



Regulatory options to assure automated vehicle safety in Australia

Discussion paper
June 2017



National Transport Commission

Report outline

Title	Regulatory options to assure automated vehicle safety in Australia
Type of report	Discussion paper
Purpose	Consultation on regulatory options for the design of a safety assurance system for automated vehicles.
Abstract	This discussion paper seeks feedback on how Australia should regulate the safety of automated vehicles. This paper assesses regulatory options against proposed assessment criteria and canvasses issues relating to the role of government, the evaluation and validation of safety, institutional arrangements, road access and compliance.
Submission details	<p>Submissions will be accepted until Friday, 28 July 2017 online at www.ntc.gov.au or by mail to:</p> <p>Att: Automated Vehicle Team National Transport Commission Level 3/600 Bourke Street Melbourne VIC 3000</p>
Key words	automated vehicles, regulation, safety assurance, Australian Design Rules, vehicle standards
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Executive summary

Automated vehicles that do not require human driver input into the driving task for at least part of the journey are expected to arrive on our roads from around 2020. Currently there is no explicit regulation covering these automated driving functions. Manufacturers are aiming to ensure automated driving functionality improves road safety, but this technology may also create safety risks for road users.

The purpose of this paper is to seek feedback on:

- whether there is a need for explicit regulation of automated driving functions, above existing transport and consumer law
- if there is a need for regulation, what form this should take.

We are seeking feedback from governments, road safety experts, automated vehicle manufacturers, technology providers, insurers and other stakeholders on these questions. This paper examines:

- how safety of automated vehicle functions should be assessed
- the options for a safety assurance system
- the criteria that should be used to decide among those options
- institutional arrangements, road access and compliance.

Based on the feedback we receive, we will make recommendations to transport ministers in November 2017 on the preferred approach and the next steps to implement any required changes to legislation.

Australian governments have started work to remove legislative barriers to increasingly automated road vehicles. These barriers relate primarily to road traffic laws that implicitly require a human driver. Without further action, once these barriers have been removed, governments would have no regulatory mechanism to proactively ensure automated driving technologies are safe.

Automated driving technologies are progressively undertaking more of the driving task, and it is likely this technology will improve road safety, mobility, productivity and environmental outcomes. However, the technology is highly innovative and diverse and requires further testing and evaluation. From a regulatory perspective, there are four key issues:

- Should governments have a role assuring the safety of automated vehicles?
- What are our measures of safety, and what is the level of safety required?
- How does a safety assurance system balance safety outcomes with innovation, certainty and regulatory efficiency?
- Where does a safety assurance system fit within the existing regulatory framework for road transport, and how does it interact with existing laws?

In November 2016 the Transport and Infrastructure Council directed the National Transport Commission (NTC) to develop a national performance-based assurance regime designed to ensure the safe operation of automated vehicles. This will form a key component of an end-to-end regulatory framework to support the safe commercial operation of automated vehicles. Based on the feedback to this discussion paper, the NTC will recommend a preferred approach to ministers in November 2017, along with the next steps on regulatory reforms to support this approach.

In the absence of agreed Australian or international standards specific to automated vehicle technologies, governments need to consider the uncertain safety outcomes associated with different applications of automated driving, and whether the safety risk justifies additional government oversight and regulatory intervention. In Australia this type of oversight would be in addition to existing general consumer and product liability laws as well as extensive regulation covering vehicle standards and vehicle operation.

As the performance of the vehicle technology becomes increasingly safety-critical, new regulatory approaches may be needed to ensure initial and ongoing safety. Such approaches will need to

cover all potential technology providers, from traditional automotive manufacturers to companies and individuals developing after-market devices to modify existing vehicles.

There is a risk that, without a national and coordinated response to automated vehicle reform, Australia's complex regulatory framework will result in inconsistent regulation or over-regulation of automated vehicles across states and territories.

Regulatory options for safety assurance of automated vehicle functions

The NTC has developed four regulatory options for consultation for the safety assurance of automated vehicle functions. These are based on our assessment of the current regulatory framework and a review of safety literature and international developments. The four options are:

1. **Continue current approach** – no additional regulatory oversight, with an emphasis on existing safeguards in Australian Consumer Law and road transport laws.
2. **Self-certification** – manufacturers make a statement of compliance against high-level safety criteria developed by government. This could be supported by a primary safety duty to provide safe automated vehicles.
3. **Pre-market approval** – automated driving systems are certified by a government agency as meeting minimum prescribed technical standards prior to market entry.
4. **Accreditation** – accreditation agency accredits an automated driving system entity. The accredited party demonstrates it has identified and managed safety risks to a legal standard of care.

We are seeking feedback on these regulatory options, recognising that the regulatory solution may draw upon elements across these options. Stakeholders are also welcome to propose new regulatory options.

Figure 1 provides an overview of the four options.

Figure 1: Overview of the regulatory options

<h3>Continue current approach</h3> <ul style="list-style-type: none"> • Safety managed through existing safeguards: Australian Design Rules (ADRs), roadworthiness, road safety laws and Australian Consumer Law, including vehicle recall. • Reforms to the Road Rules and other laws that will put legal obligations on the automated driving system entity will help ensure manufacturers manage safety. • No additional regulatory oversight or reporting to government. • In the longer term, ADRs and in-service vehicle standards are updated with automated driving standards in alignment with United Nations vehicle regulations. 	<h3>Self-certification</h3> <ul style="list-style-type: none"> • Manufacturers make a Statement of Compliance against high-level safety criteria developed by government. • ADRs and existing safeguards continue to apply. • No additional regulatory oversight or reporting to government. • If voluntary, manufacturers are incentivised to manage safety because of reforms to the Road Rules and other laws that will put legal obligations on the automated driving system entity. • Could allow for recognition of overseas approvals. • Could be supported by industry codes.
<p>Example: Current approval of new and imported vehicles under the <i>Motor Vehicle Standards Act 1989</i> (Cwlth).</p>	<p>Example: Similar elements to motor vehicle regulation in the United States.</p>
<h3>Pre-market approval</h3> <ul style="list-style-type: none"> • Automated driving systems are certified by a government agency (or a third party on its behalf) as meeting minimum prescribed technical standards, prior to market entry. • Government develops testing processes and expertise for different applications and technologies. • Manufacturer reports safety-critical events to government and must seek reapproval for any major changes to functionality. • Onus on government to assess safety (or a third party on its behalf). • ADRs continue to apply. • Able to recognise equivalent processes in a manufacturer's country of origin. 	<h3>Accreditation</h3> <ul style="list-style-type: none"> • Government accredits an automated driving system entity, not the vehicle. • The accredited party demonstrates it has identified and managed safety risks to a legal standard of care, such as 'so far as is reasonably practicable'. • Three elements of safe design: vehicle integrity, environment (including operational design domain) and driver (including human-machine interface). • No prescribed technical standards. • Safety-critical changes to functionality and errors are reported to government. • ADRs continue to apply. • Able to recognise equivalent processes in a manufacturer's country of origin.
<p>Example: An approval process to test and validate automated vehicle safety is being developed in Germany.</p>	<p>Example: Accreditation in aviation, rail, maritime and mining.</p>

In many ways, the regulatory options reflect the risk appetite of the community and how the optimum role of government is perceived and understood by the community. In broad terms, the greater the risk appetite, the less we need explicit regulation, or a proactive role for governments to ensure automated vehicle safety.

In line with developments in other countries, the NTC proposes that the safety risks are sufficiently high or unknown to warrant some level of regulatory oversight and government involvement in the safety assurance system.

Assessment criteria – how do we decide between the options?

We have proposed eight assessment criteria against which the regulatory options for the safety assurance system have been evaluated. We are seeking your feedback on the assessment criteria, outlined in Table 1, and whether other criteria should be included. Based on your feedback, we will refine the assessment criteria and reassess the regulatory options based on the finalised criteria.

Table 1: Proposed assessment criteria for the design of the safety assurance system

Criteria	Description
1. Safety	<ul style="list-style-type: none"> The model should support automated vehicle safety, including the ongoing safety over the full lifespan of the vehicle. The model should provide certainty about who is responsible for testing, validating and managing safety risks.
2. Innovation, flexibility and responsiveness	<ul style="list-style-type: none"> The model should be technology-neutral and allow innovative solutions. The model should allow government to respond and adapt to the changing market and evolving technology.
3. Accountability and probity	<ul style="list-style-type: none"> The model should ensure the decision-making process is transparent, accountable and, where appropriate, appealable. There should always be an entity (whether an individual or a corporation) that is legally accountable for the automated driving system.
4. Regulatory efficiency	<ul style="list-style-type: none"> The assurance process should be as efficient as possible and result in the least cost for industry and government, proportionate to the risk. The process of assurance should minimise structural, organisational and regulatory change necessary to implement the model.
5. International and domestic consistency	<ul style="list-style-type: none"> The model should support a single national approach, or state-based approaches that are nationally consistent. The model should be adaptable if and when there is international consistency. International approval processes and standards should be recognisable.
6. Safe operational design domain	<ul style="list-style-type: none"> The model should be able to take into consideration the operational design domain of an automated driving system.
7. Other policy objectives	<ul style="list-style-type: none"> The model should be able to support non-safety policy objectives including cybersecurity, traffic management, environmental protection and the provision of data for enforcement or insurance purposes.
8. Timeliness	<ul style="list-style-type: none"> The model should be able to be implemented and operational when the technology is ready.

Preliminary assessment of the options

Our initial assessment of the regulatory options suggests there are significant disadvantages associated with not developing a safety assurance system and continuing with the current approach (see Table 2). This is primarily because the ADRs do not have regard to automated driving technologies. Furthermore, existing safeguards, including vehicle recall powers, are focused on the technical integrity of the vehicle and do not consider environmental or human performance safety factors. This may lead to road safety risks, particularly in relation to vehicle modifications and after-market fitment.

Self-certification is a light-touch approach that, like the 'continue current approach' option, relies on existing safeguards but could introduce voluntary or mandatory compliance with automated vehicle safety principles and criteria. Showing compliance with these criteria would allow automated driving system entities to demonstrate to government that their vehicles are safe and therefore suitable to be registered under state and territory laws. Self-certification could be supported by a legislated primary safety duty for manufacturers, suppliers and automated driving system entities to provide safe automated vehicles.

Pre-market approval possibly provides the highest certainty for government and consumers that automated vehicles will be safe. However, this option is also regulation- and resource intensive and could stifle safety-related innovation if testing standards and procedures do not keep pace with technology changes.

Accreditation provides a comprehensive, risk-based and proven framework within which safety can be regulated. It focuses on outcomes, risk management and continuing improvements to safety. The accreditation model has demonstrated safety benefits in other high-risk industries including mining, rail and aviation. However, accreditation would involve a major reform of road safety, includes substantial set up costs and is not an approach that other countries are known to be exploring.

Table 2: Assessment of regulatory options against the proposed assessment criteria



Criteria	Continue current approach	Self-certification	Pre-market approval	Accreditation
1. Are safety risks managed?	P	P	F	F
2. Is the model flexible and does it support innovation?	P	F	N	F
3. Does it support legal accountability and probity?	N	P	F	F
4. Is the regulatory approach efficient?	F	F	N	P
5. Does it support consistency?	P	F	F	P
6. Can it evaluate a safe operational design domain?	N	P	F	F
7. Can the model support other policy objectives?	N	P	F	P
8. Can it be implemented within two years?	F	F	N	P

Implementation issues

A number of key issues need to be considered in implementing an approach to the safety assurance of automated vehicle functions, in particular:

- how to evaluate and validate safety
- institutional arrangements to support the approach
- how to manage access to the road network
- how to ensure compliance with the requirements of the approach selected.

How to evaluate and validate safety

Evaluation and validation of automated vehicle safety is a foundation issue for the development of the safety assurance system. The proportionate and appropriate role of a government agency to test the safety claims made by a manufacturer or technology provider will largely depend on the regulatory model adopted in Australia.

We are seeking feedback on whether safety should be defined and measured according to the rate of technical failure and incidents that result in harm to people, or be based on an agreed metric of safety such as crash rates.

The NTC is proposing that the onus be placed on the automated driving system entity to demonstrate the methods they have adopted to identify and manage safety risks.

Institutional arrangements to support the approach

If there is a role for government in safety assurance for automated vehicle functions? Which government body will have that role? Responsibility for motor vehicle safety regulation is currently shared between the Commonwealth and the states and territories. The current mix of regulatory responsibilities adds complexity to the development of a safety assurance system and the potential institutional arrangements to oversee the safety assurance system. We are seeking feedback on institutional arrangements, including the types of government entities that could support a safety assurance system.

Institutional arrangements are heavily dependent on the safety assurance option chosen, therefore the NTC is proposing that institutional models are further developed after a regulatory option has been agreed.

How to manage access to the road network

For the foreseeable future, automated vehicle functionality will be limited to parts of the road network (for example, only sealed roads). This raises the question of the role of registration authorities and road managers (including local governments) in managing access to the road as part of the safety assurance system. We are seeking feedback on the role of road managers and whether registration authorities and road managers should authorise automated vehicle access to their road network in addition to safety assurance processes.

The NTC is proposing that a national approach should be adopted that incorporates automated vehicle registration and network access into the safety assurance process. However, access issues should be further explored once a regulatory model has been agreed.

How to ensure compliance

How do governments ensure compliance with any safety assurance system? We are seeking feedback on how to ensure compliance – including what regulation (if any) is needed to ensure automated driving system entities and other parties comply with safety obligations.

We suggest that compliance could be ensured through a primary safety duty for parties to provide safe automated vehicles with associated penalties and/or specific sanctions and penalties for the automated driving system entity.

The best way to ensure compliance will depend significantly on the regulatory model agreed. Sanctions and penalties in road traffic laws could also cover automated driving system entities through the NTC reforms to driver legislation.

Consultation questions

1. Should government have a role in assessing the safety of automated vehicles or can industry and the existing regulatory framework manage this? What do you think the role of government should be in the safety assurance of automated vehicles?
2. Should governments be aiming for a safety outcome that is as safe as, or significantly safer than, conventional vehicles and drivers? If so, what metrics or approach should be used?
3. Should the onus be placed on the automated driving system entity to demonstrate the methods they have adopted to identify and mitigate safety risks?
4. Are the proposed assessment criteria sufficient to decide on the best safety assurance option? If not, what other assessment criteria should be used for the design of the safety assurance system?
5. Should governments adopt a transitional approach to the development of a safety assurance system? If so, how would this work?
6. Is continuing the current approach to regulating vehicle safety the best option for the safety assurance of automated vehicle functions? If so, why?
7. Is self-certification the best approach to regulating automated vehicle safety? If so, should this approach be voluntary or mandatory? Should self-certification be supported by a primary safety duty to ensure automated vehicle safety?
8. Is pre-market approval the best approach to regulating automated vehicle safety? If so, what regulatory option would be the most effective to support pre-market approval?
9. Is accreditation the best approach to regulating automated vehicle safety? If so, why?
10. Based on the option for safety assurance of automated vehicle functions, what institutional arrangements should support this option? Why?
11. How should governments manage access to the road network by automated vehicles? Do you agree with a national approach that does not require additional approval by a registration authority or road manager?
12. How should governments ensure compliance with the safety assurance system?

Who we are

The NTC is an independent statutory body charged with improving the productivity, safety and environmental performance of Australia's road, rail and intermodal transport systems. As an independent statutory body, we develop and submit reform recommendations for approval to the Transport and Infrastructure Council, which comprises Commonwealth, state and territory transport, infrastructure and planning ministers.

Automated vehicles are an important part of our work program because they are expected to have a significant impact on transport networks. Our work in this area began in 2015 after the Transport and Infrastructure Council asked us to identify regulatory barriers to safely introducing more automated road and rail vehicles in Australia.

Next steps

Submissions to this discussion paper close on **Friday, 28th July 2017**.

Based on feedback to this paper, we will report back to the Transport and Infrastructure Council in November 2017 with a preferred regulatory option for a safety assurance system for automated vehicle functions and next steps to implement any required changes to legislation.

1 Context

Key points

- The National Transport Commission has been directed by Australia's transport ministers to develop options for a regulatory process to ensure the safe commercial deployment of automated vehicles on public roads.
- Our aim is to ensure a safety assurance system can be designed and implemented in time for the commercial deployment of vehicles with conditional, high or full automation. A safety assurance system should be implemented in parallel with the driver reforms to remove legislative barriers to automated vehicles.

The National Transport Commission (NTC) is seeking your feedback on the design of a national safety assurance system for automated road vehicles.

The safety assurance system will be used to develop the regulation for routine on-road use of automated vehicles. The primary role of a safety assurance system is to ensure potential safety risks arising during the life cycle of an automated vehicle, or automated driving system, have been identified, assessed and mitigated.

The safety of an automated vehicle depends on more than just the technological components of the vehicle itself. We need to think about how Australia should ensure automated vehicles operate safely in three ways:

- the initial and ongoing technical performance of the vehicle
- the environment in which the vehicle operates including roads and climate
- the interaction between the vehicle and humans (if relevant).

Today, these things are regulated separately. We see this distinction in: the Commonwealth approval of new and imported vehicles; the state and territory administration of driver licensing regimes, ongoing roadworthiness and registration; and the design and build of infrastructure by road managers. Because many automated vehicles may only be safe if they are operating in a specific road environment, or with particular responsibilities for human operators, a safety assurance system for automated vehicles may need to bring these three elements together.

1.1 Objectives

In November 2016 the Transport and Infrastructure Council ('the council') approved the NTC's recommendation to develop a regulatory framework to support the safe commercial operation of automated vehicles. A key component of this framework is the development of a safety assurance system:

Recommendation 5: That the NTC develop a national performance-based assurance regime designed to ensure the safe operation of automated vehicles, with an initial focus on vehicles with conditional automation (level 3).

Lead Agency: The NTC

Timeframe: Early 2017 to November 2017.

The objective of this project is to identify and propose a national safety assurance system in Australia that will be used to develop an integrated regulatory system to allow routine use of automated vehicle functions.

This discussion paper is a critical step towards the delivery of a safety assurance system. This paper identifies and discusses:

- the potential role of government in assessing safety of automated vehicle technology – **see chapter 3**
- how to understand and measure safety – **see chapter 4**
- assessment criteria to evaluate regulatory options – **see chapter 5**
- regulatory options including benefits and disadvantages and an evaluation of each option against the assessment criteria – **see chapters 6–9**
- other issues including institutional arrangements, how to ensure compliance, and access to the road network – **see chapters 10–12.**

We are seeking your feedback on each of these areas. We will recommend a proposed approach to the council in November 2017.

1.2 About the NTC

The NTC is an independent advisory body. We submit national land transport reform proposals to the council. The council consists of Commonwealth, state and territory ministers who are responsible for transport and infrastructure.

The NTC contributes to the achievement of national reform priorities agreed by the council. Our reforms are objectively assessed against the following policy objectives:

- improve transport productivity
- improve environmental outcomes
- support a safe transport system
- improve regulatory efficiency.

One of our key focus areas is removing regulatory barriers to transport technologies that have significant safety, productivity and environmental benefits.¹

1.3 Background

Earlier work undertaken by the NTC

Since late 2015 the NTC has worked with the Commonwealth, state and territory governments, Austroads, industry and consumer groups to identify and address regulatory barriers and policy issues associated with increasingly automated vehicles.

Our initial work identified of more than 700 provisions in transport-related Acts and regulations that could be a barrier to automated road vehicles. However, through our consultation processes, we also identified concern from many in the community about removing these barriers without a regulatory process in place to ensure that vehicles permitted onto public roads will operate safely.

In February 2016 we published an issues paper for consultation, *Regulatory options to more automated road and rail vehicles*.² The consultation identified key issues and project scope and confirmed that there are no regulatory barriers to automated rail services.

In May 2016 we published a discussion paper for consultation, *Regulatory options for automated vehicles*.³ This paper discussed key issues arising from the initial NTC audit of Commonwealth and state and territory legislation, summarised stakeholder feedback to the issues paper and proposed potential options to address the identified issues. The consultation confirmed the key issues and proposed timing and sequencing of reforms.

¹ More information about the NTC can be accessed at: <http://www.ntc.gov.au/>.

² The issues paper can be accessed on the NTC website at: [http://www.ntc.gov.au/Media/Reports/\(08ED4434-DEA2-4F26-86CC-8D8DEB24561B\).pdf](http://www.ntc.gov.au/Media/Reports/(08ED4434-DEA2-4F26-86CC-8D8DEB24561B).pdf)

³ The discussion paper can be accessed on the NTC website at: [http://www.ntc.gov.au/Media/Reports/\(049B1ED1-5761-44D5-9E3C-814A9195285D\).pdf](http://www.ntc.gov.au/Media/Reports/(049B1ED1-5761-44D5-9E3C-814A9195285D).pdf).

In November 2016 the council approved the NTC policy paper, *Regulatory reforms for automated road vehicles*.⁴ This included Recommendation 5 – to develop a national performance-based assurance regime designed to ensure the safe operation of automated vehicles.

Independent report on a safety assurance system

In late 2016 the NTC commissioned Nova Systems to provide an independent report setting out the options for developing an integrated national safety assurance system that would support routine use of automated vehicle functions. This included potential governance and process models, technical performance requirements and safety validation.

Nova Systems is an Australian professional service provider of engineering services, with a focus on complex engineering systems and integration of emerging technologies into established systems.

Nova System's report, *Safety Assurance System for Automated Vehicles in Australia*, underpins many of the concepts discussed in this paper, and is an appendix to this discussion paper available on the NTC website.⁵

The safety assurance system is part of a broader national reform program

Our work to design a safety assurance system for automated vehicles is part of a broader national reform program.

Our overarching goal is to develop an integrated regulatory system for the routine deployment of automated vehicles. To that end the NTC is working with governments to build this system starting with the following projects:

- **Developing nationally-consistent guidelines for automated vehicle trials:** a project to develop national guidelines governing conditions for trials of automated vehicles. We delivered this project in May 2017.
- **Clarifying control of automated vehicles:** a project to develop national enforcement guidelines that clarify regulatory concepts of control and proper control for different levels of driving automation. We will submit proposed national enforcement guidelines to the council in November 2017.
- **Removing legislative barriers to automated vehicles ('the driver reform project'):** a project to develop legislative reform options to clarify the application of current driving laws to automated vehicles, and to establish legal obligations for automated driving system entities. We will submit reform options to the council in May 2018.
- **Clarifying regulatory access to data:** a project to scope the circumstances under which government agencies should be able to access and use data generated by automated vehicles. We will submit reform options to the council in November 2018.

In addition to work undertaken by the NTC, the Commonwealth Department of Infrastructure and Regional Development continues to participate in the development of new and updated United Nations (UN) vehicle standards, and are participants of UN Working Party 29.

It is anticipated that a safety assurance system will also affect existing registration and licensing systems, although how these systems will change is likely to depend on the regulatory approach that is adopted. Therefore Austroads, a peak organisation of Australasian road transport and traffic agencies, has this year commenced a new project to assess how registration and licensing operations can best be aligned with a safety assurance system for automated vehicles.

We are collaborating closely with the Commonwealth and Austroads to ensure we can deliver an integrated regulatory system for deploying automated vehicles.

⁴ The policy paper can be accessed on the NTC website at: [http://www.ntc.gov.au/Media/Reports/\(32685218-7895-0E7C-ECF6-551177684E27\).pdf](http://www.ntc.gov.au/Media/Reports/(32685218-7895-0E7C-ECF6-551177684E27).pdf).

⁵ The Nova Systems Report can be accessed on the NTC website at: <http://www.ntc.gov.au/current-projects/safety-assurance-system-for-automated-vehicles/>.

What is the problem?

Manufacturers have indicated that they plan to develop vehicles able to operate on at least some parts of the Australia road network for extended periods without the input of a human driver. Australia does not currently have regulations specifically covering this automated vehicle functionality. We do, however, have general consumer and product liability laws. Australia has extensive existing regulation covering vehicle standards and the operation of vehicles on Australian roads. A number of existing laws will need to be changed to allow the routine deployment of these vehicles, which raises the question of whether explicit regulation of this functionality is required.

Safety risks

Governments already play a role in managing road safety risks. Automated vehicles should increase safety by eliminating common errors of human drivers. However, this is yet to be proven. Automated vehicles may also introduce new road safety risks such as cybersecurity risks. Our earlier consultation indicates that many stakeholders expect governments to continue to play a role in ensuring road safety in a more automated future.

Current regulations do not have regard to automated vehicle safety

Governments already regulate transport to ensure safety, security, efficiency and environmental outcomes. However, existing regulations have not been designed for emerging technologies that have significantly different risks and challenges from vehicles on the road today. For example, our vehicle standards for new and imported vehicles, known as Australian Design Rules (ADRs), do not cover safety-critical components of an automated vehicle such as the ability of the vehicle to conform to road traffic laws. Likewise, our roadworthiness regimes do not facilitate the sharing of safety-critical information about in-service vehicle modifications that could affect automated vehicle safety. Governments have limited oversight of technical failures or deviations that could lead to vehicle crashes or noncompliance with road transport laws.

If legislative barriers to automated vehicles were removed, governments would not have a regulatory mechanism to assess their safety.

The role of government has not been determined

Governments could choose to rely on existing safeguards to manage automated vehicle safety including the Australian Consumer Law's consumer guarantees and power to recall unsafe vehicles. Alternatively, governments could agree to a more proactive oversight of automated vehicle safety on the grounds that the technology is new and the safety performance of these vehicles is unknown.

While the technology is in development, and many automated vehicles remain in prototype or at a design stage, resolving this question is not necessarily a barrier. However, if automated vehicles are commercialised and the role of government in assessing automated vehicle safety has still not been decided by the time automated vehicles are commercialised, this could create significant uncertainty for industry, insurers and consumers.

Risk of inconsistent regulation

There is a risk that, unless a national safety assurance system is agreed and implemented, there will be inconsistent regulation of automated vehicles across states and territories. Road transport agencies could have different technical standards, testing procedures and roadworthiness requirements for automated vehicles, while opportunities to leverage off a single government agency and reduce duplication of resources and capabilities would be lost. Inconsistent regulation could also constrain cross-border activity and potentially obstruct safety innovation.

There is also a risk that a nationally-agreed approach will be inconsistent with international standards, conventions and practices. This could be a significant barrier to introducing automated vehicles in Australia, given that the automotive industry is globally integrated and Australia currently takes up less than 1.5 per cent of global vehicle sales (FCAI Submission to NTC, 2016). We need to ensure, wherever practical, that we are aligned with international developments while

recognising that it may be many years before global harmonisation of automated vehicle safety regulation is reached.

1.4 Key terms

In the automated vehicle space there are a lot of new terms and phrases, with some varied interpretations of their meaning. The NTC has provided below an explanation of the key terms used in this document and the interpretation of these terms as we understand them. Below this we have also provided the SAE International Standard J3016 *Levels of Driving Automation* used to describe automated vehicle functions. Finally, we have provided an explanation of the entity responsible for the automated vehicle. This term can have different meanings or responsibilities depending on the regulatory option being discussed.

Automated driving system 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, high and full automation mode.

Automated driving system entity means the legal entity responsible for the automated driving system. This could be the manufacturer, the operator, the legal owner of the vehicle or another entity.

Dynamic driving task means all of the operational and tactical functions required to operate a vehicle in on-road traffic.

Government agency means a government body responsible for the safety assurance system. The functions, responsibilities and governance of the government agency have yet to be determined.

Operational design domain means the specific conditions under which an automation system is designed to function including, but not limited to, driving modes.

Safety assurance system means a regulatory mechanism to provide affirmation of the safety performance of an automated vehicle to assure it can operate safely on the network.

What do we mean by automated vehicle and what does it cover?

The levels of driving automation defined above are based on SAE International Standard J3016, *Levels of Driving Automation*. These SAE levels are currently being used in legislation in the United States (US) and in the development of regulatory responses to automated vehicles in the European Union (EU).

Partial automation means that the automated driving system may take control of steering, acceleration and braking in defined circumstances but that the human driver must continue to monitor the driving environment and the driving task, and intervene if required.

Conditional automation means that the system drives the vehicle for sustained periods of time. The human driver does not have to monitor the driving environment or the automated driving system but must be receptive to any system failures. The human driver must intervene if requested and be the fallback for the dynamic driving task. An example of this is could be the Tesla 'enhanced autopilot'. The new automated system will allow the vehicle to match speed traffic conditions, keep within a lane, automatically change lanes without requiring driver input, self-park and be summoned to and from a garage.

High automation means that the system drives the vehicle for sustained periods of time in some situations, or all of the time in defined places, and a human driver is not required to monitor the driving environment and the driving task, or to intervene, when the system is driving the vehicle. There are two different forms of high automation currently being publicly tested. Western Australia is currently trialling a Navya prototype shuttle that is highly automated. The shuttle does not require a driver or specific infrastructure but can operate only on an approved network in Perth. The shuttle covers a 2.7 km stretch of the South Perth foreshore, travelling at a speed of 25 km/h.

In contrast Volvo is running a trial of highway driving vehicles in Gottenburg, Sweden. These vehicles will be able to perform all vehicle driving tasks including steering, braking and

accelerating. On the approved roads no human driver is required to monitor the driving environment or the driving task, or to intervene, when the vehicle is in automated mode.

Full automation means that all aspects of the driving task and monitoring of the driving environment and the dynamic driving task are to be undertaken by the vehicle system. The vehicle can operate in automated driving mode on all roads at all times.

We welcome feedback on whether any of these key terms require further clarification or refinement.

See the glossary for technical terms used throughout this paper.

References to the entity responsible for the automated vehicle

Throughout this discussion paper various terms are used to refer to the entity responsible for the automated vehicle or its automated driving system, depending on the option being discussed.

‘Automated driving system entity’ is defined above as the legal entity responsible for the automated driving system. This could be the manufacturer, the operator, the legal owner of the vehicle or another entity. The ‘automated driving system’ is the software and hardware that enables the vehicle to operate as a conditionally, highly or fully automated vehicle. It is important to be able to identify the legal entity responsible for the system at different times during the life cycle of the vehicle – for example, at initial system design and during on-road use. The legal entity responsible may also be different for different purposes – for example, responsibility for safety assurance applications, product liability actions, traffic contraventions/crashes, ensuring over-the-air upgrades are installed, after-market conversions, maintenance and repair.

The safety assurance system will be the means of ensuring the safety of automated vehicles used on Australian roads. The regulatory model chosen for the safety assurance system will impact on which entity could be the automated driving system entity. When discussing the regulatory options of continuing the current approach and self-certification, the term ‘manufacturer’ is used because the vehicle manufacturer (or importer) has to show the vehicle complies with the ADRs, and there is no other known entity or required point of contact with government until the vehicle is registered. Under the pre-market approval and accreditation regulatory options, which include responsibilities for ongoing system integrity and event reporting, the applicant for approval or accreditation could be the vehicle manufacturer, the automated driving system manufacturer, the automated driving system designer, the importer, the supplier or another entity prepared to accept the responsibilities.

When discussing in-service responsibilities for automated vehicles, ‘owner’ or ‘registered owner’ is sometimes mentioned as being responsible. This is because the owner may continue to have roadworthiness obligations under state and territory laws or a role in installing over-the-air updates to automated driving system software.

In consumer guarantee and product liability discussions, the terms ‘manufacturer’ or ‘supplier’ may be used because these are the terms used in the Australian Consumer Law.

1.5 Scope

The NTC project is focused on regulatory policy – namely, identifying assessment criteria and potential regulatory options for a national safety assurance system.

We are seeking feedback on which level of driving automation the safety assurance system should apply. Currently, the scope of the safety assurance system is expected to include vehicles with conditional, high and full automation. This reflects the interim direction from the council in November 2016 and, as discussed below, is consistent with the emphasis of North America’s *Federal Automated Vehicles Policy*.

The following areas are **outside the scope** of this project:

1. A detailed analysis of how a safety assurance system would affect existing vehicle registration and driver licensing regimes. This issue is being explored by Austroads in parallel with this work.

2. An assessment of existing entities that could undertake the government agency role in a safety assurance system. This assessment is expected to take place in the next phase of work, once the council has agreed a preferred model.
3. Detailed project planning and implementation of a national safety assurance system, including an assessment of milestones, timeframes, costs and capability requirements. This assessment is expected to take place in the next phase of work, once the council has agreed a preferred model. Note: we provide guidance on likely implementation steps for each regulatory option under 13.2 and 13.3. The timing of implementation will depend on the regulatory option that ministers endorse.
4. Finalisation of any automated vehicle safety principles or criteria that could form part of the safety assurance system. If used, safety principles or criteria are expected to take place in the next phase of work, once the council has agreed a preferred model.
5. Safety assurance of automated rail vehicles or other non-standard vehicles such as land-based drones.

We welcome feedback on whether any of these areas of scope require further clarification or refinement.

1.6 International developments

United States

In September 2016 the National Highway Transport Safety Administration (NHTSA), an agency of the US Department of Transportation, published the *Federal Automated Vehicles Policy*. The purpose of the policy is to provide industry and state agencies with guidance on safety regulation for automated vehicles. The NHTSA aims to accelerate the development of a regulatory framework for automated vehicles and best practice for manufacturers in relation to the design, development, testing and deployment of automated vehicles, with an emphasis on 'Highly Automated Vehicles' or HAVs (that is, vehicles with conditional, high or full automation).

The NHTSA recognises that existing tools, including rulemakings, exemptions, recalls and enforcement will continue to play an important role in the regulation of automated vehicle safety. The policy introduces a voluntary pre-market safety assessment process for manufacturers of automated vehicles. The NHTSA is undertaking the regulatory process to make this mandatory. However, the policy also recognises that additional regulatory tools may be necessary and seeks feedback on a range of options (US Department of Transportation, 2016). Potential new tools and authorities being considered by the NHTSA include:

Pre-market safety assurance: This could include pre-market testing, data and analyses reported by a vehicle manufacturer to the Department of Transportation. These tools would be designed to demonstrate that the design, manufacture and testing processes of a vehicle apply the NHTSA performance guidance, industry best practices and other performance criteria and standards *before* those vehicles are deployed on public roads. The NHTSA gives the example of the safety assessment process referred to above (US Department of Transportation, 2016).

The NHTSA's description of safety assurance most closely aligns to our regulatory option of self-certification.

Pre-market approval: Pre-market approval authority is a distinct regulatory approach from the NHTSA's current self-assurance approach where manufacturers certify compliance with federal motor vehicle standards and the NHTSA undertakes risk-based tests/inspections of new vehicles *after* they have been released to the market. This would require legislative change. Other US agencies have used pre-market approval to regulate the introduction of new technologies. For example, the Federal Aviation Administration uses pre-market approval processes to regulate the safety of complex, software-driven products like autopilot systems on commercial aircraft, and unmanned aircraft systems (US Department of Transportation, 2016).

The NHTSA's description of pre-market approval most closely aligns to our regulatory option of the same name.

Cease-and-desist authority: If, through testing, inspection, investigation or research, the Secretary of Transportation decided that an unsafe condition or practice has caused an emergency situation involving an imminent hazard of death, personal injury or significant harm to the public, a cease-and-desist authority would empower the Secretary to issue an order immediately prescribing such restrictions and prohibitions as may be necessary to abate the situation. This would require legislative change (US Department of Transportation, 2016).

The NHTSA's description of cease-and-desist most closely aligns to our existing Australian Consumer Law powers to ban or recall products, including motor vehicles (discussed under the continue current approach regulatory option).

Expanded exemption authority: One option that the NHTSA suggests could facilitate the safe testing and introduction of HAVs would be to expand the agency's existing exemption authority. Currently, the NHTSA cannot exempt more than 2,500 vehicles per year for a two-year period. Larger numbers would increase the real-world data available and aid in analysing the on-road safety of exempted vehicles while maintaining scope and duration limits to minimise risks. Existing powers could be used to set terms and conditions on exemptions that could be used to manage safety risks and evaluate different types of controls that could be considerations for future regulatory proposals (US Department of Transportation, 2016).

In Australia, the *Motor Vehicle Standards Act 1989* (MVSA) does not limit the number of vehicle exemptions per manufacturer. The use of exemption powers to regulate automated vehicles could be considered as part of the continue current approach option put forward in this paper, but it is likely to be impractical to use exemptions for large-scale commercial deployment.

Post-sale authority to regulate software changes: The NHTSA recognises that manufacturers are likely to provide software updates for vehicles that could substantially alter automated functionality. If a software change results in an unreasonable risk to safety, the NHTSA's defects and recall authorities would apply, but the NHTSA suggests additional regulatory tools and rules may be useful to regulate the certification and compliance verification of post-sale software updates (US Department of Transportation, 2016).

The NHTSA's description of post-sale authority to regulate software changes aligns to components of two of our regulatory options: pre-market approval and accreditation.

US state-based initiatives

In 2011 the US state of Nevada enacted legislation to authorise the operation of automated vehicles. Since then, Alabama, California, Florida, Louisiana, Michigan, North Dakota, Pennsylvania, Tennessee, Utah, Virginia and Washington have legislated for automated vehicles. In 2012 Florida declared legislative intent to encourage the safe development, testing and operation of motor vehicles with autonomous technology (National Conference of State Legislatures, 2017). In 2016 legislation in Florida expanded the operation of automated vehicles on public roads and removed some testing requirements and the requirement for a human driver to be present in the vehicle (National Conference of State Legislatures, 2017).

In 2015 Arizona issued an executive order directing various agencies to 'undertake any necessary steps to support the testing and operation of self-driving vehicles on public roads within Arizona'. In 2016 Massachusetts issued an executive order to 'Promote the Testing and Deployment of Highly Automated Driving Technologies' (National Conference of State Legislatures, 2017).

California has released proposed regulations that allow for the deployment of automated vehicles for public use and the creation of a framework for selling automated vehicles. The proposed regulations require manufacturers to certify that their vehicles meet Federal Motor Vehicle Safety Standards (FMVSS). They also require manufacturers to submit a copy of the safety assessment conducted as part of their safety management process. This provides evidence that the manufacturer has engaged in a robust design, development and testing process and has

collaborated with the NHTSA at the federal level on vehicle safety requirements (National Conference of State Legislatures, 2017).

Michigan has developed regulations that specify the conditions under which automated vehicles can be tested and used on public roads. The state also allows manufacturers and service providers to operate driverless ridesharing services. Once automated vehicles have been tested and certified as safe, the regulations allow their sale for public use (National Conference of State Legislatures, 2017).

On 8 May 2017 Georgia passed an automated vehicle Bill to allow a person to operate (engage the automated driving system) a fully automated vehicle (a level 4 or 5 automated vehicle⁶) with the automated driving system engaged. A human driver does not need to be present if the vehicle:

- has been certified by the manufacturer at the time of manufacture as compliant with applicable federal motor vehicle safety standards
- can comply with the Georgia traffic laws and motor vehicle equipment and inspection requirements
- can comply with the requirements on drivers to stop, render assistance and provide information when involved in an accident involving death, injury or property damage by remaining on the scene and the vehicle or operator promptly contacting a local law enforcement agency and communicating the information required
- can achieve a minimal risk condition in the event of failure of the automated driving system
- until 2020, is covered by motor vehicle liability coverage equivalent to 250 per cent of the cover required of non-fully automated vehicles, and thereafter equivalent to the amounts specified in the legislation
- is registered, and identified in the registration as a fully automated vehicle.

The legislation exempts the automated vehicle (when the automated driving system is engaged) and the operator from the requirement to hold a driver's licence to operate a fully automated vehicle. It also makes the occupants of the vehicle responsible for compliance with the seatbelt and child restraint requirements (Georgia General Assembly, 2017).

Europe

Most EU member states are signatories to the 1949 *Geneva Convention on Road Traffic* and the 1968 *Vienna Convention on Road Traffic*. These are international treaties on road traffic designed to facilitate cross-national road traffic standards. Amendments to Article 8 of the Vienna Convention came into force in March 2016. These amendments clarify the requirement that a driver must be able to control his or her vehicle by providing that vehicle driving systems that comply with United Nations Economic Commission for Europe (UNECE) regulations, or that can be overridden or switched off by the driver, are in conformity with this requirement (UNECE, 2017). The amendment does not address the requirement in Article 8 that every vehicle must have a driver, which precludes automated vehicles that do not require a human driver.

In April 2016 European transport ministers endorsed the *Declaration of Amsterdam on connected and automated driving*. In that declaration, member states agreed that the Vienna and Geneva conventions on road traffic should be further revised to allow the use of connected and automated vehicles on public roads, and that member states should, where possible, remove legal barriers to the testing and deployment of connected and automated vehicles (European Council, 2016).

To date, the EU has not developed a European-wide safety assurance system or framework to ensure the safe operation of automated vehicles.

⁶ The Georgia Bill defines fully autonomous vehicle as 'a motor vehicle equipped with an automated driving system that has the capability to perform all aspects of the dynamic driving task without a human driver within a limited or unlimited operational design domain and will not at any time request that a driver assume any portion of the dynamic driving task when the automated driving system is operating within its operational design domain'.

Germany

The German Government has approved a draft law that allows for the full use of automated driving systems on German roads. The draft law allows drivers of highly automated vehicles to take their hands off the wheel while the automated driving system is engaged, and only requires humans to take back control if it is recommended by the system or if certain requirements are not met (The Library of Congress, 2016).

PEGASUS research project

PEGASUS is a cooperative research project between the German Government, industry and researchers. PEGASUS aims to develop accepted quality criteria, tools and methods to support highly automated driving functions. This includes the delivery of quality standards for the safeguarding of highly automated vehicles by 2019. PEGASUS has four sub-projects intended to:

- describe the function of highly automated driving with methods and tools that underpin the design criteria of a highly automated driving function
- develop a process to test safety
- develop in-field and lab tests for technical standards and the technical probability of failure
- refine the safety tests (Pegasus, 2017).⁷

The need for international collaboration will be considered by PEGASUS at its next workshop in October 2017.

German efforts to develop a testing process for specific automated driving functions most closely align to our regulatory option of pre-market approval.

Singapore

Singapore is currently updating its transport laws to keep pace with technological developments and better safeguard commuters in automated and ride-sharing vehicles. The *Road Traffic (Amendment) Act* was passed by the Singapore Government in early 2017. The amendments establish a regulatory framework that will require automated vehicles to pass a safety assessment before they will be allowed on public roads (Government of Singapore, 2017). Developers will be required to implement a robust accident mitigation plans for trials. This includes having a safety driver trained to swiftly take control of the vehicle whenever necessary and requiring automated vehicles to log travel data to facilitate accident investigations and liability claims. Although trials will only be allowed on lightly used roads in the beginning, automated vehicles that can demonstrate a high level of competency will be allowed to trial in more complex environments, including major public roads (Gateway Law Corporation, 2017).

Republic of Korea

The Republic of Korea is currently considering policies to support the commercialisation of automated vehicles. Korea's vision is to enhance safety and increase its business opportunities. Their goal is to commercialise vehicles with conditional automation by 2020 and vehicles with high automation by 2026. Korea will develop safe standards and recall and inspection regimes to promote the safe deployment of automated vehicles. It will also continue to review and amend relevant legal systems.

Between 2017 and 2020, the Korean Ministry of Land, Infrastructure and Transport is undertaking research and development into automated vehicle safety assessment technologies and test beds. This includes the development of K-city, which will be designed to conduct repeated performance testing in real-road conditions for automated vehicles, as well as building automated vehicle infrastructure for designated test zones.

The Korean Government's proactive role in the development of safety assessment standards and testing procedures most closely aligns to our regulatory option of pre-market approval.

⁷ PEGASUS is discussed in more detail in option 3. Further information about PEGASUS can be obtained from <http://www.pegasus-projekt.info/en/home>.

2 Consultation

Key points

- Any individual or organisation can make a submission to the NTC.
- We are seeking submissions on this discussion paper by **Friday, 28 July 2017**.

We encourage you to make a submission. Your views on the design of a national safety assurance system for automated vehicles will be essential in the development of policy findings and recommendations for the council in November 2017.

2.1 Consultation questions

Your views on the regulatory options for automated vehicles will be essential and we encourage you to make a submission.

1. Should government have a role in assessing the safety of automated vehicles or can industry and the existing regulatory framework manage this? What do you think the role of government should be in the safety assurance of automated vehicles?
2. Should governments be aiming for a safety outcome that is as safe as, or significantly safer than, conventional vehicles and drivers? If so, what metrics or approach should be used?
3. Should the onus be placed on the automated driving system entity to demonstrate the methods they have adopted to identify and mitigate safety risks?
4. Are the proposed assessment criteria sufficient to decide on the best safety assurance option? If not, what other assessment criteria should be used for the design of the safety assurance system?
5. Should governments adopt a transitional approach to the development of a safety assurance system? If so, how would this work?
6. Is continuing the current approach to regulating vehicle safety the best option for the safety assurance of automated vehicle functions? If so, why?
7. Is self-certification the best approach to regulating automated vehicle safety? If so, should this approach be voluntary or mandatory? Should self-certification be supported by a primary safety duty to ensure automated vehicle safety?
8. Is pre-market approval the best approach to regulating automated vehicle safety? If so, what regulatory option would be the most effective to support pre-market approval?
9. Is accreditation the best approach to regulating automated vehicle safety? If so, why?
10. Based on the option for safety assurance of automated vehicle functions, what institutional arrangements should support this option? Why?
11. How should governments manage access to the road network by automated vehicles? Do you agree with a national approach that does not require additional approval by a registration authority or road manager?
12. How should governments ensure compliance with the safety assurance system?

2.2 When to submit

We are seeking submissions on this discussion paper by **Friday, 28 July 2017**.

2.3 How to submit

Any individual or organisation can make a submission to the NTC.

To make an online submission, please visit www.ntc.gov.au and select 'Submissions' from the top navigation menu. Or post your comments to:

Att: Automated Vehicle Team
National Transport Commission
Level 3/600 Bourke Street
Melbourne VIC 3000
Australia

Where possible, you should provide evidence, such as data and documents, to support your views.

If you have any questions about the submission process, you can email the Automated Vehicle Team at automatedvehicles@ntc.gov.au.

Unless you clearly ask us not to, we will publish all submissions online. However, we will not publish submissions that contain defamatory or offensive content.

The *Freedom of Information Act 1982* (Cwlth) applies to the NTC.

3 What is the role of government in regulating vehicles and driving?

Key points

- Government regulation should be considered when a problem is serious enough to justify intervention, where the community requires the certainty provided by legal sanctions or when universal application is necessary.
- A safety assurance system for automated vehicles is likely to require a different approach from road transport regulation because the initial and ongoing technical integrity of the vehicle and the technology is more safety-critical.

The purpose of this chapter is to examine what role the government currently plays in regulating vehicles and driving. This chapter also introduces the four proposed options for what role government might take in the future regulation of vehicles and driving in the context of more automated vehicles.

Each level of government in Australia has transport and infrastructure objectives related to safety, productivity and environmental outcomes, as well as protection of infrastructure and regulatory efficiency. Governments use a range of tools to achieve these objectives including rules and regulations, licensing, pricing and mandatory standards.

The role of government and regulation varies across transport modes and services. The role of government has varied according to the likelihood and impact of risk, community expectation, international commitments and historical context.

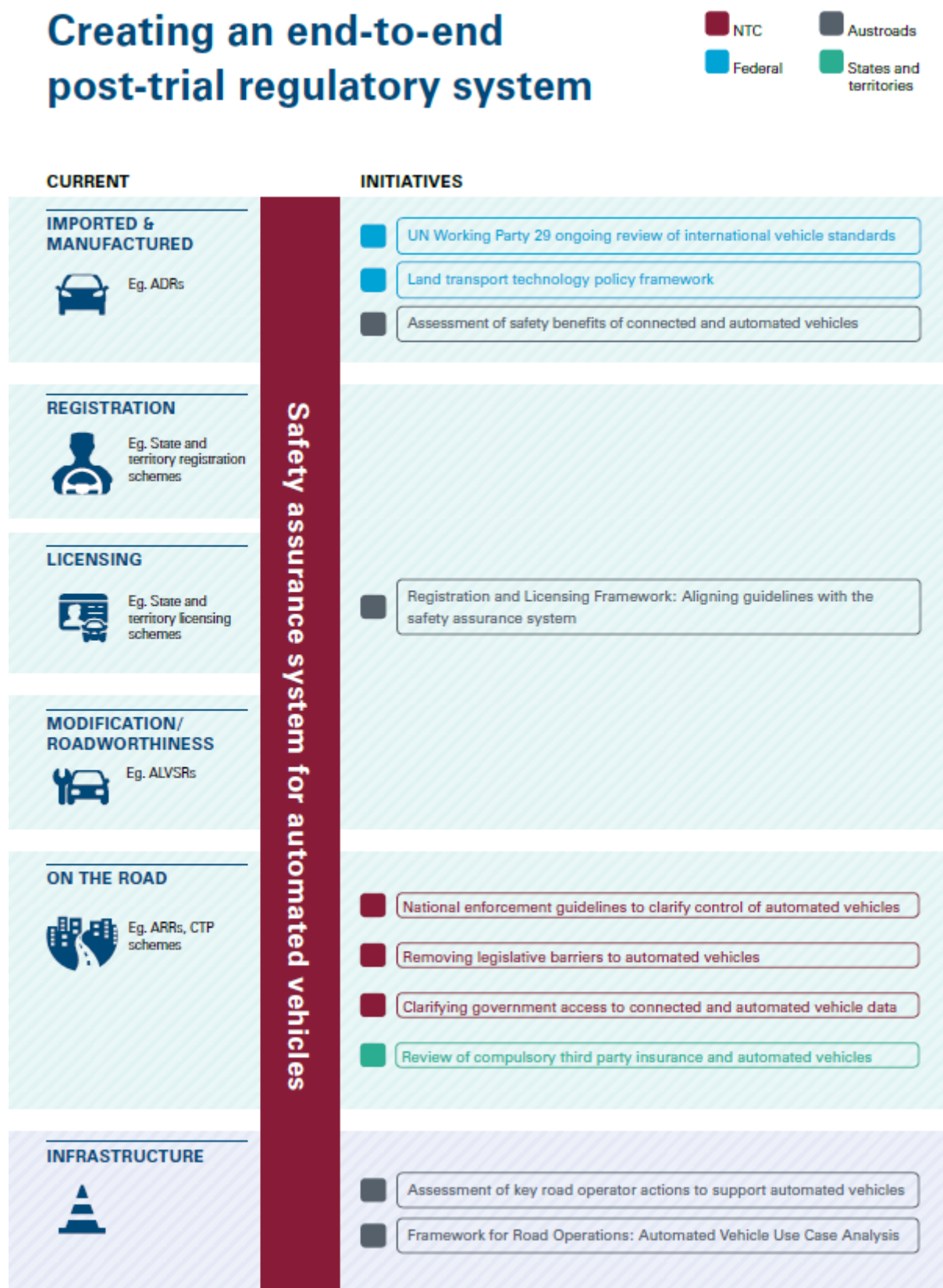
Road transport remains highly regulated; government regulates vehicles from the point of importation or manufacture through to market and on-road use. In terms of safety, this can be grouped according to the road safety pillars encapsulated in the *National Road Safety Strategy*:

- safe vehicles
- safe people
- safe roads
- safe speeds.

Figure 2 shows the existing end-to-end process regulatory system and the projects that are underway at each stage to prepare for more automated vehicles. Responsibility for each stage of this process is currently shared between the Commonwealth, the states and territories, and local governments.

Broadly, the Commonwealth has responsibility for vehicle standards for new and imported vehicles, as well as for recalls for unsafe products through administrative arrangements under the Australian Consumer Law. The states and territories are responsible for vehicle use (reflected in road traffic laws), driver licensing, vehicle registration and roadworthiness, compulsory third-party insurance and some road infrastructure. Local governments also have responsibility for road infrastructure.

Figure 2: Road transport regulation today and projects to support automated vehicles ⁸



⁸ See the glossary for an explanation of key terms.

The level of the regulatory intervention has varied according to the safety risk, the risk of damage and the matter being regulated. Generally, the greater the risk, the higher the level of regulation.

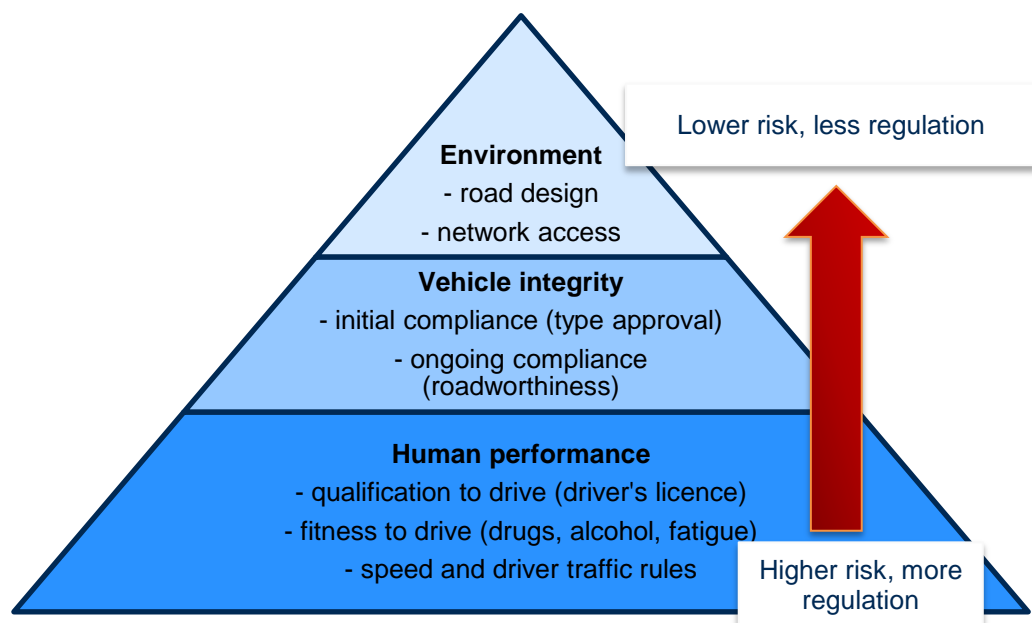
Human error makes human activities more risky, and where a human has the potential harm themselves and others these activities are more highly regulated. For example, every driver is tested for their ability to control the vehicle and knowledge of the traffic rules before he or she is granted a licence to drive a vehicle. And, once licensed, human drivers must be fit to drive and be unimpaired by drugs or alcohol or, in some cases, fatigue.

The environment within which road vehicles operate includes road design, road infrastructure and traffic management. It is less regulated than human behaviour and more reliant on non-mandatory industry or professional codes and technical standards. These include standards for road managers including guidelines developed by Austroads on behalf of road managers (such as guidelines on the geometric design of roads and road surfacing). The mandatory rules focus on controlling vehicle access to the road network. Here the risks extend from safety to amenity, road damage and productivity.

Vehicle technical integrity regulation is also relatively light-touch, reflecting the historical reliability of motor vehicle performance if correctly maintained. Initial vehicle technical integrity uses a form of pre-market approval where vehicle manufacturers provide evidence to show their vehicles comply with the ADRs. Quality-controlled audits are undertaken by government, and identification plate approval is granted. Ongoing (or 'in-service') vehicle integrity focuses on roadworthiness and compliance with vehicle standards. Government currently enforces ongoing technical integrity through roadside vehicle checks and periodic vehicle inspections (annual, at transfer of ownership or other, depending on the state or territory).

Figure 3 illustrates this relationship between risk and level of regulatory intervention according to human performance, environment and vehicle integrity. With the development of automated vehicles, we could see the safety risk of vehicle integrity increase and the safety risk of human performance decrease. If this were the case, the level of regulatory intervention may need to change.

Figure 3: Risk and the level of regulatory intervention



3.1 How governments regulate

The role of government was explored in our issues paper (NTC, 2016) and discussion paper (National Transport Commission, 2016).

In our issues paper, we proposed that government action must be in response to, and proportionate to, a policy problem. Government action should also be based on an assessment of risk, such as a risk to safety, competition or consumer certainty. In the case of automated vehicles identified risks included industry uncertainty, inconsistent outcomes and the safety of the technology.

If government intervention is necessary, it may not need to be regulatory intervention. The Australian Government's *Best Practice Regulation Handbook* (2010) provides a range of options:

- **Self-regulation:** This is characterised by industry-formulated rules and codes of conduct, with industry responsible for compliance. This is a feasible option when there is no strong public interest concern (particularly no major public health and safety concerns), when the problem is a low-risk event, of low impact or significance, and the problem can be fixed by the market itself. However, self-regulation may be less effective if industry has an incentive not to comply with the rules.
- **Quasi-regulation:** This is characterised by a wide range of rules or arrangements, where governments influence businesses to comply, but without explicit government regulations. These include industry codes of practice developed with government involvement, guidance notes, industry – government agreements and accreditation schemes.
- **Co-regulation:** This is where industry develops and administers its own arrangements, but government provides legislative backing to enable the enforcement of the arrangements. Legislation may also provide for government-imposed rules if that industry does not meet its own responsibilities. This is the current approach in rail and aviation.
- **Explicit government regulation:** This is characterised by direct regulation composed of primary and subordinate legislation. Explicit government regulations should be considered where:
 - the problem is high risk or of high impact or significance (such as a major public health and safety issue)
 - the community requires the certainty provided by legal sanctions
 - universal application is required or judged necessary
 - there is a systemic compliance problem with a history of intractable disputes.

3.2 The role of government to assure automated vehicle safety

The NTC has developed four regulatory options that closely align to the different ways that government can regulate:

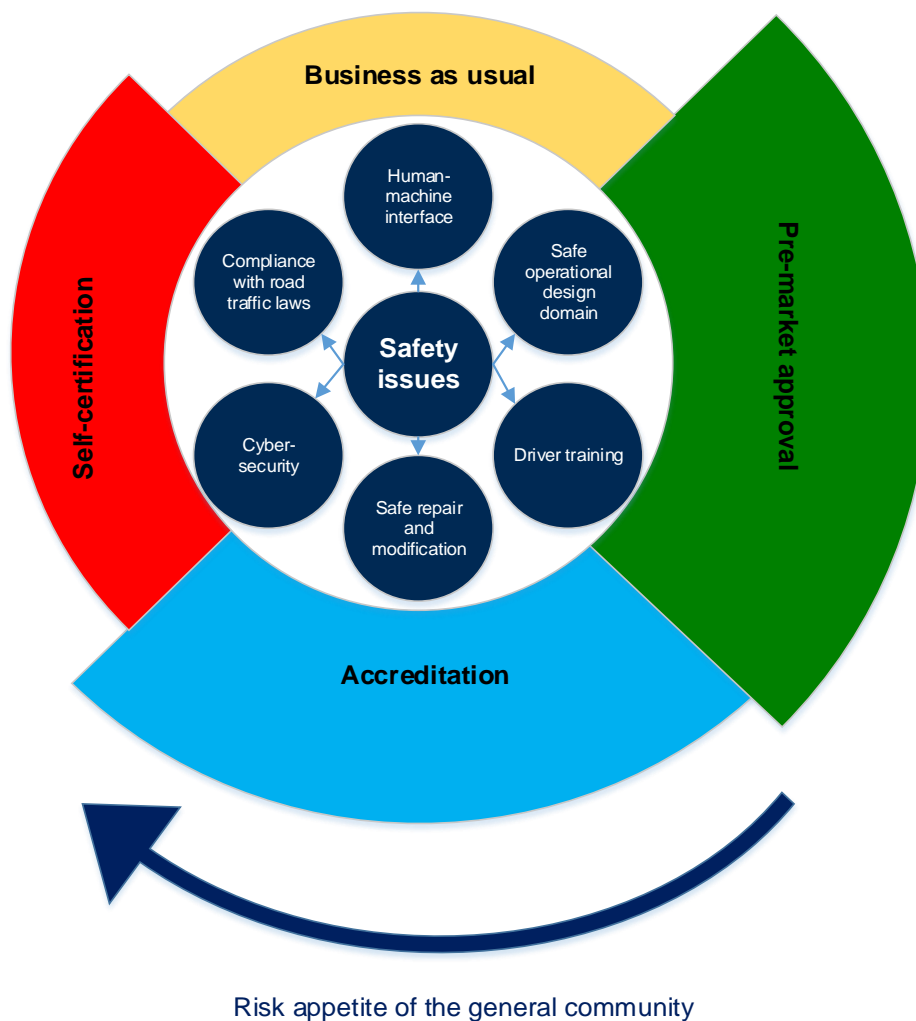
1. **Continue current approach:** No further action by government is taken to regulate for automated vehicles beyond already agreed projects. This option is aligned to self-regulation because the current regulatory approach does not have regard to automated vehicle safety.
2. **Self-certification:** This option is aligned to quasi-regulation, because governments would be influencing manufacturers to ensure safety, but there is no additional explicit government regulation.
3. **Pre-market approval:** This option would require explicit government regulation, because governments would be setting explicit technical standards and safety requirements that manufacturers would have to meet.

4. **Accreditation:** This option is aligned to co-regulation because government is providing legislative support to oversee industry's management of safety.

The appropriate response to automated vehicle safety will depend on an assessment of the safety risk and community confidence in the industry to provide safe vehicles and services.

Figure 4 illustrates the regulatory options based on the greater or lesser extent to which government oversees and regulates safety.

Figure 4: Regulatory options to address safety issues, based on risk appetite



The NTC consulted on the role of government in relation to automated vehicle safety in our discussion paper (National Transport Commission, 2016). In submissions to the discussion paper there was no government or industry support for the option of removing regulatory barriers for automated vehicles without some regulatory oversight.

The discussion paper noted the following in relation to automated vehicle safety and the role of government:

- The safety performance of automated vehicles remains to be tested and there is a wide range of functions and deployment models that carry with them different safety risks. For example, a recent Rand report calculated that it would take 275 million miles of on-road

driving to have 95 per cent confidence that the failure rate of an automated vehicle is equal to approximately one fatality per 100 million miles (Kalra & Paddock, 2016, p. 10). The report concludes that:

The technology will evolve rapidly, as will the social and economic context in which it is being introduced. In fast-changing contexts such as these ... in parallel to creating new testing methods, it is imperative to begin developing approaches for planned adaptive regulation (Kalra & Paddock, 2016, p. 10).

- The level of government intervention considered reasonable is affected by the extent to which the community, reflected in the decision making of government, industry and consumers, accepts any risks associated with automated vehicles. If the community's risk appetite is low and it expects automated vehicles to be high risk, the case for regulatory oversight is strong. If the community's risk appetite is high to attain overall benefits, the case for regulatory oversight is weaker.

Some of the safety risks of automated vehicles arise from the following:

- The technology supporting automated vehicles is variable in terms of maturity and in many cases is still being developed, tested and trialled.
- The direction of vehicle standards and road rules at the international level is also still evolving.
- It is not clear whether a vehicle tested in a manufacturer's country of origin will operate as safely on Australian roads, given that we have different road markings and road signs that may affect some vehicles' ability to accurately interpret the road environment.

The key issue we are seeking to explore through the discussion on the role of government is deciding whether safety can be managed by the private sector within the current framework, or whether additional government oversight is necessary to ensure the safe operation of automated vehicles. Furthermore, if additional oversight is necessary, deciding what level of intervention is required.

3.3 Conclusions

The planned removal of current legal barriers would enable any automated vehicles to operate without governments being satisfied that these vehicles can operate safely. In the absence of agreed Australian or international standards specific to automated vehicle technologies that would ensure minimum safety levels, governments need to consider the uncertain safety outcomes associated with different applications of automated driving and whether the safety risk justifies additional government oversight and regulatory intervention.

The NTC suggests there could be sufficient safety risks to the general community to warrant regulating automated vehicles differently from the way we regulate road vehicles today. In particular, as the performance of the vehicle technology becomes increasingly safety-critical, new regulatory approaches may be needed to ensure initial and ongoing automated vehicle integrity.

Consultation question

Question 1: Should government have a role in assessing the safety of automated vehicles or can industry and the existing regulatory framework manage this? What do you think the role of government should be in the safety assurance of automated vehicles?

4 What is safe for automated vehicles?

Key points

- Many countries are considering what benchmark or measure of safety is needed for automated vehicles, and what methodology (if any) should be adopted to assess and validate automated vehicle safety.
- The NTC is seeking feedback on whether:
 - safety should be defined and measured according to the rate of technical failure and incidents that result in harm to people, possibly with agreed metrics of safety based on crash rates
 - the onus should be placed on the automated driving system entity to demonstrate the methods they have adopted to identify and manage safety risks
 - other approaches to measuring safety risk.

The purpose of this chapter is to discuss how we currently define safety and how we might define safety in the future. This chapter also explores different approaches to how we might assess the safety of automated vehicles.

A significant issue challenging many regulators around the world is the question of automated vehicle safety. There is currently no international consensus on two related issues:

1. How safe should automated vehicles be before regulators will allow them to operate on public roads? Should they be as safe as, or safer than, human-driven vehicles?
2. What methodology should regulators adopt to assess and validate the safety of automated vehicles?

4.1 What is safe enough for automated vehicles?

A number of commentators have explored the issue of benchmarking safety and understanding whether automated vehicles will need to reach a predetermined safety target before they will be permitted on public roads (Kalra & Paddock, 2016).

In general terms, the discussion has related to whether regulators should aim for automated vehicles to be as safe as conventional vehicles (at least in the first instance) or significantly safer than conventional vehicles. And, if so, by what metric or value is an automated vehicle 'significantly' safer.

An independent report prepared by Nova Systems (2017) observed that, traditionally, the notion of road safety in Australia has been linked to the concept of the road toll. Reduction of fatalities and serious injuries has been a major focus and measure-of-success for road safety programs. Automated vehicle safety could also be assessed retrospectively through analysis of road toll and crash investigation outcomes, or proactively modelled based on automated vehicle trials and tests.

There are a number of challenges with this approach.

First, an automated vehicle would most likely have to drive many millions of kilometres in all circumstances and variables permitted within the vehicle's operational design domain before it could be retrospectively assessed as safe, or safer than, a human-driven vehicle. This method would also require comprehensive, analytical and robust crash analyses to identify vehicle crashes attributable to the automated driving system or automated driving function.

Second, the relative safety of an automated vehicle will depend on the type of conventional vehicle and driver it is being compared with. If we seek to measure the safety of an automated vehicle against human-driven low-speed passenger shuttles, we would have a very different yardstick than if we were to measure automated vehicle safety against high-speed motorcycle riding.

Third, an automated vehicle may have many complex operational design domains it can operate in with an almost infinite number of possible scenarios permitted including different weather conditions, road types and interactions with humans and other vehicles or objects. Depending on the sophistication of the automated technology, it may be overly simplistic to rely on modelling the likely impact of a specific automated technology on the road toll based on vehicle testing and trials.

Fourth, implicit within existing road safety approaches is the notion that crashes (primarily caused by human error) will occur, and road safety measures aim to minimise the probability and consequence of crashes. In the case of automated vehicles, this primarily means reducing the probability of technical failure or the probability of a vehicle operating unsafely outside its operational design domain. Therefore, the *probability of failure* is arguably a more accurate reflection of automated vehicle safety than a projected impact on the road toll, noting that automated vehicles could also reduce the severity of crashes when they do occur. This is not necessarily easier to quantify.

Nova Systems (2017) suggested that the development of the safety assurance system is an opportunity to set a safety goal based on reducing the probability of vehicle system failures or incidents that result in harm to people:

An [automated vehicle-based] safety goal could be expressed as ‘the rate of occurrence of incidents that result in harm to people’. This would be a far more encompassing goal than reducing fatalities and it reflects the opportunity that [automated vehicle] technologies offer for safety improvement (Nova Systems, 2017).

Expanding the definition of safety beyond fatalities would allow a better assessment of the overall safety of automated vehicles. Most stakeholders expect automated vehicles to be as safe as, or safer than, a human-driven vehicle is likely to be subject to ongoing discussion. Are we comparing automated vehicles to a novice human driver, the average human driver or an expert human driver? We expect automated vehicles to have safety benefits, but how much safer do we expect them to be? Safety expectations vary across different modes of transport. In aviation, the expectation is that an aeroplane will always operate safely. In rail, the expectation is that safety risks will be managed so far as is reasonably practicable.

Nova Systems is proposing that whatever the preferred benchmark may be, the safety goal should be based on the automated vehicle or automated driving function operating within an acceptable probability of failure. There could also be challenges in measuring and comparing road outcomes with a new set of metrics to today's traffic statistics.

Ethics in automated vehicles

There is a discussion in the media about the ethics of automated vehicles and how algorithms are used to resolve decision conflicts. The independent Nova Systems (2017) report notes there are a considerable number of academic papers on this area questioning whether such an issue exists at all. Given the predicted significant reduction in road injuries and fatalities, the NTC proposes that establishing the overall safe operation of a system is a more immediate task than that of rare road events and related ethical considerations. We are consulting on whether ethical considerations should be included in any safety criteria or safety system. Ethics are highlighted explicitly in the NHTSA's report in the *Federal Automated Vehicle Policy* and discussed in further detail at 7.2.

Primary safety duty to provide safe vehicles

Options 2, 3 and 4 could be supported by a legislated primary safety duty for relevant parties to ensure the safety of their automated vehicles.

Primary safety duties are sometimes known as ‘general duties’, ‘principle based duties’ or ‘effects-based duties’. Primary duties define the duty holders and the broad scope of their responsibilities and are concerned with influencing attitudes and creating an overall safety culture by requiring duty holders to consider a wide range of hazards and risk in complying with their statutory obligations.

The flexibility inherent in a primary safety duties approach to regulation allows for innovation and adaptation in risk management, tailored to the circumstances of the party to whom the duty applies, the nature of the risk to be addressed and the reasonableness of the party's use of resources to meet the risk. Parties must ensure safety; how they achieve this is up to them. This was the

primary rationale behind the use of primary safety duties as the fundamental basis for workplace and occupational health and safety, and rail safety legislation.

Primary safety duties under the Model Work Health and Safety Act

The Model Work Health and Safety (WHS) Act forms the basis of the WHS Acts that have been implemented in most jurisdictions across Australia. The Model WHS Act is designed to provide for a balanced and nationally consistent framework to secure the health and safety of workers. To achieve this objective, the Model WHS Act is structured around primary safety duties of care covering a range of parties, including persons conducting a business or undertaking (PCBU), officers, workers and other people. In addition, the Model WHS Act includes specific health and safety duties for certain identified types of PCBUs including designers, manufacturers, suppliers and importers of plant, substances or structures.

Primary safety duties under the Rail Safety National Law

The main purpose of the Rail Safety National Law (RSNL) is to provide for safe railway operations in Australia. To achieve this purpose, the RSNL imposes an affirmative and overarching duty of care on rail transport operators to ensure, 'so far as is reasonably practicable, the safety of the operator's railway operations'. Similarly to the Model WHS Act, the RSNL also imposes primary rail safety duties on others involved in railway operations including designers, manufacturers and suppliers. This duty under section 53 of the RSNL could be used as a basis for the primary safety duty for automated vehicle purposes. Section 53 states that:

53—Duties of designers, manufacturers, suppliers etc.

(1) A person—

(a) who designs, commissions, manufactures, supplies, installs or erects anything; and

(b) who knows, or ought reasonably to know, that the thing is to be used as or in connection with rail infrastructure or rolling stock, must—

(c) ensure, so far as is reasonably practicable, that the thing is safe if it is used for a purpose for which it was designed, commissioned, manufactured, supplied, installed or erected; and

(d) ensure, so far as is reasonably practicable, that such testing and examination of the thing as may be necessary for compliance with this section is carried out; and

(e) take such action as is necessary to ensure, so far as is reasonably practicable, that there will be available in connection with the use of the thing adequate information about—

(i) the use for which the thing was designed, commissioned, manufactured, supplied, installed or erected; and

(ii) the results of any testing or examination referred to in paragraph (d); and

(iii) any conditions necessary to ensure, so far as is reasonably practicable, that the thing is safe if it is used for a purpose for which it was designed, commissioned, manufactured, supplied, installed or erected.

There are a number of ways in which such a legislated primary safety duty could be reflected in the law.

Proposed approach

The NTC is seeking feedback on the approach proposed by Nova Systems, whereby safety is defined and measured according to the rate of technical failure and incidents that result in harm to people, rather than agreed metrics of safety based on crash rates, or both.

Feedback is also sought on the high-level issue of whether manufacturers and governments should be aiming for a safety outcome that is as safe as, or significantly safer than, conventional vehicles. If stakeholders prefer that automated vehicles are significantly safer, we are seeking your feedback on what 'significant' means and how it can be measured, or whether the so far as is reasonably

practicable approach adopted in rail and WHS Regulation is appropriate. We are also seeking feedback on whether this approach should be different for the different options proposed.

We also suggest for discussion purposes that Australian governments should closely follow international developments and any progress towards reaching consensus on a definition of safety or if a safety target is adopted by governments or manufacturers.

Consultation question

Question 2: Should governments be aiming for a safety outcome that is as safe as, or significantly safer than, conventional vehicles and drivers? If so, what metrics or approach should be used?

4.2 What testing methodology should assess and validate automated vehicle safety?

The tools used by governments to assess and validate the safe performance of an automated vehicle will depend on the regulatory approach adopted in Australia. For example, if a continue current approach option is adopted, governments are less likely to have a proactive role to assess or validate automated vehicle safety. The role of governments would be limited to retrospective analysis of crash causation in the context of police investigations or coronial inquests and the investigation of claims of unsafe products under Australian Consumer Law.

In contrast to this approach, pre-market approval by a government agency, or a third party on behalf of an agency, would require active and analytical assessment of automated technology safety performance. This would require the development of assessment standards and testing methodologies to evaluate safety.

These two approaches are reflected in developments overseas. The NHTSA's policy (US Department of Transportation, 2016) promotes a safety assurance approach based on aspects of self-certification while seeking feedback on a pre-market approval approach. The NHTSA is not immediately seeking to develop testing methodologies or standards (see box in discussion of option 3). The German Government, on the other hand, is working closely with industry and research partners to develop testing procedures to approve automated vehicles. This work (known as PEGASUS) was outlined in chapter 1.

Options

The NTC is seeking feedback on how a government agency (or a third party on an agency's behalf) should approach the evaluation and validation of automated vehicle safety. Three options are:

- **Option 1:** Develop standards, tests, tools and capabilities to assess and validate the safety of each type of automated vehicle, and adapt the assessment and validation process if and when international consensus emerges on each component of the safety assurance process.
- **Option 2:** Defer the introduction of a testing process and collaborate closely with key governments and standards bodies on the timely development of standards, tests, tools and capabilities.
- **Option 3:** Place the onus on the automated driving system entity to demonstrate the methods they have adopted to identify and manage safety risks.

We also welcome feedback on alternative options or an approach that incorporates elements of the options described.

It should be noted that a government role to test and validate safety would only be necessary if the safety assurance system was based on a pre-market approval model.

Option 1: Government testing based on agreed technical standards

Adopting option 1, a government agency would test each type of automated vehicle or automated driving function based on agreed technical standards.

This option is strongly aligned with a pre-market approval approach to safety assurance. It also aligns with self-certification if safety criteria set by government are specific about how safety should be evaluated.

If case-by-case testing based on agreed technical standards is adopted, it is clear that a number of components would be required. These are most likely to include the development of:

- **a functional safety standard** to assess the systems and processes within which the manufacturer managed the safety risks
- **agreed technical standards** to assess the safety performance of automated driving functions and/ or whole-of-vehicle safety
- **a performance test** to evaluate the automated driving function and/ or the whole-of-vehicle safety against the technical standards
- **software and analytical tools** to detect system failures or weaknesses
- **the capability of the regulator** (or third parties on the regulator's behalf) to undertake testing activities.

Except for a functional safety standard (vehicle manufacturers currently use ISO 26262), none of these components exist today specifically for automated driving systems.

In alignment with Commonwealth policy, wherever possible these components would be based on international developments. While it is possible that regulators in the US, the EU, Japan and elsewhere in the world will in time develop the standards, tools and capabilities to assess and validate safety, discussions in the international community indicate that we are many years away from a single approach being agreed and adopted. One reason for this is that there is no single path towards automation. With vehicle manufacturers and technology developers exploring different applications and mixes of sensor and mapping technologies, it is difficult to identify and agree what standards, tools and capabilities regulators would need if this case-by-case safety assessment and validation approach was adopted.

The challenges of case-by-case testing of automated vehicle safety are therefore twofold: one, we do not have the standards, tests, tools and capabilities to assess and validate the safety claims of manufacturers; and two, we are at risk of being out of step with countries that have a strong vehicle manufacturing base and are likely to export to Australia.

Benefits of government testing based on agreed technical standards

- It could ensure streamlined vehicle assurance based on a single set of technical standards.
- It would be cheaper and easier for manufacturers to gain approval for vehicles or technologies that the test is based upon.

Disadvantages of government testing based on agreed technical standards

- Safety assurance and testing processes could become outdated as technical standards and processes in other countries are developed.
- It could stifle innovation if only specific types of automated technologies are capable of meeting the prescribed test.
- It requires significant technical capability of a regulator or a third party to assess and validate specific technologies.

Option 2: Defer establishing a testing process until international processes and standards are developed

Adopting option 2, a testing process to assess and validate the safety of an automated vehicle or automated driving function would not be finalised until international processes and standards are developed. Governments could collaborate closely with other governments and relevant standards bodies on the timely development of standards, tests, tools and capabilities.

This option is strongly aligned with the continue current approach option to safety assurance, discussed in chapter 6.

This option places the highest value on not taking action that is out of step with international developments. Action would not be taken to design or embed a testing process until agencies in key jurisdictions (such as the US, the EU, Japan and the United Kingdom) have agreed to a common approach to assess and validate automated vehicle safety. However, testing processes must also be supported by standards against which a vehicle or automated functions is assessed. Therefore, in addition to delaying the development of testing processes, Australia would defer identifying individual standards until international technical standards were developed, validated and agreed. Technical standards could relate to either whole-of-vehicle safety performance or specific automated functions.

Until the development of international testing process and technical standards, option 3 (discussed below) could be adopted as a temporary approach.

Benefits of deferring a testing process

- It would strongly support harmonisation with international standards and practices.
- It would strongly support mutual recognition of testing process in other regions.
- It would support robust and validated technical standards.
- It would provide a regulator or a third party with an additional opportunity to develop capabilities to undertake testing activities.

Disadvantages of deferring a testing process

- It could significantly delay the introduction of automated vehicles in Australia, particularly if there is a time delay between international consensus emerging and embedding testing processes and technical standards in Australia.
- It is not clear whether the international community will adopt harmonised testing processes or technical standards, or that other governments will not adopt a design assurance process (option 3, discussed below).

Option 3: Onus on industry to test and validate safety

Adopting option 3, the onus would be on the automated driving system entity to demonstrate the methods they have adopted to identify and manage safety risks. A government agency would not undertake the tests itself but may evaluate and validate tests and procedures.

This option is most closely aligned with a self-certification or accreditation approach.

Accreditation provides an example of how the onus to test and validate safety can be industry-based. Under the accreditation model adopted in many safety-critical sectors such as mining, aviation and rail, the role of the regulator is to satisfy itself that the party seeking accreditation has an established process to identify and manage safety risks to an agreed standard. In rail and WHS in Australia the standard is to ensure safety 'so far as is reasonably practicable'. In other parts of the world that have adopted accreditation, the standard is 'as low as reasonably practicable'.⁹

As noted below, the NHTSA *Federal Automated Vehicle Policy* suggests that the US Department of Transportation will adopt an approach similar to this option, with the onus of safety evaluation and validation placed on the manufacturer responsible for the automated vehicle.

⁹ For a safety risk to be 'as low as reasonably practicable' it shall be possible to demonstrate that the cost involved in reducing the risk further would be grossly disproportionate to the benefit gained. For a risk to be accepted it shall be demonstrated to have been reduced to a level 'as low as reasonably practicable' and shall be tolerable.

The NHTSA places the onus of safety validation on industry

In the 2016 *Federal Automated Vehicle Policy*, the NHTSA does not stipulate a specific safety validation methodology for automated vehicles. The NHTSA outlines a safety assessment process whereby manufacturers and other entities voluntarily provide reports on how safety is being addressed and how their safety measures will be tested and validated to ensure a high level of safety.

Manufacturers and other entities will be encouraged to develop a robust design and validation process based on a systems-engineering approach with the goal of designing automated systems free of unreasonable safety risks.

The policy stipulates that in developing appropriate testing and validation methods, manufacturers and other entities should follow guidance, best practices, design principles, and standards developed by established standards organisations such as the International Standards Organization (ISO) and SAE International, as well as standards and processes available from other industries such as aviation, space and the military. In addition, manufacturers and other entities are encouraged to work with the NHTSA and other standards organisations to develop and update tests that use innovative methods, as well as criteria for necessary test facility capabilities (National Highway Traffic Safety Administration, 2016).

Safety assessment in California

The NHTSA's safety assessment process is also referred to in the California Department of Motor Vehicles updated draft regulations for testing and deployment of automated vehicles. Manufacturers are required to submit a copy of their safety assessment letter submitted to the NHTSA as required by the *Federal Automated Vehicle Policy*.

The regulations consider that the manufacturer's participation in the safety assessment process provides further evidence that the manufacturer has engaged in a robust design, development and testing process and is collaborating with the NHTSA at the federal level on vehicle safety matters (National Highway Traffic Safety Administration, 2016).

Safety assessment in Michigan

Similarly, Michigan's recently enacted automated vehicle legislation will be compatible with the regulatory safety scheme in the NHTSA *Federal Automated Vehicle Policy*. The state of Michigan will require manufacturers to be subject to the NHTSA's voluntary safety assessments for automated vehicle technology, acknowledging compliance with high-level safety factors (Dykema Gossett, 2016).

Benefits of industry evaluating and validating safety

- From a software and complex hardware perspective, it may not be possible to rely on trials or vehicle-level testing and inspection to be certain an automated technology is safe. For software and complex hardware, it is likely that safety could only be asserted if the design and testing of those components is conducted using a design assurance process (Nova Systems, 2017).¹⁰
- It would provide a structured and systemic approach to ensuring a vehicle is safe.
- It would not rely on the regulator foreshadowing likely technologies, or creating technical specifications for systems not yet designed or envisaged.

¹⁰ Nova Systems report, page 35, referencing D. L. Parnas, A.J. van Schouwen, S. P. Kwan, 'Evaluation of Safety Critical Software', Communication of the ACM, vol. 33, no. 6, June 1990.

- It would allow manufacturers and regulators to take into consideration industry-agreed standards or international best practise as they develop and mature.
- Innovation would not be constrained by technical standards or outdated tools or tests.
- Primary responsibility for the management of vehicle safety would remain with the manufacturer or technology provider, not the regulator.

Disadvantages of industry evaluating and validating safety

- As there is no agreed metric of what is safe, this would potentially create uncertainty for governments and consumers.
- With no set standards or agreed performance test there is a risk that it could increase costs for manufacturers and take longer to assure a vehicle or automated function.
- Unscrupulous or incompetent manufacturers could abuse the system, letting unsafe vehicles on the road.

Conclusions on safety evaluation and validation

Evaluation and validation of automated vehicle safety is a critical issue for the design and development of the safety assurance system. The proportionate and appropriate role of a government agency to test the safety claims made by a manufacturer or technology provider will largely depend on the regulatory model adopted in Australia (discussed in chapters 6–9).

The development of testing and validation processes by government potentially provides the most robust and rigorous approach to safety assurance, but is more likely to be highly time- and resource-consuming, and duplicate the efforts by industry to test and ensure the safety of their products.

Placing the onus on industry to evaluate and validate automated vehicle safety potentially provides the most support for innovation and reduces the risk of unnecessary regulation and duplication of safety validation. However, placing the responsibility on industry reduces certainty for government and the community that specific vehicles or technologies will be safe.

The NTC suggests that, subject to further consultation, the onus be placed on the automated driving system entity to demonstrate the methods they have adopted to identify and manage safety risks (option 3). This approach strongly supports innovation and recognises that governments do not have specialisation or capabilities in evaluation and validation of automated vehicle safety. This approach is also aligned with the direction being taken in the US and with rail and WHS regulation in Australia.

However, this approach should be reassessed depending on the agreed regulatory option, the direction in which international practices develop and whether a market failure warrants increased evaluation and validation by government.

Consultation question

Question 3: Should the onus be placed on the automated driving system entity to demonstrate the methods they have adopted to identify and mitigate safety risks?

5 Assessment criteria for a safety assurance system

Key points

- The NTC has developed eight assessment criteria against which the regulatory options are evaluated.
- We are seeking your feedback on the proposed assessment criteria.

The purpose of this chapter is to propose the assessment criteria that could be used to assess each of the four regulatory options in this paper. We are seeking feedback on whether these criteria are the right ones for any new system and how governments might approach transitioning to a new system.

We are proposing eight assessment criteria against which the regulatory options for the safety assurance system have been evaluated. Table 3 provides a summary.

Table 3: Proposed assessment criteria for the design of the safety assurance system

Criteria	Description
1. Safety	<ul style="list-style-type: none">• The model should support automated vehicle safety, including the ongoing safety over the full lifespan of the vehicle.• The model should provide certainty about who is responsible for testing, validating and managing safety risks.
2. Innovation, flexibility and responsiveness	<ul style="list-style-type: none">• The model should be technology-neutral and allow innovative solutions.• The model should allow government to respond and adapt to the changing market and evolving technology.
3. Accountability and probity	<ul style="list-style-type: none">• The model should ensure the decision-making process is transparent, accountable and, where appropriate, appealable.• There should always be an entity (whether an individual or a corporation) that is legally accountable for the automated driving system.
4. Regulatory efficiency	<ul style="list-style-type: none">• The assurance process should be as efficient as possible and result in the least cost for industry and government, proportionate to the risk.• The process of assurance should minimise structural, organisational and regulatory change necessary to implement the model.
5. International and domestic consistency	<ul style="list-style-type: none">• The model should support a single national approach, or state-based approaches that are nationally consistent.• The model should support international consistency. International approval processes and standards should be recognisable.
6. Safe operational	<ul style="list-style-type: none">• The model should be able to take into consideration the operational

design domain	design domain of an automated driving system.
7. Other policy objectives	<ul style="list-style-type: none"> The model should be able to support non-safety policy objectives, including cybersecurity, traffic management, environmental protection and the provision of data for enforcement or insurance purposes.
8. Timeliness	<ul style="list-style-type: none"> The model should be able to be implemented and operational when the technology is ready.

These assessment criteria are based on a review of previous work, *Better Regulation Handbook* guidance, initial stakeholder feedback and the independent report prepared by Nova Systems (2017).

We are seeking your feedback on the proposed assessment criteria in terms of both the content of the criteria and whether other criteria should be included. Based on your feedback, we will refine the assessment criteria and reassess the regulatory options based on the finalised criteria.

The finalised assessment criteria will be included in our report to the council in November 2017.

It should be noted that the assessment criteria relate to the design of the safety assurance system – it is distinct from and separate to safety criteria that may be developed for automated driving system entities as part of any future safety assurance system.

An explanation of each criterion is detailed in the following sections.

5.1 Safety

The model should support automated vehicle safety

One of the greatest benefits of automated vehicles is that they will potentially increase road safety by reducing or eliminating crashes caused by human error. In the US, it has been estimated that 94 per cent of crashes are caused by human choice or error (US Department of Transportation, 2016). For this benefit to be realised, automated vehicles must be designed to operate safely. The assurance that automated vehicles will be designed and constructed so they operate safely on the road network is critical to their public acceptance and use.

A safety assurance system that did not have a safety outcome as a key design criterion would not meet its primary regulatory objective.

In addition to an overarching criterion that the model should support a safe outcome, the NTC proposes that the model supports safety of the vehicle throughout its life cycle. That is, safety assurance should take into consideration the ongoing performance and technical integrity of the automated vehicle, not just safety of the vehicle when it is new or first imported. This is considered to be a necessary design feature of the safety assurance system given that we have already seen vehicle manufacturers and technology providers significantly change the automated driving functionality of in-service vehicles through over-the-air software updates. These modifications can have a significant impact on the safety of the vehicle. They also mean that a vehicle that has previously been assured as safe may not be safe any longer.

The model should provide certainty about who is responsible for testing, validating and managing safety risks

In addition to the overarching assurance that an automated vehicle will be safe, industry, government and the community should always have certainty that there is a clearly defined entity responsible for testing, validating and managing the safety risks associated with the vehicle.

The assessment criteria should not presuppose that this entity must be either government or industry, or indeed a corporation. It could be the human owner of the individual automated vehicle who is responsible for managing safety. Likewise, the assessment criteria should not presuppose

that one single entity must be responsible for all aspects of testing, validating and managing safety risks.

Without such a design feature, there is a risk that safety hazards will not be actively managed. There may be a lack of transparency and accountability about which individuals or parties are responsible for the safe performance of the automated driving system.

5.2 Innovation, flexibility and responsiveness

The model should be technology-neutral and allow innovative solutions

The design of the safety assurance system should support technical innovation on the basis that:

- Technical innovation can drive safety outcomes.
- Technical innovation is often about reducing costs and improving productivity.
- Automated technology advancements could be introduced incrementally and in ways regulators may not have thought of or expected.

Automated vehicles rely on new and rapidly developing technologies. It is neither possible nor preferable for governments to predict automated vehicle technology, functionality or applications that are being driven by the market. The safety assurance system should be designed in the expectation of ongoing and unforeseen technical innovation and should be able to support this developing environment.

The model should allow government to respond and adapt to the changing market, changing business models and evolving technology

We expect the regulation of automated vehicles to change as the technology matures. The design of the safety assurance system should therefore allow for emerging innovations and international developments in policy, processes and law – for example, by incorporating international standards for automated vehicles into the ADRs as they develop, or recognising automated vehicles that have been assessed by countries with acceptable processes and standards. Such measures should support innovation and minimise safety regulation.

5.3 Accountability and probity

The model should ensure the decision-making process is transparent, accountable and, where appropriate, appealable

The design of the safety assurance system should reflect community expectations of accountability and probity. The model should ensure the advice and decision-making processes are transparent and accountable, and conflicts of interest are avoided or declared, and that, where appropriate, applicants can appeal a decision.

There should always be a legally accountable entity

There should always be a legal entity (whether a human person or a corporation) responsible for the initial and ongoing safety of the automated vehicle or automated driving system. This is to ensure safety is accountable and actively managed. The assessment process should result in an entity that is identified as having legal responsibility for the automated vehicle.

This criterion is consistent with a primary objective of the NTC driver reform project, which is to ensure that an automated driving system entity is responsible for an automated vehicle's compliance with road traffic laws when in automated mode.

5.4 Regulatory efficiency

The model should be as efficient as possible and result in the least regulatory cost for industry and government, proportionate to the risk

Efficient regulation and reduction of red tape for businesses are objectives of all Australian governments.

Accepting that the automated vehicle technologies being addressed have safety and productivity improvements, and recognising that Australia may be a small proportion of the total global market for automated vehicles, the safety assurance system should not add costs such that vendors are discouraged from bringing innovative automated vehicle technologies into the Australian market.

A key way to facilitate regulatory efficiency is through recognition of assessment or approval processes in the manufacturer's country of origin.

A safety assurance system that focuses on risk and recognises international standards and processes and vehicles already assessed against them will reduce costs to applicants, governments and consumers.

The model should minimise structural, organisational and regulatory change necessary to implement the model

With a view to keeping regulatory costs down for governments and industry, any processes should be designed to minimise structural, organisational and regulatory change necessary to implement the model. The organisational structure should consider efficiencies such as using existing agencies, and providing for the use of third parties.

5.5 International and domestic consistency

The model should support a single national approach, or state-based approaches that are nationally consistent

Road vehicles are regulated by the Commonwealth and the states and territories. But in an open road network environment, automated vehicles will cross state borders and any difference in safety regulation adds cost and complexity for industry and consumers. Therefore, wherever possible the model should support a single national approach. Alternatively, the model should support state- and territory-based approaches that are consistent and enable mutual recognition across states and territories.

The safety assurance system should be consistent with existing consumer, privacy and surveillance protections, in addition to overarching safety protections in WHS laws.

The model should support international consistency

Vehicle manufacturers see Australia as a single market. Therefore, not only should safety regulation within Australia be unified but we should ensure safety assurance is consistent with international developments as best as possible. At this stage in the design and development of a safety assurance system, this is a challenging task given that, as highlighted in section 1.6, countries are presently considering very different ways to assure automated vehicle safety.

Australia should also continue to align the ADRs for new and imported vehicles with UN vehicle regulations.

5.6 Safe operational design domain

The model should be able to take into consideration the operational design domain of an automated driving system

Automated vehicles are designed to operate within specific conditions or limitations, known as the 'operational design domain'. The operational design domain could include geographic, roadway,

environmental, traffic, speed or temporal limitations. For example, an automated driving system may be designed to operate in a heavy vehicle only in low-speed port precincts, while another automated driving system may only be designed for at-speed motorways.

Assessment of the safe limits of the automated driving system is therefore a key design criterion. A government agency may not necessarily be responsible for agreeing or approving an operational design domain, but the design of the safety assurance system should ensure that an accountable entity, or entities, are responsible for considering, evaluating and explaining the conditions within the automated driving system so it can function safely.

Governments may have additional responsibilities to be informed of an automated driving system's operational design domain in their capacity as road managers. This is discussed in more detail in chapter 11.

5.7 Other policy objectives

The model should be able to support non-safety policy objectives

Safety objectives should underpin any safety assurance system. However, where it is reasonable, appropriate and in alignment with government policy to do so, the safety assurance system should be able to support other policy objectives. These could include, but are not limited to, cybersecurity, traffic management, environmental protection and the provision of data for enforcement or insurance purposes.

Many of these objectives could support safety outcomes. For example, the protection of automated vehicles from hacking or cyber-terrorism clearly supports road safety.

The design of the safety assurance system should not preclude or disallow valid policy objectives from being realised through the safety assurance process.

5.8 Timeliness

The model should be able to be implemented and operational when the technology is ready

A safety assurance system should be implemented and operational before the commercial deployment of automated vehicles. Based on industry feedback and market reports, we anticipate that vehicles with high automation will be available on the market by 2020 (although probably with limited operational design domains). This would mean that any safety assurance system would have to be scoped, designed, funded and implemented within the next two years.

It is possible that the options presented here could evolve from one to another as vehicles and system standards are developed internationally and technology is tested further. This could allow for one option to be used in the medium term and while another option is implemented for the long term.

We are seeking your feedback on whether timeliness should be achieved by introducing transitional arrangements – for example, by establishing a low-cost self-certification model in the initial period of implementation while more resource-intensive pre-market approval processes or accreditation arrangements are designed and developed.

5.9 Other potential criteria

The independent report prepared by Nova Systems (2017) proposed 11 assessment criteria for the safety assurance system. Seven of these have been incorporated into the criteria discussed above.

Four of the criteria proposed by Nova Systems have not been included for the following reasons:

1. The safety assurance system supports national road safety strategy

This is not considered necessary as a specific criterion for assessing regulatory options for a safety assurance system. Safety in its own right is an important selection criterion for the safety

assurance system, and automated vehicle safety is conceived in this paper in terms of the pillars of road safety. The *National Road Safety Strategy* sets out a series of targeted interventions that are designed based on evidence regarding the nature and causes of fatal and serious injury crashes. The strategy is expected to respond to the introduction of automated vehicles as necessary.

2. The safety assurance system accounts for a wide range of driver competencies

This criterion is considered a vehicle performance criterion (associated with human–machine interface issues) rather than a criterion for assessing regulatory options for a safety assurance system.

3. The safety assurance system supports road system operational rules

This criterion is related to compliance with road rules and is considered a vehicle performance criterion rather than a criterion for assessing regulatory options for a safety assurance system.

4. The safety assurance system supports Australian industry

This is not considered to be relevant to assessing regulatory options for a safety assurance system. However, support for Australian industry and business opportunities for local technology developers could be incorporated in criterion 7 – to support non-safety policy objectives. Whilst traditional manufacturing of light vehicles in Australia is coming to an end, Australia still maintains a heavy vehicle manufacturing industry and has a number of companies developing supporting technology for automated vehicles.

Consultation questions

Question 4: Are the proposed assessment criteria sufficient to decide on the best safety assurance option? If not, what other assessment criteria should be used for the design of the safety assurance system?

Question 5: Should governments adopt a transitional approach to the development of a safety assurance system? If so, how would this work?

6 Option 1: Continue current approach

Key points:

- If no changes are made to the current regulatory framework, it will most likely be several years before ADRs related to automated vehicle safety will be designed and implemented.
- Existing safeguards, including Australian Consumer Law, would help ensure automated vehicle safety if the 'continue current approach' is adopted.

The purpose of this chapter is to examine how the current regulatory framework, with no additional regulation, could support the safe introduction of automated vehicles into Australia. We are seeking feedback on whether this approach is a viable option for regulating automated vehicles.

Adopting option 1, the current system for managing new and imported vehicles and their operation on public roads would continue. This approach would be supported by other law reforms (including expanding the definition of 'driver' in the Australian Road Rules), as well as existing legal safeguards such as Australian Consumer Law.

Vehicle standards in Australia do not currently have regard for automated driving functions or automated vehicles, and it is Australian Government policy that ADRs for new and imported vehicles are aligned with UN vehicle regulations. It is likely to take some years before UN vehicle regulations for automated vehicles are adopted. Therefore, in the interim period, the continue current approach option would mean automated vehicles could operate on our public roads without any additional regulation.

6.1 Core attributes of continue current approach

Table 4 details the core attributes of the continue current approach option, whereby no additional changes are made except for ongoing reforms to vehicle standards and Australian Road Rules to remove barriers.

Table 4: Core attributes of the continue current approach option

Core attributes of continue current approach	
Role of government	Assesses new and imported vehicles against existing ADRs. Enforces consumer rights under the Australian Consumer Law and the MVSA (including investigation of safety issues).
Reporting to government	No ongoing reporting to government of automated vehicle performance, safety-critical changes or modifications – unless the vehicle is operating under an exemption or there has been a vehicle recall.
Use of standards	ADRs and light and heavy vehicle in-service standards, updated as UN vehicle regulations are developed.
Use of high-level safety principles and criteria	No.
Coverage	Vehicle only.
Operational design domain	The limits of the automated vehicle's operational design domain would be a matter for the automated driving system entity.

Access to data	Government has no additional access to automated vehicle data.
Legal responsibility for safety assurance	The manufacturer and/or automated driving system entity.
Regulation of in-service safety	Limited to Australian Consumer Law and existing light and heavy vehicle in-service standards.
Legislative change required	No.

Under this option, any safety-critical matters relating to an automated vehicle's operational design domain or human performance will not be explicitly regulated. More information about existing vehicle standards processes is detailed in section 6.2.

6.2 Regulating vehicle standards in Australia

Before a road vehicle can be registered for the first time in Australia, it must meet the requirements of the ADRs. When a new vehicle has been certified as meeting the ADRs it can be fitted with an identification plate. Fitting an identification plate is mandatory under the MVSA, and it indicates to the state or territory registering authority that the vehicle meets all the required ADRs. Most new vehicles are assessed by way of a type approval (meaning that if one vehicle complies all vehicles of that type are taken to comply).¹¹

Vehicle Safety Standards Branch (VSSB) within the Commonwealth Department of Infrastructure and Regional Development is responsible for administration of vehicle standards in Australia. The VSSB does not test vehicles for certification purposes. The manufacturer is responsible for ensuring compliance with the ADRs, and the manufacturer conducts the tests required by the various ADRs. Having conducted all the appropriate tests, the manufacturer must then submit an application for approval to fit identification plates to the particular make and model of vehicle that has been tested. In order to demonstrate that the testing has been done correctly and that the vehicle passed, the manufacturer is required to submit a summary of the evidence to VSSB.

The information provided by a manufacturer is subject to checking by the VSSB, using quality assurance audits and inspections of design, test and manufacturing facilities. Together, these ensure that the vehicles (or parts of vehicles) tested were constructed to the production design, that the tests were carried out correctly, that the tests showed that the vehicle (or parts) passed the tests, and that all the vehicles being produced are to the same design (Department of Infrastructure and Regional Development, 2015).

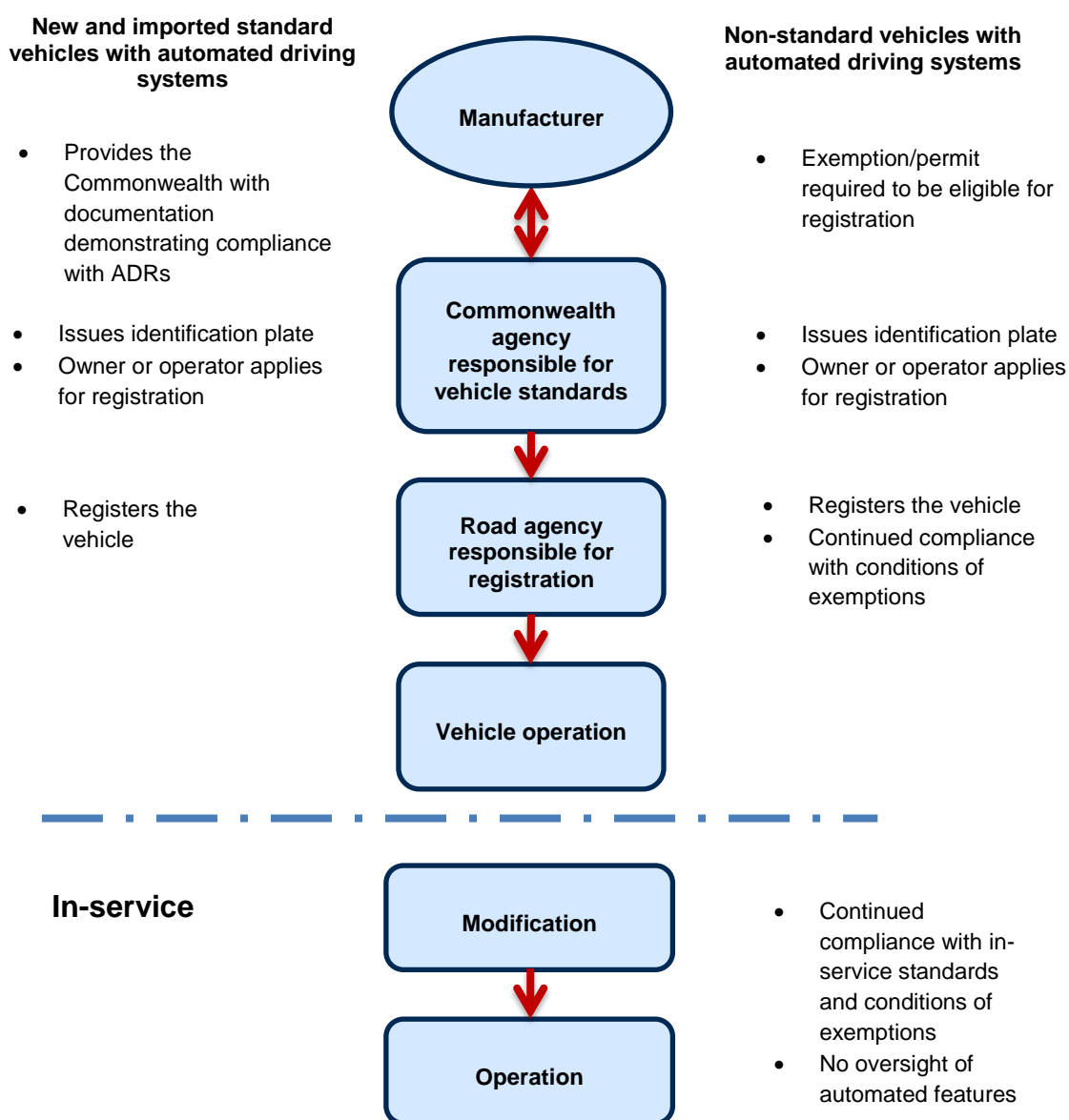
The Commonwealth powers in the MVSA apply to the point of first supply to the Australian market. State and territory governments are responsible for in-service vehicle regulation including registration, roadworthiness, approval of modifications, in-service vehicle standards and access.

Vehicle standards for heavy vehicles over 4.5 tonnes are regulated by the Heavy Vehicle National Law, or HVNL, in all jurisdictions except for Western Australia and the Northern Territory. The HVNL also covers regulatory areas including registration, mass dimension and loading, fatigue, exemptions by permit and accreditation. The National Heavy Vehicle Regulator (NHVR) administers the HVNL. State and territory police and authorised officers are appointed to enforce heavy vehicle offences under the HVNL.

Figure 5 illustrates the current process to ensure vehicle standard integrity in Australia.

¹¹ More information about ADRs can be accessed at: https://infrastructure.gov.au/roads/motor/design/adr_online.aspx.

Figure 5: How the continue current approach option could work



ALVSRs = Australian Light Vehicle Standards Rules

Developing vehicle standards

Consistent with Australia's commitments through international trade agreements and UN agreements related to standards development and reciprocal recognition of approvals, it is Australian Government policy to harmonise the national vehicle safety standards with international regulations where possible.

UN vehicle regulations are continuing to develop. This is largely being achieved through the UNECE World Forum for Harmonization of Vehicle Regulations (Working Party 29, or WP.29). Australia is represented on WP.29 by the Commonwealth Department of Infrastructure and Regional Development.

It is anticipated that through the work of WP.29, vehicle standards will be developed over time in relation to automated driving functions. However, automated driving systems are recognised as very complex, and manufacturers and technology developers are taking different approaches to safely achieving automated functionality.

As such, despite progress being made through WP.29, any changes to the UN vehicle regulations are expected to take many years to be developed and implemented internationally, before being considered for incorporation into local ADRs. This means that – in the intervening period – any automated vehicles that meet existing ADRs could be imported into Australia with no additional assurances that they are safe.

It is further noted that the current ADRs are generally prescriptive and relate to specific components of the vehicle such as brake pads, mirrors and seat belts. In the event that the ADRs do incorporate automated driving functions, it remains to be seen whether a prescriptive and components-based approach is the best way to assure automated vehicle safety. This is because safety assurance for automated vehicles that do not have a human driver will most likely have to take into account not just the safety of the technical components of the vehicle but include assurances that the vehicle behaves safely and complies with road traffic laws in each Australian jurisdiction.

A number of automated vehicles currently being trialled in Australia also require exemptions from one or more ADRs. For example, low-speed passenger shuttles operate safely without a steering column (ADR 10) or rear-vision mirrors (ADR 14). Exemptions are issued on a case-by-case basis. Unlike in the US, there are no legal limits on the number of exemptions the Commonwealth can issue per manufacturer each year; however it is unlikely that the current regulatory process would efficiently support large-scale ADR exemptions for high-volume fleets.

6.3 Regulating in-service 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, the ADRs have certain gaps in their application that 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 HVNL. A single regulator, the National Heavy Vehicle Regulator (NHVR), administers the HVNL. The HVNL established a single national system of laws for heavy vehicles over 4.5 tonnes gross vehicle mass and prescribes requirements related to:

- the vehicle standards heavy vehicles must meet before they can use our roads
- the 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 (NHVR, 2016).

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.

Industry largely self-regulates vehicle repairs through the development of accredited repairer networks and codes of practices. For example, the Motor Vehicle Insurance and Repair Industry has a voluntary code of conduct for vehicle repairers. The Federal Chamber of Automotive Industries (FCAI) has also developed the *Voluntary Code of Practice for Access to Service and Repair Information for Motor Vehicles*.

In addition to maintenance and repair, one of the key risks associated with in-service safety is vehicle modifications. Automated vehicle modification could include:

- commercial modifications undertaken by a licensed third-party repairer
- non-commercial modifications – such as a ‘backyard’ modification by the vehicle owner

- modifications directly undertaken by the manufacturer – such as software updates that modify the performance of the vehicle.

The NTC discussion paper on automated vehicles (Japan, National Police Agency, 2016) reviewed the potential impact of modifications on automated vehicle safety. Our analysis recognised that current in-service vehicle standards do not have regard for automated technologies and that the regulation of in-service vehicles is relatively light-touch. There is also no regulatory oversight of intangible modifications by manufacturers such as software updates that could significantly modify vehicle performance.

However, we also found a range of factors that are positively impacting on in-service vehicle safety without additional oversight. For example, commercial and manufacturer modifications are subject to consumer law protections such as consumer guarantees and manufacturer liability for products and safety defects. The example of Tesla's over-the-air update of its Model S that installed its Autopilot application and was subsequently amended because of consumer misuse illustrates the significance of software updates and how industry self-regulates in the context of consumer law and product liability.

Non-commercial modifications are not subject to consumer law, but vehicle owners have a personal incentive to ensure their vehicle operates safely.

6.4 Safeguards

Consumer protections

The Australian Consumer Law, as well as corporate social responsibility and commercial imperatives, provide a framework within which manufacturers and operators are already incentivised to ensure the safe operation of automated vehicles.

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 will continue to provide consumers with statutory guarantees that products will be safe, free from defects and fit for purpose, establishing manufacturer liability for products with safety defects and providing for consumer compensation claims for loss or damage. The Australian Consumer Law also 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 and Regional Development assesses complaints about vehicles with safety issues, carries out safety investigations and monitors vehicle recalls on behalf of the ACCC. Under the continue current approach option, this framework would continue to apply to automated vehicles and provide an important safeguard for automated vehicle safety.

Motor vehicle registration powers

States and territories have existing registration powers to prevent the registration of unsafe vehicles.

South Australia has the power to refuse to register a motor vehicle where 'the vehicle would, if driven on a road, put the safety of persons using the road at risk' (Government of South Australia, 2017).¹² In the Northern Territory, 'the grant or renewal or transfer of any license, permit or registration shall be in the discretion of the Registrar' (Northern Territory Government, 2017).¹³

¹² Section 55A of the *Motor Vehicles Act 1959* (SA).

¹³ Section 102 of the *Motor Vehicles Act 2017* (NT).

Other states and territories may need to amend their registration laws as similar powers do not appear to be available to them.

The disadvantage of this approach is that registration powers are exercisable for individual vehicles, at registration or reregistration, and the applicant is most likely to be the owner or operator of the vehicle rather than the automated driving system entity. Furthermore, without additional regulatory oversight, a registration authority may not have the necessary information to know that a vehicle is unsafe and should not be registered.

The Austroads project to align registration and licensing operations with the proposed safety assurance system for automated vehicles provides an opportunity to further examine in depth how registration powers could support a pre-market approval process.

Regulation-making powers to restrict road access

All states and territories have broad regulation-making powers in their road traffic laws that should allow them to make regulations to refuse or restrict road access to automated vehicles if there were safety concerns about their operation.

For example, section 146(1)(g) of the *Transport Operations (Road Use Management) Act 1995* (Qld) provides that:

(1) A regulation may prescribe rules about the operation of vehicles and use of the road network, including, for example, rules about— (g) the use of the road network by vehicles, trains, trams, persons and animals [...].

Section 23 of the *Road Transport Act 2013* (NSW) provides a broad regulation-making power:

(1) The Governor may make regulations and rules, not inconsistent with this Act, for or with respect to any matter that by this Act is required or permitted to be prescribed or that is necessary or convenient to be prescribed for carrying out or giving effect to this Act.

It is further noted that these are regulation-making powers only, and states and territories would have to use their powers to introduce specific regulations to support a pre-market approval process. The regulation could reference a pre-market approval process undertaken by a national government agency.

However, there are likely to be a variety of operational design domains that could make it difficult to define a particular class of automated vehicles in regulation.

Industry guidance

Industry guidance, such as codes of practice and principles, could also provide important support. Industry codes can build government and consumer confidence in automated vehicles by indicating how manufacturers are ensuring automated vehicle safety. Guidance could set principles or outline practices to manage safety from initial design to in-service repairs and upgrades.

For example, the FCAI is the peak industry body representing the automotive industry in Australia. The FCAI's membership comprises the three domestic passenger motor vehicle manufacturers and all major international brands that import and market passenger, light commercial and four-wheel-drive vehicles and motorcycles in Australia. The FCAI produces a range of guidance material for members. Recent publications include *Guiding Principles for Privacy and Cooperative Intelligent Transport (C-ITS) Systems* (2017) and the *Code of Practice for the Conduct of an Automotive Safety Recall* (2017). The code describes the procedures to be followed when a member is advised or becomes aware that one of its products may have a safety defect.

Guidelines produced by other organisations may also have a role. For example, the NTC's *National Guidelines for Automated Vehicle Trials* (approved by transport ministers in May 2017) are intended to indicate to trial applicants the range of factors they should consider when planning a trial. If a vehicle to be used in an automated vehicle trial requires an exemption or permit to operate legally on roads, the state and territory road transport agencies will require the exemption application to address the factors in the guidelines.

Australasian New Car Assessment Program

The Australasian New Car Assessment Program (ANCAP) is an independent vehicle safety advocate in Australia and New Zealand. ANCAP provides consumers with information about occupant and pedestrian protection provided by different vehicle models.

ANCAP also provides information about safety-related technologies, and ANCAP's standards and expectations continuously updates as the technology matures. For example, we understand that by 2018 ANCAP will only issue a five-star rating to vehicles equipped with autonomous emergency braking and blind spot sensors that detect other vehicles located to the driver's side and rear. ANCAP also works closely with equivalent organisations overseas such as Euro NCAP.

ANCAP is an example of an industry-based group that can drive safety outcomes without additional regulatory oversight. ANCAP is likely to continue to play a key role in testing, supporting and providing consumers with information about safety-related automated technologies.

6.5 Interaction with driver reforms

In section 1.3, we mentioned the project *Removing legislative barriers to automated vehicles* and how the development of a safety assurance system is being undertaken in parallel to legislative reforms to the Australian Road Rules and road traffic laws. These reforms are likely to result in automated driving system entities being recognised as legal parties with legal obligations similar to human drivers today. The aim of the reforms is to ensure there is always a legal entity responsible for the vehicle's actions, including vehicles that do not have a human driver.

These driver reforms mean that if option 1 was adopted, it would still be possible for other road users, insurers and enforcement agencies to take action against the automated driving system entity in the event of a vehicle crash or breach of the road traffic laws. However, the automated driving system entity would need to be defined as either the manufacturer or the registered owner of the vehicle, as these would be the only parties that are currently identifiable.

6.6 Benefits and disadvantages of the continue current approach option

The NTC has identified benefits and disadvantages of the continue current approach option. We are seeking your feedback on whether there are additional benefits or disadvantages, and whether our assessment requires further analysis.

Benefits of the continue current approach option

- The standards and processes are known by all those involved in the industry
- There would be no risk of Australia going down a different regulatory path from other countries or regions – delaying reform would allow us to wait to see what happens internationally.
- Continuity of policy means there would not be significant changes for industry or consumers.
- There would be no new or additional costs or time constraints.
- It would not create any additional barriers to industry.









Disadvantages of the continue current approach option

- It will most likely be several years before international standards are developed and introduced that relate to automated vehicle safety – in the intervening period ADRs will not have regard to automated technologies.
- It would expose road users to risk from automated technologies that are not covered in ADRs and that governments may never review, assure or even know about.

- Vehicle standards primarily relate to individual components of the vehicle. It is unclear how ADRs and in-service vehicle standards could effectively have regard to vehicle performance, including a vehicle's compliance with road traffic laws.
- A number of ADRs are unlikely to be relevant to automated vehicles, meaning that widespread and systemic vehicle exemptions may become necessary. This would not be cost-effective or aligned with the intent of the exemption powers in the MVSA.
- There would be no additional regulatory oversight of after-market fitment, modifications or in-service operations; this may create significant new safety risks.
- There would be no additional regulatory oversight of human performance requirements, particularly any training required for humans to interact safely with the technology.
- There would be no regulatory oversight of environmental requirements, particularly the safe operational design domain of the vehicle.
- It could expose road users to risk from technologies that are in vehicles but are not covered in the automated vehicle design standards and, hence, are not ever reviewed by regulators.

Table 5 provides our evaluation of how the continue current approach option meets the proposed assessment criteria for a safety assurance system.

Table 5: Evaluation of option 1 against the proposed assessment criteria

Continue current approach	Are safety risks managed?	Is the model flexible and does it support innovation?	Does it support legal accountability and probity?	Is the regulatory approach efficient?
				
	Does it support consistency?	Can it evaluate a safe operational design domain?	Can the model support other policy objectives?	Can it be implemented within two years?
				

The continue current approach option fully **meets** two criteria. The continue current approach option:

- would not require regulatory change and would therefore be cost-effective and efficient
- could be implemented within two years.

The continue current approach option partially **meets** three criteria. The continue current approach option:

- may not provide governments with certainty that the safety risks are being managed

- would support innovation by not constraining manufacturers, but would not facilitate an easy or simple importation process, and the lack of explicit regulation could create uncertainty
- could support international consistency over time, but there is a high risk that different levels of safety would emerge across business models and enterprises.

The continue current approach option does **not meet** three criteria. The continue current approach option would not:

- provide a mechanism to evaluate the vehicle's operational design domain
- ensure there is always a legal entity responsible for the automated driving system
- provide opportunities to use current regulations to support other policy objectives such as cybersecurity, optimum traffic management and environmental outcomes.

6.7 Conclusions

A challenge with the continue current approach option is the likelihood of a gap between automated technologies emerging on the market and new international standards being developed. While there are existing safeguards to help ensure automated vehicle safety under the continue current approach option, notably Australian Consumer Law, there are safety risks related to the vehicle's operational design domain, legal accountability and factors such as cybersecurity that would remain unregulated. Existing manufacturers may have strong safety processes in place but this approach would allow any company or individual to develop and release automated driving functionality, including after-market devices, with little regulatory oversight.

Consultation question

Question 6: Is continuing the current approach to regulating vehicle safety the best option for the safety assurance of automated vehicle functions? If so, why?

7 Option 2: Self-certification

Key points

- Self-certification is a light-touch approach that, like the continue current approach option, relies on existing safeguards but could introduce voluntary or mandatory compliance with automated vehicle safety principles and criteria.
- Showing compliance with safety criteria would allow automated driving system entities to demonstrate to government that their vehicles are safe and therefore suitable to be registered under state and territory laws.
- Self-certification could be supported by a legislated primary safety duty for manufacturers, suppliers and automated driving system entities to provide safe automated vehicles.

The purpose of this chapter is to examine how the current regulatory framework, with the addition of a voluntary or mandatory self-certification statement, could support the safe introduction of automated vehicles into Australia. We are seeking feedback on whether this approach is a viable option for regulating automated vehicles.

Adopting option 2, an automated driving system entity would self-certify the safety of an automated vehicle or automated driving system, and governments would not have a role certifying or approving the safety of an automated vehicle. Self-certification could be voluntary or mandatory.

In addition to ensuring compliance with ADRs within existing MVSA processes, the automated driving system entity would be encouraged or required to provide a statement of compliance that the vehicle meets automated vehicle safety principles and performance criteria developed by government. These criteria would be outcome-based and would not specify technical requirements.

Table 6 provides examples of potential safety principles and criteria.

Self-certification could be supported by a legislated primary safety duty for manufacturers, suppliers and automated driving system entities to provide safe automated vehicles. If this approach were adopted, making a statement of compliance against the safety criteria could assist an entity to demonstrate how a party has met its primary safety duty. A similar duty exists in the RSNL and will also be introduced in the HVNL once recent amendments come into operation.

Self-certification could also be supported through the development of industry codes.

Mandatory and voluntary approaches

A key question is whether the statement of compliance against the safety principles and criteria should be mandatory, including for significant modifications or safety-critical issues. Failure to lodge would then be an offence. To give added weight to the statement of compliance, making a false statement in a statement of compliance could also be an offence.

This variation would require legislation, which may be needed at the Commonwealth level to deal with requirements on new and imported vehicles, and at the state and territory level to deal with in-service modifications and upgrades.

Mandatory reporting of critical information would be aligned with the direction indicated by the NHTSA in its policy regarding the provision of safety assessments by manufacturers.

As well as enabling an assessment of how automated vehicles meet government safety principles and criteria, this amendment would provide government with information on the range of automated vehicles and functionalities on the market. This would allow registration authorities and road managers greater oversight of automated vehicle access to the road network.

This variation would also have the advantage of ensuring a legal entity responsible for the automated vehicle or automated driving system was identified. This would complement the

proposed driver reforms, which require the legal entity responsible for an automated vehicle to be responsible for the automated vehicle system's actions while it is controlling the vehicle.

7.1 Core attributes of self-certification

Table 6 details the core attributes of a self-certification approach.

Table 6: Core attributes of self-certification

Core attributes of self-certification	
Role of government	Provides automated vehicle safety criteria. Reviews statements of compliance and follows up on any safety concerns. Enforces consumer rights under the Australian Consumer Law (including investigating safety issues) and investigates ADR issues under the MVSA.
Reporting to government	An automated driving system entity would be mandated to or voluntarily provide a statement of compliance for new or imported vehicles, or after a significant update or modification (such as changes to functionality).
Use of standards	ADRs and light and heavy vehicle in-service standards are updated as UN vehicle regulations are developed. An automated driving system entity can use any technical standards in statements of compliance.
Use of high-level safety criteria	Yes.
Coverage	High-level safety criteria could have regard to vehicle technical integrity, human performance and environment. Impact on in-service operations would need to be determined.
Operational design domain	The operational design domain of the vehicle would be a matter for the automated driving system entity.
Access to data	Government has no access to data beyond what the automated driving system entity provides.
Legal responsibility for safety assurance	The automated driving system entity is responsible for the automated vehicle. Potentially the manufacturer and supplier (if different from the automated driving system entity) could have primary safety duties in law to provide safe vehicles.
Regulation of in-service safety	Limited to Australian Consumer Law and existing ALVSRs.
Legislative change required	Yes, but only if mandatory and / or a primary safety duty is supported.

A government agency would review the statement of compliance and supporting information and follow up on any safety concerns, but there would be no physical assessment of the vehicle.

A similar approach could apply to in-service modifications. Manufacturers could be mandated to or voluntarily provide an updated statement of compliance for major changes to the automated driving system such as safety-critical changes in functionality.

Ongoing technical compliance would be managed internally by vehicle manufacturers or by vehicles owners, and there would be no reporting of system failures to government.

If the self-certification was voluntary an automated vehicle would be free to operate on any road network (limited only by its operational design domain). Voluntary self-certification would not provide a mechanism for road managers to regulate access of specific vehicles or vehicle-types to the road network.

If self-certification was mandatory an automated vehicle would be free to operate on any road network once the statement of compliance had been received and approved. Mandatory self-certification could provide a mechanism for road managers to regulate access to the road network.

Under voluntary self-certification, it is possible that, if an automated driving system entity chooses not to make a statement of compliance, automated vehicles that meet the ADRs could operate on the road network without the knowledge of government agencies, including registration authorities and road managers.

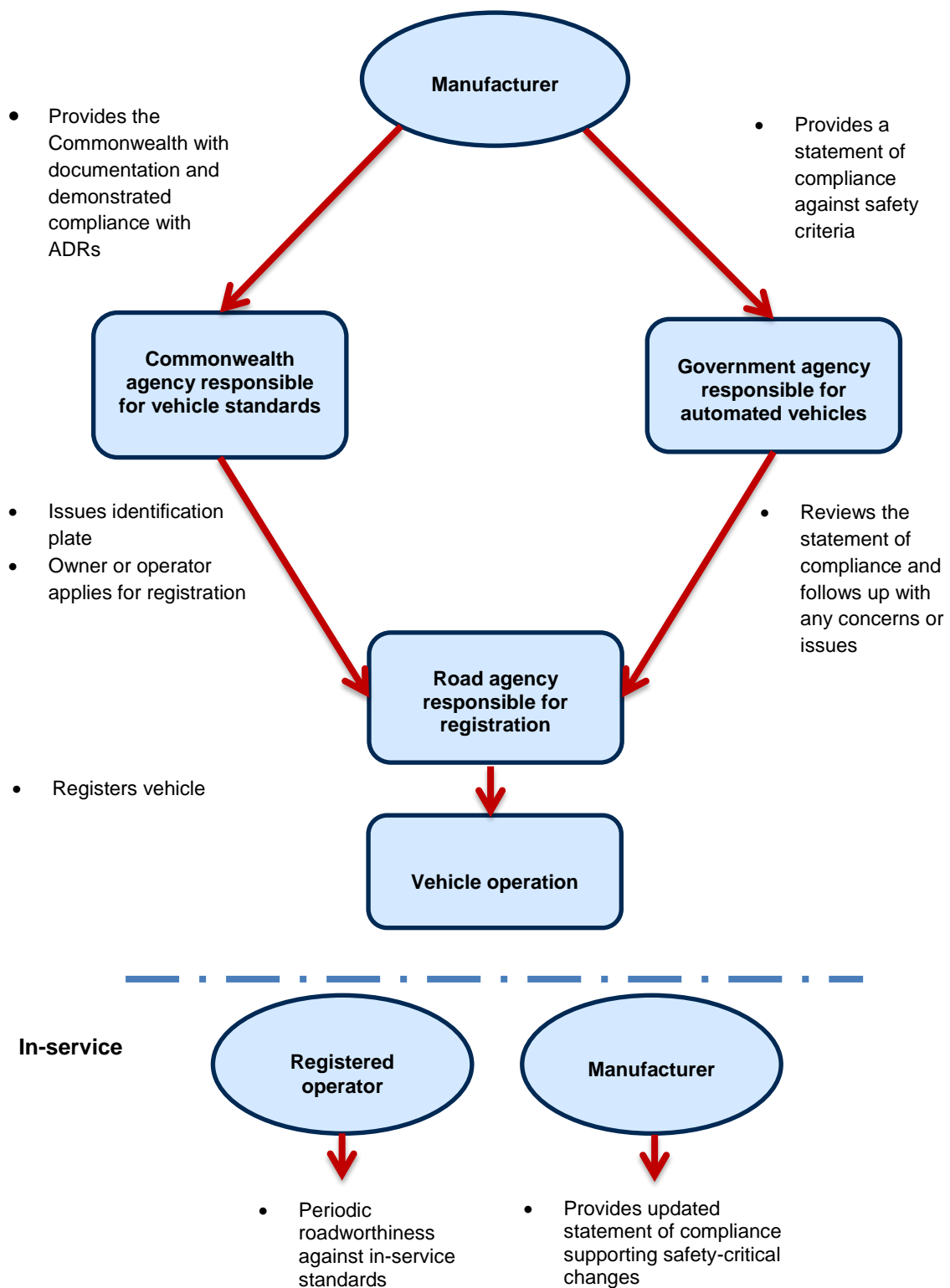
The process could be as follows:

- **Step 1:** Government develops and publishes national automated vehicle safety principles and criteria.
- **Step 2:** Automated driving system entity¹⁴ is mandated to or voluntarily provides a government agency with a statement of compliance and supporting documentation (this could be an existing agency).
- **Step 3:** The government agency undertakes reviews and follows up any concerns or issues with the automated driving system entity. In the event of a failure to provide a safe vehicle, a vehicle recall could be initiated, road transport agencies may take action using unroadworthy vehicle powers or, if the primary safety duty is supported, a government agency could prosecute for failure to meet a primary safety duty.
- **Step 4:** Automated driving system entity is mandated to or voluntarily provides the government agency with an updated statement of compliance with supporting documentation for any major changes to the automated driving system functionality.
- **Step 5:** The government agency reviews the changes and follows-up any concerns or issues. In the event of a failure to provide a safe vehicle, the same actions as under step 3 would apply.

The interaction between automated driving system entities and government in a self-certification approach is further illustrated in Figure 6.

¹⁴ This term will be defined by legislation as part of the NTC driver reforms.

Figure 6: How the self-certification process could work



7.2 High-level safety principles and criteria

To support self-certification, the government would set high-level safety principles and criteria against which industry could make a statement of compliance. The NTC's 2016 discussion and policy papers outlined an example of potential safety principles. These have been replicated in Table 7, with some refinements based on further consultation and analysis.

Table 7: Examples of potential safety principles and criteria for automated vehicles

Potential safety principles – for vehicles with conditional, high or full automation
<ol style="list-style-type: none"> 1. The vehicle design, validation and testing processes should be free of unreasonable safety risks. Where applicable, guidance, industry best practices, design principles, and standards developed by established standards organisations should be used. 2. The vehicle must only operate in automated mode on infrastructure and in conditions consistent with its operational design domain. 3. The vehicle's automated functions must be able to be disengaged if system upgrades are not installed or system faults are detected, including as a result of a crash.
Potential performance criteria – for vehicles with conditional, high or full automation
<ol style="list-style-type: none"> 1. The vehicle can operate in compliance with relevant road safety and traffic laws. 2. The vehicle has a defined operational design domain. 3. The maximum speed of the vehicle is based on a risk assessment that considers the applicable operational environment, occupant protection and vehicle mass. 4. Wherever the automated driving system operates, the vehicle can appropriately respond* to: <ul style="list-style-type: none"> • temporary speed zones (such as roadworks) • traffic controls (such as stop signs, variable speed signs and traffic lights) • all likely road conditions (such as unsealed roads) • all likely environmental conditions (such as dust storms or flooding) • interaction with trains and light rail (such as railway level crossings) • interaction with vulnerable road users (such as compliance with the one metre rule for cyclists). 5. The vehicle has real-time monitoring of driving performance and incidents, including event data records in the lead up to any crash or near miss that identifies which party was in control of the vehicle at the relevant time. 6. The vehicle operates with functionality to provide road agencies with crash and near-miss data. 7. The vehicle operates with the minimum required standards of security, mapping, privacy and data management protocols. 8. The automated vehicle meets any appropriate international standards or agreed guidelines for human-machine interfaces and allows, when relevant, the human driver to safely disengage and re-engage the driving task. 9. Human drivers are provided with appropriate training to safely disengage and re-engage the driving task. <p>* An appropriate response could include the automated driving system disengaging or bringing the vehicle to a safe stop.</p>

Additional criteria for vehicles with high or full automation

1. The automated vehicle must be capable of bringing the vehicle to a minimal risk condition (such as coming to a controlled stop) without human intervention.

The safety criteria distinguish between automated vehicles with different levels of driving automation. The relevance of each criterion will be dependent on the characteristics of the automated driving system or vehicle.

NHTSA example of self-certification

Self-certification is similar to the NHTSA's approach in the *Federal Automated Vehicle Policy*. The NHTSA recognises that, because of the rapid development of automated vehicle technology, there are as yet no FMVSS specific to automated vehicles. The NHTSA has therefore established automated vehicle performance criteria against which a manufacturer is expected to provide a safety assessment before the vehicle is released to market.

This safety assessment would assist the NHTSA, and the public, in evaluating how safety is being addressed by manufacturers and other entities developing and testing HAV systems.

The safety assessment would address the following areas:

- data recording and sharing
- privacy
- system safety
- vehicle cybersecurity
- human-machine interface
- crashworthiness
- consumer education and training
- registration and certification
- post-crash behaviour
- federal, state and local laws
- ethical considerations
- operational design domain
- object and event detection and response
- fall back (minimal risk condition)
- validation methods (US Department of Transportation, 2016).

In addition, the NHTSA expects that a new safety assessment would be submitted when significant updates to an automated vehicle or its automated system are made:

A significant update is one that would result in a new safety evaluation for any of the 15 safety assessment areas. The purpose of the updated letter would be to describe for the agency the nature of the update, its expected impact on performance and other relevant information consistent with the intent of the safety assessment letter (US Department of Transportation, 2016).

The policy expects collection of data, including crash data involving fatalities, personal injuries and crashes where a motor vehicle has to be towed away, and that it will be available to the NHTSA for crash reconstruction purposes. It expects this data to include the status of the automated system and if it or the human driver was in control of the vehicle at the time.

As noted in section 1.6, a safety assessment by manufacturers is voluntary, but the NHTSA is currently considering a regulatory process to make it mandatory.

There is considerable similarity between our examples of potential safety principles and criteria in Table 5 and the NHTSA safety assessment areas listed above. Additional areas included by the NHTSA are:

- **Crashworthiness:** Beyond compliance with the FMVSS, entities should ensure the occupant protection system maintains its intended performance level in the event of a sensor failure and should develop and incorporate new occupant protection systems that use information from the automated vehicle's sensing technologies.
- **Registration and certification:** This area deals with after-market conversions of non-automated vehicles and upgrades from lower to higher levels of automation. It suggests entities producing items for use by or with automated vehicle systems for such conversions and upgrades should submit identifying information and a description of the items they produce (in the same way they are currently required to do with vehicles and equipment covered by the safety standards).

The policy also suggests manufacturers should provide in-vehicle means to readily communicate concise information regarding the key capabilities of their automated vehicle system to human drivers and owners of such vehicles, which should be updated in line with vehicle upgrades.

- **Ethical considerations:** This suggests that if automated vehicles are required to apply particular decision rules in instances of conflicts between safety, mobility and legality objectives, that algorithms for resolving these conflict situations should be developed transparently.

We have not included these criteria in the first instance because they are either covered by the broader regulatory options (for example, after-market fitment could be covered through pre-market approval or accreditation) or may be more related to liability issues (such as ethical considerations). The NTC is seeking feedback on whether these areas should explicitly be included as safety criteria.

It should also be noted that there are some differences between the Australian and US regulatory frameworks that create distinctions between our option 2 and the NHTSA approach:

- The NHTSA has direct vehicle recall powers. In Australia, the recall powers are in consumer protection laws and are exercisable by ministers, not directly by the Commonwealth Department of Infrastructure and Regional Development.
- The NHTSA has clearly indicated its intention to start the regulatory process of making the provision of a safety assessment mandatory, whereas the option 2 statement of compliance could be voluntary or mandatory.
- The option proposes introducing a primary safety duty that does not exist in the US.

Self-certification and a primary safety duty

As noted in the introduction to this chapter, self-certification could be supported by a legislated primary safety duty for manufacturers, suppliers and automated driving system entities to ensure safe automated vehicles. Primary safety duties are discussed in more detail at section 4.1.

7.3 Benefits and disadvantages of self-certification

The NTC has identified benefits and disadvantages of self-certification. We are seeking your feedback on whether there are additional benefits or disadvantages, and whether our assessment requires further analysis.

Benefits of self-certification

- It would clearly place primary responsibility for automated vehicle safety on the automated driving system entity and other relevant industry parties.
- It would support innovation.
- It would be low cost for government and industry.
- If voluntary no legislation or amendments would necessarily be required.

- It could be implemented within a two-year timeframe (if the primary safety duty is not included because this would require legislative amendments).
- There would be no delay in introducing new automated vehicles caused by waiting for government assessments or showing compliance with specified technical standards.
- It would support the reforms to Australian legislation currently being undertaken by having an identified legal entity associated with an automated vehicle (where the manufacturer or other entity complied with the request for a statement of compliance).
- A primary safety duty would recognise that entities other than the automated driving system entity could have their own responsibilities for ensuring the safe design, build or operation of an automated vehicle.









Disadvantages of self-certification

- If voluntary, automated driving system entities may not provide government with a statement of compliance.
- If automated driving system entities do not provide a statement of compliance it may be difficult to identify an entity to take legal civil or criminal action against.
- Safeguards such as Australian Consumer Law and other primary duties are generally retrospective, in that action is usually only taken after a product has been released on the market and harm or potential harm is identified.
- If voluntary there would be no in-service reporting by automated driving system entities of safety-critical events (such as crashes) to government.
- It would rely on automated driving system entities to ensure repairs are done by approved repairers – the absence of oversight of third-party modification or repairs could have significant safety issues.
- A primary safety duty could duplicate the effect of consumer guarantees under the Australian Consumer Law.
- It could expose road users to risk from technologies that are in vehicles but are not covered in the automated vehicle design standards and, hence, are not ever reviewed by regulators.

A primary safety duty may be seen as unnecessary regulation given there are existing obligations in the Australian Consumer Law (detailed in chapter 6). As well, automated driving system entities could be subject to legal obligations such as driving offences – an option being considered in the NTC driver reforms. A primary safety duty may also be more difficult to enforce than current prescriptive regulations.

Table 8 provides our evaluation of how self-certification meets the proposed assessment criteria.

Table 8: Evaluation of option 2 against the proposed assessment criteria

Self- certification	Are safety risks managed?	Is the model flexible and does it support innovation?	Does it support legal accountability and probity?	Is the regulatory approach efficient?
				
	Does it support consistency?	Can it evaluate a safe operational design domain?	Can the model support other policy objectives?	Can it be implemented within two years?
				

Self-certification **fully meets** four criteria. Self-certification:

- would support evolving technology and a changing market
- would allow for international consistency, as it could be adapted as international approaches are developed
- would require minimal regulatory change and is therefore cost-effective and efficient
- could be implemented within two years.

Self-certification **partially meets** four criteria. Self-certification:

- if voluntary, does not provide governments with certainty that safety risks are being managed
- would provide a light-touch mechanism to ensure a legal entity is always accountable for the safe operation of the vehicle
- would provide a light-touch mechanism to ensure the automated driving system entity has ensured a safe operational design domain
- would provide a light-touch mechanism to support other policy objectives by including concepts such as cybersecurity, optimum traffic management and environmental outcomes in the voluntary or mandatory safety principles and criteria.

There were no criteria that were entirely unmet through self-certification.

7.4 Conclusions

Self-certification is a light-touch approach that, like the continue current approach option, relies on existing safeguards but introduces voluntary or mandatory compliance with automated vehicle safety principles and criteria. Showing compliance with these criteria would allow automated driving system entities to demonstrate to government that their vehicles are safe and therefore suitable to be registered under state and territory laws. Self-certification could be supported by a legislated primary safety duty for manufacturers, suppliers and automated driving system entities to ensure automated vehicle safety.

A mandatory statement of compliance would add additional rigour to the process and establish a more level playing field for industry, without significantly more regulation or oversight by government.

Consultation question

Question 7: Is self-certification the best approach to regulating automated vehicle safety? If so, should this approach be voluntary or mandatory? Should self-certification be supported by a primary safety duty to ensure automated vehicle safety?

8 Option 3: Pre-market approval

Key points

- Pre-market approval possibly provides the highest certainty for government and consumers that automated vehicles will be safe. However, this option is also regulation- and resource-intensive and could stifle safety-related innovation if testing standards and procedures don't keep pace with technology changes.
- Pre-market approval may be better suited to a long-term state when there is greater certainty related to technology, functions, standards and overseas processes and practices.

The purpose of this chapter is to examine how a pre-market approval regulatory system could support the safe introduction of automated vehicles into Australia. We are seeking feedback on whether this approach is a viable option for regulating automated vehicles.

8.1 Core attributes of pre-market approval

Adopting option 3, a government agency would be responsible for pre-market approval of automated driving systems before they are permitted to operate on public roads. Government agency approval would also extend to safety-critical changes to the vehicle, or significant changes to the vehicle's operational design domain. The automated driving system entity would also be required to provide the government agency with data on in-service safety-critical events.

The automated driving system entity would apply for approval of the automated vehicle or automated driving system, and the government would assess the vehicle against government-specified technical standards and testing procedures for automated vehicles. A third-party technical expert could be contracted to perform this assessment on behalf of the government.

Pre-market approval would be in addition to existing requirements to demonstrate compliance with ADRs. The two processes may be able to be undertaken in parallel. A government agency responsible for pre-market approvals could facilitate ADR approvals and any relevant exemptions on behalf of the applicant.

The automated driving system entity would provide evidence of the vehicle's design and testing to assist the approval process. Similar approval processes from other countries would be recognisable.

Table 9 summarises the core attributes of a pre-market approval approach.

Table 9: Core attributes of pre-market approval

Core attributes of pre-market approval	
Role of government	Establishes technical standards and testing procedures. Assesses automated vehicles against the technical standards and testing procedures. Grants approval for initial applications and for significant modification and upgrade applications. Monitors in-service reports of safety-critical events and takes action as required.
Reporting to government	Ongoing reporting to government of modifications or upgrades and significant changes to the vehicle's operational design domain, as well as safety-critical events.
Use of standards	Prescribed automated vehicle technical standards and testing procedures.

Use of high-level safety principles and criteria	Not necessarily – the safety principles used in developing the system could be the basis for issuing the pre-market approval.
Coverage	Would have regard to the safety of vehicle integrity (including initial and ongoing integrity), the environment and the driver.
Operational design domain	The operational design domain of the vehicle would be a matter for the automated driving system entity to determine, but its assessment and approval would be a government function.
Access to data	Government would be provided with safety-critical event data.
Legal responsibility for safety assurance	The automated driving system entity would be responsible for vehicle operations, and government would be responsible for safety assurance through the approval process.
Regulation of in-service safety	Government could act on safety-critical event data provided through the approvals process, and while the vehicle is in service.
Legislative change required	Yes.

The pre-market approval would consist of the following steps:

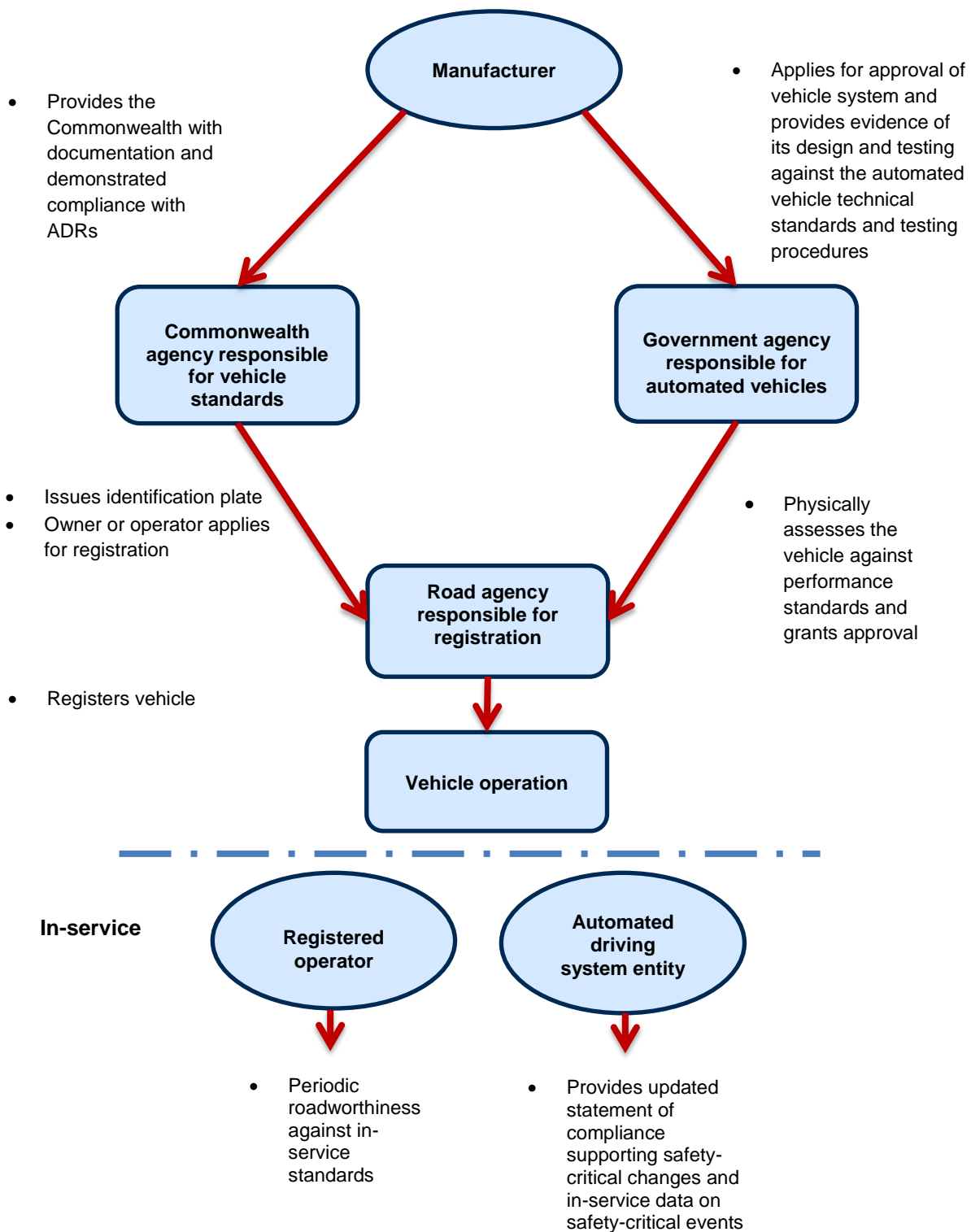
- **Step 1:** The applicant applies for approval, showing how its automated vehicle or system complies with the technical standards and testing procedures.
- **Step 2:** Government assesses the vehicle against the technical standards. If the vehicle complies, government issues an approval. The applicant becomes an automated driving system entity, with obligations in road traffic laws.

Alternatively, a third-party technical expert (approved by government) assesses the vehicle and certifies compliance. On the basis of certification, government issues an approval.
- **Step 3:** Automated driving system entity applies for further pre-market approval of a significant modification or upgrade of an approved automated vehicle (in particular changes to the vehicle's operational design domain).
- **Step 4:** Government or an approved third-party technical expert physically assesses the vehicle against the technical standards and testing procedures, and if the vehicle complies, government issues an approval.
- **Step 5:** Automated driving system entity provides ongoing reporting of safety-critical events to the government agency or approved third party.
- **Step 6:** Government analyses event information and responds proportionally. For example, by notifying a road transport agency of a safety-critical issue.

The government agency could approve appropriately qualified third-party technical experts to provide a certification service directly to automated driving system entities. This alternative approach would mean that government would not need to have (or contract) the technical expertise, as it would not undertake the physical assessment itself.

The pre-market approval process is illustrated in Figure 7.

Figure 7: How the pre-market approval process could work



Examples of pre-market approval

Performance-based standards for heavy vehicles

An example of pre-market approval currently operating in Australia is the Performance Based Standards (PBS) scheme. The PBS scheme is designed to offer the heavy vehicle industry the potential to achieve higher productivity and safety through innovative and optimised vehicle design. Approved PBS vehicles are exempted from a number of ADRs and in-service vehicle standards including height, width, length, rear overhang and trailer drawbar length.

A PBS design application has to be assessed using third-party industry expertise (PBS assessor) against 16 vehicle safety standards and four infrastructure protection standards. The National Heavy Vehicle Regulator (NHVR) determines whether or not a vehicle meets the standards and issues a PBS design approval taking into account the advice of the PBS Review panel. The PBS Review Panel comprises Commonwealth and state and territory representatives and is governed by business rules to ensure consistency.

Once built, the PBS vehicle is assessed by an accredited PBS certifier, who certifies the vehicle has been built to the approved design specifications. The NHVR issues a PBS vehicle approval based on this assessment.

Unless the PBS vehicle can operate under an existing notice, it will require an access permit to operate on roads. State and territory road managers may impose restrictions on the vehicle by way of limiting axle group mass, the total combination mass, the roads on which these vehicles can operate and/or stipulate additional operating conditions to protect the infrastructure such as roads and bridges.

Australian Design Rules

In Australia, the current approval process for new and imported vehicles, including the auditing of production and testing processes, is also an example of pre-market approval. The key difference between the current process and our regulatory option of government approval is that the Commonwealth process for new and imported vehicles does not have regard for ongoing technical integrity or reporting of safety-critical data. This is a matter for states and territories and is regulated through registration and roadworthiness schemes, which are not an example of a government approval process.

US Federal Automated Vehicle Policy

In the US, the NHTSA has identified pre-market approval as a potential new regulatory tool that might help to facilitate the safe deployment of automated vehicles. An overview of the *Federal Automated Vehicle Policy* is provided at section 1.6.

PEGASUS project

Also discussed in section 1.6 are German efforts to develop testing procedures for automated vehicles, known as PEGASUS. The PEGASUS project closely aligns with our regulatory option of pre-market approval.

Figure 8 replicates a PEGASUS concept map. It illustrates the complexity of a pre-market approval process that necessitates the development of technical standards and testing procedures for specific technology and automated driving functions. The process includes developing criteria and test procedures for specific scenarios through to operation on public roads.

Development & Evaluation of Automated Driving

PEGASUS project addresses methodology for AD on Motorways

8.2 Regulatory options to support pre-market approval

We also welcome feedback on alternative mechanisms, or an approach that incorporates elements of the mechanisms discussed here.

States and territories have the power to register vehicles with or without conditions. An automated vehicle could be registered in a state or territory on the condition it had pre-market approval – that is, its type had been successfully assessed against the automated vehicle technical standards and testing procedure. The standards and test procedures might be developed by a national (state, territory, Commonwealth and industry) technical advisory committee and approved by the transport ministerial council. Assessment of vehicle types against the standards might be undertaken by an independent assessor agreed by governments. New conditions could be put on registration, such as the sharing of safety-critical information with road agencies.

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In the absence of a legislated requirement for an automated vehicle to have a pre-market approval before it can be supplied to the market, registration authorities may not know a particular vehicle is an automated vehicle and that it should have pre-market approval, and fail to impose the relevant conditions.

The Austroads project to align registration and licensing operations with the proposed safety assurance system for automated vehicles provides an opportunity to further examine how registration powers could support a pre-market approval process.

Amend the Motor Vehicle Standards Act

The scope of the MVSA could be extended to require pre-market approval for automated vehicles and to provide a power to set automated vehicle technical standards and testing procedures (in addition to the ADR standard-setting power).

It is possible the MVSA would not need amendment if the automated vehicle technical standards and testing procedures could be made as national standards relating solely to automated vehicles. These standards could be replaced by internationally agreed automated vehicle standards as they are developed.

The role of physically assessing automated vehicles against these technical standards and testing procedures could be undertaken by the Vehicle Safety Standards Branch within the Department of Infrastructure and Regional Development, by contracted third parties, or by independent accredited assessors.

The disadvantage of this approach is that there may be constitutional impediments to requiring reporting of in-service safety-critical event data from automated vehicles once they are being used on roads and where they are not owned by a corporation.

Introduce new legislation

New legislation to establish a pre-market approval scheme could be either model law or applied law. It may need to be enacted by the Commonwealth and all states and territories to give full effect to the scheme.

The Australian Road Rules are an example of model law, whereby the NTC works with stakeholders to agree the road rules. The model rules themselves have no legal effect but are incorporated into state and territory road traffic laws through legislative processes.

The HVNL is an example of applied law, whereby the law is passed by the Queensland Parliament (the host jurisdiction) and all other participating HVNL jurisdictions (except South Australia, which replicated the HVNL as a South Australian law) reference the Queensland legislation as the law in their jurisdiction. Applied law provides greater certainty that the legislation is consistent across states and territories and ensures that amendments to the host legislation flow through to the other states and territories.

The Marine Safety (Commercial Domestic Vessels) National Law is an example of applied law where the Commonwealth is the host jurisdiction.

The disadvantage of this approach is that every jurisdiction would need to enact legislation for either mechanism to work effectively.

8.3 Benefits and disadvantages of pre-market approval

The NTC has identified benefits and disadvantages of pre-market approval. We are seeking your feedback on whether there are additional benefits or disadvantages, and whether our assessment requires further analysis.

Benefits of pre-market approval

- There would be a high level of certainty that automated vehicles are safe.









- Automated driving system entity costs would be limited to a pre-market assessment by government or a third party and ongoing reporting of safety-critical events.
- There would be consumer confidence from government approval/oversight of the initial design and modifications/upgrades.
- Technical standards and test procedures would be known by all those involved in the industry.

Disadvantages of pre-market approval

- It would only support known technologies (for which design standards and test procedures have been developed).
- There would most likely be delays while technical standards and test procedures are developed.
- Technical standards and test procedures may advantage certain automated driving system entities applications or functions.
- There could be delays in assessing new models of automated vehicles because of the diversity of automated driving systems, entities and functions.
- It could expose road users to risk from technologies that are in vehicles but are not covered in the automated vehicle design standards and, hence, are not ever reviewed by regulators.
- Having granted approval, government could potentially be held liable for safety faults.

Table 10 provides our evaluation of how pre-market approval meets the proposed assessment criteria for a safety assurance system.

Table 10: Evaluation of option 3 against the proposed assessment criteria

Pre-market approval	Are safety risks managed?	Is the model flexible and does it support innovation?	Does it support legal accountability and probity?	Is the regulatory approach efficient?
				
	Does it support consistency?	Can it evaluate a safe operational design domain?	Can the model support other policy objectives?	Can it be implemented within two years?
				

Pre-market approval **fully meets** five criteria. Pre-market approval would:

- provide governments with a high level of certainty that the safety risks are being managed
- ensure there is always a legal entity responsible for the automated driving system

- ensure consistent outcomes with states and territories, and would be consistent with approaches being considered in Europe and in parts of Asia
- provide a mechanism to evaluate the vehicle's operational design domain
- provide a mechanism to support other policy objectives such as cybersecurity, optimum traffic management and environmental outcomes.

Pre-market approval **does not meet** three criteria. Pre-market approval:

- is not flexible and would require governments to have existing knowledge about emerging automated vehicle technologies
- would most likely require regulatory change, which would be costly for government and industry
- could probably not be implemented within two years.

None of the criteria are partially met.

8.4 Conclusions

Pre-market approval is arguably the regulatory model that provides the highest certainty for government and consumers.

The extent to which vehicle types would have to be tested in Australia would depend on whether other countries such as Germany developed similar testing procedures. If they do, a pre-market approval approach could recognise these processes, and the safety assurance system in Australia could be relatively light-touch.

However, a pre-market approval approach could limit or obstruct safety-related innovations unknown today if testing procedures and standards only relate to technologies and functions we are familiar with.

Setting standards and developing testing procedures is resource-intensive and time-consuming because it involves testing vehicle types on an application-by-application basis. This is likely to cause approval delays while standards and test procedures are developed for new technologies or applications. It also involves oversight of in-service changes to functionality and safety-critical risks. However, other matters such as vehicle repair could remain the responsibility of the vehicle operator or owner.

Given the significant regulatory and resource implications of adopting pre-market approval, and the high risk that other countries will take a different approach, this option may be better suited to a long-term state when there is greater certainty related to technology, functions, standards and overseas processes and practices.

Consultation questions

Question 8: Is pre-market approval the best approach to regulating automated vehicle safety? If so, what regulatory option would be the most effective to support pre-market approval?

9 Option 4: Accreditation

Key points

- Accreditation provides a comprehensive, risk-based and proven framework within which safety can be regulated. It focuses on outcomes, risk management and continuing improvements to safety. The accreditation model has demonstrated safety benefits in other high-risk industries such as mining, rail and aviation.
- Accreditation would involve a major reform of road safety and is not an approach that other countries are known to be exploring at this time. It may be better suited in the longer term when there is greater certainty related to technology, functions, standards and overseas processes and practices.

The purpose of this chapter is to examine how an accreditation-based safety assurance system could support the safe introduction of automated vehicles into Australia. We are seeking feedback on whether this approach is a viable option for regulating automated vehicles.

9.1 Core attributes of accreditation

Adopting option 4, automated driving system entities would be accredited by an accreditation agency to operate an automated driving system on a case-by-case basis. The role of the accreditation agency would be to satisfy itself that the party seeking accreditation has an established process to identify and manage safety risks to an agreed standard. In rail and WHS in Australia, the legal standard of care is 'so far as is reasonably practicable'. In other parts of the world that have adopted accreditation, the standard is 'as low as reasonably practicable'.¹⁵

Table 11 details the core attributes of an accreditation approach.

Table 11: Core attributes of accreditation

Core attributes	Description
Role of government	Accreditation by a government agency, with oversight of safety-critical risks.
Reporting to government	There is an ongoing relationship between the accreditation agency and the automated driving system. Safety-critical changes to the operational design domain or technical functionality are reported to, and assessed by, the accreditation agency.
Use of standards	The focus of the accreditation agency is to assure the accredited party has a process in place to identify and manage risks. No prescribed standards, but standards adopted by the accredited party are agreed by the accreditation agency.
Use of high-level safety principles	High-level safety principles and criteria are used to underpin safety assessments. The automated driving system entity can choose not to apply any principle or criterion if justified to the accreditation agency.
Coverage	Initial and ongoing vehicle integrity, environment and human performance.
Operational design	The safe operational design domain of the vehicle is agreed between the

¹⁵ For a safety risk to be 'as low as reasonably practicable' it shall be possible to demonstrate that the cost involved in reducing the risk further would be grossly disproportionate to the benefit gained. For a risk to be accepted it shall be demonstrated to have been reduced to a level 'as low as reasonably practicable' and shall be tolerable.

domain	accreditation agency and the accredited party.
Access to data	The accreditation agency has access to safety-critical data. The scope, nature and rules of access are negotiated between the parties.
Legal responsibility for safety assurance	The accredited party.
Regulation of in-service safety	Yes. The accredited party must manage risks to safety of in-service vehicles.
Legislative change required	Yes.

The accreditation model is broadly aligned to the approach developed in the Nova Systems report (Attachment A), which is based on the role of the Civil Aviation Safety Authority and the regulation of aviation. The approach has a focus on the ongoing relationship between the accredited party and the accreditation agency to manage safety risks, rather than the approval of a specific technology or system, or a focus on prescriptive rules or standards.

Aviation, marine and rail are examples of transport services that are already regulated through accreditation. The regulation of road vehicles is one of the few transport services remaining in Australia that does not have a broad-based form of accreditation. The box on page 74 summarises how accreditation works in the rail industry. Many other high-risk sectors in Australia, including mining and pharmaceuticals, also regulate the management of risks in a process similar to accreditation and aim for continual safety improvement.

There are important reasons why general road transport continues to be regulated with a high level of prescription, including prescribed vehicle standards, road traffic laws and enforcement. For example:

- The road network is primarily open access.
- There are several million road vehicle operators compared with a handful of rail operators.
- The prescriptive road rules approach has a comprehensive historical foundation in the development of international road traffic conventions.
- No other country or region in the world has adopted an accreditation model to regulate vehicle standards or the driving of road vehicles (although the EU regulates heavy vehicle operators through operator licensing).

On the other hand, discrete sub-sectors of road transport *are* regulated through a form of accreditation. For example, under the HVNL, heavy vehicle operators can opt into Advanced Fatigue Management (AFM). Rather than setting maximum work and minimum rest hours, AFM offers the flexibility for operators to propose their own hours as long as the fatigue risks of those hours are offset by sleep, rest and other management practices in a compliant fatigue management system (NHVR, 2017).¹⁶

Therefore, the proposed option does not extend accreditation to the whole vehicle, or to the operation or driving of vehicles generally. We would expect to see the current level of regulation, including ADRs, road traffic laws, penalties and enforcement, applied to automated (where relevant) and non-automated vehicles for the foreseeable future.

This approach could be summarised in the following way:

- Current laws, regulations and processes continue to apply to the **automated vehicle**, but
- the operator responsible for the **automated driving system** would be accredited for the operation of specified automated driving systems or automated vehicles.

¹⁶ See <https://www.nhvr.gov.au/safety-accreditation-compliance/fatigue-management/work-and-rest-requirements/advanced-fatigue>

How accreditation would work

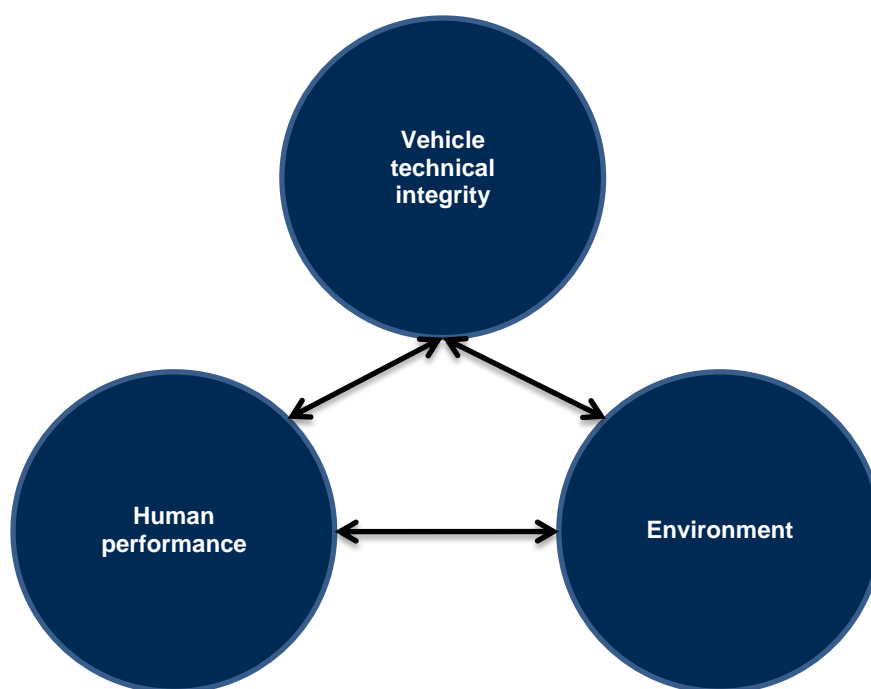
The applicant could be a vehicle manufacturer, technology provider or any other party seeking to operate an automated driving system. The threshold for requiring accreditation would be that an automated driving system entity takes responsibility for the safe operation of the vehicle and for the actions of the vehicle while the automated driving system is engaged.

Accreditation would apply to operators of highly and fully automated driving functions. Whether or not the operator of an automated driving system with conditional automation would require accreditation will depend on whether the automated driving system entity is capable of being in control and responsible for the vehicle while the automated function is engaged. To date, there has not been international consensus on whether this is the case¹⁷ and, as discussed in chapter 1, the NTC is undertaking a separate project to consider this issue.

There would be three elements of accreditation (illustrated in Figure 9):¹⁸

- vehicle technical integrity, including initial and ongoing integrity
- environment
- human performance.

Figure 9: The three core elements of accreditation



Vehicle technical integrity means the ‘through-life’ technical safety of the built thing. It includes the design and build by suitably qualified people using agreed standards and processes and monitoring for ongoing serviceability, such as critical deviations from the approved configuration.

Environment means any factor in the operating environment that relates to the safety of the vehicle or function but is outside the control of the accredited party. This includes road and digital infrastructure, road traffic laws, weather conditions and local fauna. The operational design domain links vehicle technical integrity and functionality to safe operating environments.

¹⁷ International literature indicates that the EU is potentially maintaining that the human driver remains in control, given recent amendments to the Vienna Convention. The NHTSA in the US considers that, at conditional automation, the automated driving system entity is in control while engaged.

¹⁸ Chapter 4 of the Nova Systems report (Attachment A) provides more information about vehicle technical integrity, environment and human performance.

Human performance means any human–machine interfaces that could affect the safe performance of the automated vehicle or function. It includes assessment of driver-operator competency requirements and any training, dashboard messages, vigilance controls or other interventions required to ensure the human operator or driver interacts safely with the automated vehicle.

Given that the assurance of ongoing technical integrity is a key component of the model, accreditation would require the accredited party to monitor system performance and report all safety-critical events (such as technical malfunctions) and changes to the automated functionality (including changes by software-updates) to an accreditation agency. These changes would have to be assessed and approved by an accreditation agency before they could be implemented.

Accreditation supports recognition of equivalent processes in a manufacturer's country of origin.

An example of how accreditation could work is outlined below. Unless the automated driving system is an after-market fitment to an existing vehicle, this process would run in parallel to the Commonwealth's ADR approval process for new or imported vehicles (which currently do not have regard to automated functions).

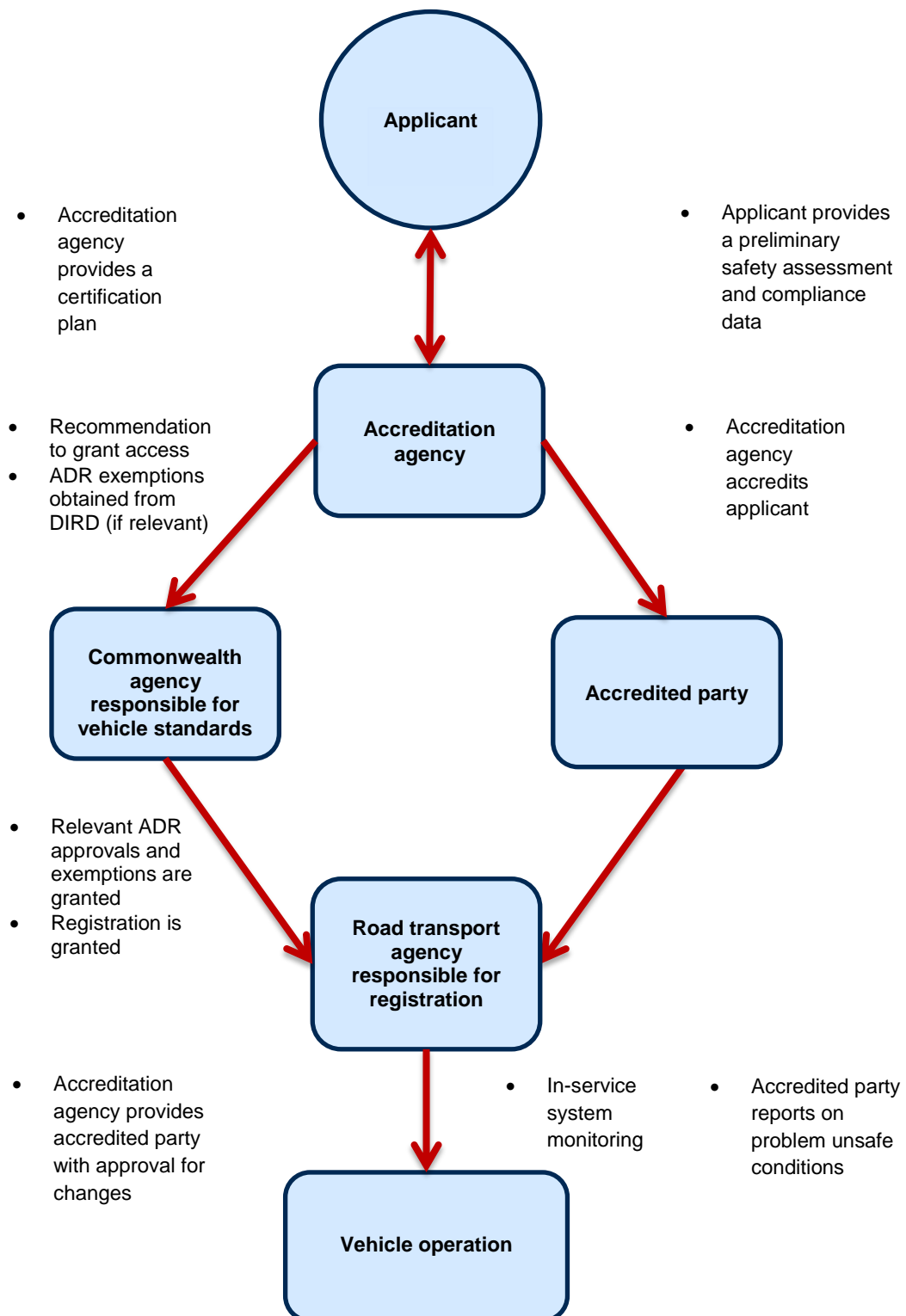
Steps involved in the initial accreditation of the automated driving system entity include:

- **Step 1:** The applicant makes an initial request for approval of a vehicle and provides the accreditation agency with a safety analysis of the vehicle or automated driving function and a certification report from the country of origin (if relevant).
- **Step 2:** The accreditation agency assesses the safety analysis and certification report and identifies if they contain any assumptions that would be invalid in Australian conditions (including ability to comply with local road rules).
- **Step 3:** The applicant undertakes additional tests or assessments required by the accreditation agency to assure safe operation in Australian conditions. The applicant demonstrates that it is ensuring the safety of its automated vehicle or function 'so far as is reasonably practicable' (or to another agreed standard of care).
- **Step 4:** The applicant provides the accreditation agency with:
 - relevant ADR compliance test results
 - artefacts from the software design assurance process
 - environmental and human engineering test reports
 - risk identification and steps taken to manage risks.
- **Step 5:** Based on the operational design domain, the applicant submits to the accreditation agency the road types and conditions under which the vehicle or function can operate safely.
- **Step 6:** The accreditation agency facilitates ADR approval and any relevant ADR exemptions.
- **Step 7:** Based on its compliance findings, the accreditation agency accredits the applicant to operate the automated vehicle or function. The accreditation agency provides the accredited party with the following outputs:
 - a statement of system integrity – recognition of assurance that the vehicle or function will operate safely
 - a statement of operational environment – including the conditions of the operational design domain
 - a human performance statement – what training must be provided to the user
 - an operational rules statement – how local rules are incorporated into the automated functionality.
- **Step 8:** The accreditation agency reports accreditation to the Commonwealth Department of Infrastructure and Regional Development and the department issues compliance plates.

- **Step 9:** The accreditation agency reports accreditation to a state or territory road transport agency for the vehicle to be registered and granted roadworthiness certificates, and confirms access to the road network (or approval).

The accreditation process is illustrated in Figure 10. It captures both initial and ongoing technical integrity.

Figure 10: How the accreditation process could work



DIRD = Department of Infrastructure and Regional Development

The accreditation agency could undertake assessments directly or commission a third party to undertake assessments on its behalf. Importantly, there are no prescribed standards. As part of its submission to be accredited, the applicant would identify relevant standards, whether they be industry- or government-approved in other countries, and justify why those standards are relevant and should be used.

The accreditation agency assures itself that the applicant or accredited party has identified and managed risks to a legal standard of care but does not approve the vehicle or take legal responsibility for its safe operation. The accredited party takes direct legal responsibility for the ongoing technical integrity of the automated vehicle, including its operation and any subsequent modifications. After an applicant is accredited, states and territories register the automated vehicle and allow road network access.¹⁹

Should the accreditation model be closely aligned to rail regulation, safety duties for all key parties could be introduced. For example, the designer and manufacturer of the automated driving system could have a legislated duty to ensure safety so far as is reasonably practicable.

To provide further insight into how accreditation could work in relation to automated driving systems, the box below summarises the current process of rail accreditation in Australia.

Rail accreditation in Australia

The Office of the National Rail Safety Regulator (ONRSR) accredits operators for certain operations, not the product or system. A requirement of accreditation is for the applicant to demonstrate to the ONRSR that it has:

- the competence and capacity to manage risks to safety associated with the railway operations for which accreditation is sought
- the competence and capacity to implement its safety management system
- undertaken consultation in relation to its safety management system
- the financial capacity or public risk insurance arrangements to meet reasonable potential accident liabilities
- complied or can comply with any other legislative requirements.

A variation of accreditation is required when an accredited operator seeks to undertake operations that are outside the scope and nature of their permitted railway operations, and must be approved before the rail transport operator can implement the proposed change.

Not all changes in operations require a variation of accreditation; however, as a condition of accreditation, they may need to be notified to the ONRSR. There are three categories of changes:

- minor change – the operator does not need to report
- medium change – the operator must report
- major change – the operator must report and seek to apply for a variation to the accreditation.

A variation to the accreditation requires a safety case and ONRSR approval.

Unlike ADRs and in-service vehicle standards for road vehicles, there are no mandatory technical standards that must be met. However, the ONRSR supports accredited parties with guidelines about how identified safety risks can be managed.

¹⁹ Whether the registration authority approves road network access or accepts the decision of the government agency responsible for accreditation is discussed in further detail in chapter 11.

Accreditation of road managers

The rail model is illustrative of an approach where accreditation extends not just to the operator of a vehicle or service. Network providers (sometimes known as 'below-rail' providers), rail designers, manufacturers, suppliers and installers must also ensure their products or services are safe so far as is reasonably practicable.

By extension, it is feasible that if an accreditation model was implemented for automated road vehicles, a future state is possible where an agency accredits the road manager or infrastructure provider responsible for the safety of the road network that automated vehicles are operating on.

The advantage of accrediting road managers and infrastructure providers is that it establishes a process to ensure infrastructure-related automated vehicle safety risks are managed to an agreed standard of care. However, such an approach would be a fundamental change to how road managers currently meet community expectations. It also remains to be seen the extent to which automated vehicles will rely on physical or digital infrastructure to operate safely.

Infrastructure providers could potentially include a range of operations, including port operators and public car parks. Furthermore, each state and territory has road corporations that are responsible for the principal road network, but the majority of roads in Australia are owned and operated by 537 different local government authorities. There are also privately operated roads, such as toll roads, that are accessible by the public.

Automated vehicles could potentially operate on any of these roads or infrastructure, and this suggests that the task of accrediting road managers or infrastructure providers for automated vehicle operations would be more complex, expensive and time consuming than accrediting rail network operators, of which there are some 27 in Australia.

For these reasons, we raise the potential for accredited road managers and infrastructure providers for discussion purposes but suggest that further maturity of automated vehicle technologies and applications will be required before it is clear whether the role of road managers should change.

Potential impact on crash investigations

As discussed above, accreditation is underpinned by an ongoing relationship between the accredited party and a accreditation agency. To encourage continuing safety improvements, accreditation can be supported by no-blame investigations aimed at identifying and reporting on safety-critical issues. In other transport modes that have adopted accreditation, these principles are mirrored in how crash investigations are undertaken.

The Australian Transport Safety Bureau (ATSB) has responsibilities for investigating rail, aviation and marine accidents. The ATSB operates independently of transport regulators, policymakers and service providers. Importantly, the ATSB undertakes no-blame investigations. Reports often contain safety action and recommendations for authorities and other parties to address in the interests of safety improvements.²⁰

The principle underpinning this approach is that parties involved in a crash or incident will be forthcoming and transparent about what occurred if the consequences are not prosecution or punishment. This helps ensure that lessons learnt from the crash investigation can be shared with accredited parties and other bodies, thereby refining and improving safety performance.

9.2 Regulatory options to support accreditation

While existing state and territory registration and roadworthiness schemes could give effect to accreditation outcomes, it is highly likely that the accreditation model would require legislative change. This includes:

- establishing primary duties for accredited and non-accredited parties (such as designers and manufacturers of automated driving systems) to ensure safety to an agreed standard of care

²⁰ For more information about the ATSB, access: www.atsb.gov.au/about_atSB/overview/

- establishing a requirement for an automated driving system entity to be accredited, with breaches to this accreditation leading to variation of their accreditation, suspension or cancellation or the requirement to develop safety management plans or other reporting
- recognition in the Australian Road Rules and road traffic laws that an automated driving system entity is the entity accredited by the relevant agency.

The MVSA may also require amendments to recognise that an identification plate will not be issued to a vehicle with an automated driving system unless the automated driving system entity has been accredited. However, this may be achieved through administrative processes.

In a similar way to pre-market approval, an accreditation scheme could be established nationally through model law or applied law. While the model WHS Act was designed to be adopted by each state and territory, it does not establish a national regulator as the national rail safety, heavy vehicle and marine safety schemes do, and each state and territory remains responsible for regulating and enforcing WHS within its jurisdiction. For accreditation of an entity to have effect in all states and territories and the accreditation body to make decisions that apply in all states and territories, a national regulator established under applied law is likely to be the most effective and efficient model.

9.3 Benefits and disadvantages of accreditation

The NTC has identified benefits and disadvantages of accreditation. We are seeking your feedback on whether there are additional benefits or disadvantages, and whether our assessment requires further analysis.

Benefits of accreditation

- It would be technology- and application-neutral – it would not require government agencies to develop technical standards or to test technologies on a case-by-case basis.
- It would support innovation by not requiring an agency to develop standards for technologies in advance of those technologies being offered to the market and would allow technologies never considered before to be assessed on merit.
- Safety would be assured throughout the life cycle of the automated driving system, not just at market entry.
- There would be comprehensive coverage of key safety risks.
- Government would not approve or take on legal responsibility for the safety of the vehicle.
- It would provide a mechanism to support broader safety requirements including cybersecurity and the provision of data.
- It would provide a mechanism to ensure there is always a legal entity responsible for the automated driving system.
- It would support recognition of approval processes in other countries.
- It could re-use many existing processes and lessons from rail, aviation and other industries.









Disadvantages of accreditation

- It would be more complex and expensive for industry to comply with compared with the continue current approach option or self-certification.
- It would be difficult to administer if there were many automated driving system entities – this would depend on the business models adopted and the extent to which automated vehicles are privately owned and operated.

- The agency responsible for accreditation would have an ongoing role, and this would most likely have higher cost implications for government (unless it is fully funded through application fees, in which case it would increase the costs for industry).
- Ongoing reporting could generate significant volumes of data for an accreditation agency to review, process and store.
- Government capability and expertise in accreditation and safety management systems would be critical.
- There would be competition implications in terms of impacts on vehicle ownership and the role of independent repairers.

Table 12 provides our evaluation of how accreditation meets the proposed assessment criteria.

Table 12: Evaluation of option 4 against the proposed assessment criteria

Accreditation	Are safety risks managed?	Is the model flexible and does it support innovation?	Does it support legal accountability and probity?	Is the regulatory approach efficient?
				
	Does it support consistency?	Can it evaluate a safe operational design domain?	Can the model support other policy objectives?	Can it be implemented within two years?
				

Accreditation **fully meets** four criteria. Accreditation would:

- provide governments with certainty that the safety risks are being managed
- support evolving technology and a changing market
- ensure there is always a legal entity responsible for the automated driving system
- provide a mechanism to evaluate the vehicle's operational design domain.

Accreditation **partially meets** four criteria. Accreditation:

- would require an ongoing relationship between an accreditation agency and the accredited party – this would have some resource and cost implications for industry and government
- would be able to support a single national approach, although no other country is known to be considering accreditation for automated vehicles, and this could challenge alignment with international practices
- could support other policy objectives, but the management of safety risks would be the primary focus of an accreditation approach
- would require new institutional arrangements and a new approach to regulating aspects of road vehicles – this would make it difficult to fully implement within two years.

There were no criteria that were entirely unmet through accreditation.

9.4 Conclusions

An accreditation approach to automated vehicles provides a comprehensive, risk-based and proven framework within which safety could be regulated. It focuses on outcomes, risk management and continuing improvements to safety. The accreditation model has demonstrated safety benefits in other high-risk industries including mining, rail and aviation. Accreditation works most effectively when there are a small number of accredited parties.

There are two key challenges associated with accreditation. First, accreditation introduces a safety management system approach to a component of road transport (the automated driving system), but it would sit within existing prescriptive rules and regulations including vehicle standards, driver licensing, road traffic laws and penalties. In practice, there could be policy or operational challenges where these two approaches join up or interact. The scale of this challenge will significantly depend on the business models adopted by industry and the extent to which automated vehicles are privately owned and operated.

Second, we don't know of any other country or region considering an accreditation approach to automated vehicle safety. Australia could be a leader in safety management systems, and it is recognised that there has been no singular approach to automated vehicle safety adopted globally. But the approaches currently being taken elsewhere in the world are clearly more aligned to self-certification and pre-market approval models and not accreditation.

Given these challenges, and the major reform undertaking an accreditation model would involve, this option may be better suited to a long-term state when there is greater certainty related to technology, functions, standards, business models and overseas processes and practices.

Consultation question

Question 9: Is accreditation the best approach to regulating automated vehicle safety? If so, why?

10 Implementation – institutional arrangements

Key points

- The NTC is seeking feedback on institutional arrangements, including the types of government entities that could support a safety assurance system.
- We suggest that institutional models are further developed after a regulatory option has been agreed.

The purpose of this chapter is to examine if there is a role for government in assessing the safety of automated vehicles. We are also seeking feedback on the five options proposed in this chapter on what form institutional arrangements could take.

If there is a role for governments in assessing the safety of automated vehicles, which government body should be responsible? As we have noted earlier, responsibility for motor vehicle safety regulation is shared between the Commonwealth and the states and territories. The current mix of regulatory responsibilities adds complexity to the development of a safety assurance system and the possible institutional arrangements to oversee the safety assurance system.

A safety assurance system might encompass initial and ongoing safety assurance, but the types of activities and the capabilities and resources required to carry them out will depend upon the regulatory option agreed by transport ministers.

The government role could be performed by a statutory authority. Examples of statutory authorities in the transport sector are the ATSB and the Civil Aviation Safety Authority. If commercial activities are proposed, a statutory corporation or government-owned company established under the *Corporations Act 2001* may be more suitable. Examples of statutory corporations in the transport sector are Airservices Australia and the Australian Rail Track Corporation. Examples of companies established under the Corporations Act are Austroads and Transport Certification Australia.

These examples are intended to illustrate the different types of institution that are possible. They are not intended to suggest a particular institution should undertake a role in the safety assurance system.

Non-government entities could include quasi-governmental organisations and Corporations Act companies. Where specialist technical assessments are needed, they could be done via subcontracting or by accrediting particular providers to certify compliance against performance criteria.

Whatever entity is chosen for a particular role, it would need to be subject to appropriate governance arrangements, in terms of oversight, accountability, probity and review of decision making.

10.1 Institutional options

Five institutional options are outlined below, together with an assessment of each option's suitability for the regulatory options for a safety assurance system discussed in this paper:

- **Option 1:** The Commonwealth manages automated vehicle safety assurance.
- **Option 2:** A national entity manages automated vehicle safety assurance.
- **Option 3:** One state or territory manages the safety assurance system for all states and territories.
- **Option 4:** States and territories manage automated vehicle safety assurance individually.

- **Option 5:** A fully commercial, quasi-governmental entity manages automated vehicle safety assurance.

Our analysis indicates that all these options are feasible for any of the regulatory options discussed in this paper.

Option 1: The Commonwealth manages automated vehicle safety assurance

Under this option, a new or existing Commonwealth agency would be responsible for the safety assurance system. States and territories would delegate powers to the Commonwealth agency in relation to in-service matters for automated vehicles only.

The Commonwealth Department of Infrastructure and Regional Development's management of new and imported vehicle standards is an example of a Commonwealth agency undertaking safety regulation on behalf of the states and territories. Another example is the Australian Maritime Safety Authority managing marine safety for domestic commercial vessels nationally.

Benefits of a Commonwealth approach

- One agency would be responsible for the safety assurance system, facilitating regulatory efficiencies and making it easier for overseas companies to do business in Australia.
- Regulatory efficiencies would be gained from one agency managing automated vehicle safety.
- It would support Australia as a single market for automated vehicles.

Disadvantages of a Commonwealth approach

- It would most likely require additional Commonwealth resources to manage new areas of expertise, although the work could be contracted out or undertaken by accredited certifiers.
- It may require amendments to the MVSA to broaden its application to in-service matters and assessing safety where there are no ADRs.
- It would duplicate some state and territory functions for non-automated vehicles.
- It could unnecessarily create overlap between Commonwealth agencies if the agency responsible for the safety assurance system was different from the Vehicle Standards Branch responsible for ADRs.
- States and territories would have to explicitly share transport-related powers with the Commonwealth.
- It may take time to establish processes and ensure technical expertise is available.

Option 2: A national entity manages automated vehicle safety assurance

Under this option, a national agency would be established under state and territory laws to be responsible for managing the safety assurance system. Automated driving system entities would still need to gain ADR approvals or exemptions from the Commonwealth, but the national agency could manage the process on their behalf in order to provide a single point of contact in Australia. This model is particularly suited to pre-market approval and accreditation.

An example of such a national entity is the ONRSR.

It may be possible to use an existing government agency (such as an incorporated entity like Austroads) without any changes to that entity's constitution or establishing legislation.

Benefits of a national entity

- One agency is responsible for the safety assurance system, facilitating regulatory efficiencies and making it easier for overseas companies to do business in Australia.
- It would be independent from governments.
- Costs could be fully recovered through fees.
- It would support Australia as a single market for automated vehicles.

Disadvantages of a national entity

- It would require staff to administer (although technical functions could be outsourced).
- It would duplicate state and territory functions for non-automated vehicles.
- If a national statutory authority was established, it would require legislation, most likely in all states and territories, and could take several years to implement.

Option 3: One state or territory manages the safety assurance system for all states and territories

Under this option, an existing or new agency of a designated state or territory would be responsible for managing a safety assurance system on behalf of the other states and territories. The other states and territories would recognise the decision of this agency under their own laws. Automated driving system entities would still need to gain ADRs approvals or exemptions from the Commonwealth, but the designated state or territory could manage the process on their behalf in order to provide a single point of contact in Australia.

Benefits of one state or territory

- One agency would be responsible for the safety assurance system, facilitating regulatory efficiencies and making it easier for overseas companies to do business in Australia.
- It would leverage existing institutions.
- It would recognise that the majority of safety regulation in Australia is a state and territory responsibility.
- It would be relatively timely to establish (unless legislation is required by other states and territories to recognise decisions).
- It would support Australia as a single market for automated vehicles.
- It would provide economic opportunities for the designated state or territory.

Disadvantages of one state or territory

- There would be resourcing and capability costs for the designated state or territory (although additional costs could be shared with the other states and territories).
- The decision of the designated state or territory would need to be given legal force in the other jurisdictions.
- The differences in legislation between the states and territories may reduce the effectiveness of the designated state or territory's decisions.

Option 4: States and territories manage automated vehicle safety assurance themselves

Under this option, state and territory agencies would be responsible for managing their own safety assurance systems. Automated driving system entities would still need to gain ADR approvals or exemptions from the Commonwealth, and there would be no single point of contact in Australia or centralised process for overseas entities. However, option 4 could be supported by mutual recognition arrangements so that an automated vehicle approved in one jurisdiction is able to operate in all other states and territories.

State and territory driver licensing schemes are an example of this option where there is mutual recognition across jurisdictions. Taxi and ridesharing regulations are examples of this option operating without mutual recognition across jurisdictions.

Benefits of all states and territories

- Existing state and territory systems could be adapted to deal with automated vehicle specific matters, possibly at a relatively low cost.
- States and territories would have control and oversight of automated vehicles operating in their own jurisdictions.
- It would recognise that the majority of safety regulation in Australia is a state and territory responsibility.

Disadvantages of all states and territories

- The work of each state and territory would be duplicated.
- There would be duplication of work by and costs for automated driving system entities (if there is no mutual recognition).
- Legislation would most likely be needed to restrict the registration and use of automated vehicles not approved under the state or territory's safety assurance system.
- There would be a significant risk of inconsistent state and territory processes and decisions.
- It could impede the flow of information about modifications and safety-critical changes or faults.
- It could discourage manufacturers from introducing automated vehicles in Australia.

Option 5: A fully commercial, quasi-governmental entity manages automated vehicle safety assurance

Under this option, a fully commercial entity would be responsible for managing the safety assurance system, including making recommendations to the Commonwealth and states and territories about ADR compliance and suitability for registration and road access.

ANCAP is an example of an independent, non-government-owned entity undertaking a quasi-regulatory role in motor vehicle safety. Transport Certification Australia is an example of a partly commercial governmental entity undertaking a quasi-regulatory role in motor vehicle safety.

Benefits of a commercial entity

- One national entity would be responsible for managing the safety assurance system.
- As a commercial entity, costs would be recovered through fees.
- It could be relatively timely to establish.
- It could combine regulatory roles with applied testing or technical functions (particularly if pre-market approval or accreditation were the preferred regulatory options).
- It would support Australia as a single market for automated vehicles.

Disadvantages of a commercial entity

- It would require government involvement (for example, to establish automated vehicle safety and performance criteria and for oversight of the entity).
- It would create an additional administrative step between the ADR approval and the road transport agencies responsible for safety regulation.
- The Commonwealth, states and territories may not accept the entity's recommendations or may feel obliged to do additional work to check them before issuing approvals.

10.2 Conclusions

The management of automated vehicles in Australia is complicated by the division of responsibilities for design of vehicles and their in-service operation between the Commonwealth and the states and territories, and the regulation of in-service operations by eight different states and territories, each with local variations in requirements.

A safety assurance system for automated vehicles involves different tasks, which would vary according to which of the four regulatory options is chosen. Most of these tasks could be undertaken by government or non-government agencies.

The NTC notes that all the institutional models we have canvassed could be applied to the regulatory options explored in this paper. No institutional arrangement is ruled out by a specific regulatory option being adopted. However, the weight given to each institutional model's advantages and disadvantages may vary depending on the regulatory option adopted. We therefore suggest that institutional models should be further explored and developed after a regulatory option has been agreed.

Consultation question

Question 10: Based on the option for safety assurance of automated vehicle functions, what institutional arrangements should support this option? Why?

11 Implementation – access to the road network

Key points

- The NTC is seeking feedback on the role of road managers, and whether registration authorities and road managers should authorise automated vehicle access to their road network in addition to safety assurance processes.
- The NTC suggests that a national approach should be adopted that incorporates automated vehicle registration and road network access into the safety assurance process. However, access issues should be further explored once a regulatory model has been agreed.

The purpose of this chapter is to examine how, if at all, automated vehicles' access to the road network should be managed. We are seeking feedback on the suggested forms this could take and specifically the three options proposed for institutional arrangements.

For the foreseeable future, automated vehicle functionality will be limited to parts of the road network (for example, only sealed roads). This raises the question of the role of registration authorities and road managers (including local governments) in managing access to the road as part of the safety assurance system.

For discussion is whether registration authorities and road managers could or should assess and determine automated vehicle access to their roads, or whether it is appropriate and safe for access to be managed entirely through the national safety assurance process.

11.1 Current regulatory approach to road network access

Access to the road network is currently managed through two processes:

- vehicle registration – undertaken by a state or territory registration authority
- access approval – undertaken by a state or territory road manager or local government.

Often the state or territory agencies are parts of the same government department, but they exercise different powers, possibly under different Acts.

Vehicle registration

Registration processes are similar across Australia as vehicle registration has been the subject of intergovernmental agreements for national consistency. Generally, registration must be granted if an applicant satisfies certain requirements, including that the vehicle complies with the ADRs.²¹

Registration could be the final stage of a safety assurance system. It could signify that the vehicle satisfies the required automated vehicle standards, can operate within the local road traffic laws and can be used on roads in a particular state or territory in accordance with the vehicle's operational design domain (which might specify a network of roads or roads of a certain type and in certain conditions). In-service automated vehicle requirements could be imposed by way of conditions on registration. This model would suit the pre-marketing and accreditation regulatory options.

Alternatively, under a more light-touch approach to a safety assurance system (the continue current approach and self-certification options), registration powers may be used separately from any safety assurance system as a safeguard to prevent automated vehicles from being registered if

²¹ Under section 14 of the MVSA, a vehicle must not be supplied to market if it is non-standard or if it does not have an identification plate indicating it meets the ADRs.

states and territories still have doubts about their safe operation and do not consider them suitable for registration – at all or without conditions.²² However, there is no certainty in these models that registration authorities will have sufficient information to know that a vehicle seeking registration is an automated vehicle, and to be able to assess whether it is safe.

Access approval

States and territories have powers to make regulations regarding road access by vehicles or types of vehicles. Local governments also have powers about access to local roads. Most light vehicles have general access to the roads, but these powers could be used to limit access by registered automated vehicles to certain routes in certain circumstances if they were considered to be a safety risk and not suitable for general access to the road network.²³

The PBS scheme is an illustration of an approach where there may be a disconnect between the approval of a vehicle and access to the road network. In the PBS scheme, a vehicle's design and performance is assessed independent to the access request. Road managers (state road agencies and local councils alike) then consider a request for an access permit separately (in line with the process in the HVNL). This process creates uncertainty for PBS vehicle operators about the eventual use of their vehicles.

The HVNL allows an operator to make one application for access to the NHVR, but for light automated vehicles, in addition to uncertainty, an automated driving system entity may have to apply to each state and territory to gain access for a vehicle to be used nationally. It is also unlikely that light automated vehicles would negatively affect road infrastructure and damage road surfaces. Road managers use the perceived infrastructure risks associated with operating PBS vehicles as the rationale for regulating road network access separately to vehicle approval.

The approach to approving access may vary according to automated vehicle system

The Nova Systems (2017) independent report recognised that automated vehicle technologies address variation in operational environments (the operational design domain) in three ways:

- **Type 1:** These are vehicle systems that assess the environment dynamically and decide continuously if the environment being encountered is suitable to operate in.
- **Type 2:** These are vehicle systems where the suitable operating environment is predetermined by an analysis of the road network and then compatible or supported roads are added into the guidance system database. Using its location the vehicle then determines if it can safely engage an automated function. Environmental factors are also included such as light and weather conditions.
- **Type 3:** These are vehicle systems operating on a closed road network or a fixed predetermined road network where compatibility can be pre-surveyed.

Each of these vehicle types could warrant a different response in relation to road network access.

For type 1 and type 3 vehicles, the vehicle's operational design domain at the initial safety assessment determines the potential or actual road network. This suggests the initial safety assurance process and acceptance of the vehicle's operational design domain could be undertaken with little or no input from registration authorities or road managers.

For type 2 vehicles, the process is more complex. Type 2 vehicles require that:

- the environment within which the vehicle has been designed to operate is fully disclosed in the operational design domain

²² Currently, in some states and territories there is a specific power to refuse registration if there is a concern the vehicle is unsafe. For example, in South Australia, section 24(3)(b) of the Motor Vehicles Act states the Registrar may refuse to register a vehicle if the vehicle (i) does not comply with an Act or law that regulates the design, construction or maintenance of such a vehicle; or (ii) would, if driven on a road, put the safety of persons using the road at risk. In other jurisdictions, such as Victoria, a roadworthiness certificate is required as evidence that the vehicle is safe to register.

²³ Prior to the HVNL, these powers were also used to manage road access by registered heavy vehicles. Under the HVNL, state and territory road managers have limited powers to refuse to approve a grant of access proposed by the NHVR.

- someone, possibly the manufacturer, has surveyed Australian roads to identify roads that match the vehicle capability
- the entity undertaking the safety assurance assessment of the vehicle or registering the vehicle or granting access must confirm that the survey process has been correctly completed and that assumptions about road environments are correct (Nova Systems, 2017, p. 50).

This confirmation that roads have been correctly identified and surveyed is likely to require a sound working knowledge of the nature of the road design, infrastructure, and weather variations on the identified road network. This suggests a close interaction between the manufacturer or automated driving system entity and the state and territory registration authorities and road managers during the initial stages of the safety assurance process to ensure the assessment and recommendations are correct and that the vehicle's operational design domain is suitable.

Type 2 and type 3 vehicles may also require regular system updates to reflect changes in the road network as roads are added, modified or closed. Road network changes may require corresponding changes in access approvals, potentially establishing an ongoing relationship between the automated driving system entity and road managers.

11.2 Options for approval to access the road network

There are three potential approaches for managing automated vehicle access to the road network. They range from each state and territory managing the processes independently, through to a national government agency making binding decisions about suitability for registration and access:

- **Option 1:** The registration authority or road manager approves access based on its own assessment of the vehicle's operational design domain.
- **Option 2:** The registration authority or road manager approves access based on advice from the government agency responsible for the safety assurance system.
- **Option 3:** The automated driving system entity and the government agency responsible for the safety assurance system agree on the operational design domain. The agency notifies the relevant road managers of the approval or accreditation. Road managers do not approve road network access.

As discussed above, under the continue current approach option and self-certification regulatory options, governments would not be actively involved in the safety assurance system, and registration and road access would continue to be managed by the states and territories. The power to refuse registration and/or access would be the safeguards to ensure only safe automated vehicles are allowed on roads.

The pre-market approval and accreditation regulatory options involve national management of the safety assurance system and all three options below are possible.

The NTC is also seeking feedback on how road access should be approached from the perspective of private roads that have public access (such a toll roads).

Option 1: Road manager approves access based on own assessment

Adopting this option, the relevant registration authority or road manager would approve access based on their own safety assessment. They may take into consideration advice from the automated driving system entity or any government agency responsible for the safety assurance system, but the final decision and authorisation would rest with the registration authority or road manager.

Approval could be road-specific if required, or it could be for the whole road network and limited only by the vehicle's agreed operational design domain. It may also be possible to gazette road networks to match specific automated vehicles to specific roads, although there is such a diversity of types of automated vehicles and operational design domains, this approach may be too complex to be effective.

Benefits of road manager approval

- There would be administrative efficiencies from continued use of current registration and road access approval mechanisms.
- It would be unlikely to require legislative change.
- States, territories and local governments would remain in control of access to their road network, and remain fully aware of what automated vehicles are operating on their roads.
- It would accommodate type 2 vehicles.

Disadvantages of road manager approval

- It could result in significant time delays between safety assurance approval or accreditation and road network access approval.
- Road managers would bear the cost and responsibility of assessing automated vehicle safety and suitability for road network access.
- Sufficient information on the operational design domain may not be available or verifiable.
- It would lead to duplication of effort and cost by state and territory government agencies because the safety assessment must be made in each state and territory in which the vehicle is to be used.

Option 2: Road manager approves access based on advice

Adopting this option, the government agency responsible for the safety assurance system would provide the relevant registration authority or road manager with advice on automated vehicle access. The relevant registration authority or road manager would have final decision-making authority and could deny access regardless of what had been agreed between the automated driving system entity and the government agency responsible for the safety management system. Approval by the registration authority or road manager would not have to be road-specific.

Benefits of approval based on advice

- It would be administratively simple for registration authorities and road managers.
- It would reduce the risk of duplication of safety assessment.
- It would be unlikely to require a change to registration or access legislation.
- It would encourage registration authorities and road managers to be part of safety assurance discussions.

Disadvantages of approval based on advice

- It could result in significant time delays between safety assurance approval or accreditation and road network access approval.
- Registration authorities and road managers would be reliant on automated driving system entities and the government agency responsible for the safety assurance system assessment to ensure automated vehicles operate safely and only on appropriate roads and infrastructure.
- For type 2 and possibly type 3 vehicles, compatibility with the road network may not be adequately addressed.

Option 3: Road manager is notified of an access decision

Adopting this option, the relevant registration authority or road manager would be notified of an approval or accreditation by the government agency responsible for the safety assurance system. Registration would be granted based on the approval or accreditation of that government agency. The registration authority or road manager would not approve road network access or change or add further restrictions to what had been agreed through the safety assurance process.

Benefits of notification

- It would reduce any risk of a disconnect between the approval or accreditation of a vehicle and road network access.
- It would ensure national consistency and provide clear roles and responsibilities between government agencies.

- It would support administrative convenience, lower costs and certainty for automated driving system entities.
- It would reduce state and territory duplication and assessment costs.

Disadvantages of notification

- It would require legislative change to state and territory laws to mandate the implementation of the safety assurance system entity's decisions.
- There would be a risk of inconsistency with state and territory treatment of non-automated vehicles.
- For type 2, and possibly type 3 vehicles, compatibility with the road network may not be adequately addressed.

11.3 Conclusions

States and territories have powers to register vehicles and control their access to the road network. In terms of automated vehicles, these powers are most relevant to the vehicle's operational design domain. This defines where and in what circumstances an automated driving system or automated function is designed to properly operate, including roadway types, speed range and environmental conditions. The operational design domain may vary significantly across automated vehicles.

The use of the registration and access powers could be integrated into the safety assurance system, or they could be used independently after the safety assurance process, as a final safeguard to limit the access of automated vehicles to roads if these vehicles were considered unsafe. The powers are exercised at the state and territory level, but in the context of a safety assurance system for automated vehicles, there could be efficiencies in a national approach.

It may be suitable to adopt more than one approach, depending on the type of automated vehicle. In particular, a greater role for road managers could be appropriate for vehicle systems where the suitable operating environment is predetermined by an analysis of the road network and then compatible or supported roads are added into the guidance system database (what Nova Systems refers to as type 2 vehicles).

The experience of the PBS scheme underscores the challenges of separating vehicle approval from road network access. Where possible, a national approach should incorporate automated vehicle registration and road network access into the safety assurance process. There are administrative, resourcing and capability benefits of a holistic approach, whereas an approach that places the onus on road managers to agree road network access will add cost, time, complexity and the risk of national inconsistency for industry, governments and consumers.

For these reasons, the NTC supports option 3 and a national approach to road network access. However, the regulatory option for the design of the safety assurance system (and whether the automated vehicle is light or heavy) will clearly affect policy and operational decisions related to road network access. The NTC therefore proposes that further consideration be given to road network access arrangements once a regulatory option has been agreed.

Consultation question

Question 11: How should governments manage access to the road network by automated vehicles? Do you agree with a national approach that does not require additional approval by a registration authority or road manager?

12 Implementation – how to ensure compliance

Key points

- The NTC is seeking initial feedback on how to ensure compliance – including what regulation (if any) is needed to ensure automated driving system entities and other parties comply with safety obligations.
- We suggest there are two broad approaches that could be adopted to ensure compliance:
 - a primary safety duty for parties to ensure automated vehicle safety, with associated penalties
 - a range of compliance sanctions to assist regulators in securing effective compliance.
- How best to ensure compliance will depend significantly on the regulatory model agreed. Sanctions and penalties in road traffic laws could also cover automated driving system entities through the NTC reforms to driver legislation.

The purpose of this chapter is to examine how automated vehicles continued compliance can be ensured and what action might be taken if there is a breach. We examine how this is ensured in other industries and propose some options for how compliance could be managed. We are seeking feedback on these proposed options.

Once automated vehicles are operating on our roads, how do we ensure they continue to operate safely? What should governments do if they don't operate safely? Ensuring that automated driving system entities, and other parties responsible for automated vehicle safety, meet their safety obligations on an ongoing basis is a key issue for each of the regulatory options we have explored.

There are a number of existing safeguards that would encourage industry cooperation and community protection from unsafe vehicles. As outlined in option 1, these include consumer guarantees for safe products in the Australian Consumer Law, industry codes of practice and state and territory powers to remove vehicles from public roads. There are also existing prescriptive penalties for failure to comply with specific road traffic laws and vehicle standards.

A safety assurance system could be underpinned by additional mechanisms to ensure compliance including:

- a primary safety duty for parties to provide safe automated vehicles with associated penalties
- specific offences attached to the pre-market approval and accreditation options
- a range of sanctions to assist regulators in securing effective compliance.

12.1 A primary safety duty to provide safe automated vehicles

Regulatory options 2, 3 and 4 could be supported by a legislated primary safety duty for parties such as manufacturers, suppliers and automated driving system entities to ensure automated vehicle safety.

A primary safety duty is a statutory duty of care that imposes a legal obligation on the party or parties it applies to. A primary safety duty to ensure automated vehicle safety could apply at first supply of the vehicle to market, or be an ongoing duty throughout the life cycle of the vehicle.

A primary safety duty to ensure automated vehicle safety could be based on a number of existing models, including WHS, rail safety law, the HVNL and civil and criminal negligence.

Primary duties under the Model WHS Act

The Model WHS Act is organised around primary duties of care intended to cover a range of people, including 'persons conducting a business or undertaking' (PCBU), officers, workers and others (Safework Australia, 2012). There are also specific duties of care for various identified types of PCBUs (including designers, manufacturers, suppliers, importers of plant, substances or structures) to ensure the health and safety of specified people who may be affected by the business or undertaking *so far as is reasonably practicable* (Safework Australia, 2012). Executive officers also have a positive duty to exercise due diligence and to ensure compliance by their PCBU with Model WHS obligations.

Primary duties under the Rail Safety National Law

The RSNL has safety duties relevant to certain roles and activities in rail. The primary duties are designed to capture various broad groups and to ensure they comply with a general concept of safety within the sphere of operations over which they have control. For example, rail transport operators (rail infrastructure managers and rolling stock operators) have an overarching and positive duty to ensure, so far as is reasonably practicable, the safety of the operator's railway operations. Likewise, the RSNL contains duties of care on those who design, commission, manufacture, supply, install or erect things to be used in connection with rail infrastructure or rolling stock to ensure (so far as is reasonably practicable) that the things are safe.

Heavy Vehicle National Law 2016 Amendments

The *Heavy Vehicle National Law and Other Legislation Amendment Act 2016* (Qld) will amend the HVNL to replace prescriptive chain of responsibility obligations with an overarching and positive primary safety duty of care on all chain of responsibility parties to ensure the safety of their transport activities so far as is reasonably practicable. The amendments will also better align the obligations of parties and executive officers with other national safety laws, such as rail and WHS. The amendments are scheduled to take effect in 2018.

Civil and criminal negligence

Negligence has been described as 'an omission to do something which a reasonable person, guided upon by those considerations which ordinarily regulate the conduct of human affairs, would do in the circumstances, or doing something which a prudent and reasonable person would not do'.²⁴

The duty of care is an objective duty to take reasonable care.

A duty of care under the civil law of negligence will generally arise when the defendant should have foreseen that their conduct could result in injury to the plaintiff. There are recognised categories of relationships that give rise to a civil duty of care, which include the relationship between road users.

In an action in negligence the plaintiff must establish that a duty of care existed, there was a breach of the duty, and that damage resulted from the breach. If successful, the plaintiff will receive compensation for the damage.

To convict an accused of criminal negligence the prosecution must prove the abovementioned civil components but must go further and prove the negligence was of such a serious degree that it amounted to a crime. The degree of negligence is variously referred to as reckless, gross or culpable, involving a moral guilt.

Criminal codes establish specific duties to take reasonable care, breach of which can be relied on when prosecuting specific offences such as manslaughter, grievous bodily harm, bodily harm and wounding.

²⁴ *Blyth v Birmingham Waterworks Co* (1856) 11 Exch. 781, at 784, per Alderson B.

Application of a primary safety duty to automated vehicle safety

In relation to automated vehicles, there are a number of ways in which a duty of care could be reflected in law. As noted in the discussion on self-certification, a primary safety duty could be created by way of an amendment to the MVSA, or each state and territory could introduce the same primary safety duty in amended road traffic legislation.

Primary duties define the duty holders and the broad scope of their responsibilities. Primary duties also require duty holders to consider a wider range of matters than would be necessary under a prescriptive regulatory approach. Primary duties are concerned with influencing attitudes and creating an overall safety culture including through establishing safety management systems.

The flexibility inherent in a primary duties approach allows for innovation and adaptation in risk management that is tailored to the circumstances of the party to whom the duty applies, the nature of the risk to be addressed, and to the reasonableness of the party's use of resources to meet the risk. Indeed, this was the main rationale behind the use of primary duties as the fundamental basis for WHS laws and rail safety legislation (Robens, 1972).

Additional benefits of a primary duties approach include that it would:

- be clearly focused on risk
- clarify the legal and public expectation that automated vehicles are safe and the responsibilities of parties involved in their design, manufacture and upgrading
- simplify and allow for better targeted enforcement, benefitting compliant and safe operators
- enable a more flexible outcomes-based approach to safety where parties tailor their compliance to suit their circumstances, the nature of the risk to be addressed and the party's resources to meet the risk
- mean that a breach of the duty does not require there to be the occurrence of some harm or injury
- better align with Australia's national safety laws.

The NTC suggests that a primary safety duty to provide safe automated vehicles would be unlikely to align with a pre-market approval approach. This is because pre-market approval is primarily prescriptive, with a greater role placed on the government agency to assess and agree that an automated vehicle or technology is safe.

While a primary safety duty may be considered to overlap with the consumer guarantees in the Australian Consumer Law that a product will be safe, free from defects and fit for purpose, we suggest there are benefits from including a primary safety duty for automated vehicles:

- Primary safety duties are common in other areas of regulation and are therefore a familiar concept.
- It would clarify the responsibilities of manufacturers, designers and others influencing automated vehicle safety.
- Primary duties are suitable for higher level systemic breaches rather than individual contraventions of traffic laws and therefore have larger penalties.
- Primary duties would be contained in motor vehicle legislation and could be used without relying on consumer protection agencies and powers under other laws.
- They need not exclude the use of consumer protection laws.

Penalties for breaches of the primary safety duty

The purpose of penalties is to encourage desirable behaviour and punish undesirable behaviour. It is important that the maximum penalty adequately reflects the serious nature of the offence being committed and is at a level that appropriately balances fairness with deterrence.

The Model WHS Act and the RSNL grade breaches of the duties based on the risk of death or series injury or illness posed by noncompliance. These are 'offence categories', with each category imposing a maximum penalty proportionate to the seriousness of the risk, with penalties running into the millions of dollars and in some circumstances including imprisonment.

Sanctions for breaches of the primary safety duty

The Model WHS Act and RSNL provides for the use of various compliance and enforcement sanctions to assist officers to secure effective compliance with, and enforcement of, WHS and RSNL legislation.

By providing these measures, the national laws recognise that different compliance and enforcement tools are needed to regulate entities with diverse operations, objectives and compliance capabilities. Equally, different tools may be needed to manage different forms and degrees of noncompliance.

Compliance and enforcement sanctions available under the Model WHS Act include the following:

- improvement notices (to require an entity to remedy a contravention that is a risk to safety)
- prohibition notices (to stop activities that involve a risk to safety)
- infringement notices
- restoration orders (to require a person to remedy the breach)
- enforceable undertakings (an undertaking to carry out specific activities).

If a primary safety duty was introduced for automated vehicle entities and other such parties, similar sanctions could be introduced to manage different forms and degrees of noncompliance.

Rather than apply driver penalties for traffic law contraventions caused by an automated driving system, it may be more appropriate to use the primary safety duty and associated compliance sanctions. This could be appropriate for multiple breaches that indicate a pattern of behaviour or for serious breaches that result in a risk of injury or death.

12.2 Specific sanctions and penalties for automated driving system entities

As noted in chapter 1, in parallel with the development of a safety assurance system, the NTC is progressing driver reforms to ensure driver obligations in the Australian Road Rules and other relevant traffic laws can be transferred to the automated driving system entity for automated vehicles.

This means that driver offences and penalties currently included in road traffic laws could be extended to automated driving system entities, which will most likely be corporations. This raises a number of issues:

- the appropriateness and effectiveness of road traffic offences and penalties for automated vehicles to improve road safety
- the appropriateness and effectiveness of corporate multipliers for offences caused by automated driving system entities that are corporations
- whether additional obligations and penalties imposed under the safety assurance system would be more effective than monetary penalties for individual breaches of the road traffic laws.

The NTC legislative audit identified 53 Acts and regulations that could be affected by highly and fully automated vehicles. Some examples of current offences in road traffic laws in different states for drivers that could be transferred to the automated driving system entity are provided below:

- **Obeying the speed limit:** A driver must not drive at a speed over the speed limit applying to the driver for the length of road where the driver is driving. Maximum penalty: \$4,876.²⁵
- **Negligent, furious or reckless driving:** A person must not drive a motor vehicle on a road furiously, recklessly or at a speed or in a manner dangerous to the public. Maximum penalty (first offence): \$2,200 or imprisonment for nine months or both.²⁶

²⁵ Section 20 of the *Transport Operations (Road Use Management—Road Rules) Regulation 2009* (Qld)

²⁶ Section 117(2) of the *Road Transport Act 2013* (NSW)

- **Direction to stop a heavy vehicle to enable the exercise of other powers:** To enable an authorised officer to exercise a power under this law, the officer may direct the driver of a heavy vehicle to stop the vehicle. Maximum penalty: \$6,400.²⁷

There may be some situations where the imposition of a monetary penalty on the automated driving system entity for such breaches may not be appropriate or effective. For example, some offences under the road transport laws are for minor traffic offences and are aimed at human behaviours. They impose relatively low monetary penalties.

Examples of these offences are:

- **Starting a left turn from a road (except a multi-lane road):** A driver turning left at an intersection from a road (except a multi-lane road) must approach and enter the intersection from as near as practicable to the far left side of the road. Penalty: \$466.38.²⁸
- **Beginning a U-turn:** A driver must not begin a U-turn unless:
 - the driver has a clear view of any approaching traffic
 - the driver can safely make the U-turn without unreasonably obstructing the free movement of traffic. Penalty: \$1,100.²⁹

For automated vehicles, these breaches may be caused by a technical or design fault rather than human error or interference. These breaches may be better managed through other avenues such as the issuing of improvement notices or entering into enforceable undertakings to encourage a greater focus on safety by the automated driving system entity, rather than relying on existing low monetary penalties.

Corporate multiplier

An additional way to ensure compliance is to multiply monetary penalties for corporations.

A corporate multiplier imposes a larger penalty for a breach by a corporation (by some factor) than for an individual. Corporate multipliers are used across a range of legislation and have been part of Australian transport law for a number of years. A corporate multiplier has been adopted where the benefits of noncompliance accruing to a corporation may outweigh the potential penalty imposed to an individual. Corporate multipliers also recognise that other sanctions, such as imprisonment, cannot be imposed on corporations.

Under the Model WHS and RSNL, a 10-time multiplier is imposed for breaches of the primary safety duty. This 10-time multiplier has also been adopted for the primary safety duty that will be introduced under the HVNL.

Specific offences attached to a safety assurance system

Specific offences that focus on compliance with a particular matter could also be imposed under the regulatory options.

Offences in a self-certification approach

In addition to the proposal for a primary safety duty, under a variation of option 2 it was proposed that the statement of compliance against the safety principles and criteria (for the initial vehicle and for significant modification or reporting of safety-critical risks) could be mandatory.

To enforce this requirement an offence of failing to lodge a statement of compliance would be required. Similar to current practices in the US, an offence of making a false or misleading statement in a statement of compliance may also be required. Alternatively, the supply or sale of an automated vehicle without providing a statement of compliance could be prohibited.

Offences in a pre-market approval approach

Pre-market approval would need to be mandated in legislation. Compliance could be enforced by prohibiting the supply or sale of an automated vehicle without a pre-market approval. This is similar

²⁷ Section 513 of the *Heavy Vehicle National Law* (Qld)

²⁸ Section 27 of the *Road Safety Road Rules 2009* (Vic)

²⁹ Section 37 of the *Road Safety Road Rules 2009* (Vic)

to the MVSA, which prohibits the supply of vehicles without an identification plate (signalling compliance with the ADRs) and establishes a process for manufacturers to apply for approval to fit an identification plate.

Approvals could be made conditional and could be cancelled, suspended or varied in certain circumstances, including a failure to observe the conditions of an approval.

The MVSA could be considered as a model for pre-market approval enforcement provisions.

Offences in an accreditation approach

In addition to the primary safety duty on specified entities to ensure safe automated vehicles so far as is reasonably practicable and associated penalties, accreditation would need to be supported by a requirement to obtain accreditation and a penalty for operating without accreditation.

Accreditation would carry with it obligations to have safety management systems and plans and to report on them. For compliance purposes, it would be useful to have the power to cancel, suspend or vary accreditation. However, we suggest that cancellation or suspension should not be relied upon as the primary means to ensure compliance. This is for the following reasons:

- The withdrawal of in-service automated driving systems could disable entire transport services or the safe operation of road vehicles. This would have major societal impacts on consumers, productivity and mobility.
- Given the potential scale of how a withdrawal could affect the society and economy, the risk of a withdrawal of accreditation may be perceived as being remote by some manufacturers, and therefore ineffective.
- The withdrawal of accreditation is likely to be retrospective – that is, a government agency may act to make a withdrawal only after it is clearly evident that an automated vehicle or function has an unacceptable safety risk. Given the major impact of a withdrawal, it is possible that this may only occur after deaths or serious injuries have occurred.

An additional automated vehicle-specific enforcement tool that may be worthwhile considering is a power to require an automated driving system entity to deactivate the automated functions of its vehicles if its accreditation is cancelled.

12.3 Conclusions

Ensuring that automated driving system entities, and other parties responsible for automated vehicle safety, meet their safety obligations is a key issue for each of the regulatory options. We suggest that compliance can be ensured through a primary safety duty for parties to provide safe automated vehicles with associated penalties and/or specific sanctions and penalties for the automated driving system entity.

If a primary safety duty is implemented, any traffic contraventions caused by the automated driving system (such as a failure to stop at a red light or a failure to give way to oncoming traffic) would most likely be taken as evidence of a breach of the primary safety duty. A failure to comply with the primary safety duty could take the place of road traffic driver penalties that would otherwise apply to the automated driving system entity.

The best way to ensure compliance will depend significantly on the regulatory model agreed. The nature of sanctions and penalties will also be affected by how automated driving system entities are recognised in the Australian Road Rules.

Consultation question

Question 12: How should governments ensure compliance with the safety assurance system?

13 Conclusions

This paper discusses the need for a national performance-based assurance regime designed to ensure the safe operation of automated vehicles in Australia in the absence of agreed Australian or international standards specific to automated vehicle technologies.

There is a risk that, without a national and coordinated response to automated vehicle reform, Australia's complex regulatory framework will result in inconsistent regulation or over-regulation of automated vehicles across states and territories.

In line with developments in other countries, the NTC proposes that the safety risks are sufficiently high or unknown to warrant some level of regulatory oversight and government involvement in the safety assurance system.

The paper addresses issues such as: the need for government intervention and the type of intervention; what is safe access to the road within the road network; institutional arrangements; and how to ensure compliance. It proposes four regulatory options (continue current approach, self-certification, pre-market approval and accreditation) and eight criteria for selecting a preferred option.

















We are seeking feedback on these issues, options and criteria. The feedback will be taken into account in formulating recommendations to Australian transport ministers in November 2017.

13.1 Assessment of regulatory options against the proposed selection criteria

Table 13 shows an assessment of the four regulatory options against the proposed selection criteria. Self-certification and accreditation both meet all criteria completely or partially. The continue current approach and pre-market approval options both do not meet some of the criteria.

Table 13: Assessment of regulatory options against the proposed assessment criteria

Criteria	Continue current approach	Self-certification	Pre-market approval	Accreditation
9. Are safety risks managed?	P	P	F	F
10. Is the model flexible and does it support innovation?	P	F	N	F
11. Does it support legal accountability and probity?	N	P	F	F
12. Is the regulatory approach efficient?	F	F	N	P

13. Does it support consistency?				
14. Can it evaluate a safe operational design domain?				
15. Can the model support other policy objectives?				
16. Can it be implemented within two years?				

13.2 Key responsibilities under each option

Table 14 shows who has responsibility for what under each option. Under continue current approach and self-accreditation, responsibilities fall mainly on manufacturers and vehicle owners. Under pre-market approval, responsibilities are more evenly shared between government, manufacturers and owners. Under accreditation, the accredited party bears the responsibility for almost all the steps.

Table 14: Key responsibilities under each option

Option/step	Responsibility				
	Government		Industry/other		
1. Continue current approach	Government directly	Outsourced provider	Manufacturer	Registered owner	Accredited party*
Develop automated vehicle safety criteria					
Develop detailed safety standards					
Develop testing protocols					
Assess initial functions against criteria/standards					
Assess changes to functions against criteria/standards					
Install upgrades/modifications					
Monitor ongoing safety performance of vehicles					
Address safety defects					

Arrange repairs					
Monitor ongoing compliance					
Provide data about safety events and incidents					
Report defects/product recalls					
Option/step	Responsibility				
	Government		Industry/other		
2. Self-certification	Government directly	Outsourced provider	Manufacturer	Registered owner	Accredited party*
Develop automated vehicle safety criteria					
Develop detailed safety standards					
Develop testing protocols					
Assess initial functions against criteria/standards					
Assess changes to functions against criteria/standards					
Install upgrades/modifications					
Monitor ongoing safety performance of vehicles					
Address safety defects					
Arrange repairs					
Monitor ongoing compliance					
Provide data about safety events and incidents					
Report defects/product recalls					
Option/step	Responsibility				
	Government		Industry/other		
3. Pre-market approval	Government directly	Outsourced provider	Manufacturer	Registered owner	Accredited party*
Develop automated vehicle safety criteria					

Develop detailed safety standards					
Develop testing protocols					
Assess initial functions against criteria/standards					
Assess changes to functions against criteria/standards					
Install upgrades/modifications					
Monitor ongoing safety performance of vehicles					
Address safety defects					
Arrange repairs					
Monitor ongoing compliance					
Provide data about safety events and incidents					
Report defects/product recalls					
Option/step	Responsibility				
	Government	Industry/other			
4. Accreditation	Government directly	Outsourced provider	Manufacturer	Registered owner	Accredited party*
Develop automated vehicle safety criteria					
Develop detailed safety standards					
Develop testing protocols					
Assess initial functions against criteria/standards					
Assess changes to functions against criteria/standards					
Install upgrades/modifications					
Monitor ongoing safety performance of vehicles					

Address safety defects					
Arrange repairs					
Monitor ongoing compliance					
Provide data about safety events and incidents					
Report defects/product recalls					

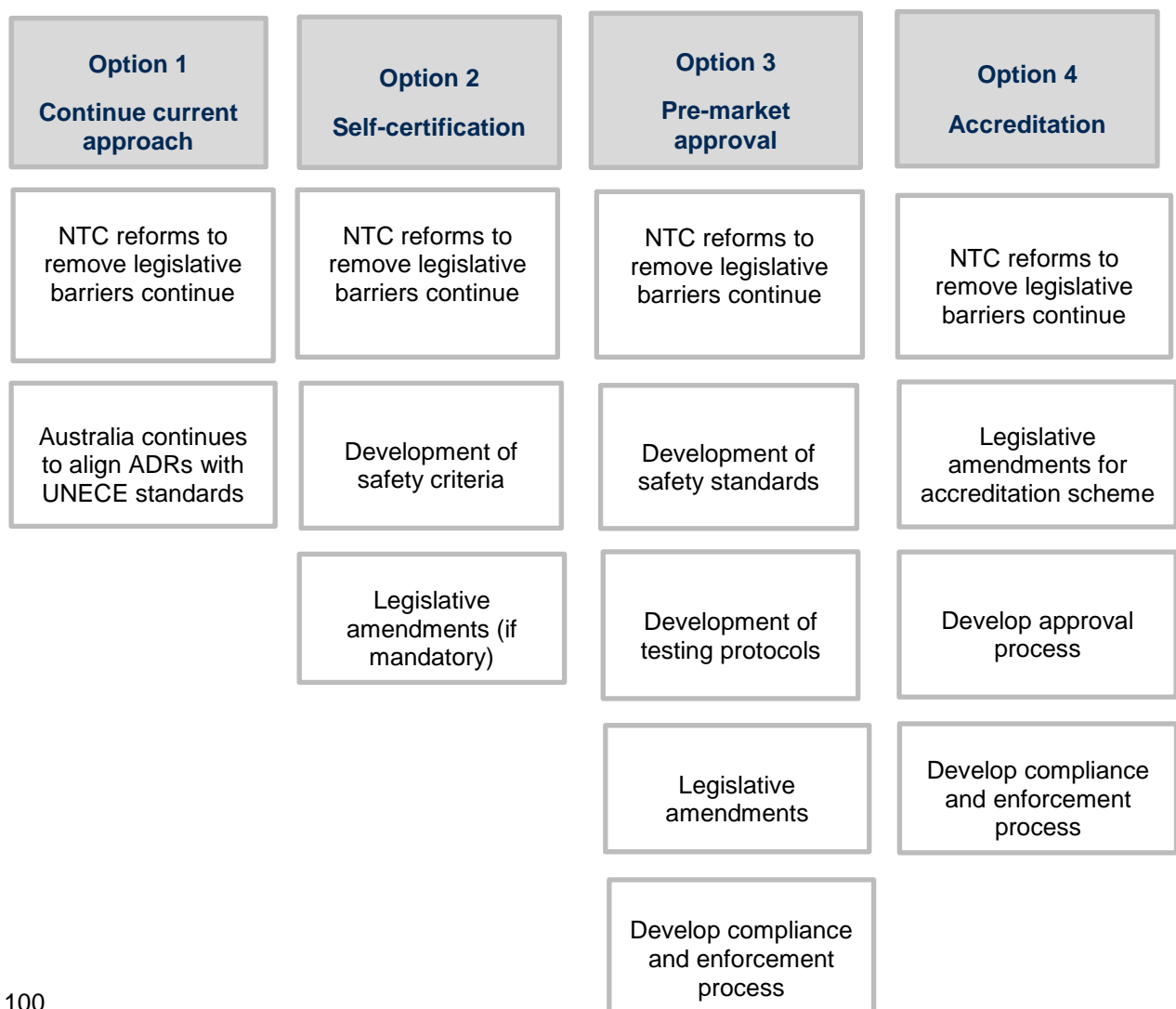
* The accredited party could be the manufacturer, owner or another entity.

13.3 Next steps

Based on feedback to this paper, we will report back to the Transport and Infrastructure Council in November 2017 with a preferred regulatory option for a safety assurance system and a proposed direction on each of the key issues. A policy paper will be released in November 2017.

The key implementation steps for each safety assurance option are summarised in Figure 11. Implementation actions for the agreed regulatory option can commence from November 2017.

Figure 11: Key implementation steps for each safety assurance option



Glossary

Term ³⁰	Definition
Advanced Fatigue Management (AFM)	Advanced Fatigue Management accreditation brings a risk management approach to managing fatigue.
Australian Competition and Consumer Commission (ACCC)	Competition regulator that promotes competition, fair trading and regulation of national infrastructure.
Australian Design Rules (ADRs)	National standards for safety, anti-theft and emissions in vehicle design.
Australian Light Vehicle Standards Rules (ALVSRs)	National model law intended to provide the basis for nationally consistent vehicle standards in each jurisdiction. These rules do not, by themselves, have any legal effect. They are based on the ADRs and require a vehicle that is subject to an ADR when supplied to the market to continue to comply with that ADR for the life of the vehicle.
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.
Australian Transport Safety Board (ATSB)	The ATSB is Australia's national transport safety investigator. Australian Government.
Austroads	The association of Australasian road transport and traffic agencies
automated driving system	In-vehicle operating system that controls the automated vehicle functions.
automated driving system entity	The legal entity responsible for the automated driving system.
conditionally automated*	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*	<p>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:</p> <ol style="list-style-type: none"> 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).
Federal Chamber of Automotive Industries (FCAI)	Peak industry organisation in Australia representing manufacturers and importers of passenger vehicles, light commercial vehicles and motorcycles.

³⁰ Terms marked with an asterisk are quoted from SAE International Standard J3016

fully automated*	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.
Global Navigation Satellite System (GNSS)	System that provides geospatial positioning based on longitudinal, latitudinal and altitudinal data.
Heavy Vehicle National Law (HVNL)	National laws related to the regulation of heavy vehicles over 4.5 tonnes. Operational in all Australia states and territories except Western Australia and the Northern Territory.
highly automated	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.
Highly Automated Vehicles (HAV)	A NHTSA term referring to vehicles with conditional, high or full automation.
human-machine interface	Interface between a human operator and a machine. Includes functional and ergonomic design of the interface (human factors).
<i>Motor Vehicle Standards Act 1989</i> (MVSA)	The Motor Vehicle Standards Act controls the safety, environmental and anti-theft performance of all vehicles entering the Australian market for the first time – both new and used.
National Heavy Vehicle Regulator (NHVR)	The NHVR administer 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 US government and part of the Department of Transportation. It describes its mission as ‘Save lives, prevent injuries, reduce vehicle-related crashes’.
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
Office of the National Rail Safety Regulator (ONRSR)	Australia’s national rail safety regulator.
operational design domain*	The specific conditions under which a given driving automation system or feature thereof is designed to function, including, but not limited to, driving modes.
partially automated*	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.
persons conducting a business or undertaking (PCBU)	People who have a primary duty of care in the Model Work Health and Safety (WHS) Act.
PEGASUS	Cooperative project in Germany to develop quality criteria, tools and methods to assess automated driving function safety. It involves the German Government, vehicle manufacturers and researchers.
Performance-Based Standards (PBS)	A government program in Australia that approves heavy vehicle designs using performance-based standards. It enables industry to achieve higher productivity and safety through innovative and optimised vehicle

scheme)	design.
Rail Safety National Law (RSNL)	The <i>Rail Safety National Law (South Australia) Act 2012</i> establishes the ONRSR as the body responsible for rail safety regulation in that state or territory. Each state and territory replicates that law so that it applies in that jurisdiction.
Society of Automotive Engineers (SAE)	Society of Automotive Engineers – international association for automotive engineers.
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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