Safety Assurance for Automated Driving Systems RIS and NTC Automated Vehicle Work Program

DEVELOPING THE RIGHT AUTOMATED VEHICLE INDUSTRY IN AUSTRALIA

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Australia & New Zealand Driverless Vehicle Initiative

What is ADVI

The Australia and New Zealand Driverless Vehicle Initiative (ADVI) is the national peak advisory body for automated vehicle technology and is a trusted adviser to government and industry partners. ADVI is well placed to provide wide, expert input into scoping, developing and finalising the NTC automated vehicle program.

Led and coordinated by the Australian Road Research Board (ARRB), the ADVI initiative is now a cooperative partnership program comprisedof more than 120 Australian and international organisations including insurance, technical, industry, policy, regulator, academic and infrastructure partners and is funded by partners from a range of sectors.

ADVI and ADVI partners individually have, and continue to, work very closely across industry and all levels of Government across the nation, to safely run events, pilots and demonstrations on and around public roads. To this end we are well placed to understand, support and protect the interests of the community in relation to these emerging technologies.

ADVI's role is to investigate and help inform the development of robust national policy; performance criteria; legislation; regulation; business models and operational procedures; and processes to pave the way for the introduction of self-driving vehicles to Australian roads.

Running parallel with those efforts, work is also underway to raise public awareness and encourage a change in mindset through knowledge-sharing, demonstrations, and simulated and in-field investigation trials.

ADVI has recently completed an analysis of the Economic Impacts of Automated Vehicles on Jobs and Investment in Australia. While various analysis have occurred overseas, the ADVI paper is relevant to Australia and to the work being undertaken by the NTC. The analysis establishes the means for automated vehicles to drive major economic outcomes in terms of public and private benefits. These benefits are underpinned by the timing and implementation of the NTC proposed regulatory reforms, and as such ADVI is very supportive of this work progressing as quickly as practicable.

The ADVI response has been prepared by the ADVI Centre of Excellence and informed by a range of partners through the ADVI Policy and Risk Group.

We note that public opinion has been included in this report, I wish to draw your attention to the fact that ADVI has also conducted two national public opinion surveys, the first set of results published in 2017 and it currently stands as the only scientific representative sample of Australian attitudes to automated vehicles (Regan et al 2017). We refer the NTC to this report and findings and suggest that future reference to public opinion in Australia considers citing the results of this

survey. The 2017 findings are scheduled to be released shortly. NTC as a member of ADVI has access to the raw data from both the 2016 and 2017 surveys, which is available upon request from the ADVI website.

Who to contact for further information?

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1. Overview

ADVI welcomes the opportunity to comment on the draft Safety Assurance for Automated Driving Systems RIS. We support the NTC objective to see the safe commercial deployment of automated vehicles in Australia, this aligns with the vision of the ADVI collaboration, of which NTC is a partner.

We congratulate the NTC for putting together such a comprehensive document and are pleased to offer in the following pages feedback on some gaps that we believe still exist.

We acknowledge that this RIS focuses on the safety outcomes from the introduction of Automated Vehicles, however it is important to understand that addressing existing regulatory processes effectively will significantly enhance the likely economic development and jobs outcome for Australia as well as the anticipated safety and social outcomes.

ADVI believes that Australia should take a proactive approach to accelerate the introduction of AVs for wide range of social and economic objectives, that are underpinned by the safety benefits.

Transport in Australia accounts for around 10% of Australian GDP. Given the significance of the industry and the productivity benefits, early initiation of a National Diverse Mobility approach, with a remit not only to foster the early introduction of AVs, but to transform mobility in Australia including rural and regional Australia, has assumed a high level of urgency.

Accordingly, we consider that the NTC Option 4 approach should be 'interim' and should be approved on the basis that far wider institutional reform is necessary to promote a more diverse mobility sector.

2. Feedback on the Safety Assurance for Automated Driving Systems (SAADS) Report

The NTC has laid out the foundations for an AV industry in its Safety Assurance for Automated Driving Systems Consultation Regulation Impact Statement (2018) report[1].

The Regulatory Impact Statement argues that early introduction of AVs (essentially in 2020 when the NTA anticipates the legal / insurance framework will be in place) will generate the general safety benefits plus early safety benefits of $154m-$464m net present value.

Currently in Australia AVs can only be legally operated as an exemption to existing legislation. All trials in Australia underway are therefore 'one off'. To achieve early introduction of AVs in Australia the SAADs report argues that AVs need to deliver reasonable safety outcomes, consumers need to be confident in safety outcomes and OEMs need a consistent regulatory framework. The report argues (page 16) that existing market and regulatory failure needs to be addressed.

[1] The self-certification approach was initially recommended by the NTC in Assuring the Safety of Automated Vehicles (2017).

This SAADS report bases the case for AVs on improved road safety outcomes in Australia. The report estimates that 89 road deaths and 306 hospitalisations can be avoided in Australia with an estimated dollar benefit of $607m annually.

In addition to direct safety benefits, indirect environmental and congestion benefits are identified but not quantified to support the business case. This also appears to primarily focus on urban considerations and not the much wider rural and remote areas of Australia where there is also considerable safety and accessibility benefits to be obtained from this technology.

ADVI supports the introduction of AV's with a complementary mobility strategy that would prevent a new freeway building era as AV make personal mobility more attractive than public transport and congestion increases from a shift into personal vehicles.

2.1 Response to SAADs Benefits

While these benefits are compelling, we believe that they significantly under estimate the benefits and for completeness the wider economic benefits (jobs, investments) participation in new global value chains) associated with the introduction of AVs as a platform technology should have been considered. Similarly, the absence of the short term negative economic impacts of increased congestion, reduced use of public transport and less active transport participants is also an omission that we believe is worthy of consideration.

2.2 Options to Support the Safe Introduction of AV

The basis of the NTC approach is to define Automated Driving Systems (ADSs) which will be supplied by Automated Driving System Entities (ADSEs). The ADSs and ADSEs are the building blocks of a mandatory self-certification framework. The report identifies four options to support the take up of and sale operation of AVs on Australian roads and unlock their broader benefits

- **Option 1:** Current approach – this is the baseline option, using existing legislation and regulatory instruments, with no explicit regulation of ADSs.
- **Option 2:** Administrative safety assurance system – a safety assurance system based on mandatory self-certification that relies on existing legislation and regulatory instruments. The safety assurance system will be implemented through administrative means
- **Option 3:** Legislative safety assurance system – A safety assurance system based on mandatory self-certification. This would include new or amended legislation to allow for the inclusion of specific offences and compliance and enforcement options, and a regulatory agency with responsibility for administering automated vehicle safety

- **Option 4:** Legislative safety assurance system + primary safety duty – A safety assurance system that includes all of the elements of option 3, plus a primary safety duty on ADSEs.

The NTC approach and the recommendation of the Option 4 pathway on face value seem to be the optimal way to address safety and to develop a safety assurance system in the short term. Consideration should be given by the NTC as an independent statutory body created to develop regulatory and operational reform for road, rail and intermodal transport, to consider AVs in the broader context of the future of mobility.

2.3 Concerns regarding establishing a new regulatory agency

We question the need to have to establish a new regulatory agency for this express purpose only.

This appears to be creating yet another government body in this area, which will add further administrative burden to applicants and create more duplication and overlap, than we are currently seeing now in Australia.

Experience in Australia has shown that establishing a national body takes time to get national agreement, if ever achieved and this protracted period of setting up such an agency with the relevant national powers, will result in Australia not being ready to address applications in the short to near term.

Rather than the creation of a new agency just to address this one element we recommend that this activity may be better suited to be undertaken by others acting as agents for governments, so that the people or organisations with the relevant expertise can be engaged, as required, to assess applications and certify compliance.

2.4 Other obligations on ADSE:

The RIS also identifies other obligations on the ADSE. We support the obligations as listed below.

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

Data recording and sharing is identified as an obligation rather than a principle. Given the likely operation of AVs as platform technologies a much more thoughtful approach is required particularly to ensure that Government and regulators understand data that is available to inform decisions such as road access pricing.

We note and accept the need to ensure that an ADSE can be held criminally and civilly liable under Australian law and that this is the main driver for the obligation to have a corporate presence in Australia. However, there is very little detail in the RIS on how this can be achieved and Appendix C.3.2 suggests that this is not included in other relevant regulatory systems that have been reviewed. ADVI suggests that this issue of whether an applicant needs to have a corporate presence in Australia, or some other mechanism to ensure that Australians do have the protection of Civil and Criminal laws should be explored further and resolved, in one way or the other as soon as possible.

2.5 High level multi-criteria analysis

The NTC uses a multi-criteria approach to assess the options and recommends the adoption of Option 4 which is the most comprehensive approach to regulation. This is understandable and appropriate given that the regulatory framework is applied to a mandatory self-reporting framework for a new product

Impact category	Option 1	Option 2	Option 3	Option 4
Road safety	This option represents the baseline option	The option would most likely result in **limited improvement** in road safety outcomes compared with the baseline option	The option would most likely result in a **moderate improvement** in road safety outcomes compared with the baseline option	The option would most likely result in a **large improvement** in road safety outcomes compared with the baseline option
Uptake of automated vehicles	This option represents the baseline option	The option would most likely result in a **limited improvement** compared with the baseline option	The option would most likely result in a **moderate improvement** compared to with baseline option	The option would most likely result in a **moderate improvement** compared with the baseline option
Regulatory costs to industry	This option represents the baseline option	The option would most likely result in **limited improvement** (lower costs) compared with the baseline option	The option would most likely result in a **moderate improvement** (lower costs) compared with the baseline option	The option could result in an **improvement or decline** compared with the baseline option
Regulatory costs to government	This option represents the baseline option	The option could result in an **improvement or decline** compared with the baseline option	The option could result in an **improvement or decline** compared with the baseline option	The option could result in an **improvement or decline** compared with the baseline option
Flexibility and responsiveness	This option represents the baseline option	The option would most likely result in **limited improvement** in flexibility and responsiveness outcomes compared with the baseline option	The option would most likely result in a **moderate improvement** in flexibility and responsiveness outcomes compared with the baseline option	The option would most likely result in a **large improvement** in flexibility and responsiveness outcomes compared with the baseline option
Summary	This option represents the baseline option	**Overall impacts:** Moderate improvement compared to with baseline option	**Overall impacts:** Moderate improvement compared to with baseline option	**Overall impacts:** Large improvement compared to with baseline option

Source: NTC Safety Assurance for Automated Driving Systems Consultation Regulation Impact Statement, May 2018, Page 59

3 ASSESSMENT OF SAFETY ISSUES

There are several safety related concerns that we believe should be considered to ensure the successful introduction of the emerging technologies and the safety benefits are to be obtained for Australians.

3.1. Relevance of safety assessment criteria

The NTC is proposing 11 Safety Criteria that the applicant must self-certify against to demonstrate ifs process for managing safety risks.

The NTC has confirmed the 11 self-certification criteria are drawn from the voluntary USA criteria required by NHTSA (US). These standards are not settled as yet in the USA and are being reviewed following recent related crashes and fatalities. It is considered problematic to base Australian policy on the USA process that is under review. It is understood that the USA focus is due to the lack of a consistent approach in European or Asian jurisdictions.

ADVI commends to NTC the 10 UK criteria proposed by Thatcham Research on behalf of the UK Insurance Industry. This report has more explicit safety related criteria (see Attachment 1) that provide far greater clarity than the NTC proposals and we encourage you to consider adapting this style and flavour to the current document. This includes additional explicit requirements to

1. Naming (#1)—must clearly describe Automated capability
2. Emergency hazard (#6) — adequate and appropriate notice must be given if the vehicle needs to unexpectedly hand back driving control
3. Crash intervention (#8) — Vehicle must avoid or prevent an accident by responding to an emergency
4. Have back-up systems (#9) — that is, Safeguards must be in place should any system fail (system redundancy).

The Thatcham standards also contain more direct requirement to manage transfer of responsibility, this includes

- Status (#4) — vehicle must manage all reasonably expected situations by itself. This is clearer than the NTC: *Human—machine interface* as UK proposal requires explicit process
- Safe Harbour (#7) — vehicle must execute an appropriate 'safe stop' if unable to continue or if the driver fails to take back control. This is clearer than the NTC: *Minimal risk condition* as UK proposal more clearly explains
- Accident data (#8) — adequate and appropriate notice must be given if the vehicle needs to unexpectedly hand back driving control. This is clearer than the NTC: *Interaction with enforcement and emergency services* as UK proposal also applies to insurance.

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Even where the intent of the NTC and UK proposals closely align ADVI considers the UK proposals provides clearer, more explicit instruction and guidance and this should be considered by the NTC. Further detail of the UK proposals is available from

http://www.mynewsdesk.com/uk/thatcham-research/documents/thatcham-research-assisted-and-automated-driving-definitions-technical-assessment-79493

3.2 Other general comments for considerations

We also offer the following general commentary as follows:

- Ensure all vehicles are V2V/ V2I (V2X) and meet common V2X standard. ADSE technology is unlikely to be able to anticipate drivers of traditional cars – likely to cause a new cause of vehicle crash. During the transitional period it is critical that it be made explicit that all connected and automated vehicles must communicate with all other connected vehicles and infrastructure and the data that be available to other road users. Provided there is no breach of privacy, there should be no ability for a vehicle owner to turn off this communication

- We support data sovereignty and the requirement that all data must be held in Australia in order to allow Australian law/ courts to access data for safety investigations under current Australian law.

- The NTC proposal for Education and training is supported as is a requirement for clearer explanation of naming of the automated capability by the technology manufacturer to avoid user confusion
- The 11 standards should require ADSE to monitor the safety/ competency of the 'driver'. This could include for example, driver fatigue and driver attention on the road. Level 5 vehicles operating everywhere are likely to be many years away and hence many vehicles are likely to have human driving elements for many years to come and road safety will be significantly improved if drivers are monitored and the system is able to mitigate the risks.

3.3 Safe system philosophy

Rather than focus all liability on the ADSE it is proposed the NTC consider broadening liability to include other parties where relevant.

The key element of the Safe System is the need for shared responsibility. While individual road users are expected to be responsible for complying with traffic laws and behaving in a safe manner, it can no longer be assumed that the burden of road safety responsibility simply rests with the individual road user.

Similarly, many factors are beyond the control of an ADSE and safety will be significantly improved through the inclusion of additional parties consistent with 'chain of responsibility' provisions in addition to the ADSE responsibilities.

Many organisations—the 'system managers'—have a primary responsibility to provide a safe operating environment for road users. They include the government and industry organisations that design, build, maintain and regulate roads and vehicles. These and a range of other parties involved in the performance of the road transport system and the way roads and roadsides are used, all have responsibility including an ADSE for ensuring that the system is forgiving when people make mistakes.

Focus on ADSE (historical focus on blaming one party) rather than the more contemporary 'Safe System' approach recognising many factors affect safety-, including, road design, vehicle standard, speed limits and driver's fitness, all beyond a single applicant – this requires shared liability and a requirement for a cooperative approach.

The NTC proposed that the primary safety duty should only cover ADSEs to ensure in-service safety risks apply to a single party (page 32). This requirement would be likely to result in the ADSE having to ensure that if an owner had not undertaken the necessary updates to the technology then the vehicle must be rendered inoperable. It is not clear if this is an intended or unintended consequence of this requirement.

Consider the issue with the recent airbag recall, where customers were notified of the recall, but this did not mean all of them took up this requirement. There are people still driving vehicles that could potentially cause them harm, in this instance who would currently be liable?

3.4 Clarifying primary safety duty

The proposed primary safety duty is not consistent with Occupational Health and Safety/ Worker Health and Safety laws which accompany a primary safety duty with a range of preventative duties that can be readily enforced to encourage compliance. In contrast the proposed primary duty is generally only enforced retrospectively after a fatality or other major breach.

The primary safety duty can be improved with additional prescriptive standards applying to the ADSE and officers within the proponent. This can include for example, establishing safety objectives as part of the SAS, forming a high level representative group to oversee the ongoing management and audit of the SAS with responsibilities to monitor the progress towards achieving the safety objectives and ensure these continue to improve safety, ensuring product liability insurance is maintained and management and release of data.

The additional prescriptive responsibilities will significantly improve understanding of the complexity of the primary safety duty and assist compliance and achievement of the safety objectives. Otherwise the proposed system/ single liability is overly complex for small start-ups and is likely to only favour large well-resourced proponents. This in turn risks stifling much innovation and loss of innovative safety improvements.

3.4.1 Insurance implications

It is noted the latest insurance trends indicate a likely substantial premium for automated vehicles due to recognised inability of insurance actuaries to price AV risk for many years ahead. Increases in cost of premiums is being experienced by many ADVI partners, seeking to undertake testing and deployment of AV. Such significant premium increase and the complexity of the proposals is likely to stifle much expected innovation towards safety and only suit large companies unless the primary safety duty is significantly improved.

Consistent with OHS/ WHS law, regulators should also be well resourced with guaranteed funding, both for compliance but also for education and building awareness to further promote better understanding of the required process and achievement of safety.

Consideration should also be given to clarifying the requirements of the safety duty of both the ADS and the user, to ensure that it clear that there is a duty for the vehicle owner to update the ADS of their vehicle. As currently applies, owners and drivers are required to maintain vehicles in a roadworthy condition and this obligation can be widened through the project to update road law to include obligation to readily update SAS systems with appropriate penalties to operate a vehicle that has not been made.

In order to optimise road safety, it is important to retain the primary safety duty, provided the duty is supplemented as proposed above. As with OHS/ WHS penalties for breach of the primary safety duty must be appropriately high, appropriate to the risk, in order to provide sufficient deterrent for major safety breaches.

3.5 Additional safety concerns

ADVI has previously advised the NTC that there are significant risks with the timing of its work program to 2020. A recent visit in May 2018 to the USA by an Australian delegation was advised by US Government Politician's, regulators and industry that level 4 vehicles will be commercially available in the USA in 2019. It is therefore reasonable to expect that level 4 vehicles will be available in Australia capable of specific use cases, in 2020, and we need to prepare our regulatory framework accordingly.

This would pre-date the expected roll out of the regulatory changes given the likely average of at least 12 months until jurisdictions are able to implement the approved amendments[2].

It is noted that the Commonwealth Government is working with UN to develop Automated Vehicle standards and this is likely to be completed within a few years to replace all or most of NTC standards as the new AV standards are added to the Australian Road Rules.

The timing of these amendments may occur at about the same time as the finalisation of the associated NTC work program. This risks the NTC end-to-end regulation proposal becoming out-of-date very quickly, if not redundant before implementation.

[2] Refer to the time taken to introduce the National Heavy Vehicle Regulator and the fact that not all States and Territories have aligned to date.

3.6 Caution about introducing alternative road law

It is also noted the NTC proposal to develop alternative road law for automated vehicles. This is a concern as this creates the potential for gaps and overlaps of the different requirements applying to road users or an ADSE.

Moreover, exempting an ADSE from specific road law will remove the motivation for manufacturers to manage or address these safety risks. For example, the obligation on a driver to ensure all passengers or a load on a trailer are properly restrained. In both examples technology is already available that alerts a driver where the legal duty may not be met.

Requiring manufacturers to meet all standards where practical will further improve safety by ensuring an automated.

4. Addressing unintended impacts

In addition to the safety concerns noted there are also a number of unintended impacts that may result from the NTC proposals. These include:

- A significant increase in vehicles on road
- Mode shift from public transport to private vehicles
- Potential Monopoly control of large vehicle fleets
- Lack of consumer control over personal mobility
- Limited access to data. There is a need for access to and wider use of all data as a basis for generating large number of service providers across a wide range of diverse mobility solutions (see the 'root and branch' institutional reform approach in Finland)
- The likely creation of AV fleets as platform technologies controlling in-vehicle time allocation (sales, marketing, etc).
- The SAADs report suggests for example that existing privacy regulations are sufficient, but this is in the context of limited current access to data.

These impacts should be researched as part of the NTC work program as it is understood legal requirements may be required to resolve the issues.

The SAAD report suggests that a national body would be required (page 31) to administer the Option 4 requirements for ADSEs in relation to their 'primary safety duty'. Rather than establishing a national body to focus on this discrete area, consideration could be given to a body that has a broader focus on future mobility to mitigate these unintended consequences.

5. Other Areas of Consideration

5.1 Public Transport Integration

While the SAADs paper suggests that driverless rail is out of scope this raises the question of how public transport is intended to integrate with AVs. It is likely that for example, successful introduction of Level 4 and Level 5 AVs will significantly impact on local bus and rail networks.

The bus networks around Australia typically operate at 40% seat occupancy. Local buses for example may potentially be replaced by a combination of taxibots, demand buses and trunk bus networks.

It is critical that AVs either integrate with public transport or pricing, availability and coverage is regulated. Private AVs should communicate/ integrate with public transport to incentivise use of high capacity public transport.

5.2 Connectivity

The narrowness of the NTC preferred option becomes more apparent considering the real transport objective in Australia, which is Connected Automated Vehicles. ADSs need to communicate and connect (be interoperable). Consideration needs to be given quickly about what standards are required to achieve this objective?

5.3 Assessment in the absence of agreed national or international standards

The NTC proposal is for OEMs to demonstrate that an ADS is safe. The standards to be utilised according to the NTC (where applicable only) are those developed by established standards organisations. However, there are no agreed standards for ADSs

Referring to the first two principles will ADSs also have safety ratings similar to ANCAP? Based on the safety principles approach (safe system design and validation processes and the operational design domain) it is important to consider that the actual design of an ADS is a black box should a Turing test or Turing Stamp be required for the AI component[3]..

5-4 Policing of Operational Design Domain application

Operational design domain definition begs the question of how it will be policed? Is it an automatic fine linked to a central database, or can the system be made to not operate outside of the agreed domain, the latter relying on programming by the ADSE. These issues need to complement any approval that is limited to a specified design domain

5.5 Dealing with Network Disruption

Network control and disruption is not considered under this proposal. GPS and cellular networks such as LTE and the imminent arrival of 5G networks are critical. For example, what level of redundancy is required to address the 'Canyon Effect'? What level of responsibility do the network providers take? These additional consideration need to be thoughtfully considered in a broader view.

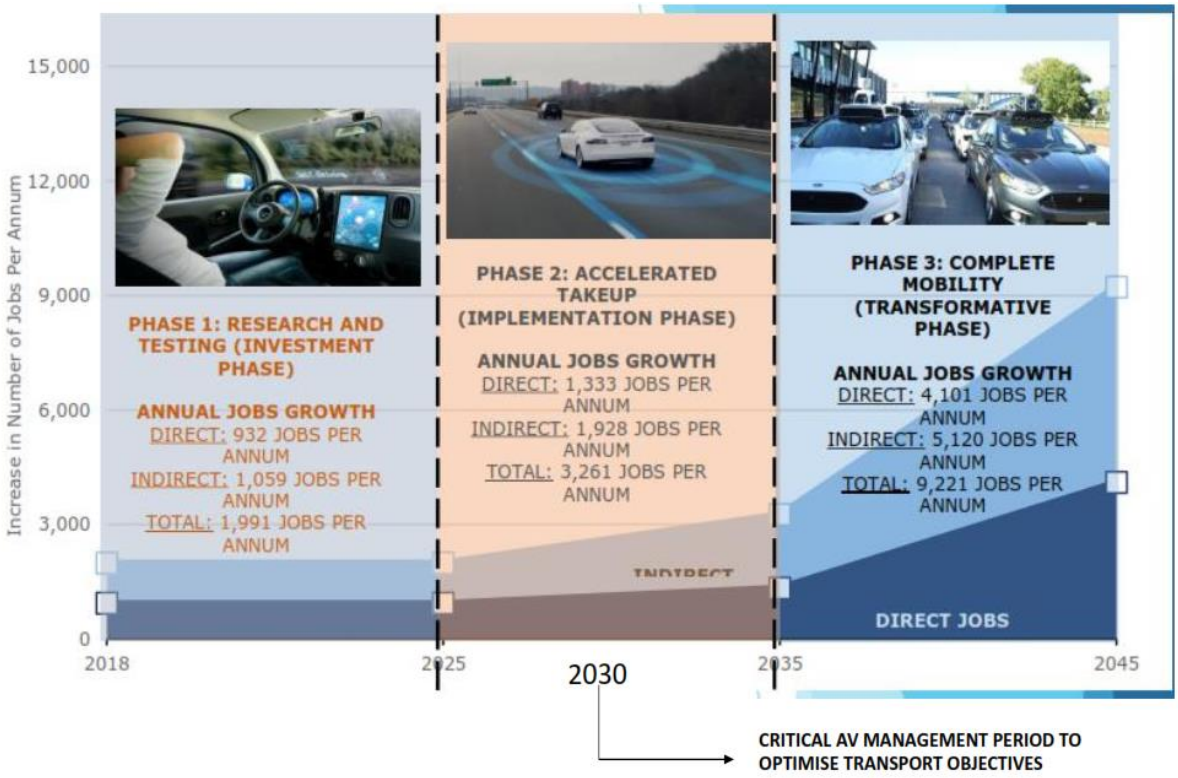
[3] Australia's Chief Scientist has suggested a voluntary Turing Stamp could be applied to AI based products (see The Conversation, May 2018)

5.7 Community Service Obligations

Currently there is no discussion about Community Service Obligations to ensure that regional and remote Australians are not further disadvantaged by not having access to these technology and allied benefits. As per the existing Telstra requirements to provide services to be operational in rural and remote areas, is there opportunity to do something similar with ADSE?

We again encourage the NTC to consider these issues raised as part of its work program.

For example, the approach in Finland which seeks to maximise transport providers through the introduction of a Mobility as a Service (MaaS) framework. Transport Network objectives should include low cost travel, optimal use of infrastructure, optimal use of public transport, privacy and charging for commercial use of kerb space and road space etc.



6 Comments on the Benefits

The case in the SAADs for early introduction of AVs is based on 'materiality' (page 95) and consideration of the potential magnitude of benefits. Whilst the NTC suggests that benefits should be considered against regulatory costs and costs to Government the SAADs report does not estimate regulatory and cost benefits and is also constrained to high level analysis.

The resultant figures of $607 million single year safety benefit with sensitivity modelling indicating benefits of $174 million to $780 million per annum appear to be extraordinarily low. For example, these levels of benefits at the low-end result in 25 less road deaths. This type of outcome would be achieved many simpler traditional ways.[4]

Costs to Government after start-up are not qualified but Tables 19, 20 and 21 (Page 102/3) suggest that significant operational costs are likely, purely from a safety assurance perspective.

Analysis of the expected benefits of AVs relies on research undertaken by third parties. Key findings include:

- Austroads estimates of 21% to 43% of road deaths / crashes avoided
- 40% penetration of cooperative cruise control required for greater than 10% increase in road capacity
- Likely increase in travel demand between 3% and 27%
- Shared AV should reduce 67% to 90% of conventional vehicles
- Shared AVs could reduce parking by 90%
- Significant fuel and energy savings from intersection design and efficient travel

The expected benefits are not included as part of the business case. These identified benefits need significant additional research to specify the use case and business case for AVs in Australia.

[4] The potential level of economic benefits is significantly higher than estimated by the NTC, hence the materiality of the case and funding for an Option 4 outcome are both understated.

7 Diverse Mobility Approach

Australia should take an aggressive approach to the introduction of AVs for much wider range of reasons and to achieve much broader objectives. Accordingly, the NTC Option 4 approach should be 'interim' and should be approved on the basis that far wider institutional reform is necessary.

Failure to take a broader approach will result in a freeway building frenzy for the next 10-15 years as the demand for road travel spikes in response to lower travel costs, productive in-vehicle time use and much better-quality transport options. De-regulation of the introduction of AVs should only be considered as part of deregulation of the wider transport network.

Major problems which can be addressed through a 'diverse mobility' approach as opposed to an 'AV only facilitation' approach include:

1. Productivity: improving labour force productivity
2. Wealth: improving access to jobs, education and health
3. Housing: improving access to lower cost housing
4. Infrastructure: improving the efficiency of existing road-based transport and controlling the expenditure in the transformation phase of AV implementation to minimise road expansion
5. Public Transport: increasing the quality and efficient use of public transport
6. Active transport: maximising short-term investment in active transport to minimise mode shift from PT to AV.

In short, whilst outside the work program of the NTC a National Diverse Mobility approach is considered necessary to transform mobility in Australia to focus on active transport, public transport, Connected and Automated Vehicles and ebikes to fill in the gaps.

Forecasted Connected and Automated Vehicle Uptake in the US, 2020 and 2030

Level of automation	Estimated uptake rates			
	2020		2030	
	Minimum	Maximum	Minimum	Maximum
Level 3	1.9%	3.5%	4.5%	8.4%
Level 4	2.0%	5.5%	10.3%	33.8%

Source: NTC Safety Assurance for Automated Driving Systems Consultation Regulation Impact Statement, May 2018, Table 25, Page 116. The uptake rates are based on forecasts in the US (Bansal + Kockelman, page 18. 2017).

NTC adapts research in the USA, Bansal and Kockelman (2017) to undertake analysis of likely AV take up rates, it is recommended that this work be done for Australia, to provide a clearer picture of what is expected.

The automation levels adopted in the NTC paper are different to the SAE levels. It is not clear if they are equivalent to SAE 4 and 5 but the NTC does not attempt to 'square up' the results. This begs the question of whether the NTC should specify Automation levels for Australia to achieve consistency.[5] [6]

Forecasted Australian Market Penetration of Highly Automated Vehicles

	2020		2030	
	Minimum	Maximum	Minimum	Maximum
Predicted passenger vehicle fleet size	14,923,322		17,739,043	
Predicted all vehicle fleet (excluding motorcycles)	19,007,822		22,594,204	
Level 3 – passenger vehicles	283,543	522,316	798,257	1,490,080
Level 3 – all vehicle types (excluding motorcycles)	361,149	665,274	1,016,739	1,897,913
Level 4 – passenger vehicles	298,466	820,783	1,827,121	5,995,797
Level 4 – all vehicle types (excluding motorcycles)	380,156	1,045,430	2,327,203	7,636,841
Combined levels 3 and 4 – passenger vehicles	582,009	1,343,099	2,625,378	7,485,877
Combined levels 3 and 4 – all vehicle types (excluding motor cycles)	741,305	1,710,704	3,343,942	9,534,754

Source: NTC Safety Assurance for Automated Driving Systems Consultation Regulation Impact Statement, May 2018, Table 26 Page 119

The NTC then analyses the rationale for early introduction of regulation and again utilising a very high-level approach. This results in 130,000 to 390,000 additional AVs on the road resulting in a net present value benefit of $154-$464 million. These figures are very subjective as we cannot really anticipate the take up of AV's until we better understand the commercial deployment model to be applied.

The maximum (9.5 million vehicles / 42% of fleet) and minimum (2.3 million vehicles, 14% of fleet) AV market penetration by 2030 suggests the need for very different policy responses. However, the forecasting technique based on growing a 19 million all vehicle fleet by 2% compounding and applying US market penetration rates raises many questions including:

- Will the vehicle fleet be significantly impacted by car share and ride share?

[5] The table outputs suggest that the McKinsey Levels 3 & 4 are similar to SAE Levels 3 & 4. For example the Table 26 maximum market penetration in Level 4 of 1.1 million vehicles cannot represent Level 5 fully automated 'taxibots'. Rather it is likely to represent Level 4 SAE.

[6] The midpoint of the 2030 minimum and maximum are consistent with the Haratsis (2017) forecasts i.e. at 2030 NTC forecasts 9.5 m combined levels 3 and 4 of all vehicles maximum and 3.3 m minimum. This compares with the Haratsis (2017) forecast of 6.9m maximum.

- Will Robo Taxis (level 5) in big fleets in the period 2023-2025?
- Will demand be a logistics curve (likely) rather than a straight line?

Mobility / transport in Australia accounts for around 10% of Australian GDP. Given the significance of the industry and the productivity benefits, early initiation of a National Diverse Mobility approach, with a remit not only to foster the early introduction of AVs, but to transform mobility in Australia including rural and regional Australia, has assumed a high level of urgency.

ATTACHMENT 1 - NTC WORK PROGRAM

Roadmap of reform – Current projects

We are implementing our roadmap of reform in phases to ensure we can prioritise the solutions based on when different levels of automation are likely to be commercially deployed.

Project	Purpose	Delivery date	Current status	Outcome
Automated vehicle trial guidelines	Develop national guidelines governing conditions for trials of automated vehicles.	May 2017	Completed	Support trials at all levels of automation. Ensure consistent trial conditions nationally. Support cross-border trials.
Clarifying control of automated vehicles	Develop national enforcement guidelines that clarify regulatory concepts of control and proper control for different levels of driving automation.	November 2017	Completed	Consistent application of law across jurisdictions.
Safety assurance system for automated vehicles	Design and develop a safety assurance regime for automated road vehicles.	November 2018	Analysing options	Support safe commercial deployment of vehicles at all levels of automation.
Changing driving laws to support automated vehicles	Develop legislative reform options to clarify the application of current driver and driving laws to automated vehicles, and to establish legal obligations for automated driving system (ADS) entities.	May 2018	Analysing options	Legal obligations of drivers support all levels of automation.
Automated vehicle exemption powers and compulsory third party insurance review	Support jurisdictions in reviewing current exemption powers to ensure legislation can support on-road trials. Support jurisdictions in reviewing injury insurance schemes to identify any eligibility barriers for occupants of an automated vehicle, or those involved in a crash with an automated vehicle.	2018	Planning	All Australian jurisdictions are able to support AV trials. Injury insurance schemes support all levels of automation.
Regulating government access to C-ITS and automated vehicle data	Develop options to manage government access to C-ITS and automated vehicle data that balances road safety and network efficiency outcomes and efficient enforcement of traffic laws with sufficient privacy protections for automated vehicle users.	May 2019	Analysing issues	Ensure privacy risks relating to government access (collection and use) of information generated by C-ITS and automated vehicle technology are appropriately addressed.

Other Australian government work:

Our work complements other government work preparing Australia for automated vehicles, including:

- The Commonwealth's Department of Infrastructure, Regional Development and Cities who is leading the national transport technology strategy, including addressing implications on cybersecurity, and keeping Australia's vehicle design rules up to date with international standards as they relate to automated vehicles.
- State and territory governments who are working on trials of these vehicles under their respective laws and regulations.
- Austroads who are exploring the impacts of connected and automated vehicles on traffic operations such as road infrastructure.

Together, we are working towards creating an end to end regulatory system that will allow for the safe, commercial deployment of automated vehicles in Australia from 2020.

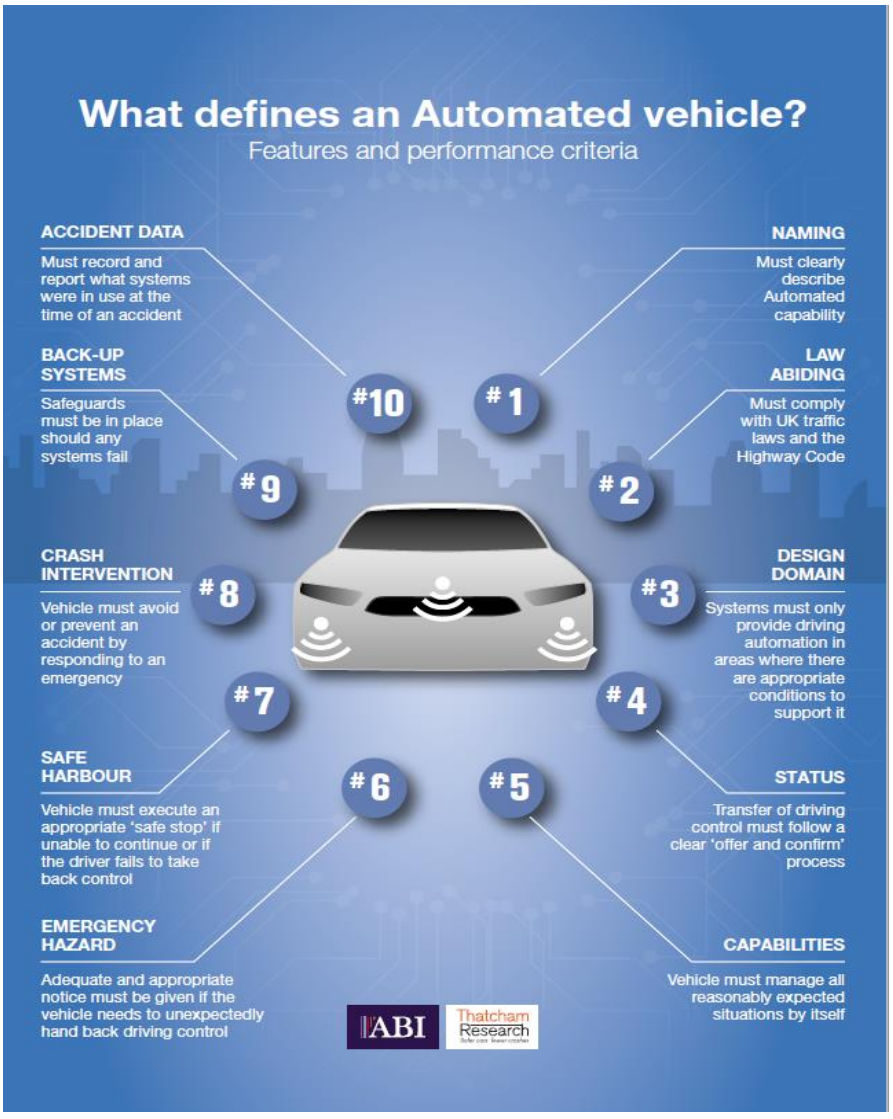
ATTACHMENT 2 – Proposed United Kingdom Automated Vehicle Standards

Automated Vehicle Standards – Thatcham Research UK standards

Motor industry body Thatcham Research and the Association of British Insurers (ABI) have produced a paper, 'Assisted and Automated Driving Definition and Assessment', which they say identifies dangerous grey areas.

These include misleading names, how and when drivers should take back control of their vehicles, and systems that are only designed to work in specific situations, such as on motorways, but can also function anywhere. The organisations say the paper comes in the wake of growing reports of people crashing while over-relying on technology that is not yet designed to drive the car independently.

The table below summarises the proposed automated vehicle standards for the United Kingdom.



Australia & New Zealand Driverless Vehicle Initiative

The table below outlines the proposed automated vehicle standards for the United Kingdom.

Automated Vehicle Criteria	
1. Naming	**The naming of the system must clearly specify Automated driving.** The description of the system must be unambiguous and clearly describe the Automated system functionality, limitations and driver responsibility.
2. Law Abiding	**Systems must abide by local traffic law including seat belt use, speed and driving behaviour.** The system must abide by Road Traffic Laws and follow the Highway Code including limiting speed to posted speed limits. Some exceptions may be permissible to avoid a collision or to deal with a developing emergency situation. Such exceptions and anticipated vehicle behaviour must be recorded in manufacturer documentation.
3. Design Domain	**Systems must only provide driving automation in areas where there are appropriate conditions to support driving automation. Systems must indicate to the driver where automation is available.** The system must be able to determine in what circumstances it is able to offer its driver an Automated Mode of operation taking into account, for example: the environment in which it is operating (type of road, car park, private drive etc); traffic conditions, road pavement conditions etc; weather; connectivity; and speed limit and/or average traffic speed.
4. Status	**Handover and hand back must follow a clear 'offer and confirm' process between driver and vehicle with appropriate notice.** The Automated Mode is only engaged after the vehicle has understood the planned journey and/or parking manoeuvre and confirmed it is safe to operate in the Automated Mode for all or part of that journey. When Automated Mode becomes available there must be a clear offer and confirm process from vehicle to driver. Similarly, the reverse must be true when the vehicle hands control back to the driver. Hand back from Automated Mode to manual driving must take place at a predetermined point in the journey (e.g. motorway off-ramp) with warnings given to the driver and a countdown timer from a minimum of 60 seconds. Driver monitoring must be in place to establish the level of driver engagement to ensure and appropriate handover is achieved. Should the driver fail to respond to a hand back request the vehicle must execute a 'safe harbour' manoeuvre, as described below.
5. Capabilities	**The system must provide driving automation which safely controls the vehicle in all reasonably foreseeable driving situations within the design domain environment.** The vehicle must be able to deal with any obstruction or incident that may appear in its path and not require involvement from, or monitoring by, the driver for any part of the journey where it is in an Automated Mode.
6. Emerging Hazard	**If the Automated Vehicle becomes aware of a situation which was unknown at the start of automation (e.g. poor weather) and which requires a handover to the driver earlier than planned, adequate and appropriate notice must be given.** Where such a situation arises, the vehicle must provide at a minimum a 60 second warning to the driver. The procedure must then follow that outlined for hand back under Status above, with the vehicle performing a 'safe harbour' manoeuvre should the driver fail to respond.

7. Safe Harbour	**If the driver fails to respond to a hand back request, the vehicle must execute a 'safe harbour' manoeuvre and navigate to a safe harbour appropriate to the design domain and traffic conditions.** Safe harbour will generally be in a position away from the main carriageways in heavy traffic. In certain circumstances safe harbour may be to stop in lane but this will vary depending on Design Domain, traffic conditions and road speed.
8. Crash Intervention	**If the vehicle senses an immediate unforeseen dangerous situation the system must initiate the minimum risk manoeuvre to avoid or mitigate a collision.** The vehicle must be able to use its available functionality to avoid or mitigate any collision to the best of its ability. Decisioning should be based on 'doing least harm'. It should not be expected to make ethical choices in life threatening circumstances.
9. Back-Up Systems	**The system must be fault tolerant so that in the event of a fault the vehicle can continue in its Automated Mode or provide a planned system handover to the driver.** Sufficient redundancy must be included within the vehicle systems to allow the Automated Mode to 'fail operational', that is to continue normally and safely with its journey whilst notifying the driver that an issue exists and its nature. As a minimum there must be sufficient redundancy for the vehicle to complete the planned journey in a reduced speed 'limp home' mode or to complete a controlled Offer and Confirm hand back to the driver. The system must have a self-diagnostic capability to detect faults and the functionality to communicate these to the driver. The system must also be capable of over the air (OTA) updates to its software or firmware and any such update deemed safety-critical must be applied automatically without any requirement for intervention or interference by the vehicle owner, operator or user.
10. Accident Data	**Data must be recorded in the event of a collision and made available to both manufacturer and insurer to quickly and impartially assess the status of Automated systems and extent of driver input leading up to the accident.** In the event of a collision, the vehicle must be able to record, and preferably transmit the minimum dataset, described in the Clarity on Driver Status: Shared Accident Data section below, via a suitable intermediary (or 'neutral server'). For the UK it is also proposed that the most suitable intermediary would be the Motor Insurers Bureau.

Australia &
New Zealand
Driverless Vehicle
Initiative