services for Australian and New Zealand state road agencies and communities
Australian Automobile Association	AAA	National peak body representing automobile clubs
Australian Logistics Council	–	Peak body representing major and national companies in the heavy vehicle, freight transport and logistics supply chain
Australian Trucking Association	ATA	National peak body representing trucking operators

Name of organisation	Abbreviation	Description
Austroads	–	Peak organisation of Australasian road transport and traffic agencies
BMW	–	Automobile manufacturer
Brisbane City Council	–	Local council
Calibre	–	Consultancy firm
Centre for Accident Research & Road Safety – Queensland	CARRS-Q	Research centre
Department of Infrastructure, Regional Development and Cities	DIRDC	Commonwealth government department
Federal Chamber of Automotive Industries	FCAI	National peak body for manufacturers and importers of light vehicles and motorcycles
Geoffrey Taylor	–	Individual
GM Holden	–	Automobile manufacturer
Heavy Vehicle Industry Australia	HVIA	Industry advocate for manufacturers and suppliers of heavy vehicles
Insurance Australia Group	IAG	Insurance company
IoT Alliance Australia	–	Peak industry body representing IoT in Australia
iTech Labs	–	Testing laboratory for online gaming systems certification and quality assurance testing
Intelligent Transport Systems Australia	ITS Australia	Independent not-for-profit incorporated membership organisation representing ITS suppliers, government authorities, academia and transport businesses and users
Law Institute of Victoria	LIV	Peak body for legal professionals in Victoria
Maurice Blackburn Lawyers	–	Law firm
Mercedes-Benz Australia/Pacific	–	Automobile manufacturer
Motor Trades Association QLD	–	Peak body representing the interests of these employers in the retail, service and repair sectors of Queensland's automotive industry
Motorcycle Council of NSW	–	Internationally recognised umbrella group for motorcycle clubs, associations and ride groups in New South Wales
Municipal Association of Victoria	MAV	Peak body for councils in Victoria
National Farmers' Federation	–	Peak national body representing farmers and agriculture across Australia
National Heavy Vehicle Regulator	NHVR	Australia's first national, independent regulator for all vehicles over 4.5 tonnes gross vehicle mass
Nova Systems	–	Consultancy firm
National Roads and Motorists' Association	NRMA	Insurance company
Office of the Victorian Information Commissioner	OVIC	Primary regulator and source of independent advice to the community and the Victorian Government about how the public sector collects, uses and shares information
Prof. Brian Fildes	–	Individual

Name of organisation	Abbreviation	Description
Prof. Robert Sparrow and Dr Mark Howard	–	Individuals
PricewaterhouseCoopers	–	Consultancy firm
QBE	–	Insurance company
Queensland Government (submitted by Department of Transport and Main Roads)	–	State government
Office of the Information Commissioner Queensland	OIC	Primary regulator and source of independent advice to the community and the Queensland Government about how the public sector collects, uses and shares information
Royal Automobile Club Queensland	–	Insurance provider and automobile club
Royal Automobile Club WA	RAC WA	Insurance provider and automobile club
Research Centre for Integrated Transport Innovation – UNSW	rCITI	Research centre
Roads Australia	–	Peak body of road industry stakeholders
South Australian Freight Council	–	Industry-based association
Steven Shladover	–	Individual
Systra Scott Lister	–	Consultancy firm
Transport Certification Australia	TCA	Australian government body responsible for providing advice, accreditation and administration services for public purpose initiatives involving the use of telematics and related intelligent technologies
Toyota	–	Automobile manufacturer
Tractor and Machinery Association	–	Member-based industry organisation
Transurban	–	Road operator company that manages and develops urban toll road networks
Truck Industry Council	TIC	Australia's peak truck manufacturer and major component supplier group
Uber Advanced Technologies Group	Uber	A peer-to-peer ridesharing, taxi cab, food delivery and transportation network company
Victorian Government	–	State government
Western Australian Government (submitted by Department of Transport)	–	State government

Appendix B Additional issues raised by stakeholders

Issue	NTC response
Move to a national registration system Raised by: A road transport agency	Austroads is considering registration and licensing requirements for automated vehicles. A national registration system is outside of current NTC and Austroads work.
Civil penalty regime Raised by: A road transport agency	Civil penalties may be considered as our reform program on automated vehicles continues.
Detailed compliance and enforcement mechanisms Raised by: An enforcement agency	The detail of any new compliance and enforcement mechanisms to enforce the in-service safety assurance of ADSs will be considered and consulted on in a further phase of work.
Institutional arrangements Raised by: A number of stakeholders	Our recommended approach in the decision RIS establishes an approach to safety at first supply (option 2) that operates within existing regulatory frameworks. The relevant institution to administer this is the Commonwealth Department of Infrastructure, Regional Development and Cities. The institutional arrangements for in-service safety will be considered and consulted on in the next phase of work. This will include consideration of the appropriate powers and allocation of functions between different levels of government or other agencies.
Specific obligations on ADSEs (for example, to develop safety management plans and national road safety campaigns) Raised by: A road transport agency, Calibre, Nova Systems	Our recommended approach in the decision RIS includes further consideration of in-service safety, which includes duties and the parties they should apply to. Specific obligations imposed on parties will be considered in the future, either in the policy development stage by the NTC, or by the bodies responsible for administering the safety assurance system.
Non-road automated driving systems Raised by: Geoffrey Taylor, Truck Industry Council	Our automated vehicle reform program focuses on light and heavy road vehicles. Other types of ADSs fall outside the scope of this work, but in future it is possible that similar safety assurance approaches could be considered.
Infrastructure (including physical infrastructure and V2V/V2I) Raised by: AAA, Brisbane City Council, Calibre, CARRS-Q, FCAI, Geoffrey Taylor, IAG, IoT Alliance Australia, iTech Labs, Municipal Association of Victoria, Truck Industry Council, Queensland	We acknowledge the importance of appropriate infrastructure to accommodate the safe operation of automated vehicles. Austroads is assessing the infrastructure design changes required through its Connected and Automated Vehicle program. Further information can be found on the Austroads website at: https://austroads.com.au/drivers-and-vehicles/connected-and-automated-vehicles.

Issue	NTC response
Government, an enforcement agency	
Mobility Raised by: CARRS-Q, ARRB, GM Holden	We have included mobility as part of our assessment criteria for the multi-criteria analysis within the 'uptake impact' category.
2020 timeframe for NTC automated vehicle program Raised by: ADVI, Calibre, Geoffrey Taylor, Queensland Government, a road transport agency	We will keep this timeframe under review based on feedback from industry and governments as our automated vehicle program progresses.
Self-certification not appropriate Raised by: CARRS-Q, IAG, Municipal Association of Victoria and the Western Australian Government	We consulted in 2017 on the high-level approach to safety assurance. This included four options – no change, self-certification, accreditation and pre-market approval. Stakeholders indicated strong support for self-certification. Transport and Infrastructure ministers agreed in principle to a self-certification approach to self-certification at their November 2017 council meeting. This was subject to a cost-benefit analysis (this decision RIS).
Liabilities for road authorities Raised by: Brisbane City Council	The NTC considered liabilities for road authorities as part of an earlier stage of work on automated vehicles. At the time there was not support for changing the current approach.
Automated Driving Assistance Systems (ADAS) Raised by: ARRB, a road transport agency and an enforcement agency	The scope of the NTC's safety assurance reform work is limited to ADS systems (level 3 and above). We are, however, aware that there may be overlaps in the safety considerations for ADASs and ADSs.
Heavy vehicle chain of responsibility duties Raised by: Queensland Government	We are considering the interaction of a safety assurance system with duties already held by parties in the chain of responsibility in the regulatory framework for heavy vehicles. This will include consideration of the review of the Heavy Vehicle National Law that is taking place concurrently within the NTC.

Appendix C Safety risks associated with automated vehicles

We have identified three types of safety risks associated with automated vehicles:

1. Design risks
2. Organisational risks
3. Operation/use risks.

These risks have been updated slightly based on stakeholder feedback on the consultation RIS.

C.1 Design risks

Inadequately designed and tested automated driving systems (ADSs) or associated modifications have the potential to lead to crashes. New risks or hazards could include:

- technological failure (malfunction due to incomplete design requirements and specifications)
- cybersecurity failure (for example, hack or attack due to poor design)
- software updates introducing new safety issues (poor quality control or the update is not supported by the vehicle's operating system)
- failure to function as expected in approved operating environments/conditions (system not up to the task)
- the ADS not being suited to Australian environmental or driving conditions
- the aftermarket system does not integrate safely with the existing vehicle
- the vehicle meets design criteria but still causes a safety risk in operation.

These types of risks would be best managed by the vehicle manufacturer or the automated driving system entity (ADSE).

C.2 Organisational risks

Organisational risks include:

- failure by the ADSE to address safety issues that emerge over time (software or hardware) – for example, through lack of appropriate support
- use of third-party components that do not meet safety requirements
- failure to monitor the performance of the system
- failure to adapt the system to changes in regulation over time
- failure to adapt the system to changes in the road environment over time
- insolvency of the ADSE
- the ADSE no longer supports legacy versions of the ADS
- the company deploys an ADS (native, aftermarket or through software upgrade) that has not been through the self-certification process

- failure to monitor and issue security updates as required.

These types of risks would be best managed by the vehicle manufacturer or the ADSE.

C.3 Operational/use risks

Operational/use risks include:

- use in inappropriate environments/conditions
- misuse outside the operational design domain
- insufficient infrastructure (or infrastructure failure)
- technological failure (degradation of hardware due to poor maintenance/repair)
- cybersecurity failure (for example, hack or attack due to failure to follow security protocols)
- software updates (failure to apply)
- divided/competing or contradictory responsibilities (between the driver and the ADS)
- unclear responsibilities of human drivers in different vehicles
- under or over trust of the ADS by users
- aftermarket fitment and vehicle modifications adversely impacting the ADS's performance
- vehicle repairs adversely impacting the performance of the ADS due to error or lack of understanding of the ADS's operation
- repairers unable to assess the impact of repairs to an ADS.

These types of risks would be best managed between a number of players including the vehicle manufacturer or the ADSE, ADS repairers, registered vehicle owners or operators.

Appendix D Compliance and enforcement for safety assurance

D.1 Compliance and enforcement measures relating to safety assurance

The purpose of a compliance and enforcement regime is to encourage desirable behaviour and punish undesirable behaviour. It is important that the maximum penalty adequately reflects the serious nature of the offence and appropriately balances fairness with deterrence.

D.1.1 Compliance and enforcement measures under the Heavy Vehicle National Law

Existing national safety laws and our *Compliance Review of the Heavy Vehicle National Law* (National Transport Commission, 2015b) provide guidance on potential categories of compliance and enforcement tools that could be used within a safety assurance system. These include the following.

Improvement notices are administrative sanctions that are educational rather than punitive. This tool could be applied when the relevant agency determines that the offender's actions could improve through education. Under the Heavy Vehicle National Law (HVNL), an improvement notice requires the offender to remedy the contravention within a set timeframe. Failure to remedy the contravention is an offence incurring a maximum penalty of $10,000 (but the initial contravention is not). Example: an improvement notice issued to address an identified safety risk with an automated driving system (ADS) technology.

Formal warnings provide an alternative sanction to initiating proceedings for noncompliance in circumstances in which the offender has taken all reasonable steps to prevent the breach and was unaware of its occurrence. They do not necessarily require court proceedings; however, the formal warning can only be used where it is proportionate to the offence (formal warnings should not be used in relation to substantial or severe contraventions of safety). Example: a formal warning is issued to a technology provider who installed aftermarket ADS technologies without lodging a Statement of Compliance; it was a one-off breach and the technology has a low safety risk.

Infringement notices are issued by an enforcement agency alleging a breach of law and providing the alleged offender an opportunity to pay a fixed amount rather than proceed to court. Infringement notices are generally used for less serious offences. Example: offences related to record keeping.

Court-imposed penalties are used for more serious offences that do not have an infringement option and require court adjudication. Safety assurance legislation could empower courts to impose financial penalties, restrict operations or impose conditions designed to enhance safety. The courts also have the power to prohibit the worst or repeat offenders through prohibition orders. Example: the automated driving system entity (ADSE) failed to lodge a compliance statement for an in-service ADS modification that results in unsafe outcomes of serious consequence.

Withdrawals of permission to operate are applied when the ADSE's behaviour is egregious and other sanctions or penalties are unlikely, or have not, changed unsafe behaviours. Withdrawal of permission to operate may also be appropriate if the ADSE shifts assets and resources out of Australia. The Western Australian Heavy Vehicle Accreditation

Scheme provides some guidance on what grounds could be included for withdrawing permission:

- not submitting a compliance statement
- falsifying documents regarding accreditation
- refusing to take part in a random or triggered audit
- refusing to cooperate with or obstructing a Main Roads Western Australia officer/auditor when conducting a random audit
- failure to resolve a major non-conformance
- any combination of the above.

These examples of types of penalties and sanctions most likely relate to a range of offences that underpin the mandatory feature of the safety assurance system. These include, but are not limited to:

- failure to lodge a Statement of Compliance to the relevant agency for an ADS prior to market introduction
- failure to lodge a Statement of Compliance to the relevant agency for an in-service modification that allows a vehicle to operate at a higher level of automation
- providing false or misleading information in the Statement of Compliance
- failure to inform the relevant agency of a significant safety risk or issue related to the ADS
- failure to follow a legal direction of the relevant agency in relation to the ADS.

In addition, a range of safety assurance offences covering the in-service safety of the ADS and relating to the ADSE's Statement of Compliance could be included such as the ADSE's:

- failure to maintain ongoing compliance with its Statement of Compliance
- failure to report breaches of the road rules, crash data, near-miss data, cybersecurity vulnerabilities and other safety-critical events to the national agency.

Maximum penalty levels

Maximum penalty levels require further consultation and analysis. The HVNL Penalties Matrix (National Transport Commission, 2015b), approved by the Transport and Infrastructure Council in 2015, aligns penalty levels across the HVNL. The levels of penalties in the HVNL are based on risk and the likely impact behaviours will have on road safety. A similar approach could be adopted for monetary penalties in the safety assurance system.

As a guide, Table 17 sets out maximum penalty levels in the HVNL.

Table 17. Risk categories and their associated penalties in the HVNL

Current HVNL risk category	Current HVNL maximum penalty
Minor – minimal risk/impact	$1,000–$3,000
Substantial – some/marginal risk/impact (not an appreciable risk)	$4,000–$6,000
Severe – appreciable/significant risk/impact	$8,000–$10,000
Critical – critical/serious risk/impact	$15,000–$20,000

Source: (National Transport Commission, 2015b, p. 6)

The HVNL Penalties Matrix has agreed principles to determine maximum penalty levels that could also be used as a guide in developing monetary penalties in the safety assurance system:

1. Maximum penalty levels should be set at a level that gives courts the ability to tailor a particular penalty to a level that will deter and punish a worst-case offence, including repeat offences.
2. Maximum penalty levels should aim to provide an effective deterrent to the commission of the offence and should reflect the seriousness of the offence within the relevant legislative scheme.
3. Offences should reflect the degree of seriousness of the violation in safety, equity and infrastructure degradation terms.
4. A higher maximum penalty will be justified where there are strong incentives to commit the offence, or where the consequences of the commission of the offence are particularly dangerous or damaging. Safety risks should attract the most serious penalties.
5. A maximum penalty should be consistent with penalties for existing offences of a similar kind or of a similar seriousness.

Introduction of a primary duty – new penalties

Amendments to the HVNL abolish deemed liability for parties in the chain of responsibility, replacing it with a duty to ensure, so far as is reasonably practicable, the safety of the party's transport activities relating to the vehicle.

Like the Model Work Health and Safety laws, there will be three categories of breaches, which are outlined in Table 18.

Table 18. Breaches and penalties of the HVNL primary duty

Category 1: Breach of duty creating risk of death or serious injury or illness (reckless) s 26F HVNL	Category 2: Breach of duty creating risk of death or serious injury or illness s 26G HVNL	Category 3: Other breach of duty s 26H HVNL
The person: ▪ has a duty under s 26C ▪ without reasonable excuse, engages in conduct related	The person: ▪ has a duty under s 26C ▪ contravenes the duty	The person: ▪ has a duty under s 26C ▪ contravenes the duty

Category 1: Breach of duty creating risk of death or serious injury or illness (reckless) s 26F HVNL	Category 2: Breach of duty creating risk of death or serious injury or illness s 26G HVNL	Category 3: Other breach of duty s 26H HVNL
to the duty that exposes an individual to a risk of death or serious injury or illness ▪ is reckless as to the risk	▪ the contravention exposes an individual, or class of individuals, to a risk of death or serious injury or illness	
Maximum penalty: Individual: $300,000 fine or five years' imprisonment, or both Corporation: $3,000,000 fine	Maximum penalty: Individual: $150,000 fine Corporation: $1,500,000 fine	Maximum penalty: Individual: $50,000 fine Corporation: $500,000 fine

Source: (National Heavy Vehicle Regulator, 2018)

The primary duty creates a broad general duty which, although inclusive of mass, dimension, loading, speed, fatigue and maintenance, is not limited to these breaches. The elements of the primary duty do not require the satisfaction (or proof) of some other obligation. The primary duty creates an obligation where none previously existed under the HVNL.

Further research and consultation is required to determine whether maximum penalties, comparable with the HVNL, would be appropriate for breaches of the safety assurance system requirements, given the potential size of an automated vehicle fleet that could be approved under a single Statement of Compliance.

D.1.2 Compliance and enforcement under Australian Consumer Law

The enforcement regime for Australian Consumer Law (ACL) may provide a guide for potential enforcement measures under a safety assurance system. Enforcement under ACL includes the following.

Substantiation notice, which the ACCC can issue to a business or individual requiring them to provide information or documents that substantiate the claim or representation.

Pecuniary penalties can be applied when there has been contravention of the ACL in respect to certain conduct including:

- unconscionable conduct
- false or misleading conduct
- pyramid selling
- failure to respond to, or providing false or misleading information in response to, a substantiation notice
- various product safety provisions.

Infringement Notices where the Australian Competition and Consumer Commission has reasonable grounds to believe a person has breached certain provisions of the ACL. There are also penalties for noncompliance of an Infringement Notice. An Infringement Notice can be issued in relation to:

- unconscionable conduct
- false or misleading conduct

- pyramid selling
- certain product safety and product information provisions
- failure to respond to a substantiation notice
- false or misleading information in response to a substantiation notice.

Such enforcement tools may be used as part of a safety assurance system. These could include, but are not limited to:

- issuing a substantiation notice to an ADSE to determine whether a particular feature or component of the ADS is safe as stated in the Statement of Compliance
- failing to respond to a Substantiation Notice relevant to a Statement of Compliance
- providing false or misleading information in the Statement of Compliance.

Maximum penalty levels

The maximum penalty level is dependent on the type of enforcement tool used. Pecuniary penalty rates are significantly higher than those found under the HVNL (Table 19).

Table 19. Maximum penalty levels

Enforcement tool	Current ACL penalty
Failure to comply with a substantiation notice	$5,400 for a corporation $1,080 for an individual
Pecuniary penalties	For corporations, the greater of: ▪ $10 million ▪ Three times the value of the benefit received ▪ 10% of annual turnover in preceding 12 months, if court cannot determine benefit obtained from the offence $500,000 for individuals
Infringement Notice	$12,600 for a corporation $2,520 for an individual

Source: (Australian Competition and Consumer Commission, n.d.)

Further research and consultation is required to determine whether the maximum penalties found in the ACL would be appropriate for breaches of the safety assurance system requirements.

D.2 Sanctions and penalties relating to primary safety duty offences

Sanctions and penalties for breaches of a primary safety duty should be commensurate with the risk and ability of the duty holder to address that risk. The Model Work Health and Safety (WHS) Act and the Rail Safety National Law (RSNL) and HVNL provide indicative benchmarks for penalty levels for a primary safety duty.

The Model WHS Act, the HVNL and the RSNL grade breaches of the duties based on the risk of death or serious injury or illness posed by noncompliance. Table 20 outlines current offence categories in both regimes, with each category imposing a maximum penalty proportionate to the severity of the risk.

Both the Model WHS Act and the RSNL apply the same three offence categories for breaches of the health and safety duties under ss 19–29 of the Model WHS Act and ss 52–56 of the RSNL respectively. However, there are differences in the quantum of fines and maximum fines. As Table 20 illustrates, there are maximum fines for the most serious offences of up to $600,000 under the Model WHS Act and $300,000 under the RSNL for an individual's breach, and $3 million for a body corporate's breach.

Penalties, including imprisonment for the most serious cases under offence category one, are a key component of deterrence and complement other types of enforcement action, such as improvement notices. Maximum penalties reflect the severity of the offences and have been set at levels high enough to cover the most extreme instances of noncompliance.

Table 20. Offence categories and maximum penalties in Model WHS Law, RSNL and the HVNL

	Category 1: Breach of duty creating risk of death or serious injury or illness (reckless)	Category 2: Breach of duty creating risk of risk of death or serious injury or illness	Category 3: Other breach of duty
Conduct	A person engages in conduct that exposes an individual to whom the duty is owed to a risk of death or serious injury without a reasonable excuse	A person fails to comply with the safety duty and that failure exposes an individual to a risk of death or serious injury or illness	A person fails to comply with the safety duty
Fault element (intent)	The person is reckless as to the risk to an individual of death or serious injury or illness	n/a (strict liability)	n/a (strict liability)
Burden of proof	The prosecution must prove: (a) the person had a safety duty; (b) the person, without reasonable excuse, engaged in conduct that exposed an individual to whom that duty is owed to a risk of death or serious injury or illness; and (c) the person was reckless as to the risk to an individual of death or serious injury or illness	The prosecution must prove: (a) the person had a safety duty; (b) the person failed to comply with that duty; and (c) the failure exposed an individual to a risk of death or serious injury or illness	The prosecution must prove: (a) the person had a safety duty; and (b) the person failed to comply with that duty
Model WHS Act maximum penalties	Individual (other than as a person conducting a business) – $300,000 and/or five years' prison Individual as a person conducting a business –	Individual (other than as a person conducting a business) – $150,000 Individual as a person conducting a business – $300,000	Individual (other than as a person conducting a business) – $50,000 Individual as a person conducting a business – $100,000

	Category 1: Breach of duty creating risk of death or serious injury or illness (reckless)	Category 2: Breach of duty creating risk of risk of death or serious injury or illness	Category 3: Other breach of duty
	$600,000 and/or five years' prison Body corporate – $3 million	Body corporate – $1.5 million	Body corporate – $500,000
RSNL maximum penalties	Individual – $3 million or five years' prison or both Body corporate – $3 million	Individual – $150,000 Body corporate – $1.5 million	Individual – $50,000 Body corporate – $500,000
HVNL maximum penalties	Individual – $300,000 or five years' prison or both Body corporate – $3 million	Individual – $150,000 Body corporate – $1.5 million	Individual – $50,000 Corporation – $500,000

Source: (National Transport Commission, 2015a)

Maximum penalties for breaching the primary safety duty should be aligned where possible with the maximum penalties available under the national safety laws. This includes uptake of a hierarchy of penalties based on the risk and nature of the harm or damage caused. Therefore, if a primary safety duty is adopted, we expect to see a similar range of offence categories and quantum of fines for individuals and corporations in the safety assurance system.

Appendix E Safety criteria for automated driving systems

Options 2, 3 and 4 introduce a safety assurance system. One of the features of this system is a requirement for automated driving system entities (ADSEs) to self-certify against specified safety criteria in a Statement of Compliance before an automated driving system (ADS) or function, or significant modification, can be introduced into the market. The ADSE, rather than government, will be responsible for testing and validating the safety of the ADS or function and documenting these processes. The role of government is to satisfy itself that the applicant has processes in place to identify and manage the safety risks. This broad approach was agreed to by transport ministers in November 2017, subject to analysis through a Regulation Impact Statement (RIS).

We recommend 11 safety criteria that require the applicant to demonstrate its processes for managing safety risks:

1. safe system design and validation processes
2. operational design domain (ODD)
3. human–machine interface (HMI)
4. compliance with relevant road traffic laws
5. interaction with enforcement and other emergency services
6. minimal risk condition
7. on-road behavioural competency
8. installation of system upgrades
9. verifying for the Australian road environment
10. cybersecurity
11. education and training.

We recommend three other obligations on ADSEs to assist relevant parties to appropriately assign criminal and civil liability for events such as road traffic law breaches and crashes:

1. data recording and sharing
2. corporate presence in Australia
3. minimum financial requirements.

These criteria were developed with the aim of balancing safety and innovation. As such, the criteria are generally outcomes-based rather than prescriptive. Overall, they received strong support from stakeholders.

Not all safety criteria are necessarily relevant to each ADS, function or significant modification. If the applicant considers that a safety criterion or other obligation is not relevant (in whole or in part), the applicant must explain why. Over time, elements of these criteria may be reflected in international technical requirements that are harmonised with to Australian Design Rules (ADRs) (for example, UN Regulation 79). In these circumstances, depending on the safety assurance option, criteria might be removed from Statement of Compliance requirements or the applicant could refer to compliance with the relevant ADR(s) to explain why a criterion is not relevant, or as evidence of meeting the criterion.

In developing the recommended safety criteria, we considered:

- stakeholder feedback including, but not limited to, feedback on the consultation RIS
- the United States National Highway Traffic Safety Administration's (NHTSA) strategy on regulating automated vehicle safety, *Automated Driving Systems 2.0: a vision for safety*[47] (and the earlier version of the policy, *Federal Automated Vehicles Policy*[48])
- the State of California Department of Motor Vehicles' (California DMV) regulations relating to the deployment of autonomous vehicles for public operation[49]
- the *Draft resolution on the deployment of highly and fully automated vehicles in road traffic*, a document prepared for the UNECE Global Forum for Road Traffic Safety's (WP.1) September 2018 meeting by the WP.1 chair and deputy chairs[50]
- the *Draft Recommendation on Software Updates of the Task Force on Cybersecurity and Over-the-air issues of UNECE WP.29 IWG ITS/AD* (WP.29 document) (December 2017)
- the June 2018 report by the Association of British Insurers and Thatcham Research on Assisted and Automated Driving (UK report)[51]
- the June 2017 report by the Ethics Commission on Automated Driving set up by the German Federal Ministry of Transport and Digital Infrastructure[52]
- the German *Road Traffic Act*, which allows drivers to operate vehicles with conditional and high automation.[53]

This appendix also outlines select criteria we consider should be excluded and criteria more suitable for legislation. These are discussed because they were raised by stakeholders or are included in other regulatory regimes.

E.1 Principles-based safety criteria

E.1.1 Safe system design and validation processes

Description of criterion

The system design, validation and verification processes should be chosen with the objective of developing an ADS free of safety risks so far as reasonably practicable. The system design process should consider appropriate risk mitigation measures over the life of the ADS (as set by the applicant), based on the ODD.[54]

Requirements for the Statement of Compliance

[47] Available at: https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/13069a-ads2.0_090617_v9a_tag.pdf.

[48] Available at: https://www.transportation.gov/sites/dot.gov/files/docs/AV%20policy%20guidance%20PDF.pdf.

[49] Refer to: https://www.dmv.ca.gov/portal/wcm/connect/a6ea01e0-072f-4f93-aa6c-e12b844443cc/DriverlessAV_Adopted_Regulatory_Text.pdf?MOD=AJPERES.

[50] Available at: https://www.unece.org/fileadmin/DAM/trans/doc/2018/wp1/ECE-TRANS-WP1-2018-4-Rev1e-bis.pdf

[51] Available at: http://www.mynewsdesk.com/uk/thatcham-research/documents/thatcham-research-assisted-and-automated-driving-definitions-technical-assessment-79493.

[52] Available at: https://www.bmvi.de/SharedDocs/EN/publications/report-ethics-commission.pdf?__blob=publicationFile.

[53] Available at: https://www.gesetze-im-internet.de/stvg/.

[54] The ODD is discussed in criterion 2.

The applicant must explain why it chose particular design, validation and verification processes and how these ensure a safe technology is developed and maintained for the life of the ADS. The life of the ADS should be set by the applicant and represent the amount of time the applicant proposes to support the ADS, including by way of software upgrades. The applicant's design and verification processes should cover all safety-critical issues such as unsafe maintenance, repairs, physical modifications and other system failure, as well as the ADS reaching the end of its life and no longer being supported by the applicant. For example, the applicant could design the ADS to disengage (temporarily or permanently) or for back-up systems to take over where safety-critical issues arise or the system otherwise fails.

Where the ADS is supplied as an aftermarket device (rather than a device already fitted to the vehicle), compatibility (that is, the vehicle types the ADS can be fitted to) should be specified as an element of system design.

The applicant should document decisions relating to the choice of design, validation and verification processes and include empirical evidence or research to support the safety assertions made. Such documentation could explain why particular processes were chosen. Where applicable, the applicant should use guidance, industry best practices, design principles and standards developed by established standards organisations.

Comparison with other relevant regulatory systems

The NHTSA's *Automated Driving Systems 2.0* suggests following a robust design and validation process based on a systems-engineering approach with the goal of designing ADSs free of unreasonable safety risks. The NHTSA encourages entities to document the entire process to ensure all design choices, and associated testing, are traceable and transparent. The NHTSA also discusses the development of validation methods that could appropriately mitigate safety risks.

The California DMV's regulations require certification that the manufacturer has conducted testing and validation and is satisfied that the vehicles are safe for deployment on public roads.

The performance criteria in the UK report require the system design process to cover safety-critical issues by allowing for sufficient redundancy (back-up systems) in the event of a fault.

E.1.2 Operational design domain

Description of criterion

The ADS must have a defined ODD and be unable to operate in areas and conditions outside of its defined ODD.

The ODD is 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 street, car park, etc.), geographic area, speed limit or average traffic speed, traffic conditions, road pavement conditions, connectivity and environmental conditions (weather, time of day, etc.).

This criterion links with the on-road behavioural competency criterion, which refers to changes in the external operating environment that could affect the ODD.

Requirements for the Statement of Compliance

The applicant must identify the ODD of the ADS and demonstrate how it will ensure the ADS is:

- able to operate safely within its defined ODD

- incapable of operating in areas outside of its defined ODD
- able to transition to a minimal risk condition when outside its defined ODD.

This could include documentation outlining the process for assessing and verifying the ADS's functionality both within and outside the defined ODD.

The applicant should also outline how it will review and manage changes to the defined ODD. Major changes to the ODD are likely to be significant modifications requiring the applicant to submit a new Statement of Compliance for approval before introducing the change into the market.

Comparison with other relevant regulatory systems

In *Automated Driving Systems 2.0*, the NHTSA notes that the ODD criterion will support the safe introduction of ADSs on public roads by providing the flexibility to limit the complex driving task to a confined ODD. The Netherlands Vehicle Authority similarly notes that in circumstances where software is undertaking the driving task, it is necessary to have a 'stepped admission' based on the software's learning curve. The ADS's ODD is likely to be quite narrow during initial deployment and its complexity can increase over time (Febbes, 2017).

The WP.1 September 2018 document similarly refers to automated vehicles only operating within the ODD, and the UK report includes a design domain criterion that requires the ADS to only operate where the conditions can support automated driving.

E.1.3 Human–machine interface

Description of criterion

The HMI must facilitate interaction between the ADS and a range of relevant parties that allows the vehicle to operate safely.

In automated vehicles, the HMI is no longer limited to the interaction between the vehicle and the driver. As the ADS undertakes the driving task, it must convey additional information about its intentions and performance through both an internal and an external interface.

The internal HMI should communicate relevant information between the ADS and the human driver, operator and occupant(s). The external HMI should communicate relevant information between the ADS and parties external to the vehicle (for example, pedestrians, cyclists and motorcyclists) in both low-speed and high-speed environments. Both the internal and external HMI could communicate information about the ADS's state of operation, for example, by way of relevant signage.

Requirements for the Statement of Compliance

The applicant must outline how the HMI will facilitate interaction between the ADS and relevant parties (both internal and external to the vehicle) that allows the vehicle to operate safely.

In relation to human drivers and occupants, elements of the HMI interaction link with the education and training criterion. The information communicated by the HMI should include, but is not limited to:

- communicating to the human driver when it is safe for the driver to engage the ADS
- informing the human driver if the ADS is engaged and the level of automation engaged
- requesting the human driver or fallback-ready user take back control of the vehicle with sufficient time for the human driver or fallback-ready user to respond, including in an

emerging hazard situation. In addition, the applicant should outline the safeguards to ensure a fallback-ready user is actually ready to take back control. This could include monitoring by the ADS of human readiness to take back control and alert systems where such readiness is not apparent

- drawing attention to potential safety risks related to human monitoring and readiness to re-engage with the driving task
- informing vehicle occupants of the ADS's current and intended actions to allow occupants to predict vehicle behaviour
- indicating whether the ADS is functioning properly or experiencing a malfunction.

In relation to parties external to the vehicle, information such as the ADS's state of operation should be communicated by the HMI via an external communication interface. This could, for example, take the form of an external screen.

The applicant must also outline how it designed and verified the HMI and reference any appropriate international standards or agreed guidelines for HMIs.

Comparison with other relevant regulatory systems

NHTSA's *Automated Driving Systems 2.0* includes an HMI criterion. The NHTSA's criterion similarly refers to considering the various interactions the ADS may encounter.

The WP.1 September 2018 document recommends that automated vehicles be capable of clearly communicating with its users and other road users in a way that is consistent and appropriate.

The report by the German Ethics Commission on Automated Driving states that automated technology must be designed to ensure efficient and reliable human–machine communication. In particular, the need for immediate handover of control from the ADS to the human driver should be avoided.

The UK report includes performance criteria covering status and emerging hazard. These cover communication between the human driver and the ADS.

E.1.4 Compliance with relevant road traffic laws

Description of criterion

When the ADS is engaged, the vehicle must operate in compliance with relevant road traffic laws. We will work with states, territories and industry to develop dynamic driving obligations for the ADS, which will likely require the ADS to operate consistently with obligations in the Australian Road Rules (model law that forms the basis of the current road rules for human drivers in each state and territory).

We are aiming to harmonise road traffic laws for the ADS across the states and territories where possible. We note that for driving laws applying to human drivers there are variations in the road safety and traffic laws between the different Australian states and territories. In addition, these laws are not static. Amendments are made from time to time to the Australian Road Rules. Amendments are also made to the road rules of each state and territory independent of any amendments to the Australian Road Rules.

There may be circumstances where strict compliance with relevant road traffic laws is not possible – for example, where the vehicle needs to cross a solid line to pass roadworks, or a cyclist. In such circumstances, the ADS must ensure the vehicle responds in a safe way.

Requirements for the Statement of Compliance

The applicant must demonstrate how it will ensure the vehicle operates in compliance with relevant road traffic laws when the ADS is engaged. In particular, how the ADS will comply with:

- relevant road traffic laws, including any variations in each state and territory
- amendments to the relevant road traffic laws when they come into force.

This could include documentation outlining the process for assessing and verifying the ADS's compliance with relevant road traffic laws and the process for updating the ADS to comply with amendments to those laws.

The applicant must also demonstrate how the ADS will respond in a safe way where strict compliance with relevant road traffic laws is not possible. This requirement closely links with the on-road behavioural competency criterion.

Comparison with other relevant regulatory systems

The California DMV's regulations require manufacturers to certify that the autonomous vehicle technology is designed to detect and respond to roadway situations in compliance with relevant laws (including changes to those laws). The NHTSA's *Automated Driving Systems 2.0* provides that the development of ADSs should account for all traffic laws, which includes developing processes to update and adapt ADSs to address new or revised legal requirements.

The WP.1 September 2018 document refers to the ADS complying with applicable domestic traffic rules. The UK report includes a requirement for the ADS to comply with traffic laws and similarly notes there are some situations where it is permissible for the ADS not to comply. These include to avoid a crash or to deal with a developing emergency situation.

E.1.5 Interaction with enforcement and other emergency services

Description of criterion

The ADSE must provide police with information that would assist with road traffic law enforcement (where such provision aligns with relevant privacy regulation). This includes information about the level of automation engaged, whether the human driver or the ADS was in control at a particular time and any handover of control requests. This information is likely broader than information communicated by an external HMI.

Where reasonably possible, police should be able to access such information in real time at the roadside. The reference to 'where reasonably possible' has been included to balance the views of police that real-time information at the roadside is necessary for effective enforcement of road traffic laws with the views of other stakeholders that this may not always be possible.

The ADS must also interact with emergency services more broadly when it is engaged. Emergency services include (but may not be limited to) police, fire and ambulance services. Such interaction should include:

- moving out of the way of emergency services vehicles
- allowing safe interaction with emergency services at the roadside (for example, when officers are attending incidents)
- following the directions of enforcement officers (for example, allowing officers to directly control the ADS to stop).

Requirements for the Statement of Compliance

The applicant must demonstrate how it will ensure that police can access accurate information about whether the ADS is engaged at a given time, the level of automation engaged and any handover of control requests. The applicant should also demonstrate how it may facilitate access by police to this information in real time at the roadside.

The applicant must demonstrate how it will ensure safe interaction with emergency services (including but not limited to police, fire and ambulance services) more broadly when the ADS is engaged. This includes interactions on-road and at the roadside.

Comparison with other relevant regulatory systems

Other relevant regulatory systems generally capture interaction with enforcement as part of data recording and sharing requirements. For this criterion, the comparison with other relevant regulatory systems is discussed under the 'Data recording and sharing' obligation in section E.3.1.

E.1.6 Minimal risk condition

Description of criterion

The ADS must take steps to bring the vehicle to a minimal risk condition when it cannot operate safely. The ADS may be unable to operate safety where there are system faults, including as a result of a crash, where there is a deterioration of vehicle hardware or physical tampering, or where the ADS is outside its ODD.

At conditional automation, the ADS notifying the driver to take back control consistent with the requirements in the HMI criterion would likely constitute sufficient steps to achieve the minimal risk condition. This is because the ADS can rely on the human driver (the fallback-ready user) to intervene to bring the vehicle to a minimal risk condition. At high and full automation, the ADS would need to bring the vehicle to a minimal risk condition without human intervention, such as coming to a controlled safe stop. The steps taken to achieve a minimal risk condition should be appropriate for the circumstances; for example, if coming to a controlled stop, the ADS should not do this in a way that would cause a crash with another vehicle or unnecessarily impact other traffic.

Following a crash, the actions necessary for the ADS to return to a safe state are likely to depend on the severity of the crash. Communication with emergency services through an automatic collision notification system (if such technology exists) may help to reduce any harm resulting from the crash.

Requirements for the Statement of Compliance

The applicant must demonstrate how the ADS will detect that it cannot operate safely and the steps the ADS will take to bring the vehicle to a minimal risk condition.

This could include documentation outlining the process for verifying the ability of the ADS to detect and respond to such circumstances. The steps the ADS must take to bring the vehicle to a minimal risk condition are likely to vary depending on the reason why the ADS cannot operate safely, other traffic and road users present, and on the level of automation engaged. Therefore, a range of approaches to bring the vehicle to a minimal risk condition may need to be considered.

Comparison with other relevant regulatory systems

The NHTSA's *Automated Driving Systems 2.0* includes a fallback (minimal risk condition) criterion. This criterion similarly requires the ADS to detect circumstances where it cannot

operate safely and to outline the strategies or approaches to transition to a minimal risk condition. The NHTSA also includes a separate criterion relating to safety post-crash.

The report by the German Ethics Commission on Automated Driving states that in emergencies the vehicle must enter into a 'safe condition' without human assistance (Ethics Commission, 2017, p. 13).

Performance criteria in the UK report require the ADS to execute a 'safe harbour' manoeuvre where it is outside the ODD or it becomes aware of an emergency hazard and the driver fails to respond to a handback request. The UK report does not distinguish between different levels of automation.

E.1.7 On-road behavioural competency

Description of criterion

When the ADS is operating, the vehicle must detect and appropriately respond to a variety of foreseeable and unusual conditions that may affect its safe operation. An appropriate response by the ADS could include, for example, the ADS disengaging or bringing the vehicle to a safe stop.

The ADS must detect and respond to other vehicles, vulnerable road users (such as pedestrians, cyclists, motorcyclists and animals) and objects that could affect the vehicle's safe operation. The ADS should also interact in a predictable and safe way with other road users such as drivers of non-automated vehicles and non-vehicular road users.

The ADS must also detect and respond to unusual events that occur within the ODD, changes to the external operating environment and new or changed hazards introduced into ODD. These could include temporary speed zones and traffic controls such as variable speed signs and police manually directing traffic.

Requirements for the Statement of Compliance

The applicant must demonstrate how the ADS will appropriately respond to foreseeable and unusual conditions that may affect its safe operation and interact in a predictable and safe way with other road users. This could include documentation outlining the process for verifying the ADS's:

- object and event detection and response capabilities
- crash avoidance capabilities
- ability to respond to unusual events within its ODD
- on road interaction with other road users, including vulnerable road users.

Comparison with other relevant regulatory systems

The NHTSA's *Automated Driving Systems 2.0* includes an object event detection and response criterion. This criterion similarly covers detecting and responding to other vehicles, vulnerable road users and objects that could affect the vehicle's safe operation, and addressing a wide variety of foreseeable encounters.

The WP.1 September 2018 document broadly refers to responding to foreseeable and unusual conditions. It provides that the ADS should prioritise road safety and aim to compensate for human errors of road users both inside and outside the vehicle.

The performance criteria in the UK report require the system to sense and respond to unforeseen dangerous situations.

E.1.8 Installation of system upgrades

Description of criterion

The ADS must be disengaged, at least temporarily, if safety-critical system upgrades are not installed (including as a result of failures in receipt of over-the-air software updates) or if system failures are detected following the installation of upgrades.

If the ADS is updated automatically by the ADSE, the registered owner/operator must be notified.

If the registered owner/operator needs to install the upgrade, the ADSE must inform registered owners/operators that over-the-air software updates or other system upgrades are available and how to access these upgrades. The ADSE should explain to registered owners/operators why a system upgrade is required when it is provided.

Requirements for the Statement of Compliance

The applicant must demonstrate how it will manage system upgrade risks. This includes ensuring safety-critical system upgrades to the ADS are installed and do not result in the operation of an unsafe ADS.

The applicant must explain how it will notify registered owners/operators that a safety-critical upgrade has been installed, or is available and needs to be installed. For such safety-critical upgrades, the applicant must also demonstrate how it will:

- detect failures to install upgrades (including failures of automatic updates, failures by registered owners/operators to take action when an upgrade is available or failures in receipt of over-the-air software updates)
- detect system failures once upgrades are installed
- ensure the ADS is safely disengaged if such failures occur.

This could include documentation outlining the process for verifying the ADS's ability to:

- update automatically and notify the registered owner/operator of the update
- notify the registered owner/operator of available system upgrades
- detect and respond to failures to install upgrades
- detect and respond to any system failures following the installation of upgrades.

Comparison with other relevant regulatory systems

The California DMV's regulations require the manufacturer to notify the registered owner that updates are available and to explain how to access the updates. We consider that only notifying the registered owner/operator may not be sufficient. The ADSE must also take action where updates are not installed because the registered owner/operator may be unable to install an update or be unaware that an update is available. This could occur where there is insufficient cellular or other network coverage for the ADS to receive or install an over-the-air software update. Therefore, the ADSE is likely to be better placed to manage the risk of an update not being installed than the registered owner/operator.

The December 2017 WP.29 document recommends imposing obligations on the original equipment manufacturer (OEM) relating to over-the-air software updates. For example, OEMs should ensure that registered owners/operators are informed of any updates and can provide approval to an update being executed. Where legally obliged, OEMs should ensure it is possible for updates to be executed automatically. Conversely, the performance criteria in the UK report require any safety-critical updates to apply automatically.

E.1.9 Verifying for the Australian road environment

Description of criterion

The ADS must detect and respond to elements of the road environment that are unique to Australia.

Certain road infrastructure differs in Australia compared with other parts of the world. For example, road signs in Australia are different from those in Europe. Many European countries are signatories to the *Vienna Convention on Road Signs and Signals*, which aims for basic and consistent sign features.[55] Australia is not a signatory to the Convention. There are also differences in road signs between the Australian states and territories.

Australia is also the home to unique flora and fauna not found in other parts of the world, which the ADS may need to detect and respond to during a journey. There may also be environmental conditions specific to Australia, depending on the ODD.

Requirements for the Statement of Compliance

The applicant must demonstrate how it has considered the Australian road environment in designing, developing and verifying the ADS, including its forward planning processes to ensure compliance with changes to the road environment (such as changes to road infrastructure).

This could include documentation outlining the process for verifying the response of the ADS to the Australian road environment such as interaction with road signs in various states and territories and interaction with Australian flora and fauna.

Comparison with other relevant regulatory systems

This criterion is not specifically included in other relevant regulatory systems we reviewed. However, the California DMV's regulations require certification that vehicles are safe for deployment on public roads specifically in California.

E.1.10 Cybersecurity

Description of criterion

The ADS must be designed, developed and maintained to minimise cybersecurity threats and vulnerabilities and the consequences of cyber intrusion.

As vehicles become increasingly automated, there are more opportunities for a cyber intrusion to occur. A cyber attack compromising the back-end servers of the ADS could disrupt the whole automated fleet. A sophisticated attack may also actively control the entire driving task to commit crimes, including acts of terrorism.

In addition to threats to road user safety, cyber intrusions and other data security breaches could result in the unauthorised disclosure of sensitive personal information.

Requirements for the Statement of Compliance

The applicant must demonstrate:

- the capacity and competency of the ADS to minimise cybersecurity threats and vulnerabilities, including risks of cyber intrusion and other data security breaches

[55] Austroads, *Assessment of Key Road Operator Actions to Support Automated Vehicles*, May 2017. See: https://www.onlinepublications.austroads.com.au/items/AP-R543-17.

- the ADS's ability to detect and minimise the consequences of cyber intrusions and data security breaches that occur. Relevant consequences include those on road user safety and consequences for individual privacy following a data breach. One way to minimise negative effects on safety could be to include a manual override mechanism
- the applicant's processes for maintaining the ADS's capacity and competency to minimise cybersecurity threats, vulnerabilities and consequences of intrusions and breaches over the life of the ADS.

The applicant should refer to relevant legislation, industry standards and guidance for vehicle cybersecurity (domestic and international) and explain how it has incorporated these into its processes for designing, developing and maintaining the ADS.

Comparison with other relevant regulatory systems

The NHTSA's *Automated Driving Systems 2.0* includes a vehicle cybersecurity criterion. The NHTSA suggests that entities should incorporate cybersecurity considerations into the design of the ADS and consider established best practices for cyber vehicle physical systems when doing so.

The California DMV's regulations require the manufacturer to certify that autonomous vehicles meet current industry standards to help defend against, detect and respond to cyber attacks.

The report by the German Ethics Commission on Automated Driving more broadly notes that automated driving is justifiable only if cyber intrusions do not destroy consumer confidence in road transport.

E.1.11 Education and training

Description of criterion

Relevant parties, such as human drivers, occupants and repairers, as well as dealers and distributors, must receive adequate education and training to ensure the ADS is safely deployed and operates safely in-service.

Education and training is likely to minimise the safety risks of the new technology by addressing changes to vehicle operation.

Requirements for the Statement of Compliance

The applicant must outline the education and training it will provide to relevant parties about its ADS and how this will minimise the safety risks of using and operating the ADS. Education and training should consider different types of vehicles (including light and heavy vehicles) and different types of vehicle users. Without limiting the education and training to be provided, such education and training should consider:

- training human drivers and fallback-ready users to safely disengage and re-engage the ADS and the driving task
- informing human drivers of their obligations and responsibilities, particularly any fallback-ready user obligations
- informing consumers of the ADS's capabilities by clearly describing its automated capability, its level of automation, use limitations, restrictions on modifications and any restrictions of the automated technology such as the ODD
- facilitating the maintenance and repair of the ADS, including post-crash before it is put back in service

- facilitating employee, dealer and distributor understanding of the technology and operation so relevant information can be accurately conveyed to consumers and purchasers
- ongoing education as required, including education and training to end users who are not the original vehicle owner and to communicate the impact of upgrades.

The development of education and training should be well documented. Such documentation could explain the reasons for the education and training chosen and how it will facilitate proper and safe use of the applicant's ADS. The ADSE should also make use of best practice or standards.

Comparison with other relevant regulatory systems

The California DMV's regulations require the preparation of a consumer or end-user education plan. Among other matters, the education plan must identify the restrictions of the autonomous technology and contain copies of sections of the vehicle owner's manual that outline the responsibilities of the operator and the manufacturer.

The NHTSA's *Automated Driving Systems 2.0* suggests that entities should develop and maintain education and training programs for employees, dealers, distributors and consumers to address the anticipated differences between automated and conventional vehicles.

The report by the German Ethics Commission on Automated Driving more broadly notes that 'the proper use of automated systems should form part of people's general digital education' (Ethics Commission, 2017, p. 13).

The performance criteria in the UK report require the functionality, limitations and driver responsibility relevant to the ADS to be described.

E.2 Select criteria that have not been included

The following criteria have been raised by stakeholders (including in response to the consultation RIS) and/or have been included in other relevant regulatory systems. For the reasons outlined below, we do not consider the applicant's Statement of Compliance needs to address these criteria.

E.2.1 Ethical considerations

Description

ADSs may face safety dilemmas with ethical implications. In the earlier version of its automated vehicle policy, the *Federal Automated Vehicles Policy*, the NHTSA noted that the choice made by an ADS could result in different outcomes for different road users in the same set of circumstances. The NHTSA suggests there may be situations when the achievement of safety, mobility and legality objectives will come into conflict. As such, the NHTSA states it is important to consider whether ADSs should apply particular decision rules to resolve conflicts between these objectives.

The report by the German Ethics Commission on Automated Driving relevantly notes the following:

- The guiding principle is to avoid accidents. Automated technology must be designed in such a way that critical situations do not arise in the first place.
- The protection of individuals takes precedence over other considerations. If hazardous situations are unavoidable, protecting human life is the top priority.

- Decisions in situations where a choice must be made between one human life and another cannot be programmed. However, general programming to reduce the number of personal injuries may be justifiable. Decisions based on attributes such as age and gender are prohibited.

Some stakeholders also suggested including ethical considerations as a safety criterion.

Reasons for exclusion

We consider that concerns regarding safety dilemmas with ethical implications are already largely captured by the safety criteria. Therefore, a separate ethical considerations criterion is not necessary and may create significant overlap and potentially contradict other safety criteria without achieving additional safety benefits.

In a conference paper, two Swedish academics proposed that as long as an ADS can 'estimate its own operational capability for handling surprising situations, and adjust its own tactical behaviour accordingly', safety dilemmas with ethical implications may be resolved (Johansson & Nilsson, 2017). The paper notes that ADSs can plan driving in a way that any risk of surprising and unsafe situations is acceptably low. This includes considering things like vehicle speed and distance to surrounding objects according to operational capabilities.

With this in mind, our recommended safety criteria relating to ODD, compliance with relevant road traffic laws, on-road behavioural competency and minimal risk condition offer a framework for addressing safety dilemmas with ethical implications. These criteria recognise the operating capabilities of the ADS and address its ability to:

- detect and appropriately respond to a variety of foreseeable and unusual conditions affecting its safe operation, and to interact in a predictable and safe way with other road users (road users include other automated and non-automated vehicles and vulnerable road users)
- take steps towards achieving a minimal risk condition when it cannot operate safely
- prioritise safety over strict compliance with road traffic laws where necessary.

While the safety criteria may not assist the ADS with choosing one human life over another in the rare and dire situations where this choice may need to be made, the report by the German Ethics Commission on Automated Driving notes this is not a decision that can be programmed in any case.

We also note that a criterion relating to ethical considerations is no longer included in the current version of the NHTSA's policy, *Automated Driving Systems 2.0*. The NHTSA notes that 'there is currently no consensus around acceptable ethical decision-making given the depth of the element is not yet understood nor are there metrics to evaluate against'.[56]

We will consider including an ethical considerations criterion if there is clearer international consensus and understanding of acceptable ethical decision making by an ADS beyond what is captured by other safety criteria. We note that it is not currently used in other safety regimes.

E.2.2 Crashworthiness

Description

The NHTSA's *Automated Driving Systems 2.0* includes a crashworthiness criterion. The criterion provides that, in the event of a crash, the occupant protection level should maintain its intended performance level, and vehicles with an ADS should be crash-compatible with conventional vehicles.

This criterion was raised by some stakeholders.

Reasons for exclusion

We consider that the crashworthiness criterion focuses on the vehicle rather than the ADS and is captured by vehicle standards (ADRs) made under the *Motor Vehicle Standards Act 1989* (Cwlth).[57] These ADRs specify vehicle crashworthiness requirements for full frontal crashes, side impacts and offset frontal impacts.

The crashworthiness ADRs will apply to automated vehicles, as they do to conventional vehicles. Therefore, we consider it is not necessary for the ADSE to meet a separate crashworthiness criterion. ADSEs may seek exemptions to use vehicles that do not comply with ADRs. In that case, any decision on an exemption may need to consider the vehicle's crashworthiness.

E.2.3 C-ITS capability

Description

This criterion was raised by some stakeholders in response to the consultation RIS.

Reasons for exclusion

We understand that automated vehicles can operate independently of the C-ITS ecosystem and therefore do not consider that they must have C-ITS capability and interact with the C-ITS ecosystem. While interaction with the C-ITS ecosystem could enhance the safety of automated vehicles, a lack of C-ITS capability does not on its own make an ADS unsafe.

Some automated vehicles may have C-ITS capability and an ADSE may use this capability as one reason to support certain safety claims made in its Statement of Compliance.

E.3 Other obligations on ADSEs

E.3.1 Data recording and sharing

Description of criterion

The automated vehicle must record data relevant to enforcement of road traffic laws and the general safe operation of the ADS (including data relating to crashes). Recorded data must be provided by the ADSE to relevant parties (such as police, insurers, road agencies and consumers) as necessary and in compliance with requirements under the *Privacy Act 1988*. The data provided must be standardised, readable and accessible to ensure its usability and relevance.

[57] Vehicle Standard (Australian Design Rule 69/00 – Full Frontal Impact Occupant Protection) 2006; Vehicle Standard (Australian Design Rule 72/00 – Dynamic Side Impact Occupant Protection) 2005; Vehicle Standard (Australian Design Rule 73/00 – Offset Frontal Impact Occupant Protection) 2005

To assist with enforcing road traffic laws, automated vehicles should record whether the human driver or the ADS was in control at a particular time, and the level of automation engaged. The vehicle should also record crash data to assist insurers and road agencies. Consumers may also want access to automated vehicle data to dispute liability, and ADSEs should facilitate access.

Requirements for the Statement of Compliance

The applicant must outline the ADS data it will record and how it will provide the data to relevant parties. Without limiting the data to be recorded and shared, the applicant must explain how it will ensure:

- the vehicle has real-time monitoring of driving performance and incidents, including event data records in the lead-up to any crash that identifies which party was in control of the vehicle at the relevant time
- the vehicle can provide road agencies and insurers with crash data
- relevant parties (including police) receive information about the level of automation engaged at a point in time if required
- individuals receive data to dispute liability (for example, data showing which party was in control to defend road traffic infringements and dispute liability for crashes) when the individual makes a reasonable request
- data is provided in a standardised, readable and accessible format when relevant
- data is retained to the extent necessary to provide it to relevant parties (the amount of time data is retained for may depend on the purpose(s) the information could be used for – for example, law enforcement, insurance)
- data relevant to the enforcement of road traffic laws and the general safe operation of the ADS (including data relevant to crashes) is stored in Australia. This does not require the applicant to store the data exclusively in Australia.

In responding to this criterion, the applicant should note that the Privacy Act places limits on the collection, use and disclosure of personal information, which may limit the data the applicant can record and share.

Comparison with other relevant regulatory systems

Several relevant regulatory systems include an automated vehicle data recording and sharing requirement.

The NHTSA's *Automated Driving Systems 2.0* focuses on crash data. It provides that vehicles should record all information relevant to a crash and whether the human driver or the ADS was in control of the vehicle leading up to, during and immediately following a crash. The NHTSA's policy also notes that such data should be available for crash reconstruction purposes.

The earlier version of the NHTSA's policy, the *Federal Automated Vehicles Policy*, discussed a broader range of data. The earlier policy refers to recording event, incident and crash data, and states that vehicles should record all information relevant to an event and performance of the system. The policy also provided that vehicles should record the status of the ADS and who was in control of the vehicle, and manufacturers or other entities should have the capability to share the relevant recorded information. Such recording and sharing was not limited to crash-related purposes.

It is not clear why the current version of the policy focuses on crash data.

The California DMV's regulations require the manufacturer to certify that the vehicle is equipped with an autonomous technology data recorder capable of being accessed and retrieved by a commercially available tool.

The WP.1 September 2018 document outlines principles for recording and sharing data. These cover automated vehicles recording and sharing data relating to control of the ADS, especially in events that affect road safety such as a collision or violation of traffic rules. This data should be recorded, secured and made available as necessary in accordance with domestic privacy regulations.

The German *Road Traffic Act* requires automated vehicles to record time and location information when control of the vehicle changes between the human driver and the ADS. Time and location information must also be stored when the driver is prompted by the system to take control of the vehicle or a system failure occurs. The Act allows the data to be transmitted to law enforcement at their request for enforcing road traffic laws. The Act also requires the data to be provided to third parties if it is required to assert, satisfy or defend against legal claims relating to death or personal injury.

The performance criteria in the UK report require ADSEs to record data to assess the status of the ADS and the extent of driver input where there is a collision, and to provide this data to insurers.

In addition, a Data Storage System for Automated Driving was proposed at the March 2018 WP.29 meeting (OICA, 2018). The proposal suggested this data storage system could establish who was performing the driving task and any takeover requests. It would store more data over a longer period than an event data recorder to support legal information needs on who was in control (the driver or the ADS) of an automated vehicle whenever a safety-critical event occurred.

E.3.2 Corporate presence in Australia

Description of criterion

The ADSE must have a corporate presence in Australia that can be criminally and civilly liable under Australian law. This is an ongoing obligation for the life of the ADS.

This will assist parties to bring legal action against the ADSE where necessary.

Requirements for the Statement of Compliance

The applicant must provide evidence of its corporate presence in Australia.

Comparison with other relevant regulatory systems

Having a corporate presence in the country where approval is sought is not specifically included in other relevant regulatory systems that we have reviewed.

E.3.3 Minimum financial requirements

Description of criterion

The ADSE must not be insolvent or in liquidation and must have sufficient grounds for claiming it will not become insolvent in the future. We are not seeking to prescribe a minimum annual turnover or other numerical financial measure. This is to ensure financial requirements do not prevent safe ADSs from entering Australia.

The ADSE must also hold an appropriate level of insurance to cover personal injury, death and property damage caused by the ADS when it is properly engaged. The form of

insurance to cover personal injury and death will be informed by the approach in our motor accident injury insurance and automated vehicles project.

These financial requirements will assist in ensuring financial risk and liability is appropriately distributed and managed. The onus is on the applicant to explain how they will remain solvent and why the level of insurance held is appropriate in the circumstances. Minimal financial requirements is an ongoing obligation for the life of the ADS.

Requirements for the Statement of Compliance

The applicant must provide evidence of its current financial position, its grounds for claiming it will have a strong financial position in the future and the level of insurance held.

Comparison with other relevant regulatory systems

The California DMV's regulations contain financial responsibility and insurance requirements.

E.4 Obligations that have not been included

The following obligation, which relates to privacy, has been raised by stakeholders, including in response to the consultation RIS. For the reasons outlined below, we do not consider the applicant's Statement of Compliance needs to address privacy.

E.4.1 Privacy

Description

In the earlier version of its policy, the *Federal Automated Vehicles Policy*, the NHTSA noted that manufacturers and other entities should take steps to protect consumer privacy. These steps include ensuring transparency, choice, respect for context, minimisation, de-identification and retention, data security, integrity and access and accountability.

The California DMV's regulations include information privacy requirements covering collection of personal information not necessary for the safe operation of the vehicle.

Some stakeholders also raised concerns about the privacy of information collected by automated vehicle technology.

Reasons for exclusion

The privacy protection regulations in Australia already cover consumer privacy. The Commonwealth Privacy Act covers Commonwealth public sector agencies and organisations with an annual turnover of greater than $3 million. The definition of an organisation is quite broad and includes individuals, corporations, partnerships, unincorporated associations and trusts. The Act requires compliance with 13 Australian Privacy Principles (APPs) covering the collection, use and disclosure, security, accuracy and ability of an individual to correct, personal information held by the agency or organisation.

We therefore consider the privacy of personal information collected and held by ADSEs is already be broadly covered by the APPs and a separate privacy criterion is not required. Privacy is also not specifically a safety issue, and private sector access to and use of data is a significant societal issue that is much broader than automated vehicle policy and regulation. In addition, the cybersecurity and data recording and sharing criteria specifically refer to the protection of personal information and to the limits on collection, use and disclosure of personal information in the Privacy Act.

We note that the entity responsible for assessing an applicant's Statement of Compliance should focus on road safety issues – a focus beyond road safety issues may be outside its mandate and expertise.

Automated Driving Systems 2.0, the current version of the NHTSA's policy, no longer includes a privacy criterion. The NHTSA notes that 'privacy is not directly relevant to motor vehicle safety and, generally, it is the Federal Trade Commission (FTC) and not the US Department of Transportation or NHTSA that is charged with protecting consumer privacy'.[58]

We also consider California DMV privacy requirements could be covered by the APPs, which provide individuals with a range of privacy protections when private sector entities collect personal information and sensitive information.

E.5 Provisions that could be captured in legislation

The following criterion, which relates to reporting obligations, has been raised by stakeholders and has been included in other relevant regulatory systems.

We consider that reporting obligations are not relevant to the Statement of Compliance because they are specific obligations on ADSEs while the ADS is in-service. As such, we consider reporting obligations would sit better in legislation.

E.5.1 Reporting obligations

Provisions requiring the ADSE to report breaches of the road rules, crash data, injuries and fatalities, cybersecurity vulnerabilities and other safety-critical events to the agency responsible for the safety assurance system are likely to be included.

Reporting will assist the agency responsible for the safety assurance system to assess the ongoing safety of the ADS while it is in-service and ensure ADS issues are dealt with consistently rather than on a case-by-case basis.

The California DMV's regulations require entities to submit to the DMV, within specific timeframes, any identified safety-related defects in the autonomous technology that create an unreasonable safety risk.

E.6 First supply and in-service safety compliance

Finally, we note that option 2 of the decision RIS would enable the Commonwealth to manage compliance with safety criteria and obligations at first supply, but certain of them will have ongoing elements that the Commonwealth may not be able to manage effectively while an ADS was in-service. The first supply and in-service elements of the safety criteria and obligations are collated in Table 21.

Table 21. First supply and in-service elements of the safety criteria and obligations

First supply	In-service
Safety criteria	
1. Safe system design and validation processes	
2. Operational design domain	2. Operational design domain
3. Human–machine interface	

[58] See: https://www.nhtsa.gov/manufacturers/automated-driving-systems.

4. Compliance with relevant road traffic laws	4. Compliance with relevant road traffic laws
5. Interaction with enforcement and other emergency services	
6. Minimal risk condition	
7. On-road behavioural competency	
8. Installation of system upgrades (ADSE)	8. Installation of system upgrades (owner/operator)
9. Testing for the Australian road environment	
10. Cybersecurity	
11. Education and training (for example, requirement to provide material)	11. Education and training (registration and licensing conditions)
Obligations	
1. Data recording and sharing	1. Data recording and sharing
2. Corporate presence in Australia	
3. Minimum financial requirements	

Appendix F Choice of assessment criteria for the multi-criteria analysis

F.1 Outline of impact categories and assessment criteria

The NTC used a multi-criteria analysis approach to assess the options for a safety assurance system. We selected five impact categories, each with a set of assessment criteria within each category. Table 22 outlines the five impact categories and assessment criteria, and they are discussed in detail after.

Table 22. Impact categories and assessment criteria

Impact category	Assessment criteria
1. Road safety	(a) Covers ADS safety over the vehicle life cycle including at first supply, in-service and at end-of-life (b) Covers parties that have not sought approval under the safety assurance system but who would be an ADSE if they sought approval (c) Ensures there is always a clearly recognised legal entity responsible for risks associated with automated vehicles (d) Ensures responsibility sits with the party best able to manage the risk (e) Addresses emergent safety risks that may not have been specifically identified or considered at first supply (f) Proactively addresses emerging ADS risks before the safety issue eventuates (g) Enables the introduction of targeted compliance and enforcement options, including sanctions and penalties for noncompliance by the ADSE
2. Uptake of automated vehicles	(a) Provides community assurance that automated vehicle safety risks have been comprehensively addressed (b) Provides clear and consistent regulatory expectations to facilitate market entry, including national consistency and alignment with international requirements
3. Regulatory costs to industry	(a) Results in low upfront and ongoing compliance, administrative and delay costs (b) Provides clear and consistent regulatory expectations to industry about its responsibilities and what is required to comply (c) Supports an approach that is consistent across all jurisdictions and is aligned with international requirements

Impact category	Assessment criteria
4. Regulatory costs to government	(a) Minimises upfront structural, organisational and regulatory change to implement the model, including a minimal impact on existing processes and minimal regulatory layers (b) Supports efficient ongoing administrative processes including, if required, mandatory self-certification, safety assurance system assessments, registration and responding to breaches (c) Clearly defines the roles and responsibilities of states, territories and the Commonwealth (and a separate national agency if applicable) for regulating automated vehicle safety
5. Flexibility and responsiveness	(a) Can be implemented by 2020 (b) Allows for transition as international approaches evolve (c) Allows flexibility for industry by focusing on safety outcomes, minimising prescriptive requirements, remaining technology-neutral and allowing innovative solutions (d) Allows flexibility for government in addressing emerging safety risks (e) Allows for regulation of the ADS separate from the vehicle

F.2 Choice of road safety assessment criteria

We assessed each of the four options against seven road safety assessment criteria. The criteria were chosen to address new road safety risks that would arise from introducing ADSs.

The chosen road safety assessment criteria aim to ensure that each option is assessed against a variety of road safety risks that would arise at different times in the life cycle of the ADS. This includes road safety risks that may arise because someone other than the ADSE, such as the vehicle owner or a repairer, does or fails to do something. For example, a vehicle owner might fail to install a software upgrade or a mechanic might make a repair that affects the ability of the ADS to function correctly.

F.3 Choice of uptake assessment criteria

We assessed each of the four options against two uptake criteria. The criteria were chosen to assess the extent to which each of the four options would be likely to increase the uptake of automated vehicles in Australia by promoting consumer and business confidence (NAB, 2018).

Criterion (a) provides community assurance that automated vehicle safety risks have been comprehensively addressed. This criterion focuses on community uptake of automated vehicles and the idea that consumers are more likely to use automated vehicles if they are confident that they are safe. A reform option that provides this assurance is likely to increase consumer confidence and increase the uptake of automated vehicles.

Research suggests that government approval regulation on the safety of a product decreases uncertainty about available products. This means consumers are more willing to change to a new product (such as automated vehicles) than if there is no approval regulation. Approval regulation causes businesses to provide more information about a

product than they would otherwise (Carpenter, et al., 2010). Regulation that enhances information availability can also improve safety outcomes (Jin & Leslie, 2003). Additionally, availability of information increases consumer confidence in the product and may increase their willingness to change more quickly to a new product (Carpenter, et al., 2010).

Criterion (b) provides clear and consistent regulatory expectations to facilitate market entry, including national consistency and alignment with international requirements. This criterion focuses on manufacturers' willingness to enter the Australian market. If they have certainty about the regulatory requirements and the requirements are consistent with international requirements, they are more likely to enter the Australian market because it is not unduly complicated or burdensome to do so.

There is evidence that government regulations affect business confidence, which in turn may affect their willingness to enter or stay in a market (ABS, 2015, Branstetter, et al., 2014, NAB, 2018). Evidence suggests that inconsistent or uncertain regulation – whether across Australian states and territories or between Australia and other countries – may slow or deter entry to the market, which would delay the widespread use of automated vehicles in Australia. Inconsistent regulation in the United States has slowed progress in the industry (Clayton UTZ, 2016, p. 9).

The uptake of automated vehicles may also be affected by the extent to which the regulatory process is efficient and minimises cost implications on purchasing and operating automated vehicles.

F.4 Choice of regulatory costs to industry assessment criteria

We assess each of the four options against three regulatory cost to industry assessment criteria. The assessment criteria were chosen to assess the extent to which each option would reduce new regulatory costs for industry.

Criterion (a) results in low upfront and ongoing compliance, administrative and delay costs. This assessment criterion is based on the Office of Best Practice Regulation's definition of substantive regulatory costs.[59]

Criterion (b) provides clear and consistent regulatory expectations to industry about its responsibilities and what is required to comply. This assessment criterion recognises that clear and consistent regulatory expectations for industry about what is required to comply allows for streamlining of processes and reductions in costs.

Criterion (c) supports an approach that is consistent across all jurisdictions and aligned with international requirements. This assessment criterion recognises that consistent regulatory requirements reduce business costs. It removes the costs associated with multiple, variable regulatory processes and allowing businesses to streamline processes.

F.5 Choice of regulatory costs to government assessment criteria

We assess each of the four options against three regulatory costs to government assessment criteria. The criteria were chosen to assess the extent to which each of the four options would be likely to affect regulatory costs to government.

[59] It defines these as follows: compliance costs are 'costs incurred to deliver the regulated outcomes being sought', administrative costs are 'costs incurred by regulated entities primarily to demonstrate compliance with the regulation', delay costs are 'the expenses and loss of income incurred by a regulated entity through one or both of: an application delay…[and] an approval delay…' (OBPR, 2016, pp. 2,3).

Criterion (a) minimises upfront structural, organisational and regulatory change to implement the model, including a minimal impact on existing processes and minimal regulatory layers. This criterion recognises that costs relating to building the systems, capabilities and capacities are not likely to be recovered from industry. This means they are likely to be borne by the relevant governments, and ultimately by the community through taxes. It also recognises that multiple regulatory layers add to costs.

Criterion (b) supports efficient ongoing administrative processes including, if required, mandatory self-certification, safety assurance system assessments, registration and responding to breaches. This criterion recognises that a failure to create efficient ongoing administrative processes is likely to result in duplicated or delayed processes and increase costs to governments or industry if the system is based on a cost-recovery model.

Criterion (c) clearly defines the roles and responsibilities of states, territories and the Commonwealth (and a separate national agency if applicable) for regulating automated vehicle safety. This criterion recognises that a failure to clearly define the roles and responsibilities of relevant governments is likely to result in inefficiencies, duplication of processes and increased costs to government.

F.6 Choice of flexibility and responsiveness assessment criteria

We assessed each of the four options against five flexibility and responsiveness assessment criteria. The assessment criteria were chosen to assess the extent to which each option will provide flexibility and responsiveness to allow for the uncertainty about regulating automated vehicles to be addressed as it emerges.

The criteria are intended to capture the benefits of options that do not exclude certain market structures or prevent future adaptation of the regulatory framework.

Criterion (a) can be implemented by 2020. This criterion reflects manufacturer predictions that vehicles with conditional or high automation may be available for commercial deployment by 2020.[60] The Transport and Infrastructure Council agreed that Australian governments will aim to have end-to-end regulation in place by 2020 to support the safe deployment of automated vehicles (Transport and Infrastructure Council, 2017, p. 3).

Criterion (b) allows for transition as international approaches evolve. This criterion reflects the fact that international regulation of automated vehicles is in its infancy. It aims to ensure Australia's regulatory approach is sufficiently flexible to allow it to easily change to align with international approaches as they develop.

Criterion (c) allows flexibility for industry by focusing on safety outcomes, minimising prescriptive requirements, remaining technology-neutral and allowing innovative solutions. This criterion aims to allow for industry innovation by avoiding prescriptive requirements about how a safety outcome must be achieved.

Criterion (d) allows flexibility for government in addressing emerging safety risks. This criterion recognises that because ADS technology is still being developed not all safety risks can be predicted. The regulatory model needs to be sufficiently flexible to allow for government to address safety risks as they emerge.

Criterion (e) allows the ADS to be regulated separate from the vehicle. This criterion recognises that an ADS is the 'driver' of the vehicle. It allows for the recognition of the

[60] See Figure 8 for a timeline of manufacturers' predicted release of automated vehicles.

vehicle even if the ADS has not been approved. This might be useful to allow for the sale of ADS-enabled vehicles in regions where infrastructure may not support automated functions.

Appendix G Existing road safety laws and regulations

G.1 The Motor Vehicle Standards Act and the Road Vehicle Standards Act

The *Motor Vehicle Standards Act 1989* (MVSA) requires all road vehicles imported as new or second hand to comply with the relevant Australian Design Rules (ADRs) at the time of manufacture and supply to the Australian market. When a vehicle is first used on Australian roads the relevant state or territory government's legislation generally requires that it continues to comply with the relevant ADRs as at the time of manufacture (Department of Infrastructure, Regional Development and Cities, 2017b).

Road Vehicle Standards Bill

The MVSA is expected to be replaced by the Road Vehicle Standards Act (RVSA),[61] which is, at the time of writing, at Bill stage before the Australian Senate. The RVSA will provide a wider range of compliance enforcement tools than those available in the MVSA. These include infringement notices, enforceable undertakings, civil penalty orders and the ability to recall vehicles. The terminology of 'standard' and 'nonstandard' vehicles will also change; however, the concepts will remain. The RVSA will maintain the ADRs as the mechanism for implementing vehicle standards in Australia (Department of Infrastructure and Regional Development, 2017a, p. 5)

The MVSA is the legal instrument for Australia's pre-market type-approval process for new and imported vehicles. The process allows self-testing by manufacturers against the technical standards in the ADRs.

Type-approved new vehicles that fully comply with the national standards are standard vehicles[62] and must be fitted with an identification plate.[63] These vehicles are approved for unrestricted supply to the Australian market.

As long as a vehicle meets the ADRs, it must be approved as a standard vehicle irrespective of any safety issues related to the automated driving system (ADS) itself.

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[61] The Australian Government introduced the Road Vehicle Standards Bill into parliament early in 2018. It is expected to be debated and passed by parliament in 2018 (although both the timing and the decision are ultimately a matter for parliament to decide). The reforms will commence 12 months after the passage of legislation as the *Road Vehicle Standards Act*.

[60] Refer to subsection 10A(1) and the definition of **standard vehicle** in s 5 of the MVSA.

[61] Upon the commencement of the RVSA, 'identification plates' will be replaced by providing the vehicle information, currently shown on the identification plate, on an online Register of Approved Vehicles containing information currently shown on the identification plate. Refer to: https://infrastructure.gov.au/vehicles/mv_standards_act/files/Overview_Brochure.pdf.

ADRs and the type-approval process only apply when vehicles are first supplied to the market. State and territory governments (and the National Heavy Vehicle Regulator) are responsible for licensing, registration and in-service vehicle compliance.

Penalties and sanctions under the MVSA are imposed on the approval holder, who is likely to be the vehicle manufacturer. Given that the automated driving system entity (ADSE) may not be the vehicle manufacturer, sanctions and penalties may not be targeted to the most appropriate body. There is a possibility that the ADSE could be recognised as the manufacturer of a separate component and therefore be the holder of the approval for the ADS under the MVSA.

The sanctions and penalties for noncompliance with the MVSA regulations include the following:

- Contravening a condition of approval under the MVSA is an offence with a maximum fine of 60 penalty units (or $12,600). Failure to comply with a condition of approval may also lead to the cancellation, suspension or variation of the approval to place identification plates on road vehicles of that type.
- The cancellation, suspension or variation of the approval to place identification plates on road vehicles of a particular type may affect the registered owner/operator rather than the party who failed to get approval under the safety assurance system.
- Potential refusal to register a vehicle – again, it is not clear whether this would affect the responsible party (the party who failed to get approval under the safety assurance system). It may affect the responsible party indirectly because new vehicles are generally registered in bulk by dealers, not purchasers. A dealer's inability to register vehicles is likely to be transferred back to the manufacturer.

G.2 Australian Design Rules

The ADRs are national standards for vehicle safety, anti-theft and emissions. They are generally performance-based and cover occupant protection, structures, lighting, noise, engine exhaust emissions, braking and a range of miscellaneous items (Department of Infrastructure, Regional Development and Cities, 2017b).

The standards are administered by the Australian Government under the MVSA.

G.3 Registration and roadworthiness

Vehicle registration permits a vehicle to operate on public roads and regulates the in-service safety performance. States and territories have registration powers to prevent the registration of unsafe vehicles.

While vehicles are being used on public roads they must continue to comply with Australian Light Vehicle Standards Rules (ALVSRs), as implemented in each state and territory, and Heavy Vehicle (Vehicle Standards) National Regulation.

Light and heavy vehicle standards are primarily based on ADRs; however, they have certain gaps in their application. These are covered by the ALVSRs and heavy vehicle in-service standards, including vehicle combinations and ongoing maintenance requirements.

Unlike light vehicles, which are regulated on a state-by-state basis, heavy vehicles are regulated under the Heavy Vehicle National Law, which is administered by the National Heavy Vehicle Regulator. The Heavy Vehicle National Law established a single national system of laws for heavy vehicles over 4.5 tonnes gross vehicle mass and prescribes requirements related to:

- vehicle standards that heavy vehicles must meet before they can use our roads
- maximum permissible mass and dimensions of heavy vehicles
- securing and restraining loads on heavy vehicles
- ensuring parties in the chain of responsibility are held responsible for drivers of heavy vehicles exceeding speed limits
- preventing drivers of heavy vehicles from driving while impaired by fatigue (National Heavy Vehicle Regulator, n.d.).

State and territory road transport agencies currently rely on a mix of self-regulation and roadside enforcement to ensure compliance with vehicle standards. In most jurisdictions, vehicle roadworthy checks are also required on an annual basis or when the vehicle is sold or reregistered.

The in-service vehicles standards are set out in the ALVSRs and the Heavy Vehicle (Vehicle Standards) National Regulation. Both sets of standards are based on the ADRs that are developed and administered by the Commonwealth.

For nonstandard vehicles, road managers may attach certain conditions to the registration of these vehicles. These conditions may relate to safety performance or access to parts of the road network.

Sanctions and penalties applied if a vehicle fails to meet relevant vehicle standards once it is in-service include:

- vehicle recalls to rectify a systemic problem (for example, faulty airbags)
- registration withdrawal for vehicle specific problems (for example, unsafe modifications or inadequate maintenance leading to safety standards not being met).

G.4 Licensing

Driver licensing is used to regulate drivers' understanding of road laws and competency in operating specific vehicle types. It is administered by state and territory road authorities, and state-based licenses are mutually recognised in all jurisdictions.

There is currently no licensing system for ADSs. Austroads will lead work to investigate whether additional driver education will be required to operate vehicles with ADSs.

Sanctions and penalties that could be applied if a vehicle failed to meet relevant vehicle standards once in-service are:

- road traffic infringements, including financial penalties and demerit points
- licence suspension or cancellation.

G.5 Australian Consumer Law

The Australian Consumer Law, corporate social responsibility and commercial imperatives already provide a framework for manufacturers and operators where safe operation of automated vehicles is incentivised.

Product safety regulation in Australia for general consumer products is a shared responsibility between the Australian Competition and Consumer Commission (ACCC) and the states and territories.

Consumer law provides consumers with statutory guarantees that products will be safe, free from defects and fit for purpose. It establishes manufacturer liability for products with safety

defects and provides for consumer compensation claims for loss or damage and provides a regulatory mechanism to mandate product recalls.

A recall may be undertaken if there is:

- a risk that a product will or may cause injury
- awareness of a death, serious injury or illness associated with a product.

The system for vehicle recalls is well established through the ACCC and is in regular use, with around 200 recalls in 2016 alone. The Commonwealth Department of Infrastructure, Regional Development and Cities assesses complaints about vehicles with safety issues, carries out safety investigations and monitors vehicle recalls on behalf of the ACCC. Under the current approach option, this framework would continue to apply to automated vehicles and provide an important safeguard for automated vehicle safety.

It should be noted that if the Road Vehicles Standards Bill is passed, recalls for road vehicles (including automated vehicles) will be dealt with under that Act rather than Australian Consumer Law.

G.6 International regulations on automatically commanded steering function

The United Nations Economic Commission for Europe (UNECE) contributes to enabling automated driving functionalities by hosting the Multilateral Agreements and Conventions ruling for the requirements and use of these technologies.

The UNECE Sustainable Transport Division provides the secretariat services to the World Forum for the Harmonization of Vehicle Regulations (WP.29). WP.29 is the UN World Forum dedicated to technical regulations applied to the broad automotive sector, addressing the safety and environmental performance of wheeled vehicles. This forum aims to ensure that the benefits of new technologies, such as automated driving, can be captured without compromising safety and other policy objectives (United Nations Economic Commission for Europe, n.d.). In June 2018, WP.29 also established a subsidiary Working Party on Automated/Autonomous and Connected Vehicles.

United Nations R79 (UN R79) provides provisions concerning the approval of vehicles in relation to steering equipment. This regulation currently limits the use of automated systems to functions that operate at speeds at or below 10 km/hr (such as ‘traffic jam assist’ or ‘parking assist’) and lane-keeping functions. The regulation does not allow ADSs capable at operating at full automation.

An informal working group on Automatically Commanded Steering Functions is working on an amendment to UN R79 that would enable the approval of automated systems for use at speeds above 10 km/h (nominally SAE level 3 vehicles). The update will focus on the technical requirements for systems allowing the driver to undertake secondary activities. The update is currently expected to be finalised in 2019 and available for adoption by countries in mid-2020. UN R79 will need to be further updated to accommodate automated vehicles above level 3.

As a United Nations member state, Australia has committed to harmonising its regulations, including the ADRs, with these international standards. The proposed ADR 90 series will reflect the current regulation. When UN R79 is amended, the ADR 90 series will subsequently be updated.

Appendix H Testing the materiality of the key benefits

The options assessment did not specifically weight the different impact categories; however, consideration was given to the relative potential magnitude, or materiality, of some of the key benefits. This consideration is described below.

H.1 Results of materiality tests

The two tests in this appendix show that, under a range of plausible, conservative assumptions, an effective safety assurance approach will provide:

- significant road safety benefits in terms of reducing the number and severity of road crashes
- significant economic benefits resulting from earlier and higher uptake of automated vehicles.

These benefits should be considered against the quantum of regulatory costs and the costs to governments imposed by the reform options. Based on current information, the assessment below shows that these costs are highly uncertain, but they do appear to be of an order that would be a fraction of the value of the benefits that could be realised.

If we accept the relative strength of the possible road safety benefits, the overall assessment of options should be viewed with a heavier weighting towards those options that deliver the greatest road safety benefits. Conversely, the relative strengths of options with lower regulatory costs and costs to governments may be viewed as a somewhat less important consideration.

ADVI submitted that the potential magnitude of the benefits is estimated too low. We believe that taking a conservative approach to calculating any benefits is justifiable given that the degree of uncertainty that surrounds the estimates.

While the uptake benefits appear to be significant, there is currently limited information available to differentiate the options relative to this impact category. As such, no general weighting needs to be applied.

H.2 Materiality of road safety outcomes

Theoretically, road safety impacts are a function of the change in the number of crashes and the average cost of those crashes. This could be represented in a model as a function of change in a baseline safety indicator, such as the annual social costs of road fatalities, with the following variables:

1. **Generalised safety benefits of automated vehicles** – the degree that automated vehicles are safer than comparable human-driven vehicles, expressed as a percentage. This would be expected to be in the range of 0–94 per cent (where 0 is automated vehicles are equally as safe as the average human-driven vehicle and 94 is the complete elimination of the proportion of crashes in which human error is a *contributing* factor).
2. **Market penetration of automated driving systems** – the percentage of the total vehicle fleet that is automated.
3. **Effectiveness of the safety assurance system** (or alternative approach) – the degree to which regulation prevents unacceptable safety risks, improves safety outcomes and

increases automated vehicle uptake, expressed as a percentage. This is a measure of the option's effect on safety above the safety outcome of the baseline option.

This model could be expressed as:

Road safety benefit = change in safety indicators

= BSI x GSBAV x MPAV x ESAS

Where:
BSI = baseline safety indicators (number, $)
GSBAV = generalised safety benefit of automated vehicles (%)
MPAV = market penetration of automated vehicles (%)
ESAS = effectiveness of the safety assurance system (%)

All percentages are defined within a range of 0–100%.

For example, if:

BSI =

- $4 billion social cost of road fatalities in 2020 (1,141, the predicted number of fatalities in 2020[64] × $3.452 million,[65] the cost of fatal crashes in 2017 dollars)
- $13.58 billion social cost of road injuries in 2020[66]
- $9.38 billion social cost of property damage in 2020[67]

GSBAV = 50 per cent (estimate reflecting some but not all of the potential benefit of eliminating human error);

MPAV = 6.45 per cent (mid-point between US uptake rates of level 3 and 4 automated vehicle for 2020); and

ESAS = 70 per cent (assuming a fairly effective safety assurance system, compared with the base case); then

Road safety benefit = ($4 billion + $13.58 billion + $9.38 billion) × 0.5 x 0.0645 × 0.7 = $607.2 million cost benefit.

Table 23 outlines the estimated single-year road safety benefits based on the preceding assumptions.

[62] Road crash forecasts are detailed in Appendix J.

[63] The social cost of road crashes in outlined in Section J.3.

[64] Figure is an estimate for 2016, based on a recent paper (Litchfield, 2017).

[65] Figure is an estimate for 2016, based on a recent paper (Litchfield, 2017).

Table 23. Estimated road safety benefits under 70 per cent ESAS ($m)

	Fatalities	Injuries	Property damage	Total
Road safety benefit	88.9 (26 fatalities averted)	306.6 (729 serious injuries averted)	211.8 (10,239 property damage crashes averted)	607.2

These road safety benefits need to be compared with the compliance, administration and other costs in order to assess the policy merits.

The expected road safety benefit of an option is influenced by both:

- the effectiveness of the safety assurance system to improve safety of automated vehicles
- the uptake of automated vehicles that comply with the safety assurance system.

This shows the intrinsic trade-off considered in this RIS and that it is undesirable to set policy requirements for improved safety so high that they become barriers to the introduction and uptake of automated driving systems.

There is significant uncertainty both within and outside of the assessment. As a result, there is insufficient information to populate this model with a satisfactory degree of confidence. However, using the formula as described above, we can see the effectiveness of different levels of the safety assurance system. This is a useful test because regulatory responses are not always 100 per cent effective at achieving their stated objectives. As each assessed option differs in the extent of regulatory scope, they are likely to differ in effectiveness to address specific automated vehicle safety risks.

As new regulatory systems mature, their effectiveness can improve as governments and industry better understand their roles, obligations and requirements; that is, the effectiveness of a regulatory system is not static.

For this test, we have identified two ‘high’ effectiveness values (ESAS values in the formula) and two ‘low’ effectiveness values:

- high 1 – 90 per cent effective (ESAS90)
- high 2 – 80 per cent effective (ESAS80)
- low 1 – 30 per cent effective (ESAS30)
- low 2 – 20 per cent effective (ESAS20).

These effectiveness values also show the sensitivity of a 10 percentage point difference in effectiveness on safety outcomes from relatively high and low effectiveness starting points.

Using the formula and keeping other variables (BSI, GSBAV and MPAV) static, we can also examine the material impact of varying the effectiveness of the regulatory response, using the above ESAS values. Table 24 shows the results of the model under different levels of effectiveness in the regulatory responses.

Table 24. Estimate of road safety benefits under different ESASs ($m)

	Fatalities	Injuries	Property damage	Total
Road safety benefit under ESAS90	114.3 (33 fatalities averted)	394.2 (938 serious injuries averted)	272.3 (13,164 property damage crashes averted)	780.7
Road safety benefit under ESAS80	101.6 (29 fatalities averted)	350.4 (833 serious injuries averted)	242.0 (11,702 property damage crashes averted)	694.0
Road safety benefit under ESAS30	38.1 (11 fatalities averted)	131.4 (313 serious injuries averted)	90.8 (4,388 property damage crashes averted)	260.2
Road safety benefit under ESAS20	25.4 (7 fatalities averted)	87.6 (208 serious injuries averted)	60.5 (2,925 property damage crashes averted)	173.5

This analysis shows the potential of the safety assurance system to avert fatalities. It also shows that a 10 percentage point improvement in effectiveness could generate additional safety outcomes of approximately $86.7 million per year, not including the benefits from reductions in non-fatal accidents.

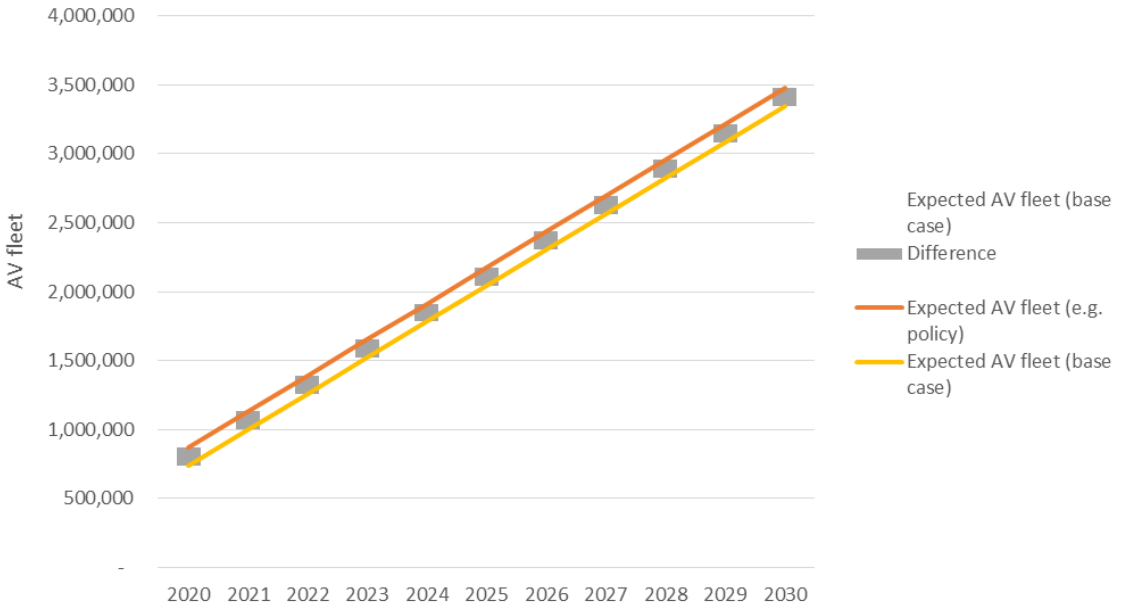
Other qualitative factors that influence the generalised safety benefits and the uptake of automated driving systems will largely be driven by the development and supply of the technologies and consumer demand.

H.3 Materiality of automated vehicle uptake outcomes

The following test considers the potential magnitude of the benefits of supporting automated vehicle uptake. These benefits are considered in the context that there are potential benefits from having additional automated vehicles in the Australian vehicle fleet that are expected to have better than average safety outcomes. This test centres on a policy that supports automated vehicle uptake equivalent to fast-tracking automated vehicle take-up by six months (namely consumer confidence, supplier clarity or similar) (Figure 5).

Using a low automated vehicle uptake scenario (where automated vehicles on the road go from 741,305 in 2020 to 3,343,942 in 2030), the effect of the policy intervention leads to approximately 130,000 more automated vehicles in use. Given that it is assumed that automated vehicle uptake proceeds at the same rate with or without the policy intervention, this difference of 130,000 persists in every year.

Figure 5. Impact of fast-tracking automated vehicle take-up by six months



An advantage is gained from the difference in automated vehicle fleet only if there is an intrinsic benefit in having automated vehicles on the road (for example, safety improvements, reduced congestion, more efficient journeys, mobility). The magnitude of this is unknown, but it may be broadly estimated using assumptions around crash performance. Given the full social costs attributable to road crashes (from road fatalities, road injuries and property damage) are approximately $27 billion, then this corresponds to $1,418 per vehicle (if unitised across the predicted vehicle fleet of 19 million). Given human error is a contributing factor in up to 94 per cent of crashes, then if an automated vehicle can avoid 10 per cent of crashes by reducing the scope for human error, the safety benefits of an additional automated vehicle on the road (as opposed to a human-driven vehicle) may be approximately $142 per automated vehicle.

Under these assumptions, the benefits of the additional 130,000 automated vehicle on the road annually are equal to $18 million per year. Making the net present benefit of a policy intervention that fast-tracks automated vehicle take-up by six months over the period 2020 to 2030 is in the order of $154 million.

If the policy change is considered in the context of a high automated vehicle uptake (of 1,710,704 in 2020 to 9,534,754 in 2030), then the net present benefit is approximately $464 million. The estimated benefit is higher since an additional 390,000 automated vehicles are expected to be on the road each year as a result of the example policy.

This suggests that if automated vehicles can avoid 10 per cent of crashes, then a policy that can promote automated vehicle uptake and fast-track uptake by six months may provide a net present benefit in the order of $154–464 million. This finding demonstrates that, even under a set of conservative assumptions, the potential uptake impacts are significant over the proposed regulatory period.

Appendix I Costs to government

I.1 Assessment of options against the costs to government assessment criteria

Upfront structural, organisational and regulatory change costs

Table 25 outlines the expected once-off structural, organisational and regulatory change costs to the Commonwealth government and/or national agency administering the safety assurance system for each option.

Once-off administrative costs to the Commonwealth government and/or national body administering the safety assurance system are expected to be highest for option 4, followed by option 3 and then option 2. These costs are not applicable for option 1 because this option does not involve any changes to administrative systems.

The existing vehicle certification process, including developing and implementing legislation and systems changes, cost around $2 million to establish.[68] Similar once-off administrative costs could be incurred for developing and implementing the legislative and administrative systems necessary for a legislated safety assurance system (options 3 and 4). Costs are likely to be lower if a safety assurance system is introduced within existing legislative frameworks (option 2).

Table 25. Once-off administrative costs to the Commonwealth government or a national agency administering the safety assurance system

Once-off administrative costs	Option 1	Option 2	Option 3	Option 4
Upfront investments into administrative systems	Costs not applicable[69]	Developing systems to assess Statements of Compliance and recording outcomes	The same costs as option 2 and additional costs to develop an enforcement system for new sanctions and penalties	The same costs as option 3 and additional costs to develop systems to investigate and enforce breaches of primary safety duties
Employee training	Costs not applicable	Training costs (may be significant)		
Developing a national advisory panel	Costs not applicable	Yes (insignificant)		

[68] This information was provided by the Department of Infrastructure, Regional Development and Cities' (DIRDC) Vehicles Safety Standards Branch.

[67] For context, DIRDC advised that the existing certification process cost $2 million to establish.

[68] For context, DIRDC has advised that establishing new ADR(s) for automated vehicles may cost up to $100,000 upfront and maintaining the ADR(s) would incur costs of around $100,000 annually.

Once-off administrative costs	Option 1	Option 2	Option 3	Option 4
Regulatory change	Costs not applicable[70]	No additional costs	Costs associated with amending or developing new legislation	

Table 26 outlines the expected once-off costs to state and territory road managers and the National Heavy Vehicle Regulator for each option.

Option 2, 3 and 4 would remove the need for upfront investments to develop rules for conditional registration of ADSs.

Options 3 and 4, however, require regulatory change that may impose costs on state and territory road managers.

Table 26. Costs to road managers (state and territory governments and National Heavy Vehicle Regulator)

Once-off administrative costs	Option 1	Option 2	Option 3	Option 4
Upfront investments into administrative systems	Expanding registration systems to record ADS details, and developing rules for conditional registration of ADSs	Expanding registration systems to record ADS details Removes costs associated with option 1 for developing rules for conditional registration of ADSs		
Employee training	Training costs expected for all options			
Developing a national advisory panel	Costs not applicable	Yes (insignificant)		
Regulatory change	Costs not applicable	Potentially (TBC)		

Ongoing administrative costs to government[71]

DIRDC's Vehicle Safety Standards Branch made some preliminary cost estimates for administering a safety assurance system. These estimates were developed as indicative estimates for the purposes of the consultation RIS.[72] While some submissions have included

[69] See Table 35, Appendix L for a summary of ongoing cost estimates for existing administrative processes.

[70] They are premised on the broad automated vehicle uptake assumptions described in Appendix K and on the assumption that administrative costs will be significantly lower once automated vehicles become 'mainstream'.

[71] This is based on the estimates and assumptions provided by DIRDC's Vehicle Safety Standards Branch.

estimates of additional costs, we have not changed these indicative estimates because they are strongly dependent upon the design of the institutional arrangements that will support a safety assurance system. These arrangements will be considered further in the next phase of the work. It may be necessary to undertake further work to clarify the ongoing administrative costs to government at this stage.

Table 27 shows potential costs for administering a safety assurance system.

Some of the costs described in Table 27 may be offset by fees or charges for those seeking certification under the type approvals regime and/or approval under the safety assurance system. Such fees and charges have not yet been considered.

Table 27. Potential ongoing costs for administering a safety assurance system

Process	Cost per unit	Unit range	Estimated cost per year
Administering a safety assurance system, including assessing an applicant's Statement of Compliance	Niche – around $10,000 per assessment Mainstream – around $2,500 per assessment	Niche – 10 per year Mainstream (plausible peak) – 200 per year Mainstream (upper frontier) – 400 per year	Niche – around $100,000 Mainstream (plausible peak) – $500,000 Mainstream (upper frontier) – $1,000,000
Notifying road agencies of safety assurance system assessment outcomes	Negligible	Niche – 10 per year Mainstream (plausible peak) – 200 per year Mainstream (upper frontier) – 400 per year	n/a
Monitoring in-service safety-related incidents relating to ADSs	Nil additional cost to business as usual Process is the same as for the general case of safety recalls	Quantity unknown	n/a
Investigating in-service safety-related incidents relating to ADSs	Variable	Quantity unknown	Unquantifiable

Table 28 outlines the expected ongoing administrative costs to the Commonwealth government and/or a national agency responsible for administering the safety assurance system.

Table 28. Ongoing administrative costs to the Commonwealth government or a national agency responsible for administering the safety assurance system

Ongoing administrative costs to government	Option 1	Option 2	Option 3	Option 4
Administering the current certification or safety assurance system	No additional costs to administer the certification process (unless additional assessments were required)[73] The annual variable cost of assessing automated vehicles under the ADRs may be somewhere between $1,000 and $80,000 based on a cost of $100 per ADR per application, and depending on the number of approvals sought	The variable cost of assessing a Statement of Compliance may be between $100,000 and $1 million per year based on having an advisory panel, although this may decrease significantly if automated vehicles requirements were absorbed within ADRs or new legislation[74]		
National advisory panel	No applicable costs	Incorporated into the costs of 'administering the safety assurance system'		
Notifying state and territory road agencies of certification outcomes	No additional costs	No significant additional costs to business as usual[75]		
Monitoring in-service safety-related incidents relating to ADSs	No applicable costs	Uncertain, but there is potential for some government costs		Likely to be some significant government costs, but insufficient information available to quantify
Investigating in-service safety-related incidents relating to ADSs	No applicable costs	Uncertain, but there is potential for some government costs		Likely to be some significant government costs, but insufficient information

[72] Advice from DIRDC. The existing certification process has $5.5 million overhead costs per year.

[73] Advice from DIRDC.

[74] Advice from DIRDC.

Ongoing administrative costs to government	Option 1	Option 2	Option 3	Option 4
				available to quantify
Applying sanctions and penalties	No applicable costs	Likely to be some significant government costs, but insufficient information available to quantify		
Record-keeping costs	No applicable costs	Ensuring Statement of Compliance is maintained and up to date		The same costs as option 2 and 3 plus costs associated with maintaining records for primary safety duty investigations and enforcement

Option 1 (the baseline option) could have the lowest regulatory costs for government and applicants but also the least safety assurance. This is true if there are no additional safety assessment requirements for a vehicle with an ADS under the certification process.

Alternatively, the certification process under option 1 could include additional assessment requirements similar to those of the safety assurance system. This means regulatory costs to government of option 1 might be equivalent to the estimated costs of administering a safety assurance system. These alternate scenarios illustrate the regulatory uncertainty of option 1.

The most significant cost component is likely to be for administering the current certification process (options 1 and 2) and/or administering the safety assurance system (options 2–4).

Under the current certification system, the applicant pays fees and charges so that overall administrative costs are recovered. We assume that a similar cost recovery model would be adopted under a safety assurance system.

It unclear whether administration costs to government would be significantly different for a safety assurance system compared with the current certification processes. Assuming a comparable safety standard and assessment scope, administrative costs should be broadly similar across all options.

However, option 4 potentially provides a greater level of regulatory oversight than options 2 and 3. The administrative costs of the Commonwealth government or the national agency administering the safety assurance system may be highest for option 4.

Table 29 outlines the expected ongoing costs to road managers (including the National Heavy Vehicle Regulator) for each option.

Table 29. Ongoing administrative costs to road managers (state and territory governments and National Heavy Vehicle Regulator)

Ongoing administrative costs to road managers	Option 1	Option 2	Option 3	Option 4
Registering an ADS	Costs would be incurred Uncertain of these costs			
Notifying national body of identified ADS incidents	No applicable costs		There are likely to be significant costs of providing dedicated analysts to interrogate and share the data	
Assessing Statements of Compliance (as a member of the national advisory panel)	No applicable costs	There are likely to be some costs to road managers, but the bulk of costs likely to be incurred by the Commonwealth or the national agency administrating the safety assurance system		
Record-keeping costs	There may be minimal additional costs in maintaining registration data			

The costs to road managers for registering automated vehicles are not expected to differ significantly between options.

The costs for road managers to provide a national agency with intelligence about automated vehicle technical errors or safety performance issues (options 3 and 4) are expected to be significant.[76]

Under options 2, 3 and 4, state and territory road managers would have a role in assessing Statements of Compliance as members of the national advisory panel. We expect that the bulk of these assessment costs would be incurred by the Commonwealth or the national agency administering the safety assurance system.

[76] Our cost benefit analysis relating to the *National Heavy Vehicle Enforcement Strategy* suggested that 'the costs of providing dedicated analysts to interrogate and share the data was identified by the agencies as the main area of cost of implementing the Strategy' (National Transport Commission, 2009, p. 5).

Appendix J Research on the expected benefits of automated vehicles

J.1 Safety benefits

Improvements to road safety are expected to be key benefits of automated vehicles (Austroads, 2017b, pp. 19, 20). A large literature has emerged investigating this topic (see summary in Melakis, et al., 2017 (pp. 327, 328)).

A recent Austroads paper investigated if lower levels of automation, or driver assistance, could reduce the number of road crashes in Australia (Austroads, 2017b). Using a dataset of actual crashes, the paper analysed (probabilistically) whether certain technologies[77] could have prevented the crashes if they had been available in the vehicles when the accident occurred. Because of the uncertainties involved and the probabilistic approach used, the paper provides lower and upper bounds for the number of crashes that could have been prevented by the technologies.

Table 30 shows crashes that could potentially be avoided if the technologies provided a signal when human intervention is required (columns 3 and 4).[78] Columns 5 and 6 show the hypothetical crash reduction (based on the authors' judgment) if the vehicle control was automated across all of the technologies, rather than relying on human intervention after a warning. Column 6 (42 per cent of crashes avoided) is roughly comparable to a figure cited in a US study, which suggested that there could be at least a 40 per cent reduction in fatal crashes following the introduction of automated vehicles (Fagnant & Kockelman, 2015, p. 3).[79] The final column assumes 94 per cent of crashes are avoided based on findings in the literature that human drivers cause this percentage of crashes (National Highway Traffic Safety Administration, 2015, p. 1).

Note that all estimates in Table 30 are likely to over-estimate the potential reduction in crashes. Estimates assume 100 per cent deployment of vehicles in the fleet with the relevant technologies, which is unlikely over the time period of the current analysis. Second, as a result of the combination of human-controlled and automated vehicles – as well as the potential for vehicles with conditional automation – there are several human factors that may offset the effectiveness of automation.[80] Last, there may be vehicle automation risks such as system failure or the potential for hacking of the automated driving system (Litman, 2017, p. 12).

[77] Namely: Cooperative Forward Collision Warning, Curve Speed Warning, Intersection Movement Assist, Right Turn Assist, Lane Keeping Assist, Auto Emergency Braking.

[78] Except for Lane Keep Assist and Auto Emergency Braking, which are automated.

[79] The basis for this figure is that over 40 per cent of fatal crashes involve some combination of alcohol, distraction, drug involvement and/or fatigue.

[80] The Austroads paper cites the following: Driver Overreliance (Automation Complacency); Adoption of Risky Driving Behaviours; Driver Workload; Driver Distraction; Driver Acceptance; Driver Trust; Loss of Skill; Regaining Manual Control; human–machine interface issues (Austroads, 2017b).

Table 30. Road crashes, deaths and injuries in Australia

Statistic	Annual statistics in Australia	Austroads paper – lower bound (21% of crashes avoided)	Austroads paper – upper bound (33% of crashes avoided)	Austroads paper – hypothetical lower bound (27% of crashes avoided)	Austroads paper – hypothetical upper bound (42% of crashes avoided)	Assuming 94% of crashes are avoided
Crashes	19,874	15,724	13,389	14,526	11,496	1,192
Deaths*	1,227	971	827	897	710	74
Injuries*	34,901	27,613	23,513	25,509	20,189	2,094

* Data in columns 3–7 of the table are estimates based on scaling down the total number of deaths/injuries by the same percentage as the reduction in crashes.

Data sources for the 'Annual statistics in Australia' column. 'Crashes' is average fatal and serious injury crashes in Australia over the period 2009–2013 (Austroads, 2017b, p. 39). 'Deaths' is an average over the five years to 2016, and 'Injuries' is hospitalised injuries averaged over the three years to 2014 (BITRE, 2016, pp. 2, 16).

The data in the third and fourth columns of Table 30 provides a range for the potential for certain vehicle technologies/automation – which can be deployed without the safety assurance system – to reduce crashes. However, other factors such as increased driving distances may potentially offset this reduction.

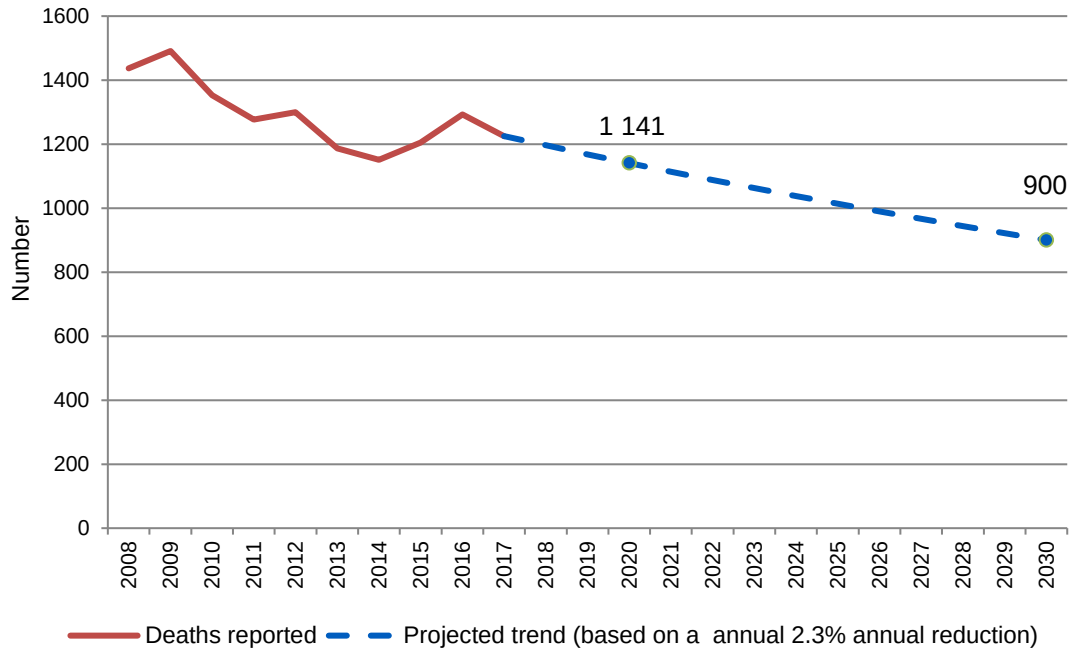
J.2 Projected road safety baseline

We have estimated a baseline level of road safety outcome that could be achieved through the uptake of automated vehicles. Projecting road safety as the underlying rate of accidents would likely change from current levels irrespective of the regulatory approach taken for automated vehicles. Therefore, the potential rate of crashes is uncertain.

Historical numbers serve as a guide for the future, but actual outcomes in the future will be influenced by various other factors, for example, an increase in number of kilometres travelled by vehicles on the road, increased penetration of connected and automated vehicle technology, increased penetration of other vehicle safety features such as electronic stability control ESC, and the removal of 'black spots' on roads.

For the purposes of comparative analysis, the we have projected a baseline for annual road fatalities. This projection, as presented in Figure 6, uses a straight-line trend based on the average annual reduction between the *National Road Safety Strategy's* 2008–2010 baseline and 2017 of 2.3 per cent extended from 2017 to 2030.

Figure 6. Projected annual road fatalities to 2030



Under this baseline projection, the annual road toll would fall from 1,141 in 2020 to around 900 by 2030.

We emphasise that the projections are only theoretical baselines to assess impacts against. Such projections need to be credible as far as it is practical, but absolute accuracy is not necessary, nor possible.

J.3 Costs of crashes

There are a variety of estimates of the costs of different crash severities. For this assessment we have used the Bureau of Infrastructure, Transport and Regional Economics (BITRE) estimates for the costs of different types of crashes (BITRE, 2009, p. 85), adjusted from 2006 to 2017 dollars (presented in Table 31).

Table 31. Estimated average costs of road crashes in Australia by crash outcome ($, 2017)

Fatal crash	Hospitalised injury crash	Non-hospitalised injury crash	Property damage only crash
3,451,685	344,028	19,065	12,869

Original data from Table T7.4 of BITRE's report (BITRE, 2009, p. 85). Values have been indexed using the ABS All groups CPI (Series ID: A2325846C) using the December 2006 and December 2017 data points.

Estimates of road crash costs can be used to quantify the expected benefits of the different reform options and allow for consistent comparisons between them.

J.4 Other benefits

Automated vehicles offer many additional benefits (for example, improved mobility, transport options, road network efficiencies, reduced travel costs and alternate uses of travel time) that will be realised as automated vehicles are adopted and as they penetrate the vehicle fleet.

The literature on the potential wider benefits of automated vehicles is large and diverse; however, several papers contain good reviews of this literature (Milakis, et al., 2017; Litman, 2017). The evidence presented for many of the benefits is mixed and will depend on how automated vehicles are used in the future.

To illustrate the degree of uncertainty, we have selected research findings that highlight one benefit of automated vehicles that is quite likely to materialise and another that's outcome is highly uncertain.

It is likely that wide uptake of automated vehicles will increase access to mobility for currently unserved or underserved groups of society. These groups include those who may currently rely on transportation by relatives, government assistance or public transport due to their age or medical conditions that prevent them from driving. A US study found there could potentially be a 14 per cent increase in total annual distance travelled by light vehicles if automated vehicles were available for use by these groups (Harper, et al., 2016, p. 14). Although this travel is beneficial to the individuals concerned, it is difficult to quantify the overall value of this potential benefit.

As a contrasting example, the probable energy consumption of automated vehicles is far more uncertain. The US Energy Information Administration (EIA, 2017, p. 43) has noted that automated vehicles could potentially:

- reduce energy consumption – due to factors such as 'light-weighting' (reductions in vehicle weight due to the removal of certain safety features, the steering wheel, pedals, etc.), 'rightsizing' (where, in a situation of an automated vehicle fleet, a size-optimised vehicle is used for every journey depending on the number of passengers), and the potential for platooning, or
- increase energy consumption – due to factors such as increased vehicle travel (because of a fall in the generalised cost of travel,[81] increased mobility for user groups that were previously unserved, or vehicles driving empty between destinations), increased weight because of additional features in the vehicle (for example, if a vehicle was a 'mobile office') or higher highway speeds.

Other potential benefits, such as reduced congestion and improvements in travel comfort and use of time, also have somewhat mixed evidence in the literature, and may depend on how the market develops in the future (Milakis, et al., 2017, p. 327). 0 outlines a summary of the literature, as reported by Milakis et al. (2017).

[81] The generalised cost of travel includes both monetary and non-monetary costs (such as the time taken and what the journey time can be used for).

Table 32. Summary of automated vehicle impacts

Automated vehicle impacts	Impact direction	Description
Travel costs		
Fixed costs of automated vehicles	Benefit	Current automated vehicle applications cost several times the price of a conventional vehicle in the US, but the price could be gradually reduced to $3,000 or even lower with mass production and the technological advances of automated vehicles.
Travel comfort	Uncertain	Comfort has been incorporated in trajectory planning and adaptive cruise control algorithms as the optimising metric. Motion sickness, apparent safety and natural human-like paths could be included in path planning systems. Time headway between vehicles below 1.5–2.0 seconds can influence comfort.
Travel time	Cost	Vehicle automation can reduce delays on highways, at intersections and in contexts involving shared automated vehicles.
Value of time	Uncertain	Automated vehicles (level 3 and higher) could reduce the value of time. Yet, the value of time could increase for users of automated vehicles as an egress mode to train trips. The ability to work on the move is not perceived as a major advantage of an automated vehicle.
Road capacity		
Highway capacity	Benefit	The higher the level of automation, cooperation and penetration rate, the higher the positive impact on road capacity. A 40 per cent penetration rate of cooperative adaptive cruise control appears to be a critical threshold for realising significant benefits on capacity (> 10 per cent), while a 100 per cent penetration rate of cooperative adaptive cruise control could theoretically double capacity. Capacity impacts at level 3 or higher levels of vehicle automation and more advanced levels of cooperation among vehicles, but also between vehicles and infrastructure, could well exceed this theoretical threshold. Capacity might be affected by vehicle heterogeneity. Capacity could decrease in entrance/exit of automated highway systems.
Intersection capacity	Benefit	Significant capacity benefits (more than 100 per cent under certain conditions) are expected from automated intersection control systems.
Travel choices		
Vehicle kilometres travelled	Benefit	Automated vehicles could induce an increase in travel demand of 3–27 per cent due to changes in destination choice (longer trips), mode choice (modal shift from public transport and walking to car) and mobility (more trips, especially from people currently experiencing travel restrictions such as the elderly). Shared automated vehicles could result in additional kilometres travelled because of their need to move or relocate with no one in them to

Automated vehicle impacts	Impact direction	Description
		serve the next traveller. Extra kilometres travelled are expected to be lower for dynamic ride-sharing systems.
Vehicle ownership	Cost	Shared automated vehicles could replace from about 67 per cent up to over 90 per cent of conventional vehicles delivering equal mobility levels. The overall reduction of the conventional vehicle fleet could vary according to the automated mode (vehicle-sharing, ride-sharing, shared electric vehicle), the penetration rate of shared automated vehicles and the presence or absence of public transport.
Local choices and land use	Uncertain	Automated vehicles could enhance accessibility citywide, especially in remote rural areas, triggering further urban expansion. Automated vehicles could also have a positive impact on the density of economic activity at the centre of the cities. Parking demand for automated vehicles could be shifted to peripheral zones. Parking demand for shared automated vehicles can be high in city centres, if empty cruising is not allowed.
Transport infrastructure	Cost	Shared automated vehicles could significantly reduce parking space requirements up to over 90 per cent. The overall reduction of parking spaces could vary according to the automated mode (vehicle-sharing, ride-sharing, shared electric vehicle), the penetration rate of shared automated vehicles and the presence or absence of public transport. Less wheel wander and increased capacity because of automated vehicles could accelerate pavement-rutting damage. Increase in speed of automated vehicles could compensate for such negative effect by decreasing rut depth.
Energy consumption and air pollution		
Fuel efficiency	Benefit	Significant fuel savings can be achieved by various longitudinal, lateral (up to 31 per cent), and intersection control (up to 45 per cent) algorithms and optimisation systems for automated vehicles. Higher level of automation, cooperation and penetration rate could lead to higher fuel savings.
Energy consumption	Uncertain	Battery electric shared automated vehicles are associated with significant energy savings (90–100 per cent) in the long term. The energy gains are attributed to more efficient travel and electrification. Several factors could lead to increased energy use (for example, longer travel distances and increased travel by underserved populations such as youth, people with disabilities and the elderly). Thus, the net effect of vehicle automation on energy consumption remains uncertain.
Emissions	Benefit	Vehicle automation can lead to lower emissions of NOx, CO, and CO_2. Higher level of automation, cooperation and penetration rates could lead to even lower emissions. Shared use of automated vehicles could further reduce emissions (VOC and CO in particular) because of lower number of times vehicles start.

Automated vehicle impacts	Impact direction	Description
Air pollution	Uncertain	Long-term impacts of battery electric shared automated vehicles are associated with up to 94% less GHG. Yet, the net effect of vehicle automation on GHG emissions remains uncertain.
Social equity	Uncertain	In-vehicle technologies can have positive effects (avoiding crashes, enhancing easiness and comfort of driving, increasing place, and temporal accessibility) for the elderly. Automated vehicles could induce up to 14 per cent additional travel demand from the non-driving, elderly and people with travel-restrictive medical conditions. Automated vehicles offer the opportunity to incorporate social justice aspects in future traffic control systems.
Economy	Uncertain	Social benefits per automated vehicle per year could reach $3,900 when there's a 90 per cent market share of automated vehicles. Jobs in the transportation and logistics sectors have a high probability of being replaced by computer automation within the next two decades.
Public health	Uncertain	No systematic studies were found about the implications of automated vehicles for public health. However, public health outcomes could be negative if automated vehicle use reduces active transport (walking, cycling) and hence health benefits gained from these activities.

Appendix K Automated vehicle uptake

K.1 Increasing automation in vehicles

Vehicle manufacturers are progressively introducing higher levels of automation in their vehicles. In the near future, automated driving systems (ADS) will be capable of controlling the driving task of a vehicle for defined periods of time.

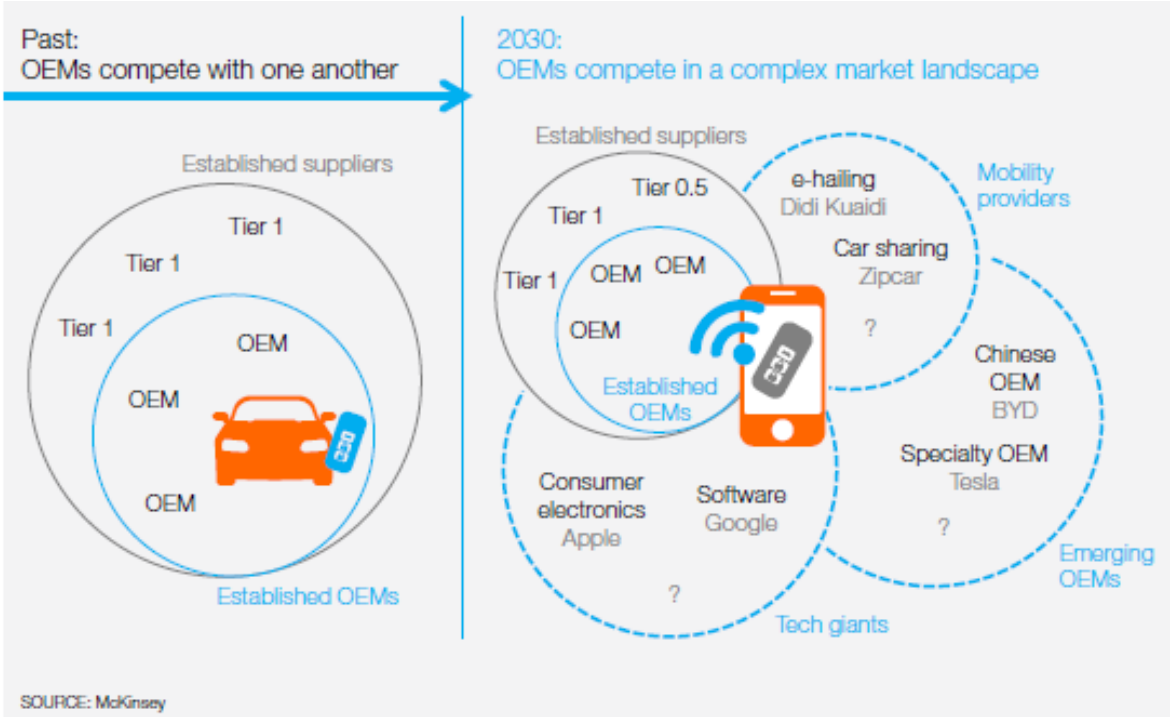
An increasing number of advanced driver assistance systems (ADAS) have been introduced into the Australian vehicle market. Systems such as autonomous emergency braking, lane-keeping assistance and parking assistance help the driver to complete the driving task but do not perform the entire dynamic driving task autonomously. The Federal Chamber of Automotive Industries stated in their submission to the NTC' 2017 discussion paper on *Clarifying control of automated vehicles*, that these systems 'are part of an evolution' progressively being developed and becoming readily available in new vehicles (Federal Chamber of Automotive Industries, 2017, p. 4). It is uncertain how automated vehicles will be developed and commercialised in the future because vehicle manufacturers are all taking different approaches. Some manufacturers are focusing on vehicles that require a human driver to monitor the environment and intervene if required (conditional automation/SAE level 3). Other manufacturers want to skip this level, developing vehicles that do not require a human driver (high automation/SAE level 4). These vehicles can only operate in defined low-speed zones with limited interaction with other vehicles, such as in a university campus or airport precinct. It is not expected that manufacturers will progress from vehicles that require a human to monitor the environment to vehicles that do not.

K.2 Complexity of the automated vehicle market

The automated vehicle market is likely to consist of new and mature technology manufacturers. A large group of companies are developing components for and complete ADSs. These companies include traditional automotive manufacturers and suppliers, technology companies and start-ups (Navigant Research, 2017, p. 12). Many of the traditional automotive manufacturers have been developing automated driving technologies for a number of years. Some other companies that have entered the market more recently have progressed rapidly through acquisitions, investments and strategic hiring of key personnel.

Figure 7 shows the growing complexity of the market.

Figure 7. Complex automated vehicle market



OEM = original equipment manufacturer

Source: (McKinsey & Company, 2016)

We also note that increasing autonomy in the transport sector will also support consumer-side disruptions (for example, increasing ride-sharing and mobility as a service), leading to further complexity of the broader transport sector.

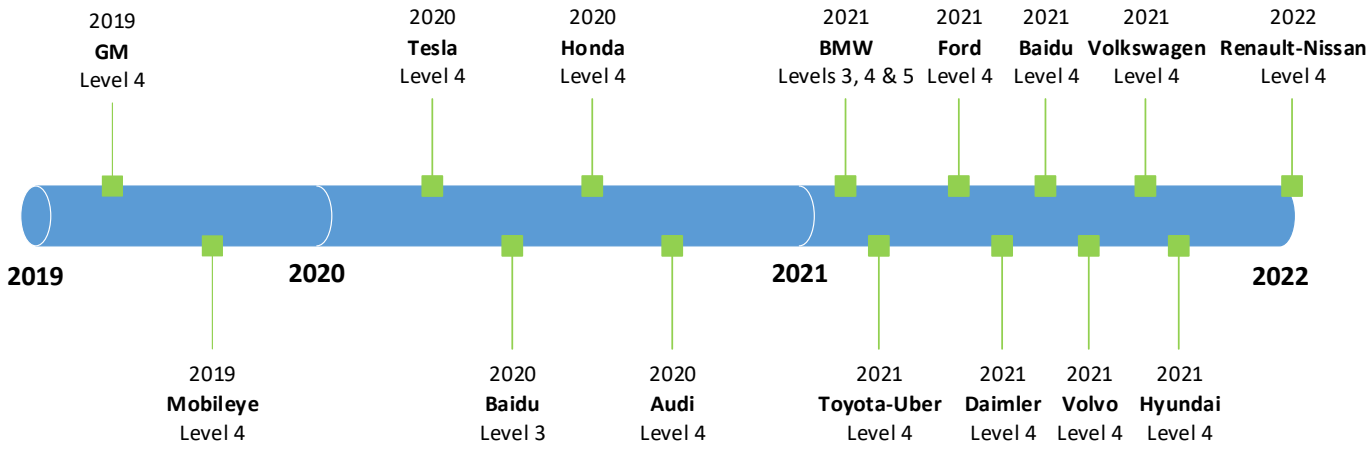
K.3 Commercial availability of automated vehicles

Major vehicle manufacturers and newer technology companies expect initial ADS models (SAE level 3 or above) to be commercially available to overseas markets between 2018 and 2021. It is not known when ADS models will be made available in the Australian market. There is even less certainty about when ADS will become a mainstream product offering, or even a standard feature in new vehicle models.

Figure 8 shows a timeline of predicted international release dates of ADS models as announced by the respective manufacturers.[82]

[82] Manufacturer predicted release timeframes are subject to change and are accurate at the time of writing.

Figure 8. Timeline of manufacturers predicted release of automated vehicles



Traditional automobile makers such as General Motors expect to have vehicles capable of operating at high levels of automation in 2019 in big cities (CNBC, 2018). Volvo has announced it aims to have 'fully autonomous' vehicles commercially available in 2021 (Volvo, 2017). BMW has also announced it aims to deploy a vehicle capable of operating at high levels of automation in 2021 (The Verge, 2018). As shown above in Figure 8, most traditional automobile makers are aiming to commercialise vehicles equipped with high automation by 2021; however, there is a large degree of uncertainty in these timelines.

K.4 Effect of cost on uptake of automated vehicles

It is uncertain what the uptake rates of automated vehicles will be and what proportion of new vehicles sales or the total vehicle fleet they will make up.

Automated driving functionality is likely to be released in new vehicle models, starting with high-end luxury models and eventually in mainstream models over time.

It is possible that a marginal number of operators may fit ADSs to conventional vehicles; however, it is not expected to be widespread because very few consumers would have added airbags or ABS to existing vehicles, despite their clear value.

The speed and extent of ADS uptake will be dependent on the cost of the systems (upfront purchase and operating) as well as the perceived benefit of the ADS functionality (value).

The advanced technology components required for vehicles with high levels of automation are expensive. LIDARs (light detection and ranging) alone currently cost approximately $75,000, making the full cost of the required technology $150,000. These high upfront costs could be a potentially limiting factor in the take-up of vehicles with high automation.

As advanced technology costs fall, high levels of automation will become more affordable and their uptake should increase. Experts predict that vehicles with high levels of automation will become affordable by 2025–2030.

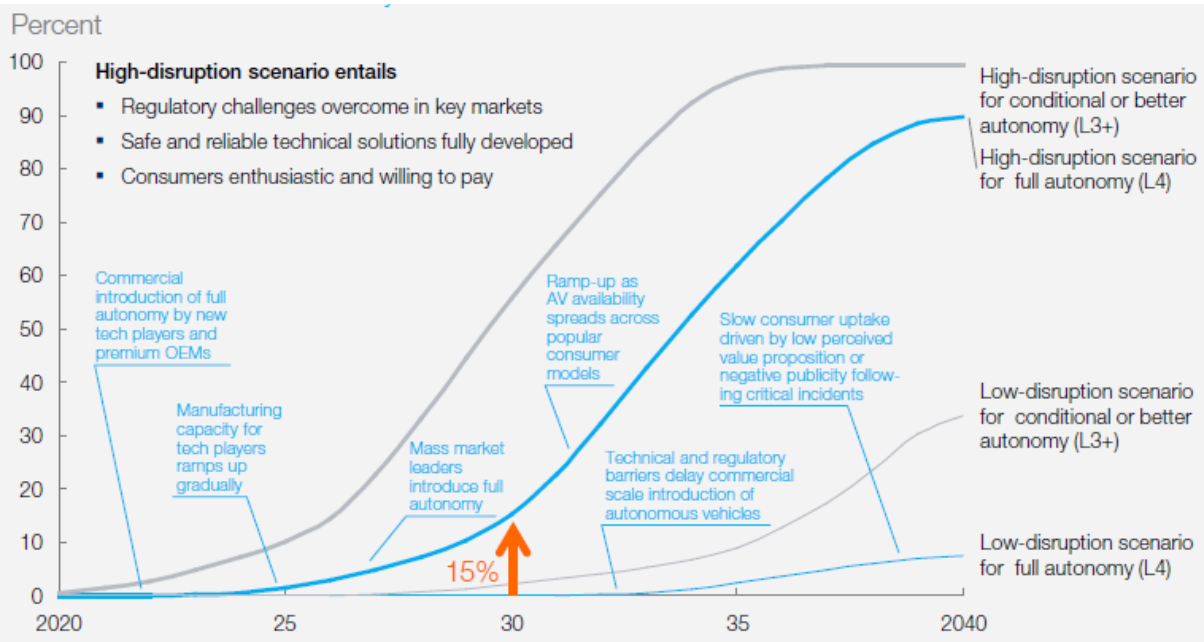
K.5 Predicted automated vehicle uptake

McKinsey & Company developed predictions of new vehicle market shares for conditional automation and high automation[83] for low-disruption and high-disruption scenarios between

[83] McKinsey predictions are based on National Highway Traffic Safety Administration (NHTSA) levels of automation.

2020 and 2040. These predictions generate four uptake curves of market penetration as shown in Figure 9.

Figure 9. New vehicle market share of conditional and level 3 and 4 automated vehicles



Source: (McKinsey & Company, 2016)

Under the high disruption scenarios,[84] vehicles with conditional and higher levels of automation would reach 60 per cent market share by 2030, and up to 15 per cent of all new vehicles would high/full automation. Under the low-disruption scenarios,[85] vehicles with conditional automation would make up less than 5 per cent of new vehicle sales, while sales of vehicles with high/full automation would be negligible.

A paper by Bansal and Kockelman forecasts the uptake rate of connected and automated vehicles in the US under different levels of automation (Bansal & Kockelman, 2017, p. 18). The study uses simulations and takes into account developments in demand and supply within the market. Across the various scenarios, the study suggests minimum and maximum uptake rates in 2020 and 2030 as presented in Table 33. The 'levels' used in the paper are as defined by the NHTSA, ranging from level 0 to level 4, with levels 3 and 4 corresponding to those used in the McKinsey paper (McKinsey & Company, 2016, p. 11).

[84] The high-disruption scenarios entail: regulatory challenges being overcome; safe and reliable technical solutions being fully developed; and consumers being enthusiastic and willing to pay.

[85] The low-disruption scenarios entail: gradual resolution of regulatory challenges; incomplete development of safety and reliable technical solutions; and limited consumer acceptance and willingness to pay.

Table 33. Forecasted connected and automated vehicle uptake in the US, 2020 and 2030

Level of automation	Estimated uptake rates			
	2020		2030	
	Minimum	Maximum	Minimum	Maximum
Level 3	1.9%	3.5%	4.5%	8.4%
Level 4	2.0%	5.5%	10.3%	33.8%

A study in the Netherlands conducted simulations showing considerable uncertainty about the potential fleet size for different levels of automated vehicles (Nieuwenhuijsen, 2015, p. 316). The simulations show that the fleet size of level 0 and level 1 vehicles – which is currently around eight million vehicles in the Netherlands – is expected to fall relatively rapidly. By contrast, take-up of levels 4 and 5 is expected to be relatively slow, with the 75 per cent confidence interval suggesting that the fleet size in 2025 could be between 1.1 million and 2.2 million for levels 4 and 5, respectively (or as low as zero).

Lavasani, Jin and Du (2016, p. 12) also run simulations of the uptake of automated vehicles. In their model, sales of automated vehicles are assumed to begin in 2025, with relatively limited uptake occurring by 2030. The results of the authors' prediction model show that uptake is far more sensitive to variations in the market size than variations in the costs of the automated vehicles.

The broad range of predictions demonstrates the high level of uncertainty for future uptake. In addition, the previous studies have focused on foreign (developed) countries, meaning the results may not be transferable to the Australian context. However, the results can potentially be treated as indicative of what may occur in Australia.

The Vehicle Safety Standards Branch of the Department of Infrastructure, Regional Development and Cities suggested some preliminary assumptions on the uptake of automated vehicles:

- Within the first five years (2020–2025), automated vehicle models are likely to be **'niche'**, with around 10 new automated vehicle applications per year.
- Beyond 2025, automated vehicles may start to become '**mainstream**'. If all new vehicle models were automated vehicles, there could be an **'upper frontier'** of around 400 applications per year under a safety assurance system; however, the department suggests that a more **plausible 'peak'** within the regulatory timeframes under consideration (until 2030) could be around 50 per cent of new vehicle models being automated vehicles.

For the purposes of this analysis, we have used the estimates contained in Table 33 as a guide to develop two baselines for the penetration of vehicles with conditional and high automation. These market penetration rates are shown in Figure 10 and Figure 11 using a linear projection to interpolate values between the 2020 and 2030 data points. Notably, the forecasts predict that:

- Vehicles with conditional automation (level 3) would make up between 1.9 and 3.5 per cent of the vehicle fleet by 2020 and between 4.5 and 8.4 per cent by 2030.
- Vehicles with high automation (level 4) would make up between 2.0 and 5.5 per cent of the vehicle fleet by 2020 and between 10.3 and 33.8 per cent by 2030.

Figure 10. Forecasted market penetration rates of vehicles with level 3 automation

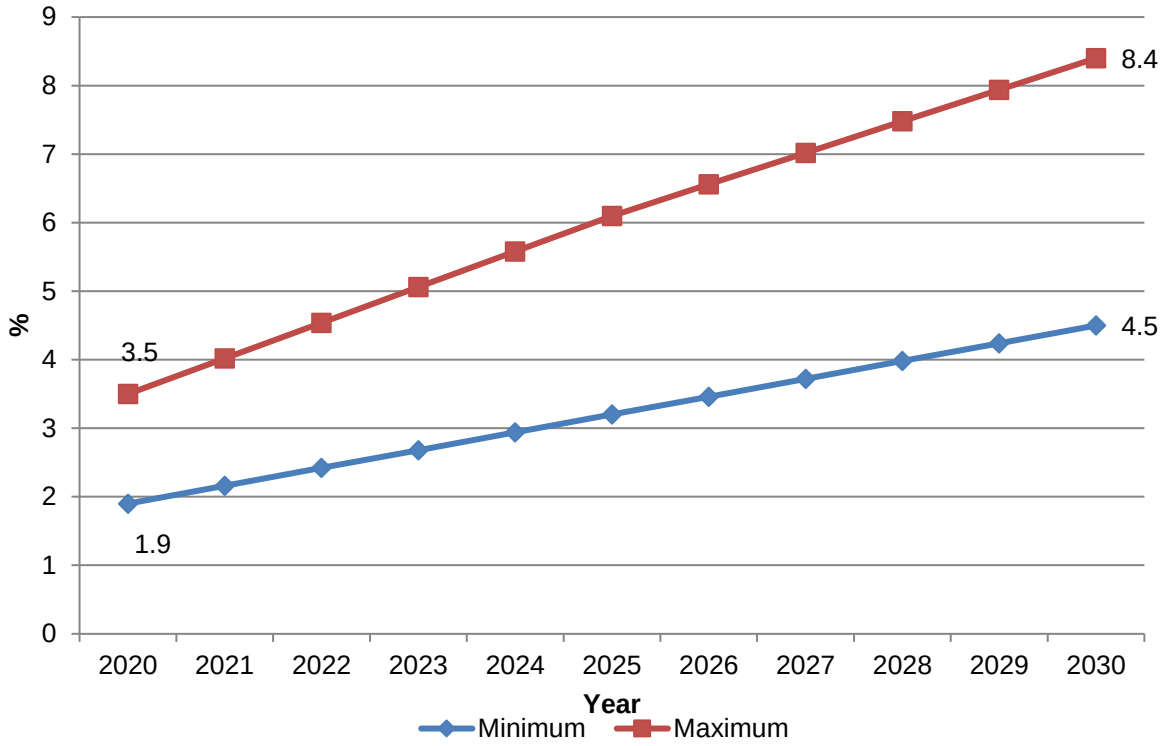


Figure 11. Forecasted market penetration rates of vehicles with level 4 automation

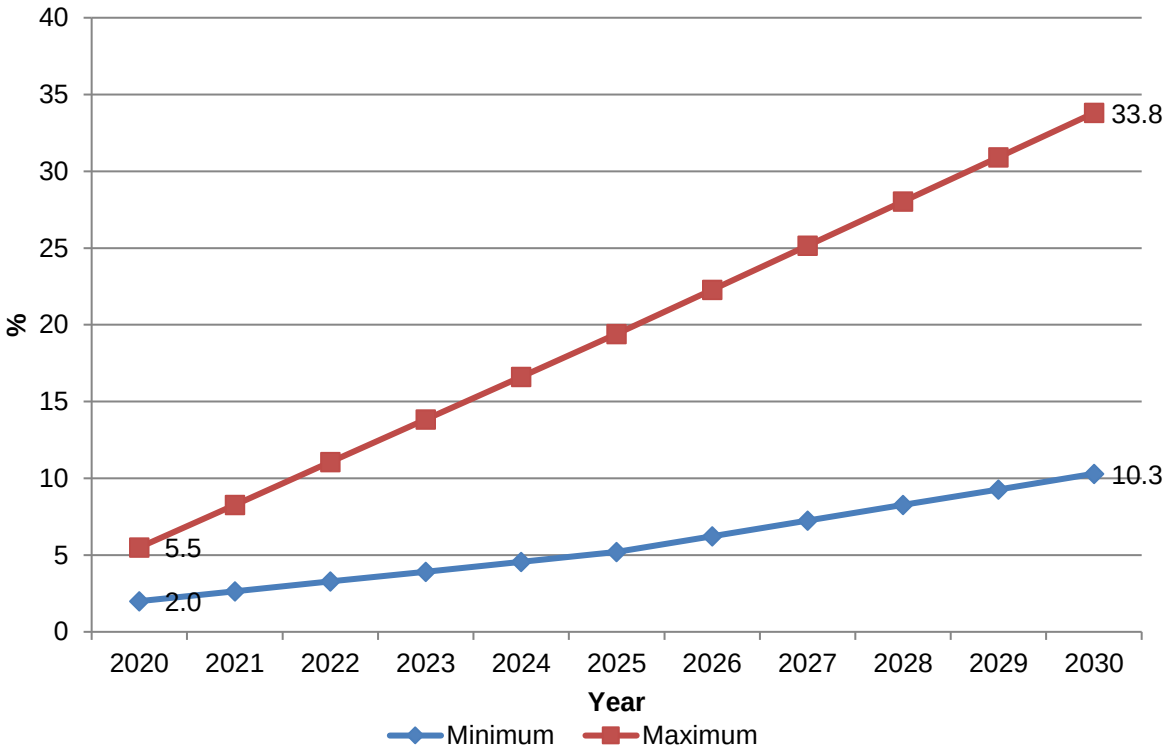


Table 34 applies the forecasted US uptake rates to the Australian context showing maximum and minimum market penetration numbers. It also shows Australian passenger vehicle and all vehicle (excluding motor cycles) population estimates for 2020 and 2030.[86] The results suggest there could be up to 1.7 million highly automated vehicles in the Australian fleet by 2020 and almost nine million by 2030.

Table 34. Forecasted Australian market penetration of highly automated vehicles

	2020		2030	
	Minimum	Maximum	Minimum	Maximum
Predicted passenger vehicle fleet size	14,923,322		17,739,043	
Predicted all vehicle fleet (excluding motorcycles)	19,007,822		22,594,204	
Level 3 – passenger vehicles	283,543	522,316	798,257	1,490,080
Level 3 – all vehicle types (excluding motorcycles)	361,149	665,274	1,016,739	1,897,913
Level 4 – passenger vehicles	298,466	820,783	1,827,121	5,995,797
Level 4 – all vehicle types (excluding motorcycles)	380,156	1,045,430	2,327,203	7,636,841
Combined levels 3 and 4 – passenger vehicles	582,009	1,343,099	2,625,378	7,485,877
Combined levels 3 and 4 – all vehicle types (excluding motor cycles)	741,305	1,710,704	3,343,942	9,534,754

On face value, these estimates appear optimistic in terms of the penetration rates and/or the timing. However, as there is no specific research of automated vehicle uptake or penetration in the Australian market, we have assumed that automated vehicle uptake in Australia could occur along similar projections to those presented in the international research. We recognise there may be a slight delay as some manufacturers may choose to initially focus their product offerings in the larger markets such as the US, Europe and China. We emphasise that the projections and estimates are only theoretical baselines to assess impacts against. Such projections need to be credible as far as it is practical, but absolute accuracy is not necessary, nor possible.

[86] Vehicle population estimated use Australian Bureau of Statistics 2017 vehicle population estimates and a 2 per cent per annum growth rate.

Appendix L Ongoing cost estimates for existing administrative processes

The Commonwealth government's existing ongoing administrative costs include:

- assessing new and imported vehicle compliance against the Australian Design Rules (ADRs)
- administering the existing ADR certification process (including costs of issuing an identification plate and/or revised costs associated with the anticipated amendments to the *Motor Vehicle Standards Act 1989*)
- notifying state and territory road agencies of new and imported vehicle-type certification outcomes
- notifying state and territory road agencies of nonstandard new and imported vehicle-type exemption outcomes.

The Vehicle Safety Standards Branch of the Commonwealth Department of Infrastructure, Regional Development and Cities advises that there are around 400 new vehicle model applications per year and around 1,000,000 new vehicle sales per year.

Table 35 shows cost estimates for existing administrative processes provided by the Vehicle Safety Standards Branch.

Table 35. Cost estimates for existing ongoing administrative processes

Process	Cost per unit	Unit range	Estimated cost per year
Assessing new and imported vehicle compliance against the ADRs	$100 per application	400 per year	$40,000 per year
Administering the existing ADR certification process, including compliance and enforcement, administration and maintenance of legislation	$5.5 million per year	1 per year	$5.5 million per year (~$55 million over 10 years)
Notifying state and territory road agencies of new and imported vehicle-type certification outcomes	No applicable costs	400 per year	n/a
Notifying state and territory road agencies of nonstandard new and imported vehicle-type exemption outcomes	No applicable costs	Unknown	n/a
Fees or charges that are applied to industry bodies that are seeking ADR certification	$6 per vehicle	1,000,000 new vehicle sales per year	$6 million per year (cost offset)

Glossary

Term[87]	Definition
Australian Design Rules (ADRs)	National standards for safety, anti-theft and emissions in vehicle design.
Australian Road Rules	National model law intended to provide the basis for nationally consistent road rules in each jurisdiction. These rules do not, by themselves, have any legal effect.
Austroads	The association of Australasian road transport and traffic agencies.
automated driving system (ADS)	In-vehicle operating system that controls a vehicle's automated functions.
automated driving system entity (ADSE)	The legal entity responsible for the automated driving system.
automated vehicles	Vehicles that include an 'automated driving system' capable of performing the entire dynamic driving task including steering, acceleration, braking and monitoring the driving for sustained periods of time. This term encapsulates vehicles with conditional, high and full automation.
conditional automation	An automated vehicle where the system drives the vehicle for sustained periods of time, but the human driver must be receptive to system errors and be the fallback for the dynamic driving task.
dynamic driving task*	All of the real-time operational and tactical functions required to operate a vehicle in on-road traffic, excluding the strategic functions such as trip scheduling and selection of destinations and waypoints, and including without limitation: 1. Lateral vehicle motion control via steering (operational); 2. Longitudinal vehicle motion control via acceleration and deceleration (operational); 3. Monitoring the driving environment via object and event detection, recognition, classification, and response preparation (operational and tactical); 4. Object and event response execution (operational and tactical); 5. Manoeuvre planning (tactical); and 6. Enhancing conspicuity via lighting, signalling and gesturing, etc. (tactical).

[87] Terms marked with an asterisk are quoted from SAE International Standard J3016.

Term[87]	Definition
full automation	An automated vehicle where all aspects of the driving task and monitoring of the driving environment and the dynamic driving task are undertaken by the vehicle system. The vehicle can operate on all roads at all times.
Heavy Vehicle National Law (HVNL)	National laws related to the regulation of heavy vehicles over 4.5 tonnes. Operational in all Australian states and territories except Western Australia and the Northern Territory.
Heavy Vehicle (Vehicle Standards) National Regulation	Heavy vehicle regulation made by the Queensland Governor with approval from state and territory transport ministers and commenced at the same time as the HVNL in 2014.
high automation	An automated vehicle where the system drives the vehicle for sustained periods of time in some situations, or all of the time in defined places, and no human driver is required to monitor the driving environment and the driving task, or intervene, when the system is driving the vehicle.
human–machine interface	Interface between a human operator and a machine. Includes functional and ergonomic design of the interface (human factors).
Motor Vehicle Standards Act 1989 (MVSA)	Commonwealth legislation to control the safety, environmental and anti-theft performance of all new and used vehicles entering the Australian market for the first time.
National Heavy Vehicle Regulator (NHVR)	The NHVR administers one set of laws for heavy vehicles under the HVNL, delivering a comprehensive range of services under a consistent regulatory framework.
National Highway Traffic Safety Administration (NHTSA)	An agency of the Executive Branch of the United States Government and part of the Department of Transportation.
National Transport Commission (NTC)	Independent statutory body that contributes to the achievement of national transport policy objectives by developing regulatory and operational reform of road, rail and intermodal transport.
operational design domain* (ODD)	The specific conditions under which a driving automation system or feature is designed to function (for example, locations, weather conditions, driving modes).
Original equipment manufacturer (OEM)	The original manufacturer of a vehicle's components that are assembled and installed during the construction of a new vehicle.
partial automation	An automated vehicle where the automated driving system may take control of steering, acceleration and braking in defined circumstances, but the human driver must continue to monitor the driving environment and the driving task, and intervene if required.

Term[87]	Definition
National Exchange of Vehicle and Driver Information System	A national system that exchanges information about vehicles and driver licences, managed by Austroads.
Department of Infrastructure, Regional Development and Cities (DIRDC)	Department of the Australian Government responsible for administering the MVSA.
system failure*	A malfunction in a driving automation system and/or other vehicle system that prevents the driving automation system from reliably sustaining dynamic driving task performance (partial or complete).
Transport and Infrastructure Council	Group comprising Commonwealth, state, territory and New Zealand ministers with responsibility for transport and infrastructure issues, as well as the Australian Local Government Association.
United Nations Working Party 29 (WP.29)	International regulatory forum within the institutional framework of the UNECE Inland Transport Committee.

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