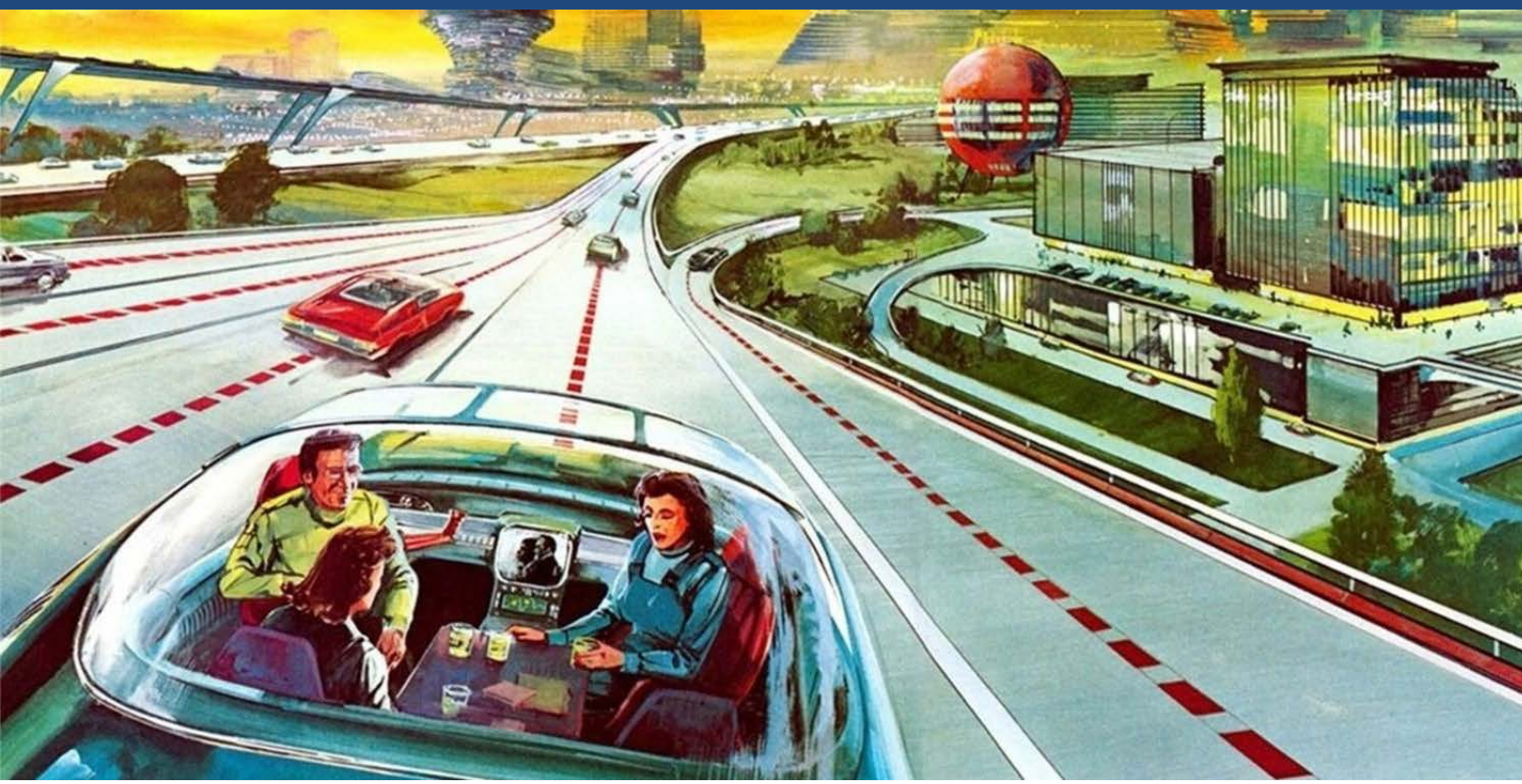
Parliamentary Library & Information Service
Department of Parliamentary Services
Parliament of Victoria

Research Paper



Automated Vehicles

No. 7, December 2017

Igor Dosen
Marianne Aroozoo
Michael Graham
Research & Inquiries Officers
Parliamentary Library & Information Service

Acknowledgments
The authors would like to thank Dr Ani Desai, Debra Reeves, Alice Petrie, Bella Lesman and Jon Breukel for their help in the preparation of this paper.

ISSN 2204-4752 (Print) 2204-4760 (Online)

Contents

Executive summary

This research paper will look at a number of issues related to automated vehicles, including regulation of, and legislation addressing, the testing of automated vehicles in Australia, as well as the likely economic impacts of introducing these vehicles and existing schemes in overseas jurisdictions. It will also present the potential benefits and obstacles related to the development and deployment of automated vehicles and discuss key issues that will face policy makers in Australia.

While automakers are committed to producing a driverless car, many experts agree that the development of a truly autonomous vehicle is unlikely (or is at least decades away). However, vehicles which can operate at high levels of automation and which will not require a driver for long periods of time are possible and imminent. Further, automakers predict that such vehicles will be brought to market by 2020. It is therefore vital that policy makers understand the implications of this emerging technology.

The development and deployment of automated vehicles will likely see a wide array of economic benefits. Because of the likely structural changes to the economy, a number of important economic impacts of the introduction of the technology have been raised. The first section of the paper focuses on three main areas of economic change: structural changes to private car ownership, ramifications for employment and product liability and insurance schemes. Research suggests that there will be a paradigm shift away from private car ownership towards automated ridesharing services or 'transport as a service'. Analysis shows that those employed primarily in driving roles, along with those working in related industries such as automotive production and operation, will be most affected. It is expected that insurance and product liability law will cope with the introduction of automated vehicles, though the National Transport Commission (NTC) is set to report further on this issue in 2018.

The second sections focuses on the current regulatory environment in Australia. The NTC has been tasked at the federal level with steering the regulatory reforms required for the safe introduction of automated vehicles from SAE level 3 and up. To date the NTC has produced guidelines for safe on-road testing, enforcement guidelines for police, and will be producing the regulatory impact statement for the COAG Council early in 2018. Victoria's regulatory reform has commenced with the introduction of the Road Safety Amendment (Automated Vehicles) Bill 2017 (Vic) for the testing of SAE levels 3, 4 and 5 vehicles in November 2017. South Australia has had an automated vehicle testing regime in place since 2016. Infrastructure Victoria are to advise the Victorian Government over the next year on the transport infrastructure investment required to meet the introduction of SAE levels 4 and 5 on Victorian roads, as well as advising on the anticipated changes in vehicle ownership and market models.

The final section of this research paper provides an international comparison of approaches to regulation of the driver and regulation of the testing and manufacturing of automated vehicles. It also provides descriptions of some of the more innovative trials occurring worldwide. Varying international jurisdictions differ in their approaches to regulating the testing and production of automated vehicles. However, policy and legislation across most jurisdictions share the view that a balance must be struck between encouraging speedy development and deployment of the technology on one hand, while ensuring that such development has appropriate legal safeguards on the other. The analysis shows that Australia tends to adopt vehicle safety laws which are generally consistent with the European approach. More broadly, the Automated Vehicles Bill 2017 is similar to the approach taken in both the EU and California.

Introduction

We are currently at the cusp of a transport revolution. The coming years will see a substantial change in the way transport is structured, while the traditional paradigm of private car ownership will be challenged[1]. At the centre of the coming disruption are automated vehicles. The last few years have seen huge investment in the technology from industry experts and manufacturers and it is clear that the question of automated vehicles must no longer be framed in the context of 'if', but instead 'when'.

At the end of this road lies the potential for the 'driverless' car. While highly automated vehicles are today primarily in developmental and testing stages, it is important for policy makers to formulate an approach as early as possible to ensure a smooth transition towards safe and economically sound driverless transport. The ascent of Uber and Airbnb has showed how technology can quickly gain traction while legislation and regulation play catch-up.[2] Policy makers must not be caught off-guard with the advent of automated vehicles, not only for public safety but for the broader structural and economic changes that will come with their introduction.

Part of this economic shift is being fuelled by the potential for automated vehicles to greatly improve safety.[3] This is certainly the driver for investment by automakers themselves. Despite these intentions, a significant concern of automakers, technology companies and financial institutions is a lack of clarity in regulation, which is subsequently reducing the potential for greater capital investment. Automated vehicles also pose far-reaching implications for issues such as insurance[4], data security and privacy[5], public infrastructure, and ethics[6], along with social and economic issues relating to private car ownership[7], ridesharing[8] and employment[9]. As the implications of the imminent widespread adoption of automated vehicle technology are so vast, the following paper aims to provide a snapshot of where the technology is now and, in doing so, aims to flag several important issues which are relevant to policy makers moving forward.

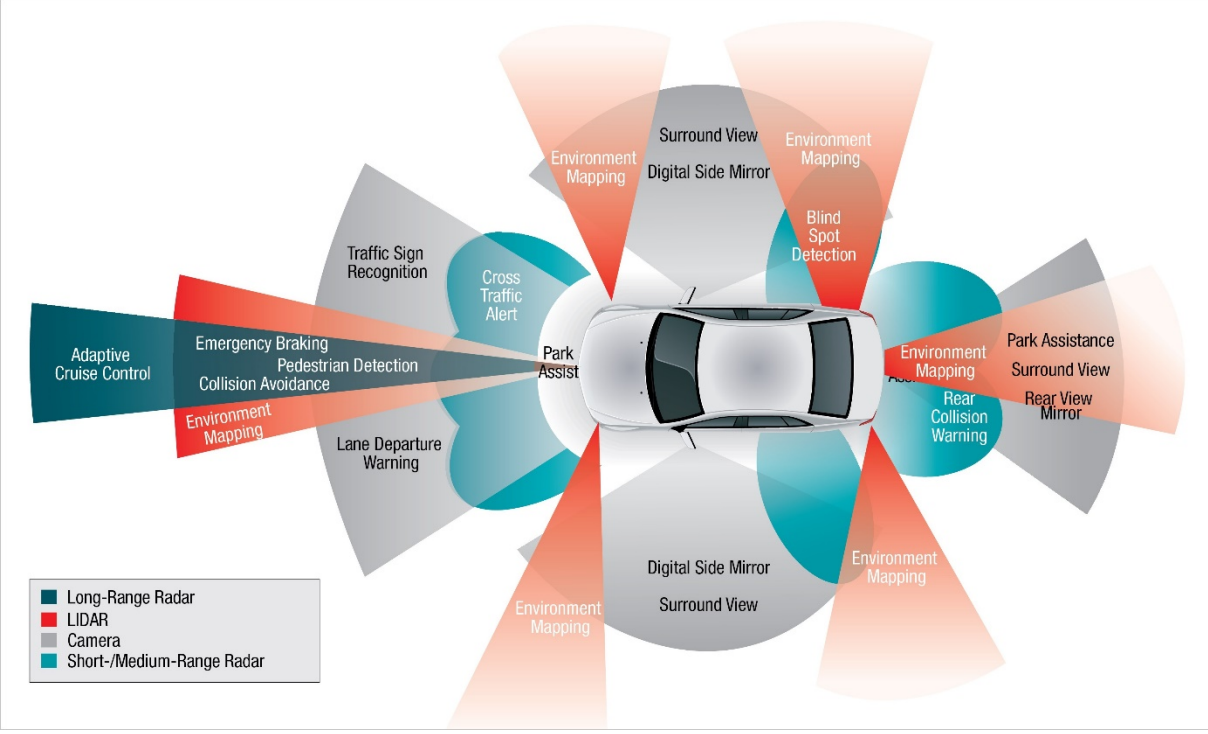
What are automated vehicles?

Automated vehicles have one or more aspects of the dynamic driving task performed by an automated system rather than the human driver.[10] Highly automated vehicles, or driverless cars, are vehicles capable of sensing their environment and navigating without human input. Autonomous or driverless vehicles use a number of cameras, sensors, radars, real-time maps and large quantities of data through

[1] J. Arbib & T. Seba (2017) *Rethinking Transportation 2020-2030*, RethinkX, May, p. 15.
[2] M. Johnston, M. Schulz & M. Dunn (2015) 'Uber Melbourne: Ride sharing service effectively illegal as driver guilty in landmark case', *Herald Sun*, 5 December.
[3] European Transport Safety Council (2016) *Prioritising the safety potential of automated driving in Europe*, Brussels, ETSC, April, p. 11.
[4] Clayton Utz (2016) *Driving into the future: regulating driverless vehicles in Australia*, Melbourne, Clayton Utz, p. 25.
[5] ibid., p. 28.
[6] Ethics Commission (2017) *Automated and connected driving*, Berlin, Federal Ministry of Transport and Digital Infrastructure, June, p. 6.
[7] National Roads and Motorists' Association (2017) *The future of car ownership*, Strathfield, NSW, NRMA, August.
[8] J. Arbib & T. Seba (2017) op. cit.
[9] Office of the Chief Economist (2017) *The Employment Impact of Autonomous Vehicles*, Washington, DC, US Department of Commerce, August.
[10] National Highway Traffic Safety Administration (2017) 'Automated Vehicles for Safety', Washington, DC, US Department of Transportation.

specialised software to paint a virtual picture of external traffic, road and environmental conditions. Figure 1 shows the technologies behind automated vehicles and their approximate location and range:

Figure 1. Technologies on an automated vehicle



Source: S. Ashley (2016) 'Centimeter-accurate GPS for self-driving vehicles', SAE International.

Consequently, different vehicles will operate at different levels of autonomy, depending on the particular technologies they use. In addressing the technology, the House of Representatives Standing Committee on Industry, Innovation, Science and Resources has recommended the use of the term 'automated vehicles'. This committee has also recommended formally accepting the standard definition for the automation level of vehicles as that used by the Society of Automotive Engineers (SAE) International Standard J3016.[11] The SAE classification system is the most widely accepted international standard by which to measure levels of vehicle autonomy. The classifications are derived from the amount of driver attentiveness and attention required, rather than vehicle capabilities.[12]

The table below outlines the levels of autonomy and the tasks the automated driving system (ADS) is expected to undertake at those levels:

Table 2. Levels of automation

SAE Level	Automation level	Description	Timing[13]
0	None	Human driver responsible for all aspects of driving task (no assistance – not even power steering)	Past

[11] Standing Committee on Industry, Innovation, Science and Resources (2017) *Social issues relating to land-based automated vehicles in Australia*, Canberra, The Committee, p. iii
[12] SAE International (2016) Automated Driving, SAE International.
[13] Standing Committee on Industry, Innovation, Science and Resources (2017) op. cit. p. 3; Australia and New Zealand Driverless Vehicle Initiative (2017) 'What is a driverless car?' ADVI website.

1	Driver assistance	In some circumstances the system is capable of either steering *or* acceleration (including braking), with the expectation that the human driver performs all remaining aspects of the driving task.	Past
2	Partial	In some circumstances the system is capable of *both* steering and acceleration / deceleration. The human driver must monitor the driving environment and respond as needed (hands on the wheel at all times)	Now
3	Conditional	Same as level 2, but when the system is operating in automated mode the human driver is not required to monitor the driving environment. The human driver must respond to requests from the driving system to intervene (hands off wheel – but must be prepared to take back control when prompted)	2017-2020
4	Highly	Same as level 3, but no human monitoring or intervention is required when the system is operating in automated mode (driver no longer needed)	2020-2025
5	Fully	Automated system in control at all times, and in all road environments (no steering wheel or driver's seat)	2026-2030

Source: Compiled form DIRD Submission to Standing Committee; ADVI website

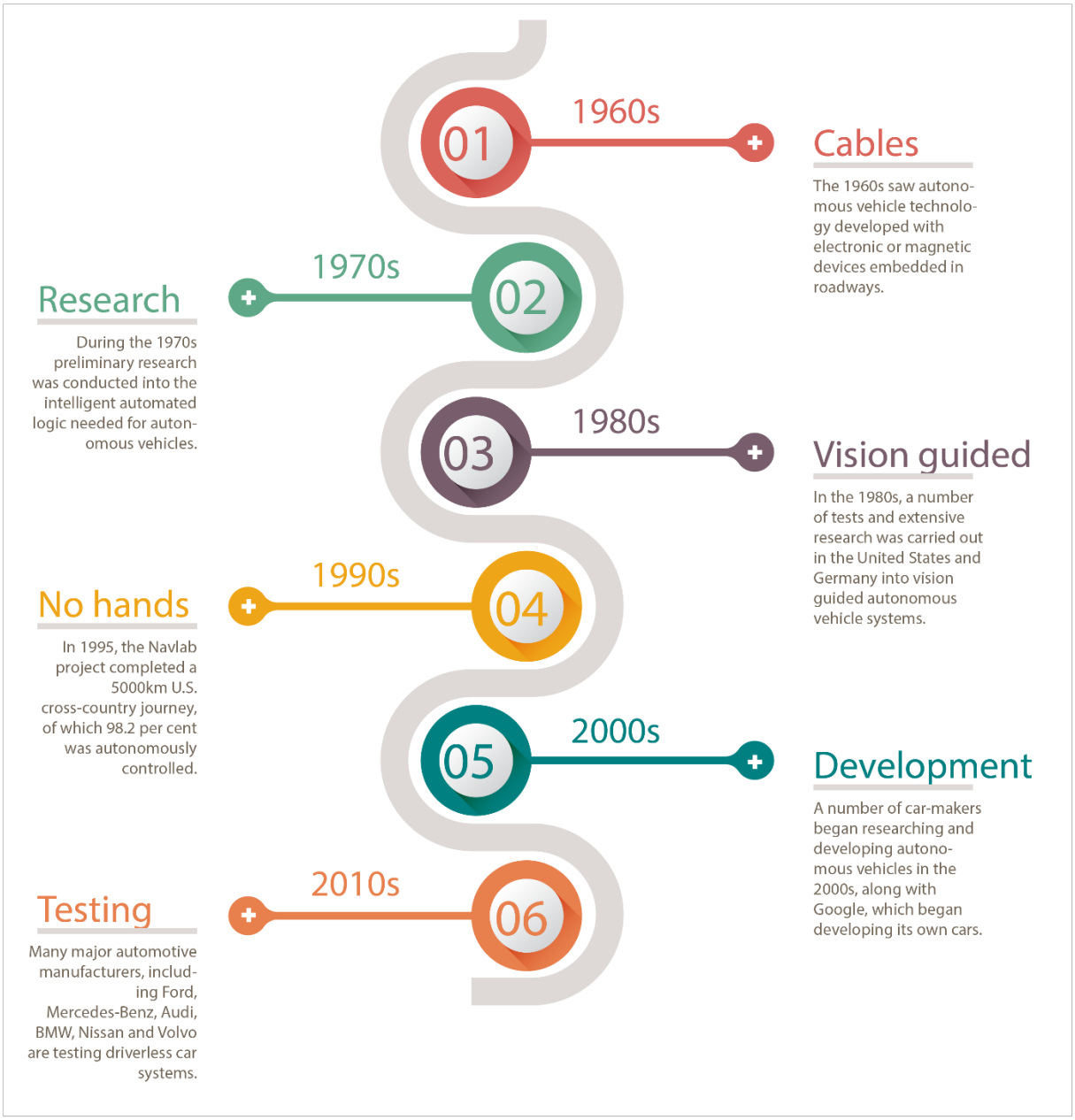
In this context, driverless vehicles would strictly apply to SAE levels 4 and 5. Level 1 and 2 vehicles are already commercially available in Australia and are used on public roads. Vehicles at higher levels are currently being utilised in controlled environments such as mining, or specific vehicle trials, for example, the RAC Intellibus used in Perth and on the Darwin Waterfront.[14] As this paper seeks to provide information on highly automated vehicle technologies, the phrase 'automated vehicles' will be used for vehicles at SAE levels 3 to 5 unless otherwise stated.

A brief history

Although the concept of driverless cars is seen as something that has only recently begun to emerge, experiments have been conducted on automated vehicle technologies since at least the 1920s.[15] The first truly driverless cars were developed in the 1980s at Carnegie Mellon University's Navlaband and Bundeswehr University Munich's Eureka Prometheus Project.[16] Since these relatively early developments, a number of major companies and research organisations have developed automated vehicles, including; Google, Oxford University, Volvo, Audi, Nissan, Bosch, General Motors and Mercedes-Benz. Figure 2 below outlines some of the key achievements and historical developments regarding automated vehicles.

[14] Standing Committee on Industry, Innovation, Science and Resources (2017) op. cit., pp. 3-4
[15] A. King (2016) 'The Fascination With Self-Driving Cars Started Nearly 100 Years Ago', in *Jalopnik*, 26 June.
[16] The Robotics Institute (2017) 'Navlab: The Carnegie Mellon University Navigation Laboratory', Pittsburgh, PA, Robotics Institute website.

Figure 2. Key achievements and historical developments in automated vehicles technology



Source: Parliament of Victoria (2017).

Why now?

'Ninety-eight per cent of driving is just following the dotted line. It's the other two per cent that matters'.[17] The two per cent that matters has been the development of a vehicle which can effectively and safely detect its environment in order to drive without any human input. Although the development of such technology spans several decades, there are three key factors as to why highly automated vehicles are poised to enter the market only now.

The first is economic viability. Previously, it was not economically or commercially viable to produce automated vehicles because of the substantial costs involved in designing, building and maintaining the technology.[18] The second is safety improvements in the technology. Only now are highly

[17] B. Bilger (2013) 'Auto Correct', *The New Yorker*, 25 November.
[18] S. LeVine (2017) 'What it really costs to turn a car into a self-driving vehicle', *Quartz*, 5 March.

automated vehicles beginning to operate at an accepted level of safety. These improvements in automated driving technology mean that automated vehicles are potentially safer than human drivers.[19] Thirdly, technology is maturing into deliverable systems. Technology in the field of sensors, radar, cameras and computing has been rapidly developing and has now come to a point where it can be combined in order to operate a vehicle with high levels of automation.

Predictions and forecasts

A number of organisations, institutions, manufacturers and individuals have made forecasts and predictions regarding the commercial introduction of automated vehicles. A highly influential report from RethinkX predicts that in the United States:

- self-driving cars will launch to the general public around 2021;
- a private ride will be priced at 16c per mile, falling to 10c over time;
- a shared ride will be priced at 5c per mile, falling to 3c over time; [20]
- by 2022, oil use will have peaked;
- by 2023, used car prices will crash as people give up their vehicles. New car sales for individuals will drop to nearly zero; and
- by 2030, gasoline use for cars will have dropped to near zero, and total crude oil use will have dropped by 30 per cent compared to today.[21]

Industry announcements

The following recent developments and announcements by automakers and industry players support similar forecasts:

- at the Bosch Connected World 2017 conference, NVIDIVA announced that it will provide technology enabling SAE level 4 automated driving capabilities by the end of 2018;[22]
- Audi announced that a self-driving Audi will be available for purchase by 2020;[23]
- NuTonomy is set to provide self-driving taxi services in Singapore by 2018, with plans to expand to ten cities around the world by 2020;[24]
- MobilEye and Delphi have announced they will provide an off-the-shelf self-driving system into the market by 2019;[25]
- the CEO of Ford has said that the company plans fully automated vehicles for mobility services by 2021;[26]
- Volkswagen predicts the first self-driving cars to hit the market 2019;[27]
- General Motors has outlined that automated vehicles will most likely be deployed by 2020 or sooner;[28]and

[19] C. Thompson (2016) 'Why driverless cars will be safer than human drivers', *Business Insider*, 17 November.
[20] All figures are in USD and are given for the United States of America.
[21] J. Arbib & T. Seba (2017) op. cit.
[22] D. Shapiro (2016) 'NVIDIA and Bosch Announce AI Self-Driving Car Computer', *Nvidia*, 16 March.
[23] P. E. Ross (2017) 'CES 2017: Nvidia and Audi Say They'll Field a Level 4 Autonomous Car in Three Years', IEEE Spectrum, 5 January.
[24] M. Abbugao (2016) 'Driverless taxi firm eyes operations in 10 cities by 2020', *Yahoo*, 30 August.
[25] A. J. Hawkins (2016) 'Delphi and Mobileye are teaming up to build a self-driving system by 2019', *The Verge*, 23 August.
[26] A. Sage & P. Lienert (2016) 'Ford plans self-driving car for ride share fleets in 2021', *Reuters*, 16 August.
[27] S. Frank (2016) 'Die Zukunft nach dem Abgas-Skandal', *Focus Magazin*, 24 April.
[28] J. D. Stoll (2016) 'GM Executive Credits Silicon Valley for Accelerating Development of Self-Driving Cars', *The Wall Street Journal*, 10 May.

Economic impacts of automated vehicles

The economic implications of automated vehicles—particularly fleet operated driverless cars—will be the driving force behind greater development and implementation of the technology. As fully automated vehicles become increasingly viable, it is only a matter of time until they are sufficiently safe, reliable and affordable to be widely deployed. Once these measures are met, automated vehicles will gain greater market penetration, generating significant economic ripple effects throughout a number of industries.[29]

Indeed, many of the potential benefits that automated vehicles offer to consumers and society as a whole are economic in nature. Despite this understanding, there is a dearth of information addressed to the economic impacts of the introduction of the technology. The list below therefore offers the most important potential benefits of automated vehicles as discussed in the US context, but which are also widely applicable to the Australian context:

- reduced number of road accidents—accidents cost the economy a large amount of money, but with reduced accident rates lives will also be saved. The US National Highway Traffic Safety Administration (NHTSA) has estimated that 94 per cent of traffic accidents can be attributed to human error;[30]
- increased productivity—a major source of savings is the time freed up that is currently used to drive a vehicle;
- greater efficiency:
  - Reduced congestion—with fewer traffic accidents there will be fewer reasons for slowdowns in traffic. Traffic accidents in the US account for 25 per cent of congestion and this could be greatly reduced with the introduction of safer vehicles.[31]
  - Increased lane capacity—the ability of automated vehicles to platoon[32] allows them to operate at higher speeds and at reduced space between vehicles, which can lead to a 500 per cent increase in lane capacity;[33]
- space saving—automated vehicles will have an impact on the way city infrastructure is designed and built. Parking lots occupy large areas of valuable real estate in cities which will become available for other purposes; and
- affordability—private vehicle ownership will no longer be necessary for fast and convenient transport.

A new paradigm in transport

The deployment of automated vehicles is likely to result in the rise of transport-as-a-service (TaaS). TaaS is the shift away from privately owned vehicles and modes of transport to mobility solutions that are consumed as a service, much like ridesharing today.[34] Mobility service providers currently

[29] L. M. Clements & K. M. Kockelman (2017) 'Economic Effects of Automated Vehicles' in *Transportation Research Record* No. 2602,

[30] Energy Information Administration (2017) *Study of Potential Energy Consumption Impacts of Connected and Automated Vehicles*, Washington, DC, U.S. Department of Energy, March, p. iv.

[31] ibid., p. 45.

[32] Platooning refers to a method of increasing the capacity of roads using electronic coupling, allowing automated vehicles to accelerate or brake simultaneously, meaning the gap between vehicles can be significantly reduced.

[33] J. M. Anderson et al. (2016) *Autonomous Vehicle Technology: A Guide for Policymakers*, Santa Monica, Rand Corporation, p. 21.

[34] J. Arbib & T. Seba (2017) op. cit.

operating include ridesharing and e-hailing services, bike-sharing programs and car-sharing services. The anticipation of fully deployed automated vehicles will put in question the economic benefit of private vehicle ownership, as on-demand car services are expected to become significantly more affordable.

Possible implications and characteristics of wide-scale automated vehicle deployment will be felt on a macroeconomic level. The change will be network wide and national in scale. This large scale shift is expected to improve access to labour, markets and goods. It is therefore widely accepted that the introduction of these technologies will positively stimulate shifts in supply and demand curves, characterised by economies of scale, new markets and new services.

Infrastructure Australia has estimated that the future avoidable social costs of traffic congestion in Australian cities are up to $53.3 billion per annum by 2031.[35] Currently, the Department of Infrastructure and Regional Development (DIRD) estimates that the annual economic loss of road crashes is $27 billion per annum.[36] Thus, the total avoidable costs of introducing automated vehicles to Australia represents an estimated $80 billion.[37]

Private vehicle ownership

Car ownership occupies a central tenet in the Australian mindset, having been part of the Australian family for at least three generations. As a result, private cars have served as an expensive convenience in Australia for many decades, but at the same time represent an extremely inefficient asset. It is currently estimated that cars are parked 95 per cent of the time.[38] Growing trends worldwide—such as increasing levels of car sharing, carpooling and on-demand services—are pointing to a future in which there is decreasing uptake of private vehicle ownership. The NRMA outlines that 'mobility will no longer be a privately-funded undertaking, but an evolving and efficient service supported by interconnected modes of transport'.[39]

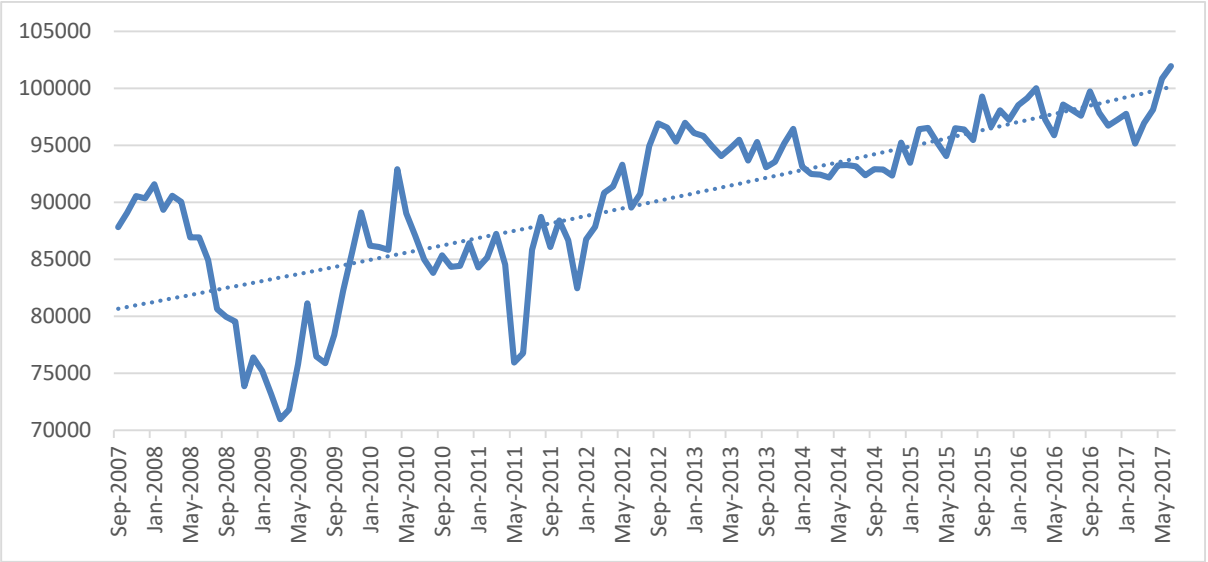
Australian cities have been planned and have expanded around the concept of vehicular mobility. The suburban structure of Australian cities is designed for the use of privately owned cars as our fundamental mode of transport. However, the evolution and deployment of automated vehicles in Australia will most likely make private vehicle ownership unnecessary for the majority of people.[40]

Although in Australia there remains a healthy demand for new vehicles, a change of thinking is slowly gripping a wide array of industries. This change is exemplified by the KPMG Global Auto Executive Survey, which is considered the leading marker on trends within the automotive industry. In 2009, the terms 'automated vehicle', 'driverless vehicle' or 'self-driving vehicle' were not mentioned. Yet in 2017, 'mobility-as-a-Service/car sharing' and 'automated and self-driving cars' were at eight and nine respectively in the top ten issues list.[41] However, due to Australia's heavy reliance on private cars, vehicle sales have tended to remain relatively steady. The chart below outlines the total number of new vehicle sales in Australia for the past decade.

---

[35] Infrastructure Partnerships Australia (2017) *Automated Vehicles: Do We Know Which Road to Take?*, Sydney, IPA.
[36] Department of Infrastructure and Regional Development, 'Road Safety', Canberra, DIRD.
[37] B. Haratsis (2016) *Economics Impacts of Automated Vehicles on Jobs and Investment*, Australia Driverless Vehicle Initiative, September.
[38] D. Z. Morris (2016) 'Today's Cars Are Parked 95% of the Time' *Fortune*, 14 March 2016
[39] National Roads and Motorists' Association (2017) *The future of car ownership*, Strathfield, NRMA, August, p. 6.
[40] ibid.
[41] ibid., p. 8.

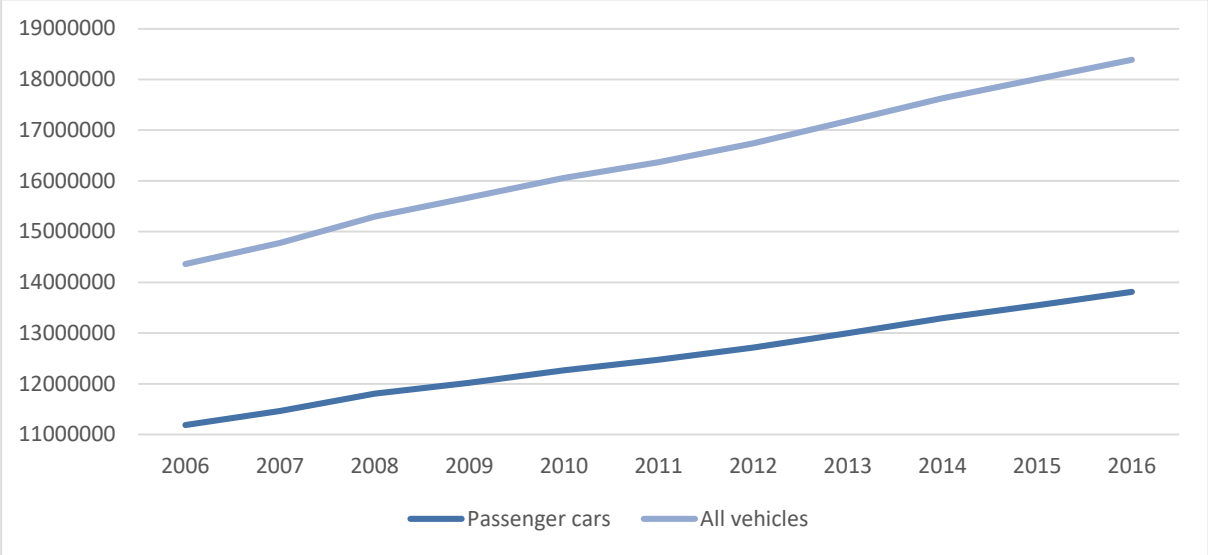
Chart 3. Total vehicles, Australia, seasonally adjusted.



Source: ABS 9314.0 – Table 1: New Motor Vehicles Sales by Type, Aust. Total vehicles, seasonally adjusted.

Australians value car ownership because it is viewed as safe, comfortable and peaceful when compared to public transport.[42] This is reflected in car ownership statistics, as there are currently about 18.8 million registered motor vehicles in Australia, with a 2.1 per cent increase between 2016 and 2017.[43] The chart below outlines the change in the stock of registered motor vehicles in Australia for the decade 2006-16.

Chart 4. Registered vehicles, Australia



Source: Department of Infrastructure and Regional Development (2016) *Australian infrastructure statistics – yearbook 2016*, Commonwealth of Australia, Canberra, p. 87.

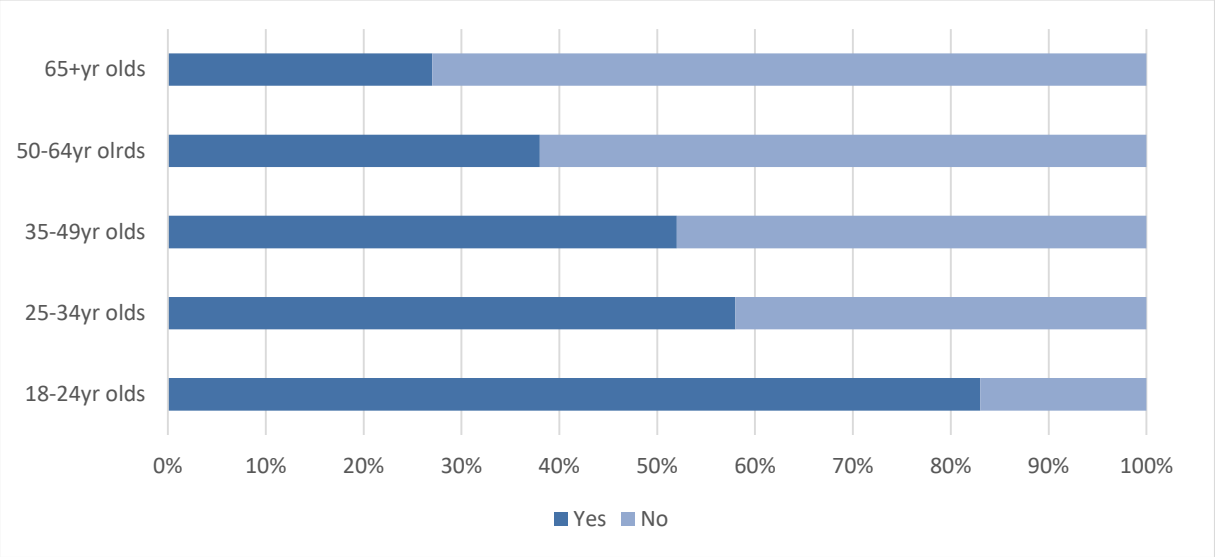
While private vehicle purchase rates and stocks of registered vehicles have increased consistently for a number of decades, they are not a clear indicator of whether car ownership will continue into the future.[44] A study by the Boston Consulting Group concluded that although car sharing is expected to

[42] Ibid., p. 9.
[43] Australian Bureau Statistics (2017) *Motor Vehicle Census*, cat. no.9309.0, Canberra, ABS, 31 January.
[44] National Roads and Motorists' Association (2017) op. cit. p. 11.

increase fairly quickly and widely, there will be minimal effects on new car sales, as many drivers will not give up ownership entirely and a share of lost car sales will be offset by sales into car sharing fleets.[45]

A further issue is consumer acceptance of the technology. Research has found that 46 per cent of Australians are willing to travel in automated vehicles, 51 per cent of men compared to 41 per cent of women. The majority of those under 50 years old are ready for the new technology. The chart below gives a more detailed picture on the analysis by age:

Chart 5. Willingness to use automated vehicle technology



Source: Roy Morgan Research (2017) 'Australian want driverless cars – NOW', 6 April.

The research also finds that residents of New South Wales are the most welcoming of automated vehicles, with 49 per cent saying they would use the technology. The least welcoming is Tasmania, where the 'yes' response was 34 per cent, while Victoria stood at 43 per cent.[46]

Employment

Much of the focus on automated vehicles has been related to how they will affect personal mobility, however, they will also transform the way businesses provide goods and services. Importantly, automated vehicles will most likely drive a capital investment in labour saving technology with the potential to completely substitute labour currently assigned to driving.[47] Previous research has shown that the impact of automation on labour will depend on the characteristics of the services provided by workers, including the degree to which an occupation consists of routine and easily automatable tasks.[48] This means that while automated vehicle implementation will inevitably eliminate jobs, there is the potential for an increase in demand for some existing tasks and for the creation entirely new tasks requiring new skills.

The Standing Committee on Industry, Innovation, Science and Resources has argued that 'both governments and industry should begin the process of preparing for the automation-led transition of

[45] J. Bert, et al. (2016) *What's Ahead for Car Sharing*, Boston Consulting Group, February.
[46] Roy Morgan Research (2017) 'Australian want driverless cars – NOW', *Findings no. 7209,* 6 April.
[47] Office of the Chief Economist (2017) *The Employment Impact of Autonomous Vehicles*, Washington, DC, U.S Department of Commerce, August.
[48] C. B. Frey & M. A. Osborne (2013) *The Future of Employment: How Susceptible are Jobs to Computerisation?* Oxford, Oxford Martin School, University of Oxford.

the Australian workforce as soon as possible in order to minimise any potential negative effects'.[49] The Australian Academy of Technology and Engineering (ATSE) has indicated that automated vehicles will have a wide impact on employment on a global level in the short and medium term.[50] Modelling conducted by the Committee for Economic Development of Australia shows that in Australia, five million jobs have a high probability of being replaced due to technological, socioeconomic and demographic factors.[51]

Professional drivers

The DIRD has outlined that professional driving roles are most likely to be affected by the deployment of automated vehicles. To place this in perspective, in 2015 around 247,000 people were employed in driving trucks, buses and taxis in Australia.[52]

Nonetheless, employment changes may be manageable as there are several mitigating factors which could reduce the risk of unemployment for professional drivers. The Department of Industry, Innovation and Science (DIIS) suggests that any wide-scale adoption of highly automated vehicles will take decades rather than years.[53] If such an assumption is correct, a gradual shift towards automation would allow opportunities for labour to be absorbed by other industries. This argument is also supported by the fact that an estimated one million people have changed jobs every year over the past five years.[54]

The DIIS also notes the changing demographics in the professional driving sector, specifically a continued increase in the age profile of employees over the last 30 years.[55] In 2016, over half of workers in the professional driving industry were 45 and over.[56] Thus, the DIIS argues that automation will reduce new entrants and allow older drivers to finish their careers, rather than displace the current workforce.[57] Even so, it is likely there would be job losses and the Bus Industry Confederation has contended that the retraining and redeployment of older workers will pose significant challenges to government and employers.[58]

Findings by the US Office of the Chief Economist generally support the DIIS estimates and suggest that workers in primarily professional driving occupations may have difficulty finding alternative employment paths.[59] This is due to a range of factors, but most importantly: 'workers in motor vehicle operators jobs are older, less educated, and for the most part have fewer transferable skills than other

[49] Standing Committee on Industry, Innovation, Science and Resources (2017) op. cit, p. 47.
[50] ibid.
[51] Australian Academy of Technology and Engineering (2017) Submission 38: to Standing Committee on Industry, Innovation, Science and Resources *Inquiry into Social issues relation to land-based automated vehicles in Australia*, The Committee, August, pp. 2-3.
[52] Standing Committee on Industry, Innovation, Science and Resources (2017) op. cit., p. 49.
[53] Department of Industry, Innovation and Science (2017) Submission 29 to the Standing Committee on Industry, Innovation, Science and Resources. *Inquiry into Social issues relation to land-based automated vehicles in Australia*, Canberra, The Committee, p. 6.
[54] ibid., p. 6.
[55] ibid.
[56] ibid.
[57] ibid.
[58] Bus Industry Confederation (2017) Submission 27 to the Standing Committee on Industry, Innovation, Science and Resources. *Inquiry into Social issues relation to land-based automated vehicles in Australia*, Canberra, The Committee, p. 7.
[59] Office of the Chief Economist (2017) op. cit. p. 19.

workers, especially the kinds of skills required for non-routine cognitive tasks'.[60] The requirements for new skills mean that governments will need to invest in education and retraining.

Related sectors

Automated vehicles are likely to have a consequential impact on many other sectors, primarily the broader vehicle industry. There are expected to be significant changes in employment structures and profiles, meaning some jobs will be phased out while others will be created.[61] It is also anticipated that automated vehicles will reduce the number and severity of motor vehicle accidents and collisions, leading to an expectation that employment numbers will fall for occupations that deal directly with the cause and effect of accidents.[62] These occupations include crash repairers, enforcement officers, insurers, highway patrol officers, parking officers, emergency service workers and crash investigation workers.[63]

Implications for employment go even further when considering the wide range of organisations and institutions directly or indirectly involved with the use of motor vehicles. Courts will likely see a reduction in caseload relating to traffic offences, potentially affecting employment for occupations such as registrars and lawyers.[64] There are also likely to be effects for the health sector and allied health professionals insofar as a reduction in road accidents occurs.[65]

New jobs

Although there will inevitably be job losses caused by structural changes to employment, these changes have the potential to create new jobs. Such jobs will be driven by an increase in demand in some existing sectors along with the establishment of new industries.[66] The DIRD has stated that 'there could be new roles in supplying, maintaining and operating automated vehicles, or other roles that use automated vehicles as a platform to deliver new kinds of services to the market'.[67] DIIS has identified increased employment prospects for Australian industry in manufacturing, mining, agriculture and integration with global value chains.[68]

Product liability and insurance in Australia

The impact of highly automated vehicles on Australian product liability law is currently unclear. Despite this lack of certainty, it is important to flag product liability as an issue for consideration for policy makers. Currently, the Australian Consumer Law (ACL) provides a regulatory system of obligations and warranties in order for manufacturers to meet quality and safety standards.[69] In reference to automated vehicles, manufacturer liability under the ACL will become clearer once the NTC has established the responsibilities of the legal entity responsible for the ADS.

There are two prevailing views on how the insurance industry will be impacted by the uptake of automated vehicles. One view is that the deployment and wide scale uptake of automated vehicle

---

[60] ibid., p. 19.
[61] Standing Committee on Industry, Innovation, Science and Resources (2017) op. cit.
[62] C. Thompson (2016) 'Why driverless cars will be safer than human drivers', *Business Insider*, 17 November.
[63] Department of Infrastructure and Regional Development, (2017) op. cit., p. 29.
[64] University of the Sunshine Coast (2017) Submission 37, to the Standing Committee on Industry, Innovation, Science and Resources. *Inquiry into Social issues relation to land-based automated vehicles in Australia*, Canberra, The Committee, p. 12.
[65] ibid.
[66] Standing Committee on Industry, Innovation, Science and Resources (2017) op. cit.
[67] Department of Infrastructure and Regional Development (2017) op. cit., p. 30.
[68] Department of Industry, Innovation and Science, op. cit., pp. 7 – 10.
[69] The Treasury (2013) *The Australian Consumer Law: A framework overview*, Canberra, Australian Government, p. 3.

could impact on the insurance industry.[70] Existing regimes could be disrupted due to a number of factors, including:

- changes to driver responsibility and liability;
- manufacturer responsibility for automated vehicle accidents;
- the possibility of new stakeholders becoming responsible for automated vehicle accidents;
- new risks associated with automated vehicle usage, particularly regarding malicious usage of automated vehicles; and
- new sources of liability for manufacturers, particularly third party losses caused by defects in automated vehicles.

Another view is that manufacturers, retailers, and other service providers will be served by commercial insurance services which are already available in the market.[71] In that sense, the regulatory issues will be whether minimum insurance standards should be imposed on these players in order to protect consumers.

As shown below, some jurisdictions have exempted automated vehicle manufacturers from compulsory third-party schemes and have imposed public insurance requirements. Others have allowed existing regimes to extend to cover automated vehicles.

Regulation

National Transport Commission Review of regulation

In November 2016, the COAG Transport and Infrastructure Council of state and territory transport ministers tasked the NTC to develop options for legislative reform to clarify the application of current driver and driving laws to automated vehicles and to establish legal obligations for automated driving system entities (ADSEs).[72] The current legislative framework is perceived as a barrier to the possible community benefits in terms of safety, productivity, environmental and mobility gains promised by automated vehicles. Paul Rette, Commissioner of the NTC, had stated that there were 716 potential issues with current laws that need to be reviewed.[73] The reform, however, has to ensure that public safety principles are not compromised.

The NTC's focus in its review of existing regulation is to establish who or what is in 'control' (the 'driver') of an automated vehicle and therefore where legal responsibility lies—particularly when there is an accident. Key road safety regulations are based on the assumption that the 'control' of a vehicle rests with a human driver.[74]

The first phase in the NTC reform process was the launch of a discussion paper on *National guidelines for automated vehicle trials* in November 2016.[75] The guidelines allow for on-road trials of automated

[70] KPMG (2015) *Marketplace of change: Automobile insurance in the era of autonomous vehicles, whitepaper*, [Amstelveen], KPMG, October.
[71] Clayton Utz (2016) *Driving into the future: regulating driverless vehicles in Australia*, Melbourne, Clayton Utz, p. 26.
[72] National Transport Commission (2017) *Changing driving laws to support automated vehicles,* Melbourne, NTC, p. 1.
[73] P. Retter (2016) 'Laws must overtake driverless cars', *The Age,* 10 May.
[74] National Transport Commission (2016) *Regulatory options for automated vehicles: discussion paper,* Melbourne, NTC, p. 6-7.
[75] National Transport Commission (2016) *National guidelines for automated vehicles trials: discussion paper*, Melbourne, NTC, p. 8.

vehicles under a single, nationally-agreed framework. The *National guidelines for trials of automated vehicles in Australia* was released in May 2017 following approval of state and territory transport ministers.[76]

In November 2017, the COAG Transport and Infrastructure Council agreed to the NTC's *National enforcement guidelines for automated vehicles* to assist police agencies when enforcing road rules for automated vehicles (up to SAE level 3).[77] The guidelines provide clarity on who has 'proper control' of the vehicle when the ADS is engaged in driving or parking. At this level of automation, the human driver remains responsible for complying with the road rules, and while not required to have 'hands on steering wheel', must be seated in the driver's seat and be alert enough to resume driving tasks if and when requested by the ADS. The guidelines will be reviewed when amendments to regulation are required to recognise ADSEs.[78]

The Council also agreed that the Australian government will aim to have 'end-to-end' regulatory system in place by 2020 to support the safe development of automated vehicles.[79] The new safety assurance framework being developed by the NTC will form the basis for the mandatory manufacturer self-certification scheme. The Council acknowledged that this will allow for a flexible approach to regulation as the technology and international standards develop. The framework will be subject to the Regulation Impact Statement being developed for the Council by the NTC and due in early 2018.[80]

The NTC has identified two levels of legislative reform to be developed concurrently, in time for the commercial deployment of high or fully (SAE levels 4 and 5) automated vehicles.[8l] That is, the stage where the ADS is in full control of operating the vehicle and there is a designated legal entity (ADSE) responsible for its operation. Firstly, legislative reform to establish a safety assurance system or scheme (for example, certification) for an ADS, which the NTC is currently developing. Secondly, the establishment of the legal entity (ADSE), that is, the entity responsible for the ADS (which could be the manufacturer, operator, legal owner or another entity).

In terms of recognising ADSEs, the NTC's preferred option is for the ADSE to be responsible only for those functions performed by the ADS ('dynamic' driving tasks). The NTC will investigate if there is a gap in the obligations for tasks that the ADS cannot control and if so, where the responsibility and obligations rest.[82] Clarifying the responsibilities of ADSEs will provide certainty for manufacturers and developers.

Federal regulation

The Australian Design Rules (ADR) provides the standards for the physical structure and operation of a newly manufactured or new or used imported vehicle and are based on international standards of design safety.[83] The ADR inform the *Motor Vehicle Standards Act 1989* (Cth) administered by the

[76] National Transport Commission (2017) *Guidelines for automated vehicles trials,* Melbourne, NTC,
[77] National Transport Commission (2017) *National enforcement guidelines for automated vehicles*, Melbourne, NTC. The guidelines do not at this stage extend to civil or criminal responsibility for crash or road trauma, and do not provide indicators for 'proper control' for SAE 4 or SAE 5 vehicles. (p. 2)
[78] National Transport Commission (2017) 'Clarifying control of automated vehicles', NTC website.
[79] Transport and Infrastructure Council (2017) 8th Meeting *Communique,* 10 November.
[80] National Transport Commission (2017) '*Towards 2020; transport ministers approve vital next phase of automated vehicle regulation*', media release, NTC website, 13 November.
[8l] National Transport Commission (2016) op. cit.
[82] National Transport Commission (2017) *Changing driving laws to support automated vehicles*, Melbourne, NTC, p. 55.
[83] Clayton Utz (2017) *Driving into the future: regulating driverless vehicles in Australia,* p. 11.

federal government and cover aspects such as occupant protection, lighting, noise, engine exhaust emissions, and braking.

The federal Australian Road Rules are a model law providing for uniform road safety rules for road users across Australia, including drivers, riders, passengers and pedestrians. These Rules are broadly consistent with the *1968 Vienna Convention on Road Traffic*. While they have no legal effect at the federal level, they are incorporated into state and territory road safety legislation. There are also rules specifically determined at state level, including rules for culpable driving and licensing.[84]

Victoria

The initial audit by the NTC in May 2016 of state and territory legislation that relates to automated vehicles identified the following Acts and regulations for Victoria:[85]

- *Road Safety Act 1986*
- *Transport (Compliance and Miscellaneous) Act 1983*
- *EastLink Project Act 2004*
- *Melbourne City Link Act 1995*
- *Crimes Act 1958 – culpable driving or dangerous driving causing death*
- *Transport (Compliance and Miscellaneous) (Conduct of Public Transport) Regulations 2015*
- *Transport (Buses, Taxi-Cabs and Other Commercial Passenger Vehicles) Regulations 2005*

In December 2016, VicRoads released the *Future directions paper* to provide an overview of the existing regulatory framework in relation to automated vehicles in Victoria. Feedback was sought on planned changes to the framework to support the development and trials of highly automated vehicle technology.[86] Up to this point, on-road trials in Victoria were supported by a Code of Practice based on the UK Code for testing driverless vehicles and modified for Victorian conditions and laws. [87] While the Code afforded more flexibility than legislation—requiring only compliance with the ADR and any necessary exemptions from the Australian Road Rules—automated vehicles could only be trialled on closed roads and would still require a human driver to be in control. As it served only as a guide, there were also no penalties under the Code for non-compliance.[88]

On 14 November 2017, the Minister for Transport, Luke Donellan, introduced the Road Safety Amendment (Automated Vehicles) Bill 2017 ('Automated Vehicles Bill').[89] The Bill seeks to amend the *Road Safety Act 1986* to establish a permit scheme for the trialling of automated vehicles on Victorian roads.

Safety is the overriding premise for the draft legislation with VicRoads being allocated powers to regulate safety management under the permit scheme. The scheme will allow for applications for the testing and development of ADS at SAE levels 3, 4 and 5. Once issued, the permit would be valid for three years, bar contravention of any offences as prescribed in the Bill. The Minister described the

---

[84] NTC (2017) *Changing driving laws to support automated vehicles,* Melbourne, NTC, pp. 23-24.
[85] National Transport Commission (2016) *Regulatory options for automated vehicles: Annexe,* Melbourne, NTC, pp. 26-32.
[86] VicRoads (2016) *Future directions paper: how Victoria will continue to support the development of automated vehicles,* Melbourne, VicRoads, 15 December, p. 5.
[87] VicRoads (2016) 'Testing automated vehicles' VicRoads website, 15 December; VicRoads (2016*)* Op. cit., p. 8
[88] VicRoads (2016) op. cit., pp. 8-9.
[89] L. Donellan (2017) 'Introduction and first reading: Road Safety Amendment (Automated Vehicles) Bill 2017', *Debates,* Victoria, Legislative Assembly, 14 November, p. 3760.

scheme in his second reading speech within the context of 'automation to autonomy'.[90] The legislative development has been welcomed by transport technology researchers.[91]

The Bill provides for definitions of an ADS and human 'vehicle supervisor' and importantly, differentiates the responsibilities of the supervisor and the ADS permit holder. The Bill does not provide exemptions from safety laws—as is the case in South Australia—but 'reallocates accountabilities' from the driver to the permit holders. Proposed amendments to the *Crimes Act 1958* provide for the definition of 'drive' as set out in the Road Safety Act, thereby including the driving of an ADS with driving-related offences under the Crimes Act, including culpable or dangerous driving.

The statement of compatibility recognises that the Bill has the potential to 'protect and promote human rights' as it is enabling technology that will increase the mobility for people with a disability such as vision impairment.[92]

What next?

On 25 October 2017, the Special Minister of State, Gavin Jennings, issued a request for advice to Infrastructure Victoria on infrastructure requirements to enable automated and zero emissions vehicles to operate in Victoria.[93]

Infrastructure Victoria's *30 year infrastructure strategy* identified automated vehicles as one of the greatest uncertainties for Victoria's transport system.[94] The Minister's request acknowledges that the uncertainties as to when fully automated vehicles will become commercially available, how they will be adopted by consumers, and the consequences for road and public transport infrastructure are challenges for the government's long term infrastructure investment.[95]

The terms of reference provided by the Minister details the scope of the advice, which includes: infrastructure requirements that would enable the operation of highly automated vehicles (at SAE levels 4 and 5); responses to ownership and market models that may emerge; and for zero emissions vehicles as a high proportion of the Victorian government fleet.[96]

The advice is to be delivered in two phases. The first report—to be delivered in April 2018—will include possible future scenarios (in consultation with Transport for Victoria[97]) and set out their potential risks and benefits. The second report—due in October 2018—will analyse the current situation and will recommend the key points at which the supporting infrastructure should be delivered.

Have other states progressed on automated vehicles?

There is a strong push from industry for regulation at the federal level to ensure Australia does not end up with a patchwork of state and territory legislation that is inconsistent and not 'technology

---

[90] L. Donellan (2017) 'Second reading: Road Safety Amendment (Automated Vehicles) Bill 2017', *Debates,* Victoria, Legislative Assembly, 15 November, p. 3825.
[91] T. Jacks 'Driverless cars set to green light', *The Age,* 14 November 2017.
[92] L. Donellan (2017) 'Statement of compatibility: Road Safety Amendment (Automated Vehicles) Bill 2017', *Debates,* Victoria, Legislative Assembly, 15 November, p. 3823.
[93] G. Jennings (2017) Advice from Infrastructure Victoria on automated and zero emission vehicle infrastructure, Infrastructure Victoria website, 1 November.
[94] Infrastructure Victoria (2017) '*Providing advice on automated zero emission vehicle infrastructure*', media release, 1 November.
[95] G. Jennings (2017) op. cit.
[96] ibid.
[97] Transport for Victoria was established in 2016 as an overarching agency for the planning, coordination and operation of Victoria's transport system and its agencies, including VicRoads and Public Transport Victoria. (Department of Economic Development, Jobs, Transport and Resources (2017) DEDJTR website)

agnostic'.[98] It is worth noting the US experience where each state had devised their own set of laws before the US federal government finally introduced a draft federal legislative regime in September 2017 (see US section below). Chris Urnson, director of Google's self-driving cars project, testified to the US Senate in early 2016 that such a development would enable safety innovation, interstate commerce and national competitiveness.[99]

South Australia

South Australia was the first state to amend its motor vehicle legislation to accommodate the testing of automated vehicles with the enactment of the *Motor Vehicles (Trials of Automotive Technologies) Amendment Act 2016.*[100] Applicants are subject to the criteria provided in the NTC's *Guidelines for trials for automated vehicles in Australia*. The Act also allows the Minister to make certain exemptions from road safety provisions for automated vehicle trials, apart from state laws on driving with due care and dangerous driving. Automated vehicles are, however, excluded from the state's Compulsory Third Party Insurance Scheme, and applicants must instead hold public liability insurance.[101]

Other considerations?

The Standing Committee on Industry, Innovation, Science and Resources in its report in August 2017 on *Social issues relating to land-based automated vehicles in Australia,* made a number of recommendations for the federal government, including:

- investigating cyber security issues related to automated vehicles;
- investigating data rights for consumers, vehicle manufacturers and third parties such as insurers and relevant government agencies;
- funding of trials in association with state, territory and local governments of automated vehicles with public transport application;
- a coordinated approach to regulation and policy setting for national consistency, as well as efforts to standardise road infrastructure; and
- establishing a dedicated national body or taskforce in conjunction with state and territory governments working with vehicles and software manufacturers to coordinate preparation for automated vehicles.[102]

International conventions and automated vehicles

In the regulation of road, traffic and vehicle safety, Australia often adopts law which is broadly consistent with the European approach (which in turn often takes its lead from the UN). The Victorian Automated Vehicles Bill is broadly consistent with both the EU and the current Californian approaches to the regulation of testing and manufacture of automated vehicles. It is possible that soon to be published Australian Commonwealth guidelines will follow these approaches.

It is therefore important to highlight the European approach to regulating ADS, along with the UN approach from which the EU draws much of its rules. Below, Sweden and the UK have been selected as case studies of developed vehicle testing sites due to their progressive regulatory regimes. As examples of the US regulatory context, California has been selected as a case study due to its similarity

[98] Clayton Utz (2017) *Driving into the future: regulating driverless vehicles in Australia,* p. 11
[99] P. Retter (2016) op. cit.
[100] Department of Planning, Transport and Infrastructure (2017) 'Driverless vehicles' DPTI website
[101] Clayton Utz (2017) op. cit. p, 25.
[102] Standing Committee on Industry, Innovation, Science and Resources (2017) *Social issues relating to land-based automated vehicles in Australia*, Canberra, The Committee, pp. iii-v.

to the Automated Vehicles Bill. Arizona has also been selected as a basis of comparison, representing US states which have far less regulation in place.

Background

Most jurisdictions around the world refer to a 'driver' in laws and regulations on driving. Until recently, the most significant international Convention on road safety also referenced a driver.[103] The implication is that in driving, there is always a human at the wheel. With the introduction of more widespread testing of automated vehicles technology this is beginning to change. For example, some jurisdictions have begun to adopt laws in which obligations on the road are shared by a 'driver' (which could be an automated driving system) and an 'operator' (which is always either a human or the manufacturer of the automated driving system). Another popular approach is splitting the driving task between a human driver when the ADS is not engaged, and the ADS itself when it is engaged.[104]

Jurisdictions also differ in their approaches to regulating the testing and production of automated vehicles. Despite differences, policy and law across international jurisdictions share the view that a balance must be struck between encouraging the rapid development and deployment of the technology on the one hand, while ensuring that such development has appropriate legal safeguards on the other. Internationally, relatively less work has so far been addressed to other challenges the technology presents, such as security, data protection, compliance assessment, smart infrastructure and hybrid intelligent communication between vehicles operating under different levels of automation.

United Nations

There are two important UN conventions which address driving. These are the *Geneva Convention on Road Traffic 1949* and the *Vienna Convention on Road Traffic 1968*.[105] While Australia is not a signatory to the *Vienna Convention*, the NTC has stated that the model Australian Road Rules are broadly consistent with it.[106] Beyond that, the *Vienna Convention* is an important piece of international law and has shaped the approach to ADS technology testing and production across Europe (the site of much of the current automated vehicle testing and manufacture).

Until recently, the *Vienna Convention* required that a 'driver' be in control of their vehicle.[107] This law was amended in 2016 so that an automated system can perform driving functions so long as the system conforms to international standards and as long as a driver can switch off the system.[108] This amendment is significant in that it provides a legal basis for signatories to the *Vienna Convention* to test automated vehicles technology.

It is also significant in that it links the fundamental concepts of regulating the activity of driving and regulating the production and manufacture of automated driving systems. However, the amendment does not remove the requirement that there be a driver in the vehicle, and so limits the amendment's scope to automated vehicles SAE levels 1 to 4 only (as discussed below, this requirement does not appear to be a barrier to the testing of 'driverless' vehicles for signatories such as Sweden).

---

[103] United Nations (1968) *Convention on Road Traffic*, art 8, Vienna, UN.

[104] This is the approach taken in the Automated Vehicles Bill.

[105] *Convention on Road Traffic*, opened for signature 19 September 1949,125 UNTS 3 (entered into force 26 March 1952) art 8.5 ('Geneva Convention') | *Convention on Road Traffic*, opened for signature 8 November 1968, 1042 UNTS 17 (entered into force 21 May 1977) art 8.5 ('Vienna Convention')

[106] National Transport Commission (October 2017) op. cit., p.23.

[107] *Convention on Road Traffic* 1968 (*Vienna Convention*), art 8.

[108] United National Economic Commission for Europe (2014) *Report of the sixty-eighth session of the Working Party on Road Traffic Safety*, UNECE/Trans/WP.1/145, 17 April.

The United Nations Economic Commission for Europe (UNECE) is the most important UN body working to introduce laws around automated vehicles. The Commission has contributed to a range of amendments to international law and practice through the work of several working parties.[109] While progress to date has been slow, it is clear that the UN and instruments which act within it have accepted the technology, and are committed to introducing policy and law which will facilitate its safe adoption.

European Union

The European Union's European Commission (EC) is the body which is tasked with proposing legislation and upholding EU treaties. The EC is therefore the body which is most relevant to implementing legislation and regulations addressed to automated vehicles. In a broad sense, the EU has so far focused its attention towards policy and strategy rather than legal reform. The EC is explicitly concerned with expediting the rapid uptake of automated vehicles technology, particularly with regard to regulations for vehicle testing and manufacture, and ADS testing and manufacture. This has led to the production of political documents such as the *Rome Letter of Intent* and the *Declaration of Amsterdam*.[110]

These documents affirm a commitment to cooperation in the development of rules and regulations which will allow automated vehicles to operate on European roads. The documents also identify the great importance of automated vehicles to broader strategies, such as the European target of a 60 per cent reduction in transport emissions and 'vision zero' (a global road safety target in which nobody is killed in road collisions beginning in 2050).[111]

Overall, such political statements are a necessary step towards linking policy and regulatory initiatives to ensure a regulatory environment which can also adapt to the rapidly expanding technology. These objectives are relevant to the Australian context in that Victoria will face similar challenges when attempting to introduce its new regulatory regime, of which the Automated Vehicles Bill is the very beginning.

C-ITS Strategy

Another important aspect of the EC's work, and a further challenge for future Victorian and Australian legislation more broadly, is intelligent transport systems (ITS). Intelligent transport systems refers to systems which allow vehicles to communicate, leading to greater efficiency and safety on the road.[112] Intelligent transport systems can be deployed in vehicles across all SAE levels. However, vehicles with higher levels of automation are expected to rely on more intelligent systems technology.

The Cooperative Intelligent Transport Systems Strategy (C-ITS Strategy) was adopted by the EC in November 2016.[113] The C-ITS Strategy proposes a plan for the commercial introduction of C-ITS in Europe by 2019, with the ultimate goal of achieving Connected, Cooperative and Automated

---

[109] Two of the key working parties are: the Working Party on Road Traffic Safety (now known as the Global Forum for Road Traffic Safety, or WP.1); the World Forum for Harmonization of Vehicle Regulations (or WP.29).

[110] European Commission 23 (2017) *Letter of Intent on the testing and large scale demonstrations of Connected and Automated Driving (CAD)*, Rome, EU, 23 March | European Commission (2016) *Declaration of Amsterdam on cooperation in the field of connected and automated driving,* Amsterdam, EU, 14-15 April.

[111] Directorate-General for Mobility and Transport (2011) *White Paper on transport: Roadmap to a single European transport area—towards a competitive and resource-efficient transport system*, Luxembourg, EU, pp. 1, 9.

[112] C-ITS Platform Phase II (2017) '*Certificate Policy for Deployment and Operation of European Cooperative Intelligent Transport Systems (C-ITS) Release 1*', Brussels, European Commission, June, p. 13.

[113] European Commission (2016) 'A European strategy on Cooperative Intelligent Transport Systems, a milestone towards cooperative, connected and automated mobility', *COM 766,* 30 November.

Mobility.[114] It is unique in its scope in that other policy documents do not consider the implications of intelligent systems in such detailed terms.

The C-ITS Strategy highlights that legal certainty is necessary in order for industry players to commit to the development and implementation of C-ITS systems technologies. It further proposes that an effective method for such regulation would be through an ITS Directive Delegated Act, which would set out the guiding principles for best practice legislation.[115]

In September 2017, the C-ITS Platform Phase II Final report was published by the EC.[116] The report makes several conclusions on security, data protection, compliance assessment and hybrid communication. The report reiterates that greater legal certainty is required in order to develop and deploy intelligent transport systems throughout Europe.[117] The mechanism proposed is again a Delegated Act. This would ensure that common rules and policies could be applied across public and private stakeholders.[118]

In terms of data protection and security, the EU's General Data Protection Regulation rules are due to be implemented in May 2018.[119] These rules are not specifically addressed to automated vehicles but the rules are expected to adequately regulate concerns around data security as it pertains to automated vehicles technology. This is another example of the rapidly changing legal environment within which automated vehicles technology is being developed and tested.

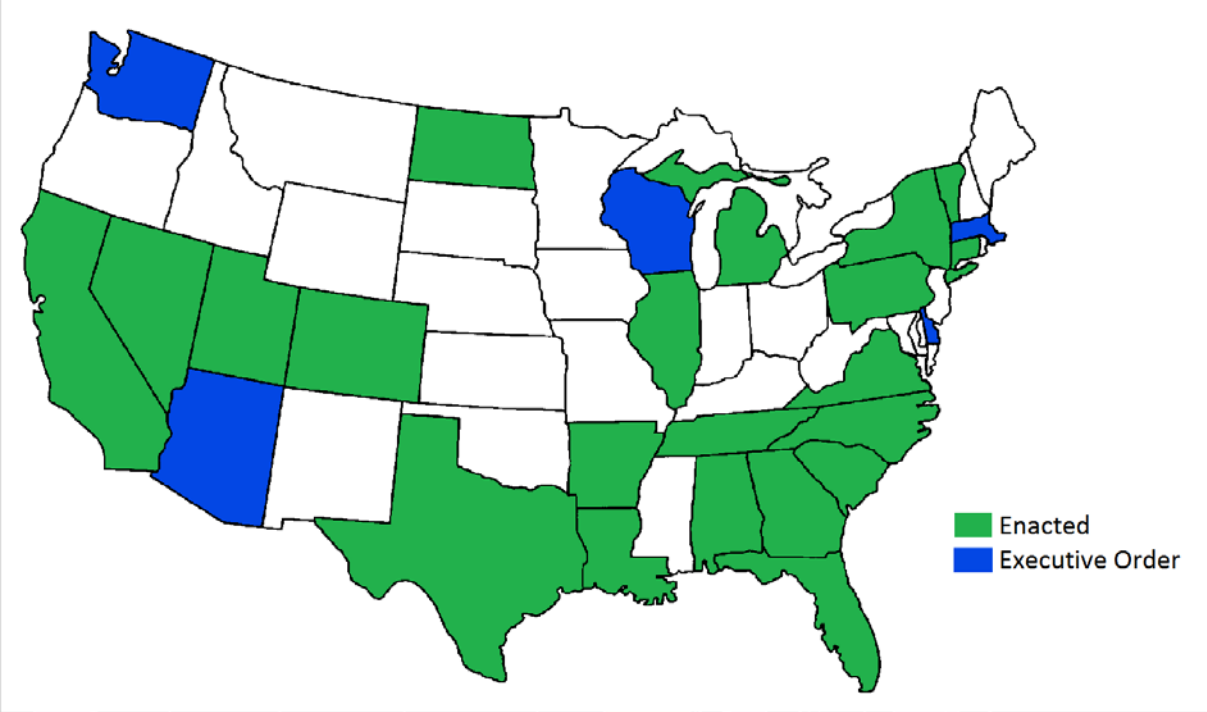
At the time of publishing, Australia has no comparable stated objective to work towards a specific intelligent transport systems Act or policy which would address automated vehicle issues. It is possible that forthcoming reports by the NTC and Infrastructure Victoria might address these challenges in more detail. Those reports are due for release in 2018.

United States

The National Conference of State Legislatures records that at the time of writing, 33 states in the US had introduced legislation for automated vehicles (see Figure 3).[120] Twenty-two of these states had passed legislation. A further four state governors had issued executive orders related to automated vehicles.[121]

[114] C-ITS Platform Phase II (2017) *Final report-2017*, Belgium, European Commission, September, p. 8.
[115] European Commission (2016) op. cit., p. 11.
[116] C-ITS Platform Phase II (2017) op. cit.
[117] C-ITS Platform Phase II (2017) op. cit., p. 8.
[118] C-ITS Platform Phase II (2017) op. cit., p. 9.
[119] European Commission (2016) 'Reform of EU data protection rules' EC website.
[120] The NCSL provides the current status of AV legislation for each state. See: National Conference of State Legislatures (2017) *Autonomous Vehicles | Self-Driving Vehicles Enacted Legislation*, NCSL website.
[121] ibid.

Figure 3. Laws addressing automated vehicles in the US



Source: National Conference of State Legislatures (9 September 2017).

No state has legalised the commercial sale of automated vehicles.[122] However, many states have accommodated ADS trials run by entities such as Waymo, Uber, Volvo and others (some of these trials are discussed below).

A large challenge in the US, as in Europe, is developing a cohesive regime for the testing and manufacture of automated vehicles which also encourages innovation. A coherent regime is necessary so that vehicles can be sold safely across the entire jurisdiction. Until recently, regulation has been left to individual states who have implemented vastly different regulations, leading to stakeholder uncertainty in the developing market.

In September 2017, the Safely Ensuring Lives Future Deployment and Research In Vehicle Evolution (Self Drive) Act 2017 (US) ('Self Drive Act')[123] was read and passed in the House of Representatives.[124] The Act represents a major shift in the current regulations, with the aim of accelerating and homogenising rules on the testing of automated vehicles across all states. It would amend United States Code, Title 49, granting more authority to the National Highway Traffic Safety Administration (NHTSA) to regulate on automated vehicles. The Act proposes a new regime in which states will be prevented from regulating the design and construction of ADS vehicles and ADS components. States will retain the ability to regulate on processes such as:

[122] John W. Zipp (2016) 'The Road Will Never Be the Same: A Reexamination of Tort Liability for Autonomous Vehicles' *Transportation Law Journal* Winter (Winter) 43(137) pp. 139-180.
[123] Note: the US uses the term 'Act' for laws before Congress. Such 'Acts' in this paper should therefore be considered 'Bills'.
[124] Safely Ensuring Lives Future Deployment and Research In Vehicle Evolution Act of 2017, HR 3388, 115th Congress (2017)

registration, licensing, driving education and training, insurance, law enforcement, crash investigations, safety and emissions inspections, congestion management of vehicles on the street within a State or political subdivision of a State, or traffic.[125]

The Self Drive Act also proposes that automakers would be exempt from existing federal safety standards provided that automakers submit safety assessment reports.[126] This system would subsume any other regulatory approval process, including the pre-market approval process proposed by California (see below). The Act coheres with a general shift towards federal regulation on automated vehicles.

In October, the Senate Committee on Commerce, Science, and Transportation approved the American Vision for Safer Transportation through Advancement of Revolutionary Technologies (AV START) Act 2017 (US) ('AV Start Act').[127] The Act also seeks to accelerate the safe deployment of automated vehicles into the public fleet. It introduces similar measures regarding Federal oversight and provides a mechanism to exempt automakers from existing safety processes in production. It is coherent with the Self Drive Act. Both Acts exempt automated trucks from the new measures.

California

California is one of the largest automated vehicles test sites in the US and there are currently 43 entities which have been issued with an Automated Vehicle Testing Permit in California.[128]

In early 2017, the State government released a *Notice of Proposed Regulatory Action*, flagging an intention to extend the existing regulatory regime to include driverless vehicles.[129] Broadly, the Californian approach most aligns with the 'pre-market approval' option for testing certification as identified by the NTC.[130] The proposed amendments to the existing regulatory regime outline a process in which ADS manufacturers are required to submit an application, and receive a permit, before testing their vehicle. The proposed rules add a 'Driverless Vehicle' permit to the existing permit scheme. There would therefore be two permits under the scheme. These are:

- Manufacturer's Testing Permit (the existing permit). Used for vehicles which require a driver inside the vehicle; and
- Manufacturer's Testing Permit—Driverless Vehicles. Used for vehicles which do not require a driver inside the vehicle.

The regulations closely follow the Federal *Vision for Safety* and existing safety rules under the federal *National Traffic and Motor Vehicle Safety Act 1966*. The new state rules are on track to be introduced in mid-2018.[131] While the proposed regulations do outline a specific and rigorous regime, it is unclear as to whether they would cohere with the final drafting of the Self Drive and AV Start Acts currently before Congress. If passed in their current forms, the proposed federal laws would introduce a contradictory regime to that of the proposed extension to the Californian permit scheme.

---

[125] ibid., s 3(3)(A).
[126] In other words, this is the NTC's 'self-certification' standard for testing and production.
[127] American Vision for Safer Transportation through Advancement of Revolutionary Technologies Act of 2017, S 1885, 115th Congress (2017)
[128] Department of Motor Vehicles (2017) 'Testing of Autonomous Vehicles', DMV website.
[129] Department of Motor Vehicles (2017) 'Deployment of Autonomous Vehicles for Public Operation', DMV website.
[130] See: National Transport Commission (2017) *Changing driver laws to support automated vehicles: Discussion Paper*, Melbourne, NTC, p. 2-3, 62-69.
[131] Department of Motor Vehicles (2017) 'Deployment of Autonomous Vehicles for Public Operation', DMV website.

In terms of the definition of 'driver', the Californian draft legislation is clear that 'driver' means human.[132] The new regulations also specify when the driver and when the manufacturer's 'remote operator' will be responsible for liability in the vehicle's operations.[133] It is expected that existing law will be adequate in determining fault and liability for crashes.[134] In vehicles with conditional automation, the driver remains responsible for the safe operation of the vehicle. For a vehicle with high and full automation (SAE levels 4 and 5), the manufacturer is responsible for the safe operation of the vehicle while the ADS is engaged—the same approach taken in the Victorian Automated Vehicles Bill. The rules also address the commercial sale of automated vehicles.

Arizona

An example of a state which has taken the opposite approach to regulation is Arizona. Simply, Arizona has decided not to regulate at all. Consequently, Arizona does not require a safety driver to sit behind the wheel of an automated vehicle. Along with its consistently dry climate, this has led to Arizona becoming another large test-ground for automated vehicles.

Since October 2017, Waymo (an affiliate of Google) has tested driverless automated vehicles in Phoenix, Arizona.[135] These tests have been monitored by an engineer who rides in the back of the vehicle with an emergency safety stop button. In November 2017, the company announced it would expand this driverless testing as a rideshare service for registered members of the general public in its 'Early Rider' program, without an engineer's supervision.[136] This trial is understood to be the first of its kind in the US. Waymo has not stated the duration of the testing.

Singapore

Singapore allows for controlled testing of automated vehicles. Under the *Road Traffic Act*,[137] the Land Transport Authority (LTA) is authorised to regulate automated vehicle trials. In August 2014, the LTA announced it would create the Singapore Automated Vehicle Initiative, a joint partnership between LTA and the Agency for Science, Technology and Research.[138]

Currently tests take place within a designated test zone, not open to the general public. The first tests began in 2015 and in 2016 the length of test routes was doubled. In 2017, the test area was expanded to include a wider range of on-road scenarios.[139]

The purpose of the Road Traffic Act is to provide the LTA with the flexibility to adapt to innovations in automated vehicle technology, while also ensuring the safe development of that technology.[140] Before approval for testing, all test vehicles are required to undergo a thorough vehicle safety assessment and test vehicles can only be driven in automated mode within the approved site. All test vehicles are also required to have a qualified safety driver who is ready to take over control of the vehicle should the

---

[132] Vehicle Code (2012) Second Modified Express Terms, Title 13, Division 1, Chapter 1, Article 3.7 – Testing of Autonomous Vehicles, s 227.02(3)(f), State of California.
[133] Ibid, s 227.38.
[134] Department of Motor Vehicles (2017) Statement of Reasons for the Second Modified Regulatory Text, s. 228.26, Sacramento, DMV.
[135] Waymo (2017) 'Waymo', Waymo website
[136] Waymo (2017) 'Be an early rider', Waymo website.
[137] Note: Singapore does not include the year of enactment in the short title of its Acts. The *Road Traffic Act* was enacted in 1961.
[138] Department of Transport (2015) *Pathway to Driverless Cars A detailed review of regulations for automated vehicle technologies*, London, DoT, p. 154.
[139] Land Transport Authority (2017) *On-road testing of autonomous vehicles to expand beyond one-north,* media release, LTA, 23 June.
[140] Land Transport Authority (2017) *Factsheet: Second reading of Road Traffic (Amendment) Bill*, Singapore, LTA. (Note: this Bill passed and the factsheet is now law).

need arise. When trial participants can demonstrate their technology is ready for fully automated operations, there is scope for the LTA to authorise the removal of the safety driver from the vehicle. Third party insurance for test vehicles is required, and data from trials must be shared with the LTA.[141]

While the regulations seem stricter than other jurisdictions, this does not seem to have deterred investment in the Singaporean market. In partnership with ridesharing company Lyft, the automated vehicle technology company nuTonomy plans to bring a commercial self-driving taxi fleet to the market by the end of 2018.[142]

Selected trials

Several countries in Europe are currently undertaking advanced testing of automated vehicles technology. While the international law discussed above is relevant to EU members, different countries have taken different approaches in reading this international law into their domestic frameworks.

Sweden

In Sweden the international standards have been interpreted to allow for a wider range of testing to take place. This has led to initiatives such as Drive Sweden, a Strategic Innovation Program launched by the Swedish Government in 2015.[143] It is funded by the Swedish Energy Agency, the Swedish Research Council Formas and Sweden's Innovation Agency (VINNOVA). The ultimate goal of the Program is to transition towards a majority automated vehicle fleet. At the time of writing, Drive Sweden is engaged in two Partnership Projects, two Strategic Projects, four Open Call Projects and eleven Associated Projects.

One of these Associated Projects is the Volvo Drive Me program which begins testing in Gothenburg in December 2017.[144] The pilot is a large-scale trial of automated driving technology carried out by consumers (similar to the Waymo trial in Arizona). The program is part of Volvo's Vision 2020 which outlines a goal for more sustainable and safe personal transport, delivered through the commercial sale of automated vehicles.[145] The trial will see families and households allocated a 'driverless' automated vehicle which will drive its occupants around the city. While the vehicle will drive in 'driverless' mode, it will sometimes require human intervention.

A large component of the Drive Me program is focused on human interaction with the automated vehicle as the vehicle switches between automated and human driver modes. In this sense, the vehicle is still 'supervised.'[146] Volvo has stated that the uptake of automated vehicles will be determined not by whether the technology is safe or advanced enough, but whether humans are willing to accept the technology.[147]

UK

The UK has signed but not ratified the *Vienna Convention*; this makes it one of only two EU member states not to have ratified the Convention, along with Spain. This less rigorous regulatory environment has led to greater testing of automated vehicles in the UK, which allows for testing so long as such vehicles are supervised by a safety operator who can take control of the vehicle if necessary.[148] As part

---

[141] Land Transport Authority (2017) op. cit.
[142] WBUR (2017) 'Why Singapore is a Key Part of NuTonomy's Strategy for Driverless Cars', Bostonomix website, 25 October; nuTonomy (2017) 'Tomorrow's cars today', nuTomy website.
[143] Drive Sweden (2017) A new approach to mobility', Drive Sweden website.
[144] Volvo (2017) 'Autonomous Driving', Volvo website.
[145] Volvo (2017) 'Vision 2020', Volvo website.
[146] This is a point of difference from Waymo's proposed trial, discussed below.
[147] Volvo (2017) 'Drive me', Volvo website.
[148] Department of Transport (2015) op. cit., p. 10.

of a series of reports published by the Department of Transport, the UK has also released a reasonably detailed plan to alter domestic law by 2017 and to participate in amendments to international law by 2018, in order to promote the safe development of automated vehicle technologies.[149] The first part of this plan is already being implemented: in the Autumn Budget 2017, the Treasury announced that new rules will soon be introduced so that self-driving cars can be tested without a safety operator.[150] This is part of the UK Government's goal to see highly automated vehicles on British roads by 2021.[151]

One key project which has been underway since 2015 is UK Autodrive. The project is 'the largest of three separate consortia that are currently trialling automated vehicle technology as part of a government-backed competition to support the introduction of self-driving vehicles into the UK'.[152] Its focus is on developing automated vehicles technology and vehicles connectivity technology.

UK Autodrive has to date completed testing on what could be classified as SAE levels 3 to 4 vehicles, including automated vehicles technology which interacts with smart infrastructure technology. An example of such a test required the vehicle to respond to information transmitted from traffic lights to the vehicle, communicating when the light would change and requiring the car to respond according to the relevant road rule (effectively, getting the vehicle to stop at a red light). This test and all other tests have so far been successful. The trial is currently moving into a new phase which will test self-driving pods which are intended to offer a 'last-mile' service. [153] The trial will conclude with a series of open road trials and tests held in Milton Keyes and Coventry in 2018.[154]

Other trials

China has not ratified the *Vienna Convention*. As of last year, specific legislation addressed to automated vehicles had not been introduced. Despite this, recent years have seen significant investment in automated vehicles technology—in September 2017, Chinese search engine Baidu announced a USD1.5 billion investment in automated vehicles technology.[155] A roadmap to automated vehicles was released in 2016 with a stated aim of deploying highly automated vehicles onto Chinese roads by 2021.[156]

Currently, digital mapping licencing laws are preventing new developers from entering the automated vehicle market.[157] Accurate maps are necessary in order for the vehicles to navigate and licences are difficult to obtain, meaning that automakers seeking to develop automated vehicles must partner with technology firms which have an existing licence.[158]

Dubai has announced plans for 25 per cent of its vehicles to become autonomous by 2030.[159] The Roads and Transport Authority has entered into an agreement with French autonomous vehicle maker

---

[149] Department of Transport (2015) *Pathway to Driverless Cars Summary report and action plan,* London, DoT, pp. 34, 38.
[150] HM Treasury (2017) *Autumn Budget 2017: 25 things you need to know*, London, HM Treasury, November.
[151] United Kingdom (2017) *Autumn Budget 2017*, HC 587, London, Treasury, November, p. 46.
[152] UK Autodrive (2017) 'About UK Autodrive', UK Autodrive website.
[153] ibid.
[154] UK Autodrive (2017) 'UK Autodrive completes first trials', UK Autodrive website, 21 October.
[155] (2017) 'China's Baidu launches $1.5 billion autonomous driving fund', *Reuters,* 21 September.
[156] J. Spring (2016) 'China issue roadmap for rapid development of self-driving cars', *Reuters*, 26 October.
[157] J. Spring (2017) 'Automaker Geely calls on China to relax mapping rules to speed self-drive development', *Reuters*, 2 March.
[158] ibid.
[159] United Arab Emirates Government (2017) 'Dubai Autonomous Transportation Strategy', UAE website
Dubai Future Foundation (2016-2017) 'Dubai's Autonomous Transportation Strategy'. Government of Dubai website.

EasyMile which will conduct tests in Dubai. Apart from this agreement, the policy is uncosted and there have been no statements on how automated vehicles will be regulated.

South Korea produced 4.23 million vehicles in 2016, making it the sixth largest producer of vehicles in the world. The country also has robust broadband infrastructure. These technologies make South Korea an attractive test site for automated vehicles.[160] In 2017, South Korea completed a permit test drive of a 'No Steering No Pedal' automated vehicle.[161]

South Korea has set a goal for the commercialisation of SAE 3 vehicles by 2020. This would lay the foundation for the widespread adoption of automated vehicles.[162] In order to achieve this goal K-City is being constructed—a pilot city for autonomous vehicles. Hyundai-KIA, Renault Samsung and GM-Daewoo are all believed to be actively researching automated vehicle technologies.[163]

[160] Kim Chae-gyu (2017) 'Korea's Automated Vehicle Policies', paper presented at Automated Vehicles Symposium, San Francisco, 11-12 July.
[161] ibid.
[162] ibid.
[163] Department of Transport (2015) Op. cit., p 155.

References

Australia

Arbib, J. & T. Seba (2017) *Rethinking Transportation 2020-2030,* RethinkX, May, p. 15.

Australia and New Zealand Driverless Vehicle Initiative (2017) 'What is a driverless car?' ADVI website

Australian Bureau Statistics (2017) *Motor Vehicle Census*, cat. no.9309.0, Canberra, ABS, 31 January.

Australian Academy of Technology and Engineering (2017) Submission 38: to Standing Committee on Industry, Innovation, Science and Resources *Inquiry into Social issues relation to land-based automated vehicles in Australia*, The Committee, August.

Bus Industry Confederation (2017) Submission 27 to the Standing Committee on Industry, Innovation, Science and Resources. *Inquiry into Social issues relation to land-based automated vehicles in Australia*, Canberra, The Committee.

Clayton Utz (2016) *Driving into the future: regulating driverless vehicles in Australia*, Melbourne, Clayton Utz.

Department of Infrastructure and Regional Development (2017) 'Road Safety', DIRD website.

Department of Infrastructure and Regional Development (2016) *Australian infrastructure statistics – yearbook 2016*, Canberra, DIRD.

Department of Industry, Innovation and Science (2017) Submission 29 to the Standing Committee on Industry, Innovation, Science and Resources. *Inquiry into Social issues relation to land-based automated vehicles in Australia*, Canberra, The Committee.

Department of Planning, Transport and Infrastructure (2017) 'Driverless vehicles' DPTI website.

Donellan, L. (2017) 'Introduction and first reading: Road Safety Amendment (Automated Vehicles) Bill 2017', *Debates,* Victoria, Legislative Assembly, 14 November.

Donellan, L. (2017) 'Second reading: Road Safety Amendment (Automated Vehicles) Bill 2017', *Debates,* Victoria, Legislative Assembly, 15 November.

Donellan, L. (2017) 'Statement of compatibility: Road Safety Amendment (Automated Vehicles) Bill 2017', *Debates,* Victoria, Legislative Assembly, 15 November, p. 3823.

Haratsis, B. (2016) *Economics Impacts of Automated Vehicles on Jobs and Investment*, Adelaide, ADVI, September.

Infrastructure Partnerships Australia (2017) *Automated Vehicles: Do We Know Which Road to Take?*, Sydney, IPA.

Infrastructure Victoria (2017) '*Providing advice on automated zero emission vehicle infrastructure*', media release, 1 November.

Jacks, T. (2017) 'Driverless cars set to green light', *The Age,* 14 November.

Jennings, G. (2017) Advice from Infrastructure Victoria on automated and zero emission vehicle infrastructure, Infrastructure Victoria website, 1 November.

Johnston, M. Schulz & M. Dunn (2015) 'Uber Melbourne: Ride sharing service effectively illegal as driver guilty in landmark case', *Herald Sun*, 5 December.

National Roads and Motorists' Association (2017) *The future of car ownership,* Strathfield, NSW, NRMA, August.

National Transport Commission (2017) *Changing driving laws to support automated vehicles,* Melbourne, NTC.

National Transport Commission (2017) 'Clarifying control of automated vehicles', NTC website.

National Transport Commission (2017) *Guidelines for automated vehicles trials,* Melbourne, NTC.

National Transport Commission (2017) *National enforcement guidelines for automated vehicles*, Melbourne, NTC.

National Transport Commission (2017) '*Towards 2020; transport ministers approve vital next phase of automated vehicle regulation'*, media release, NTC website, 13 November.

National Transport Commission (2016) *National guidelines for automated vehicles trials: discussion paper*, Melbourne, NTC.

National Transport Commission (2016) *Regulatory options for automated vehicles: discussion paper,* Melbourne, NTC.

Retter, P. (2016) 'Laws must overtake driverless cars', *The Age,* 10 May.

Standing Committee on Industry, Innovation, Science and Resources (2017) *Social issues relating to land-based automated vehicles in Australia*, Canberra, The Committee.

Thompson, C. (2016) 'Why driverless cars will be safer than human drivers', *Business Insider*, 17 November.

Transport and Infrastructure Council (2017) 8th Meeting (Hobart) *Communique,* 10 November.

The Treasury (2013) *The Australian Consumer Law: A framework overview*, Canberra, Australian Government.

University of the Sunshine Coast (2017) Submission 37, to the Standing Committee on Industry, Innovation, Science and Resources. *Inquiry into Social issues relation to land-based automated vehicles in Australia*, Canberra, The Committee.

VicRoads (2016) *Future directions paper: how Victoria will continue to support the development of automated vehicles,* Melbourne, VicRoads, 15 December.

VicRoads (2016) 'Testing automated vehicles' VicRoads website, 15 December.

Overseas

(2017) 'China's Baidu launches $1.5 billion autonomous driving fund', *Reuters,* 21 September.

American Vision for Safer Transportation through Advancement of Revolutionary Technologies Act of 2017, S 1885, 115th Congress (2017)

Anderson, J.M., et al (2016) *Autonomous Vehicle Technology: A Guide for Policymakers*, Santa Monica, Rand Corporation.

Abbugao, M. (2016) 'Driverless taxi firm eyes operations in 10 cities by 2020', *Yahoo*, 30 August.

Bert, J., et al. (2016) *What's Ahead for Car Sharing*, Boston Consulting Group, February.

Bilger, B. (2013) 'Auto Correct', *The New Yorker*, 25 November.

C-ITS Platform Phase II (2017) '*Certificate Policy for Deployment and Operation of European Cooperative Intelligent Transport Systems (C-ITS) Release 1*', Brussels, European Commission, June.

C-ITS Platform Phase II (2017) *Final report-2017*, Belgium, European Commission, September.

Clements, L. M. & K. M. Kockelman (2017) 'Economic Effects of Automated Vehicles' in *Transportation* Research Record No. 2602.

Convention on Road Traffic, opened for signature 19 September 1949,125 UNTS 3 (entered into force 26 March 1952) art 8.5 ('Geneva Convention')|

Convention on Road Traffic, opened for signature 8 November 1968, 1042 UNTS 17 (entered into force 21 May 1977) art 8.5 ('Vienna Convention')

Department of Motor Vehicles (2017) 'Deployment of Autonomous Vehicles for Public Operation', DMV website.

Department of Motor Vehicles (2017) Statement of Reasons for the Second Modified Regulatory Text, s. 228.26, Sacramento, DMV.

Department of Motor Vehicles (2017) 'Testing of Autonomous Vehicles', DMV website.

Department of Transport (2015) *Pathway to Driverless Cars A detailed review of regulations for automated vehicle technologies*, London, DoT.

Department of Transport (2015) *Pathway to Driverless Cars Summary report and action plan,* London, DoT.

Directorate-General for Mobility and Transport (2011) *White Paper on transport: Roadmap to a single European transport area—towards a competitive and resource-efficient transport system*, Luxembourg, EU.

Drive Sweden (2017) 'A new approach to mobility', Drive Sweden website.

Dubai Future Foundation (2016-2017) 'Dubai's Autonomous Transportation Strategy', Government of Dubai website.

Energy Information Administration (2017) *Study of Potential Energy Consumption Impacts of Connected and Automated Vehicles*, Washington, U.S. Department of Energy, March.

Ethics Commission (2017) *Automated and connected driving*, Berlin, Federal Ministry of Transport and Digital Infrastructure, June.

European Commission (2017) *Letter of Intent on the testing and large scale demonstrations of Connected and Automated Driving (CAD)*. Rome, EU, 23 March.

European Commission (2016) *Declaration of Amsterdam on cooperation in the field of connected and automated driving,* Amsterdam, EU, 14-15 April.

European Commission (2016) 'A European strategy on Cooperative Intelligent Transport Systems, a milestone towards cooperative, connected and automated mobility', *COM 766,* 30 November.

European Commission (2016) 'Reform of EU data protection rules' EC website.

European Transport Safety Council (2016) *Prioritising the safety potential of automated driving in Europe,* Brussels, ETSC, April, p. 11.

Frank, S. (2016) 'Die Zukunft nach dem Abgas-Skandal', *Focus Magazin*, 24 April.

Frey, C.B. & M. A. Osborne (2013) *The Future of Employment: How Susceptible are Jobs to Computerisation?* Oxford, Oxford Martin School, University of Oxford.

Hawkins, A. J. (2016) 'Delphi and Mobileye are teaming up to build a self-driving system by 2019', *The Verge*, 23 August.

HM Treasury (2017) *Autumn Budget 2017: 25 things you need to know*, London, HM Treasury, November.

HM Treasury (2017) *Autumn Budget 2017*, HC 587. p. 46, London, HM Treasury, November

Kim Chae-gyu (2017) 'Korea's Automated Vehicle Policies', paper presented at Automated Vehicles Symposium, San Francisco, 11-12 July.

King, A. (2016) 'The Fascination With Self-Driving Cars Started Nearly 100 Years Ago', in *Jalopnik*, 26 June.

KPMG (2015) *Marketplace of change: Automobile insurance in the era of autonomous vehicles, whitepaper*, [Amstelveen], KPMG, October.

Lambert, F. (2016) 'BMW will launch the electric and autonomous iNext in 2021, new i8 in 2018 and not much in-between', *Electrek*, 12 May.

Land Transport Authority (2017) *Factsheet: Second reading of Road Traffic (Amendment) Bill* Singapore, LTA.

Land Transport Authority (2017) '*On-road testing of autonomous vehicles to expand beyond one-north',* Singapore, LTA, 23 June.

LeVine, S. (2017) 'What it really costs to turn a car into a self-driving vehicle', *Quartz*, 5 March.

Morris, D.Z. (2016) 'Today's Cars Are Parked 95% of the Time' *Fortune*, 14 March 2016

National Conference of State Legislatures (2017) *Autonomous Vehicles | Self-Driving Vehicles Enacted Legislation,* NCSL website.

National Highway Traffic Safety Administration (2017) 'Automated Vehicles for Safety', Washington, DC, US Department of Transportation.

nuTonomy (2017) 'Tomorrow's cars today', nuTomy website.

Office of the Chief Economist (2017) *The Employment Impact of Autonomous Vehicles,* Washington, DC, US Department of Commerce, August.

The Robotics Institute (2017) 'Navlab: The Carnegie Mellon University Navigation Laboratory', Pittsburgh, PA, Robotics Institute website.

Ross, P. E. (2017) 'CES 2017: Nvidia and Audi Say They'll Field a Level 4 Autonomous Car in Three Years', IEEE Spectrum, 5 January.

Roy Morgan Research (2017) 'Australian want *driverless* cars – NOW', *Findings no. 7209,* 6 April.

SAE International (2016) Automated Driving, SAE International

Safely Ensuring Lives Future Deployment and Research In Vehicle Evolution Act of 2017, HR 3388, 115th Congress (2017)

Sage, A. & P. Lienert (2016) 'Ford plans self-driving car for ride share fleets in 2021', *Reuters*, 16 August.

Shapiro, D. (2016) 'NVIDIA and Bosch Announce AI Self-Driving Car Computer', *Nvidia*, 16 March.

Spring, J. (2016) 'China issue roadmap for rapid development of self-driving cars', *Reuters*, 26 October.

Spring, J. (2017) 'Automaker Geely calls on China to relax mapping rules to speed self-drive development', *Reuters*, 2 March.

Stoll, J. D. (2016) 'GM Executive Credits Silicon Valley for Accelerating Development of Self-Driving Cars', *The Wall Street Journal*, 10 May.

Thompson, C. (2016) 'Why driverless cars will be safer than human drivers', *Business Insider*, 17 November.

UK Autodrive (2017) 'About UK Autodrive', UK Autodrive website.

UK Autodrive (2017) 'UK Autodrive completes first trials', UK Autodrive website, 21 October.

United Arab Emirates Government (2017) 'Dubai Autonomous Transportation Strategy', UAE website.

United National Economic Commission for Europe (2014) *Report of the sixty-eighth session of the Working Party on Road Traffic Safety*, UNECE/Trans/WP.1/145, 17 April.

Vehicle Code (2012) Second Modified Express Terms, Title 13, Division 1, Chapter 1, Article 3.7 – Testing of Autonomous Vehicles, s 227.38, State of California.

Volvo (2017) 'Autonomous Driving', Volvo website.

Volvo (2017) 'Drive me', Volvo website.

Volvo (2017) 'Vision 2020', Volvo website.

Waymo (2017) 'Waymo', Waymo website

Waymo (2017) 'Be an early rider', Waymo website.

WBUR (2017) 'Why Singapore is a Key Part of NuTonomy's Strategy for Driverless Cars', Bostonomix website, 25 October.

Zipp, John W. (2016) 'The Road Will Never Be the Same: A Reexamination of Tort Liability for Autonomous Vehicles' *Transportation Law Journal* Winter (Winter) 43(137) pp. 139-180.

Research & Inquiries Service

Research papers are produced by the Library's Research & Inquiries service. They provide in-depth coverage and detailed analysis of topics of interest to Members of Parliament. Research publications are prepared for Parliament in response to Members, and in anticipation of their requirements, in areas of interest to the Victorian legislature.

Information in this paper was current as at the time of printing. It should not be considered as a complete guide to the particular subject or legislation covered. While it is intended that all information provided is accurate, it does not represent professional legal opinion. Any views expressed are those of the author(s).

Some hyperlinks may only be accessible on the Parliament of Victoria's intranet. All links are current and available as at the time of publication.

Enquiries:
Jon Breukel
Coordinator, Research & Inquiries
Victorian Parliamentary Library & Information Service
Parliament House
Spring Street, Melbourne
Telephone (03) 9651 8633
www.parliament.vic.gov.au