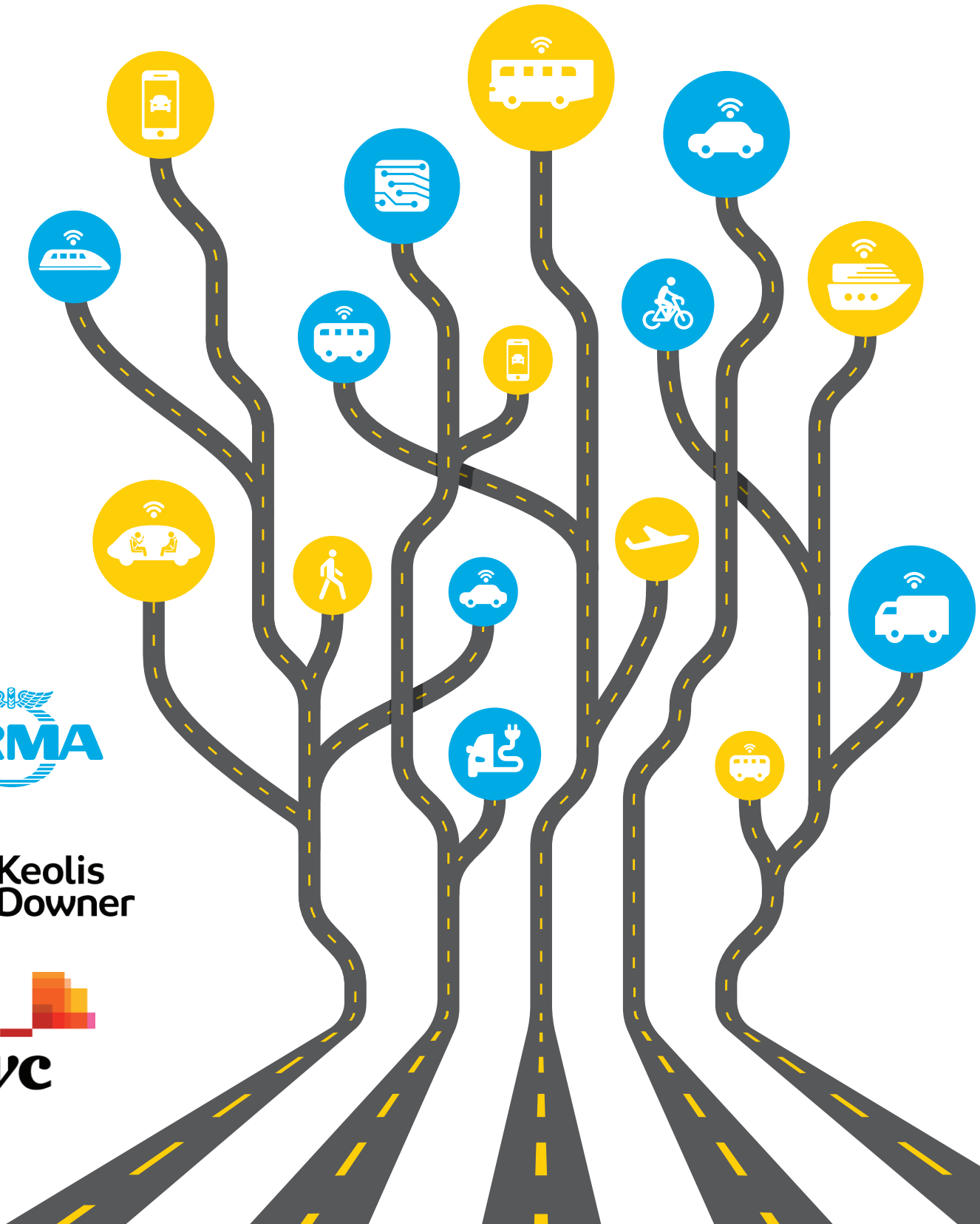
November 2017

Transforming mobility

A regulatory roadmap for connected and automated vehicles



NRMA

Keolis Downer

pwc

Better road and transport infrastructure has been a core focus of the NRMA since 1920 when our founders lobbied for improvements to the condition of Parramatta Road in Sydney. Independent advocacy was our foundation activity, and it remains critical to who we are as we approach our first centenary.

We've grown to represent over 2.6 million Australians, principally from New South Wales and the Australian Capital Territory. We provide motoring, mobility, travel and tourism services to our Members and the community.

Today, we work with policy makers and industry leaders, advocating for increased investment in road infrastructure and transport solutions to make mobility safer, provide value for money and peace of mind for our Members, and deliver sustainable communities. By working together with all levels of government to deliver integrated transport options, we give our Members real choice about how they get around.

We firmly believe that integrated transport networks, including efficient roads, high-quality public transport and improved facilities for cyclists and pedestrians, are essential in addressing the challenge of growing congestion and providing for the future growth of our communities.

Keolis Downer is Australia's largest private provider of multi-modal public transport.

Our operations combine world-leading expertise and deep local knowledge, drawing on the experience of Keolis, international operator and integrator of all mobility modes, and Downer, one of Australia and New Zealand's leading providers of services in markets including Transportation and Infrastructure.

Together Keolis Downer's commitment to safety, operational performance, innovation, and customers enable to deliver success.

Keolis Downer is the largest light rail operator in Australia, operating and maintaining Yarra Trams in Melbourne and G:link on the Gold Coast. Keolis Downer also has significant bus operations in Western Australia, South Australia and Queensland, and is the operator of the integrated public transport network in Newcastle. We also develop new forms of shared and customised mobility to answer local needs, such as demand responsive transport services and autonomous vehicles.

Keolis Downer is committed to the development of integrated transport solutions that provide seamless connections for people, supporting modern lifestyles and shaping urban environments.

Keolis Downer employs 4,000 staff and is headquartered in Sydney.

PwC is one of Australia's leading professional services firms, bringing the power of our global network of firms to help Australian businesses, not-for-profit organisations and governments assess their performance and improve the way they work. Having grown from a one-man Melbourne accountancy practice in 1874 to the worldwide merger of Price Waterhouse and Coopers & Lybrand in 1998, PwC Australia now employs more than 7,000 people.

Our people are energetic and inspirational and come from a diverse range of academic backgrounds, including arts, business, accounting, tax, economics, engineering, finance, health and law. From improving the performance of Australia's transportation systems, to performing due diligence on some of Australia's largest deals, and working side-by-side with entrepreneurs and high-net-worth individuals, our teams bring a unique combination of knowledge and passion to address the challenges and opportunities that face our community.

Disclaimer

Comments and queries

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Contents

Executive summary

Connected and automated vehicle technology will transform the way people move around. By facilitating the provision of affordable, convenient and synergised mobility solutions to people in urban, regional and rural areas, including those who are less mobile, a sustainable and desirable transport future is possible.

This transformational change will have a profound effect on society. Individual users, transport networks, land use policy, development and planning instruments will be impacted.

With technology rapidly moving the automotive and transport industries to an integrated and automated future, cities and regions will need to adapt to accommodate people moving around in a new and improved way. Fully automated on-demand cars, taxis and shuttles will enable people to access transport more efficiently and conveniently by solving the "first mile last mile" access dilemma. Consequently, door-to-door transportation solutions will be presented as real alternatives to private car journeys, making individual vehicle ownership far less necessary and less desirable.

International and domestic trends already point to reduced driver licence uptake and a greater emphasis on shared vehicle and public transport use. If door-to-door transportation is provided to consumers in an affordable and efficient manner, the shift away from private vehicle ownership will exacerbate.

The benefits of a shared and automated mobility future are immense. Improved safety, accessibility and productivity are achievable in conjunction with reduced costs, congestion and emissions.

However, there are a number of barriers to overcome to realise this mobility future.

While connected and automated vehicle technology is advancing very rapidly, more trials throughout states and territories are needed. Given Australia's unique geographical features and native elements, learnings that are exclusive to Australian conditions are necessary for manufacturers to consider, and for policy makers and legislators to address.

Connected and automated vehicles already exist, and a high level of automation is expected on Australian roads within the next five years. Full automation, which will drive mobility transformation for all citizens, is expected within the next 10 years. These timeframes are not long, and Australia is currently unprepared for the arrival of high and full levels of vehicle automation.

With the exception of approved trials, the Australian regulatory environment does not currently allow for highly or fully automated vehicles to operate on Australian roads. Most applicable road and associated legislation does not consider automated vehicles, and all current road rules assume that a human being is in control at all times.

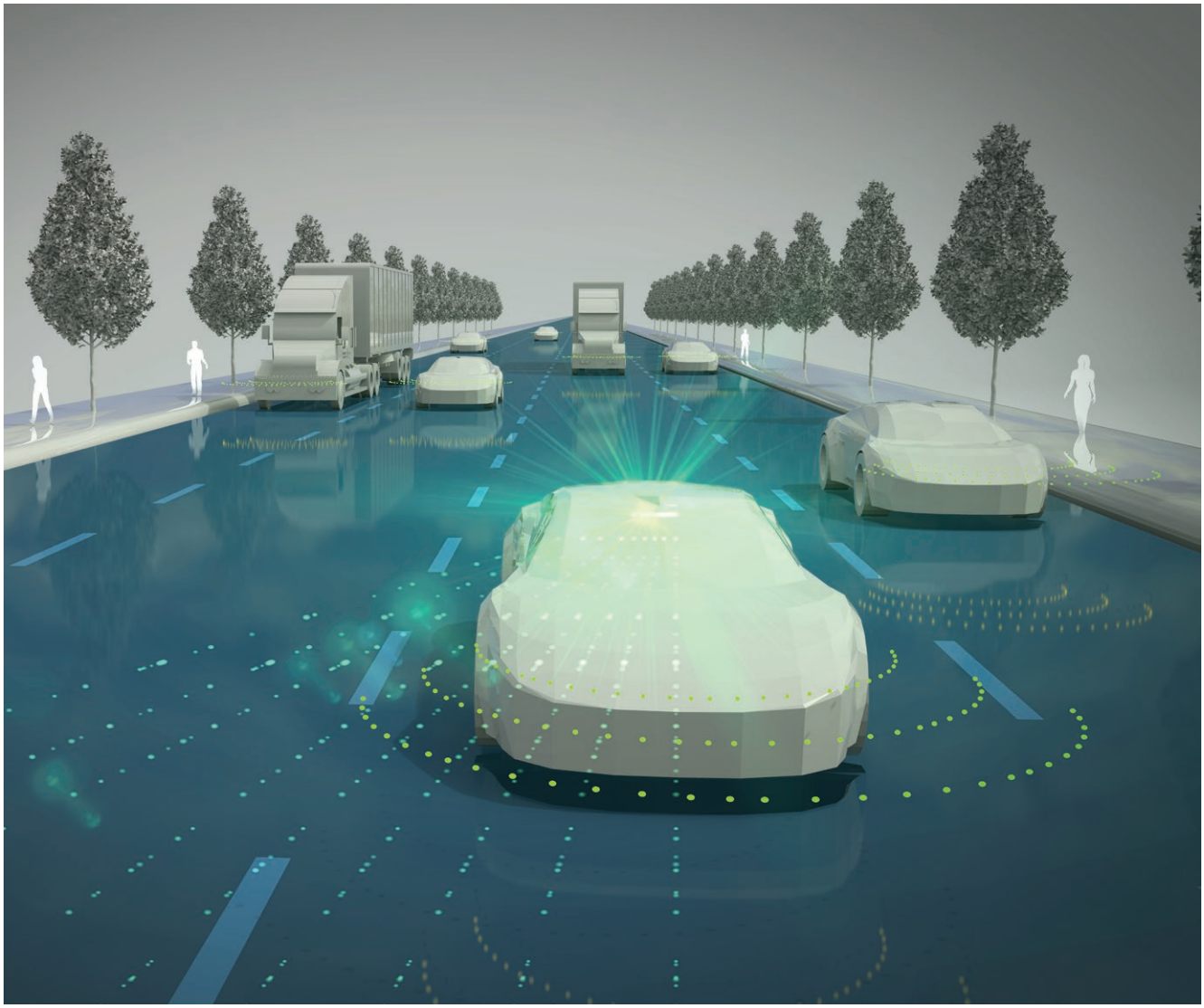
State and territory road rules must now recognise that a vehicle can be driven by an automated driving system rather than a human being. To achieve this, road rules that are presently expressed to apply to a driver should be amended so that they instead apply to a vehicle operator.

In addition to the road rules, federal, state and territory road transport and safety legislation will require amending.

Frameworks governing liability, insurance, privacy and data need to be considered, and subjective issues such as consumer acceptance, ethics and trust need to be better understood. Addressing and overcoming these issues and barriers will require significant collaboration with the community.

While a clear roadmap to connected and automated vehicles in Australia is presented, there are indirect societal issues that will be impacted by their existence.

To support a new era of mobility, land use and planning will need to be rethought, including the requisite for local government areas to provide on-street and off-street parking infrastructure. With car share and ride



share expected to be incentivised, reducing the total fleet of vehicles operating on Australian roads, urban spaces may be freed up for alternative uses.

Improved access to affordable transport will open up job opportunities, which are expected to increase in the short term as new businesses form offering new products and services. Companies associated with electrics, automation, engineering and communications may see an opportunity to support or service the new form of mobility.

Connected and automated vehicles will improve social inclusion and liveability generally by opening up access for all citizens, and improving productivity.

If the identified benefits of autonomy can genuinely be realised, then it is incumbent on governments to accelerate the development and implementation of this technology.

A sustainable and complete mobility solution is within reach, and Australia must now prepare to reap the benefits.

Recommendations

The looming transition to connected and automated vehicles will transform mobility. While users will be presented with new and accessible mobility solutions, Australia's regulatory environment and transport network will be profoundly impacted. These recommendations are intended to address regulatory issues and support an improved form of mobility for all Australians.

Connected and automated vehicles

Australian states and territories should actively promote themselves as destinations of choice for connected and automated vehicle trials (sandboxing and road network testing).

To demonstrate the benefits of automation and increase collaboration and knowledge, manufacturers and technology companies should be invited and encouraged to conduct trials, including citizen focused trials, in specifically defined areas (sandboxing), as well as across the broader road network (road network testing).

Throughout 2017, the NRMA led the charge for establishing automated vehicle trialling legislation in NSW. With unanimously supported legislation now in place, proactively encouraging trials to take place will build on this important first step.

An inter-governmental working group to co-ordinate the transition to connected and automated vehicles should be established.

The transition to connected and automated vehicles will provide significant safety, accessibility, productivity and environmental benefits.

An inter-governmental working group representing governments, industry and consumers should be established and tasked with forming a roadmap for the co-ordinated transition to connected and automated vehicles.

The regulatory environment

Road rules and other laws should be amended to accommodate increasingly automated vehicles.

To allow highly and fully automated vehicles to operate seamlessly on Australian roads, all legislation that refers to the "driver" of a motor vehicle will require amending. There are more than 50 federal and state/territory pieces of legislation that are impacted in addition to the road rules.

Of particular importance, current road rules should be amended to:

- Separate the concept of controlling the motion of a vehicle from the concept of ensuring a vehicle complies with the road rules.
- Permit an automated driving system to 'watch the road' and control the motion of a vehicle (i.e. control steering, acceleration and braking).
- Allow the police and enforcement agencies to issue traffic infringement notices to a registered vehicle operator (owner or provider) when a vehicle is being driven by an automated driving system.

If a registered operator of a vehicle receives a traffic infringement notice as a result of the failure of a vehicle's automated driving system, the registered operator should be able to bring a claim against the party that is responsible, including the supplier/manufacturer, maintainer, or any party that the registered operator has engaged to modify the vehicle.

Regulatory change to accommodate connected and automated vehicles should be fast-tracked. Necessary amendments to road rules should be put in place next year.

Current road rules make reference to the "driver" and assume that a human being will be sitting in the driver's seat – the rules don't allow for automated driving technology. Even the legality of utilising a simple automated operation in cars today such as park assist is uncertain.

With vehicle manufacturers and technology companies continuing to quickly progress automated driving technology, it is necessary to amend the model Australian Road Rules to remove these out-dated assumptions.

Necessary amendments to the South Australian Road Rules have been prepared (see *Amended South Australian Road Rules*, an annexure to this white paper). The National Transport Commission should invite comment on the proposed amendments and aim to publish a redraft of the model Australian Road Rules by mid-2018. States and territories should subsequently revise their road rules to reflect the amendments before the end of 2018. Longer term, a single national set of consistent road rules is preferred.

The future prudential framework to regulate liability and capital requirements for automated vehicle insurance should be considered by an appropriate body.

Victims of personal injury caused by motor accidents should not be worse off as a consequence of a vehicle being driven by an automated driving system. Future compensation schemes for personal injury arising from a mixed fleet, including different levels of automated driving systems, should ensure premiums are appropriately funded by the parties responsible. These schemes should also meet community expectations of prioritising early access to treatment to support optimal recovery.

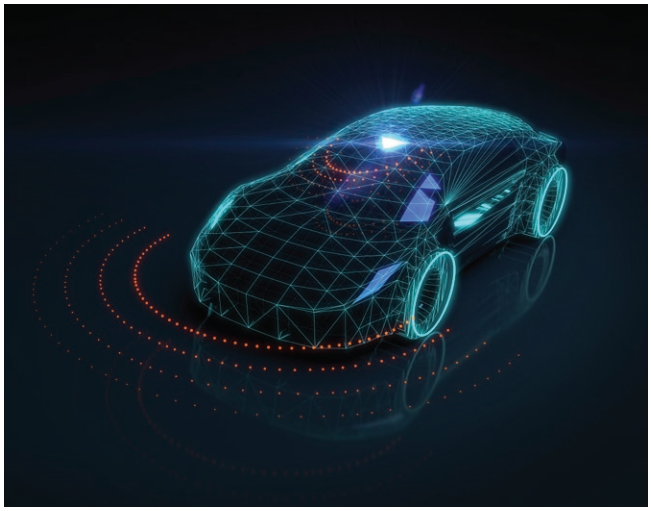
Due to dispersed liability in a connected and automated vehicle future, insurance premiums for individual consumers should be lower than that of today. While it is appropriate for vehicle owners to fund a scheme for injuries arising from the fault of drivers in the current environment, there are further considerations for a scheme involving complex liability issues including where the fault lies solely with the vehicle manufacture or other party. The UK has established a 'single insurer' model which allows an injured party to access the recovery and compensation they need, with the insurance industry providing the mechanism to deal with the legal complexity behind the scene with vehicle manufacturers and other liable parties.

As part of an inter-governmental working group to co-ordinate the transition to connected and automated vehicles, there needs to be exploration of the liability and capital issues presented by automated vehicle insurance with the aim of creating an appropriate insurance framework for the future.

An industry-wide agreement for the sharing of vehicle telematics data should be established, along with a specific set of principles to guide data availability and use.

As technology progresses and a greater need for data becomes mandatory for proper connected and automated operation and interaction, consumers will increasingly become more wary about what information is collected, and what transpires as a result.

Users of connected and automated vehicles should have access to the data generated as a result of undertaking a journey, and maintain the right to control its availability and use whenever reasonably practical. Users should also have the option to provide generated data to third parties, including nominated data custodians.



Shared mobility and transport

Governments should implement strategies that match service objectives and consumer preferences in readiness for a shared mobility model.

To ensure widespread behavioural change and consumer acceptance of a shared mobility model, governments should look to implement strategies that match service objectives and consumer preferences in readiness for the arrival of connected and automated vehicles and interconnected modes of transport.

A shared mobility sandbox should be created to test transport interconnectivity and public acceptance of the multi-mode transport model.

Efficient and accessible shared mobility solutions will reduce the number of privately-owned cars on Australian roads and meaningfully reduce transport emissions.

A testing sandbox focused on commuters should be created to test public acceptance of the multi-mode transport model. Interconnected transport modes should be phased in, with the aim of progressing to door-to-door transport solutions applicable to the individual.

Governments are encouraged to consider what arrangements might incentivise and accelerate a transition to shared mobility solutions.

Introduction

Mobility is an integral part of life that drives productivity, economic development and social wellbeing. While one's ability to move around freely has progressed and evolved over time, there are technologies on the horizon that have the potential to transform the status quo.

To move around easily, Australians have relied on the motor car – the best-known and most convenient form of mobility – for over a century. However, with population growth and urbanisation becoming more evident, today mobility is increasingly being viewed as a major challenge.

Congestion on roads, lost productivity, environmental awareness and cost of living pressures have partly led to a transition away from individualised forms of transport. Growing trends around the world point to increasing levels of ride sharing, bike sharing, carpooling, on-demand services and public transport use.

Advancing communication technology continues to support a sharing economy by bringing people and services together. Based on current trends, this mindset shift, which is primarily being led by millennials, will only become more widely accepted.

Set to complement this mindset shift is vehicle automation. With advanced communications and automated technologies converging, the privately-owned motor car, an expensive and inefficient proposition, appears out of place in the likely shared mobility future.

Automated technologies have been around for decades, but only now are becoming more commonplace in the vehicle fleet. Self-parking, emergency automated braking, adaptive cruise control and lane guidance are just a few examples of automation on the road today. With technology advancing at an exponential rate and new learnings occurring almost daily, higher levels of automation will enter the market quickly over the coming years. *The Future of Car Ownership* by the NRMA suggests that the humble steering wheel may well be a thing of the past in some vehicles as early as 2025.

Given the rapidly changing environment, we expect private car ownership will decline as time progresses.

Mobility will no longer be a privately-funded undertaking, but an evolving and efficient service supported by connected and automated vehicles and interconnected modes of transport.

Removing the privately-owned, human controlled motor car from the mobility equation will provide society with a myriad of benefits, including greatly improved safety, convenience and productivity; reduced costs, emissions and congestion; and improved access for the young, the elderly and those with disability.

People will live the future mobility experience differently and also make better use of the travel journey, transforming it into more productive time.

To achieve this comprehensive change, regulatory challenges demand attention.

While some progress has been made to harmonise thinking around the regulatory framework needed to support connected and automated vehicles, progression has been slow considering that conditional automation will arrive on roads in 2018.

Governments in Australia (as in other parts of the world) were caught on the back foot late in 2012 when Uber quickly launched into the transport marketplace. This unpreparedness caused angst, frustration and uncertainty among many stakeholders. A repeat of that situation is highly undesirable.

Such a major technological shift will require Australian governments and industry bodies to examine numerous regulatory barriers, including consumer laws, road and vehicle design rules, road and transport legislation, liability and insurance issues, and data and privacy concerns.

With the right regulatory framework in place and a holistic approach to autonomy and transport interconnectivity, an opportunity exists to significantly improve access to safe and reliable mobility services that represent good value for money.

The future of mobility

Transitioning to shared mobility

Consumers are increasingly turning away from private ownership, opting to instead share and access goods and services when required. The phenomenon is certainly not limited to the automotive industry; books can be borrowed on a tablet screen, movies loaned via remote control, and music subscribed to online.

Even when consumers choose to privately possess an item or asset they are becoming more willing to share and lend, especially if a financial gain can be realised. This new peer-to-peer sharing economy in its simplest form is the sharing or lending of underutilised assets. Exchange services such as Airbnb and Skillshare simply bring people together – and when a need exists that can be met by a solution, it's a win-win for the parties involved.

One underutilised and highly inefficient asset that is gaining great attention in the sharing economy is the private car – it sits idle about 95 per cent of the time,[1] generally at home or the workplace. Exchange services like Car Next Door have realised the shift towards sharing and accessing and have put in place systems to make lending or borrowing a car simple and convenient.

Many car manufacturers, technology companies and governments view sharing via subscription to be the most logical future for the car. While Australians have revered its very existence since the early 1900s, for the first time in Australia's history, young adults are less likely to hold a driving licence than their parents.[2]

Since the 2000s, licensing rates have decreased steadily, and Australia is not alone. Youth licensing rates have declined in the US, Canada, UK, Japan and much of Europe.[3]

The maturing of millennials and the rapid shift to connected and automated vehicles will exacerbate this decline as technologies and mindsets lend to a mobility service that is more efficient and more cost-effective.

1. http://fortune.com/2016/03/13/cars-parked-95-percent-of-time/
2. Delborsc, A & Currie, G, Why are young people less likely to get a driving licence?, WCTR, 2013
3. http://www.tandfonline.com/doi/abs/10.1080/01441647.2013.801929

The transformational element

The progressive uptake of connected and automated vehicles and the move towards a new form of mobility will usher in enormous benefits that are likely to be broadly spread throughout the community.

Increased choice and convenience will allow motorists to transition away from owning their own vehicles if they feel the traditional model of ownership does not offer value for money or peace of mind.

Connected and automated vehicles will significantly improve accessibility to existing transport services and transform liveability for those who cannot presently access a car.

However it is fair to say that automated vehicles need to be connected to efficient mass transit solutions to allow people to move from owning their cars to shared mobility solutions.

Society will enjoy reduced costs and energy consumption, improved efficiency, reliability and transport interconnectivity, and increased safety and productivity.

With the progressive roll-out of connected and automated vehicles on Australian roads, work commutes, school pick-ups, patient transport, visits to shopping centres and the movement of goods across large distances are just a small example of the potentially broad-ranging benefits on offer to the community.

The following is just a snapshot of some of the benefits that will lead to transformational change in the automotive and transport industries.

Safety

Community safety will be a big winner in an automated mobility future. At present, 94 per cent of road accidents are caused by human error. The economic cost of road trauma to the Australian economy resulting from these accidents is $30 billion per year – the equivalent of the Australian Budget deficit in 2017-18.[4]

94% of road accidents are caused by human error. The annual cost of road trauma in Australia is $30 billion#*

Greater mobility options

Removing the need to perform the driving task will present all road and transport users with greater mobility options and improved accessibility. In particular, the elderly, the young and those with disability will gain access to new mobility devices and transport connections.

The young, the elderly and those with disability will benefit from new mobility options

4. http://www.budget.gov.au/2017-18/content/bp1/download/bp1_bs3.pdf
* https://www.nhtsa.gov/technology-innovation/automated-vehicles & http://www.aaa.asn.au/storage/1-aaa-econ-cost-of-road-trauma-sep-2017.pdf
# http://www.aaa.asn.au/storage/1-aaa-econ-cost-of-road-trauma-sep-2017.pdf

Reduced congestion

The automated and shared mobility future will reduce congestion on Australian roads by shrinking the size of the private vehicle fleet. Greater numbers of car sharing vehicles, ride sharing vehicles and on-demand taxis and shuttles will improve efficiency and increase mass transport usage provided they are seamlessly integrated to mass transit services and multimodal hubs that are efficient and adapted to local mobility needs.

Congestion is currently one of Australia's most significant handbrakes on economic growth.

*The economic cost of congestion is expected to grow to $42.8 billion in 2028 from $17.7 billion in 2015**

Reduced pollution and emissions

Some estimates contend that transport energy consumption could be reduced by up to 90 per cent compared with current levels in an electric and automated future.[5] With significant reductions possible, urban places of work and play will become cleaner and healthier, leading to better lifestyle outcomes and improved productivity.

The transport sector accounts for 16% of Australia's greenhouse gas emissions#

5. http://www.nrel.gov/docs/fy13osti/59210.pdf
* PwC 2016, Modelling of Potential Policy Reforms, p.29
# http://www.climatechangeauthority.gov.au/reviews/light-vehicle-emissions-standards-australia/opportunities-reduce-light-vehicle-emissions

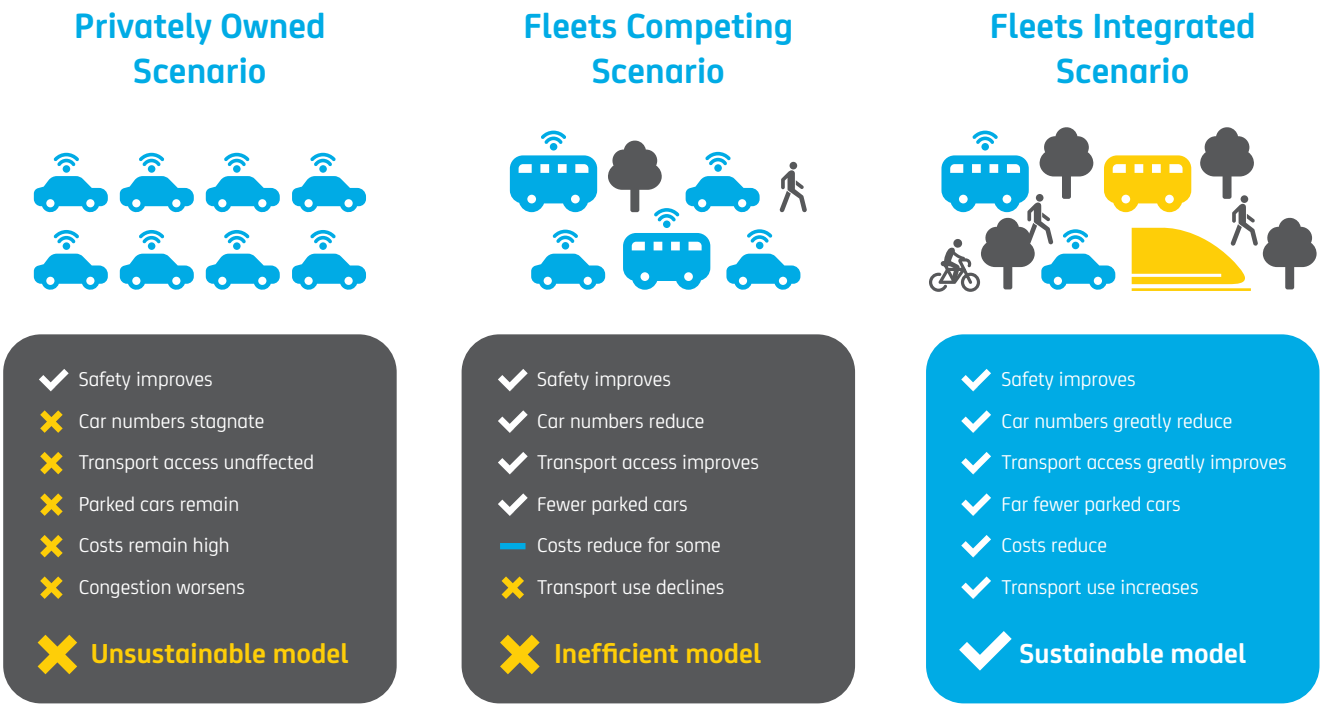
Integration

Major societal benefits will only be realised if connected and automated vehicles are a component of a shared mobility model where traditional transport services are integrated. If privately-owned vehicles are simply replaced, the opportunity to transform mobility will be lost. Fleets of shared connected and automated vehicles integrated with traditional transport services will result in a myriad of benefits for society.

Constantly improving transport and in-vehicle communications and technical data capture will support the shift to integrated services by aiding the development of mobility concepts. These concepts could be personalised to suit individual travel preferences, incentivising users to adopt the new form of mobility.

An integrated scenario that offers a compelling alternative to private car ownership would need to be coordinated, optimised, and delivered in a way that suits the individual user.

FIGURE 1: INTEGRATION IS VITAL



To ensure widespread behavioural change and consumer acceptance of a shared mobility model, governments should look to implement strategies that align passenger mindsets in readiness for the arrival of connected and automated vehicles and interconnected modes of transport.

With efficient and accessible mobility solutions set to reduce transport emissions and the number of privately-owned cars on Australian roads, a testing sandbox focused on commuters should be created to test public acceptance of the multi-mode transport model.

Solving the first mile last mile dilemma

Most mass transport services in Australia offer good value for money to users, but are often underutilised due to poor access. The troublesome first mile last mile transfer (access to and from a transport station, port or interchange) is often the greatest obstacle to utilisation.

The private motor vehicle has been such a highly valued asset in the past due to being a convenient, comfortable, schedule-less travel option offering door-to-door mobility. Despite being poorly utilised and expensive to purchase, run and maintain, Australian society has placed such a high value on its benefits that the car has remained king of mobility since first appearing in the early 1900s.

With the arrival of connected and automated vehicles, however, accessing mass transport quickly and easily becomes possible, and the private motor vehicle's main benefits become much less desirable.

Like walking and cycling, fully automated on-demand cars, taxis and shuttles have the capability to act as feeder services, linking people with mass transport in an efficient manner. By offering potential users availability, flexibility and comfort at a reasonable cost, a strong incentive to desert the private car is created.

Connected and automated vehicles should not be viewed as a substitute for mass transport; rather, their capabilities should be seen as complementary, enabling significant improvements to accessing other transport modes. People will still need to move en masse in the future, especially in densely populated urban environments.

Optimising access, choice and efficiency for users is key to maximising public transport use. Presenting a tailored, individual mobility solution centred around integrated mass transport and connected and automated vehicles could dramatically improve the performance of Australia's transport networks.

To encourage intermodal transport, operators must be open to meeting increasing user demands, many of which are based around technology. These increasing demands are partly being driven by millennials who have grown up with access to real-time information at their fingertips.

Delivering quality information and attractive shared mobility solutions that offer efficiency at a reasonable cost will drive transport patronage and reduce congestion on roads. The overall mobility experience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is what encourages or discourages repeated use. The provision of quality infrastructure and services, reliable and useful data, Wi-Fi access, clean and accessible amenities for individuals and families, and efficient interchanges, together present a compelling case for potential users.

With connected and automated vehicles ferrying people to and from transport stops and hubs, the need for dedicated pick-up and drop-off areas will become critical. Connecting feeder services with mass transport will require a holistic approach to land use and planning supported by all relevant key stakeholders. Smart transport interchanges that are seamless and incorporate vehicle-to-vehicle and vehicle-to-infrastructure communications technologies will transform road and transport integration and improve choice for users.

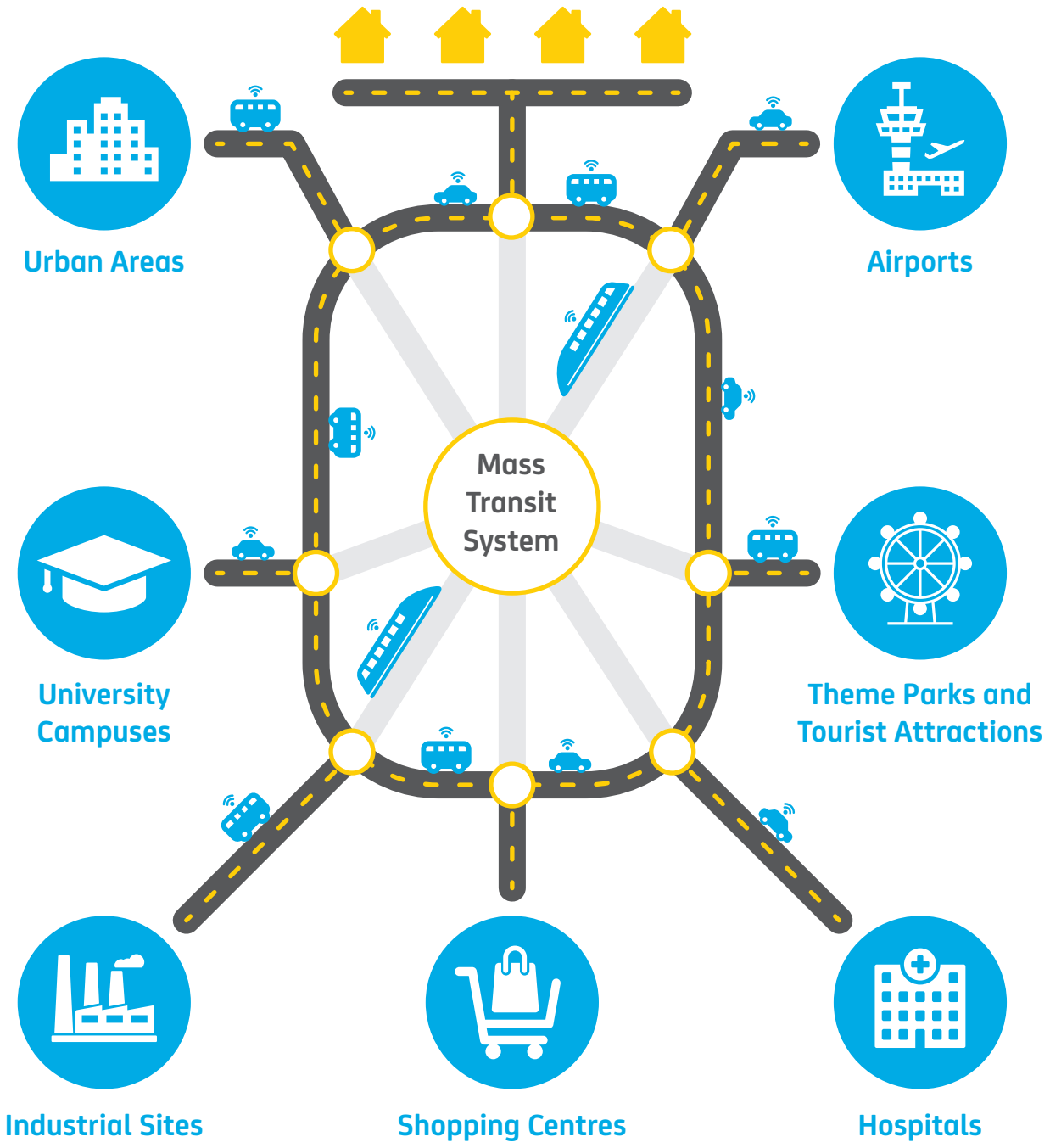
Interchanges or hubs offer a further opportunity to encourage increased patronage on transport. Currently viewed by many commuters as an inconvenience, simply existing to facilitate transferring to another service, interchanges have shown that they can become desirable destinations in themselves.

Interchanges can be places for people to meet, socialise, dine and shop. In some well-equipped transport interchanges throughout the US, Asia and Europe, it's not uncommon for people to mingle and eat dinner with friends and colleagues after a day's work. Similarly, it's not uncommon for people to spend hours on the weekend shopping and relaxing, and perhaps even taking in some of the stunning architectural designs that are transforming interchanges around the world.

The potential to create destination hubs has been realised by many governments, operators and providers who have placed great significance in recent times on offering customers a tantalising transport experience.

In Australia, Sydney's Central Station and several new Sydney Metro stations are currently being proposed as integrated world-class destinations, offering commercial, residential, community and retail opportunities. In particular, Victoria Cross (North Sydney) and Pitt Street (Sydney CBD) are being touted as vibrant places and landmarks in their own right that will shape the city's future. Further world-class stations along the Sydney Metro line are expected to be announced over the coming months.

FIGURE 2: HOW AUTOMATED SHUTTLES/CARS CAN SOLVE THE FIRST MILE/LAST MILE DILEMMA



Shared mobility learnings

Replacing private cars with shared mobility services is not a revolutionary concept, but it has never really been feasible. With advanced technology, testing and trialling of the new understanding of shared mobility has recently been conducted.

Findings from simulations and focus groups in Lisbon (Portugal) and Helsinki (Finland)[6] have found that replacing private car travel with shared vehicles in urban spaces dramatically reduces the number of cars needed, significantly cuts emissions, and frees public land for alternative uses – without making it more difficult for users to get from door to door.

The study found that, utilising shared services, all current car journeys in the Helsinki metro area could be completed with just four per cent of the private vehicle fleet.

The Helsinki study also supports an important previous finding from Lisbon – shared mobility improves access to jobs and public services. In addition, shared vehicles were found to be highly effective at ferrying people to and from public transport stations and hubs; rail and metro patronage increased between 15 and 23 per cent using shared vehicles as feeder services.

Feedback from potential users in Helsinki suggests that citizens are very positive about shared services complementing existing transport.

Helsinki's study will be used to frame its long-term land use, housing and transport planning process.

Case Study: NAVLY

In September 2016, Keolis and Navya, supported by the Métropole of Lyon, launched the NAVLY project. NAVLY is the first integrated and regular transport service in the world operated by an automated shuttle.

Approved by the French Ministry of Ecology, Sustainable Development and Energy in July 2016 as a national experiment, NAVLY operates in Lyon along the river Saône, connecting the stops of Charlemagne, Passerelle, Les Salins, La Sucrière and Magellan with the Confluence tram, providing access to nearby train and metro stations.

NAVLY facts

- Launched September 2016
- 7.30am to 7pm Monday to Friday (Saturdays recently commenced)
- Every 15 minutes during peak hours (every 30 minutes in off-peak)
- 1350 metre path with five stops along the river Saône
- Transported more than 22,000 people

The success of NAVLY in the Confluence has led to the recent establishment of a broader trial in the crowded business district of Paris La Défense.

6. https://www.itf-oecd.org/shared-mobility-simulations-helsinki

Automated vehicle trials

Types of trials and their benefits

Broad acceptance of connected and automated vehicles will only happen if consumers accept them to be safe and useful to their everyday needs. This has been realised by companies such as Volvo, who are trialling automated vehicles on roads in Sweden with members of the public.

Original Equipment Manufacturers (OEMs) and technology companies should be invited to conduct trials to demonstrate the benefits of automated vehicles, and to increase collaboration and knowledge.

State and territory governments should also promote automated vehicle trials focused on citizens that at present have high mobility inequalities such as the elderly, those with disability, and those living in remote areas.

A mix of sandboxing (specifically defined areas) and road network testing creates a welcoming and highly desirable environment for manufacturers and technology companies to test and trial automated technologies and concepts.

Sandboxing – *everything somewhere*

- Operating capability and limitations assessment
- Consistent interactions with infrastructure and signalling
- Automated vehicle operator learning and training
- Rapid data collection to inform insurance and liability matters
- Safe environment for ultra-innovative concepts

Road network testing – *something everywhere*

- Cross-border and long-distance trialling and testing
- Altering environmental conditions and road surfaces
- Varying road infrastructure and signalling
- Interactions with human-driven road vehicles
- Road hazard and roadworks awareness testing
- Moving hazard and unforeseen scenario perception testing

To bring forward the many benefits of autonomy, Australian states and territories should be focusing on creating the least restrictive testing model possible.

Making up less than 1.5 per cent of the world's vehicle demand,[7] it is important for Australia to allow and support testing and trialling under a variety of conditions to attract leading manufacturers and technology companies. Although demand for vehicles is relatively small compared with many overseas markets, Australian cities and regions will derive enormous benefits from connected and automated vehicle technology.

Governments taking a lead in investment and facilitation of technology development may be able to attract manufacturing clusters as a further economic incentive to promote this technology.

88 million vehicles were sold globally last year – around 1.2 million were sold in Australia

7. https://www.treasury.gov.au/~/media/Treasury/Consultations%20and%20Reviews/Consultations/2016/2017%20PreBudget%20submissions/Submissions/PDF/Australian%20Automotive%20Dealer%20Association.ashx

Current Australian and international trials

In May 2017, the National Transport Commission and Austroads jointly released *Guidelines for Trials of Automated Vehicles in Australia*. The guidelines are intended to:

- support nationally consistent conditions for automated vehicle trials in Australia.
- provide certainty and clarity to industry regarding expectations when trialling in Australia.
- help road transport agencies manage trials in their own state or territory as well as across state borders.
- establish minimum standards of safety.
- help assure the public that roads are being used safely.
- help raise awareness and acceptance of automated vehicles in the community.[8]

The guidelines provide criteria covering the following areas:

Management of trials

- Location.
- Technology description.
- Traffic management.
- Infrastructure and network requirements.
- Public engagement.
- Managing change.

Insurance

- Appropriate cover.

Safety management

- Security.
- Risks to road users.
- Risks to infrastructure.
- System failure.
- Transition processes.
- Human driver requirement.
- Pre-trial testing.
- Training.
- Fitness-for-duty.
- Vehicle identifiers.

Data and information

- Incident data.
- End-of-trial reporting.
- Sensitive information.

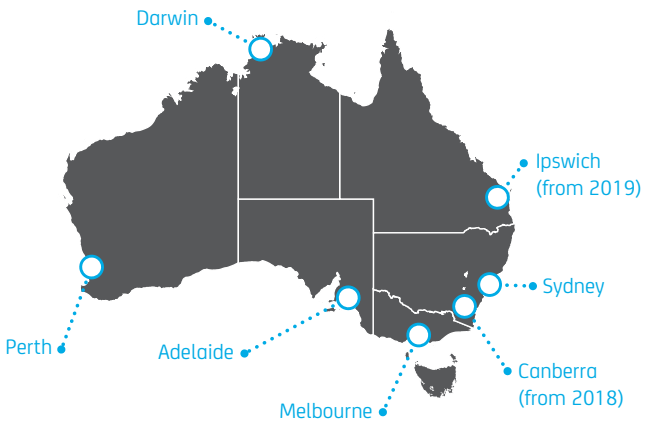
Implementation

- Cross-border trials.
- Existing trials.
- Trials to commercial deployment.
- Commercial trials.
- Vehicle limits.
- Time limits.

The guidelines are an important step on the path to a connected and automated vehicle future. Providing a certain degree of clarity to industry is crucial to attracting trial proposals.

A nationally and fundamentally consistent set of guidelines allows industry to view Australia as one holistic marketplace, encouraging investment, engagement and innovation.

AUSTRALIAN AUTOMATED VEHICLE TRIALS



8. http://www.ntc.gov.au/Media/Reports/(00F4B0A0-55E9-17E7-BF15-D70F4725A938).pdf

South Australia

In June 2016, the South Australian Parliament enacted the *Motor Vehicles (Trials of Automotive Technologies) Amendment Bill 2016*.

This new legislation provides a framework to facilitate on-road trials, testing and development of driverless vehicles and other advanced automotive technology on South Australian roads.[9]

South Australia's legislation has been referenced by Google as a benchmark for other countries to follow due to its design and support of innovative technologies.[10]

As an alternative to introducing an entirely new motor vehicles act to facilitate automated vehicle trials, the South Australian legislation is based on a framework of exemption (to remove barriers within the current *Motor Vehicles Act 1959*). If automated vehicle trials prove successful, it is likely that South Australia will put in place significant and permanent amendments to the current Act, or otherwise introduce an entirely new Act to the South Australian Parliament.

Since the *Motor Vehicles (Trials of Automotive Technologies) Amendment Bill 2016* was assented, around 20 automated vehicle trial proposals have been presented for consideration. The proposals, which include on-road trials, off-road trials and heavy vehicle trials, will provide key learnings to assist the progression of automated vehicles on roads.

New South Wales

In August 2017, the NSW Parliament passed the *Transport Legislation Amendment (Automated Vehicle Trials and Innovation) Bill 2017*. The legislation, which is largely based on South Australia's model, enables the approval of trials on NSW roads that would not otherwise be lawful because the vehicle is highly or fully automated and therefore may not have a human being driving the vehicle some or all of the time. The legislation also puts in place measures to ensure adequate insurance is in place to cover injury and property damage that may arise during trialling, and provides for the modification of references in laws to the driver or person in charge of a vehicle that is highly or fully automated.

The legislation enables industry, researchers and government to trial highly or fully automated technologies on both urban and regional roads in NSW. By adopting a similar approach to South Australia, NSW has supported establishing a welcoming and highly desirable environment for manufacturers and technology companies to test and trial automated technologies and concepts.

Recently, the NSW Government, HMI Technologies, Telstra, IAG, Sydney Olympic Park Authority and the NRMA launched the first automated shuttle trial in NSW. The landmark trial opens up the opportunity for NSW to fully embrace the future of driverless technology.

The NRMA led the charge for the trialling of automated vehicles in NSW and, since the launch of the automated shuttle, has called for further trials to take place in regional hubs such as Newcastle and the Hunter region. In addition, the NRMA has identified Sydney Olympic Park as a potential sandbox for future mobility technology.

9. http://dpti.sa.gov.au/driverlessvehicles
10. https://www.premier.sa.gov.au/index.php/stephen-mullighan-news-releases/337-sa-becomes-first-australian-jurisdiction-to-allow-on-road-driverless-car-trials

New Zealand

In May 2014, the New Zealand Government released an action plan setting out its proposed program on intelligent transport systems. The *Intelligent Transport Systems Technology Action Plan 2014–18* positioned New Zealand as a supportive test-bed for innovative transport technologies and concepts, including automated vehicles.

Little was required of the government to support automated vehicle testing and trialling as existing transport legislation did not explicitly require a vehicle to have a driver present for it to be used on the road. So long as safety standards and requirements are adhered to, no obvious barriers to introducing automated vehicles in New Zealand exist.

Testing of automated vehicles in New Zealand is not limited to any specific or designated area – testing is able to take place on any part of the road network.

Following the release of the *Intelligent Transport Systems Technology Action Plan 2014-18*, the New Zealand Government actively promoted and publicised its desire to host automated vehicle trials in New Zealand.

In January 2017, the first automated vehicle trial was conducted at Christchurch International Airport.

While no legislative barriers exist for testing and trialling purposes, manufacturers and technology companies wishing to utilise New Zealand's welcoming environment must hold appropriate public liability and professional indemnity insurance and adhere to New Zealand's road rules and safety provisions under the *Land Transport Act 1988*.

United States

In September 2017, the United States House of Representatives unanimously passed a bill to allow manufacturers and technology companies to deploy up to 100,000 automated vehicles each in a 12-month period on public roads across the United States.

The *SELF-DRIVE Act* nationalises and harmonises the approach to automated vehicles on public roads. In an effort to stop a patchwork of inconsistent rules and regulations across individual states that can stymie the introduction of new technologies, the *SELF-DRIVE Act* overrides any applicable legislation introduced at the state level.

In terms of safety, the *SELF-DRIVE Act* exempts automated vehicles from existing safety standards, provided participants can show that the vehicle functions as intended and contains fail-safe features. Safety assessment reports will be required by regulators prior to the commencement of any trial.

While the *SELF-DRIVE Act* overrides state legislative efforts pertaining to the trialling of automated vehicles, registration, liability, insurance and licensing rules will remain the responsibility of the states.

The bipartisan *SELF-DRIVE Act* recognises the urgency of bringing forward the promised safety benefits that automated vehicles afford. US road deaths rose to 35,200 in 2015, a 7.7 per cent increase on the previous year – the biggest annual increase since 1966.[11]

11. https://futurism.com/first-ever-us-legislation-on-self-driving-cars-comes-to-the-house/

Automated vehicle introduction

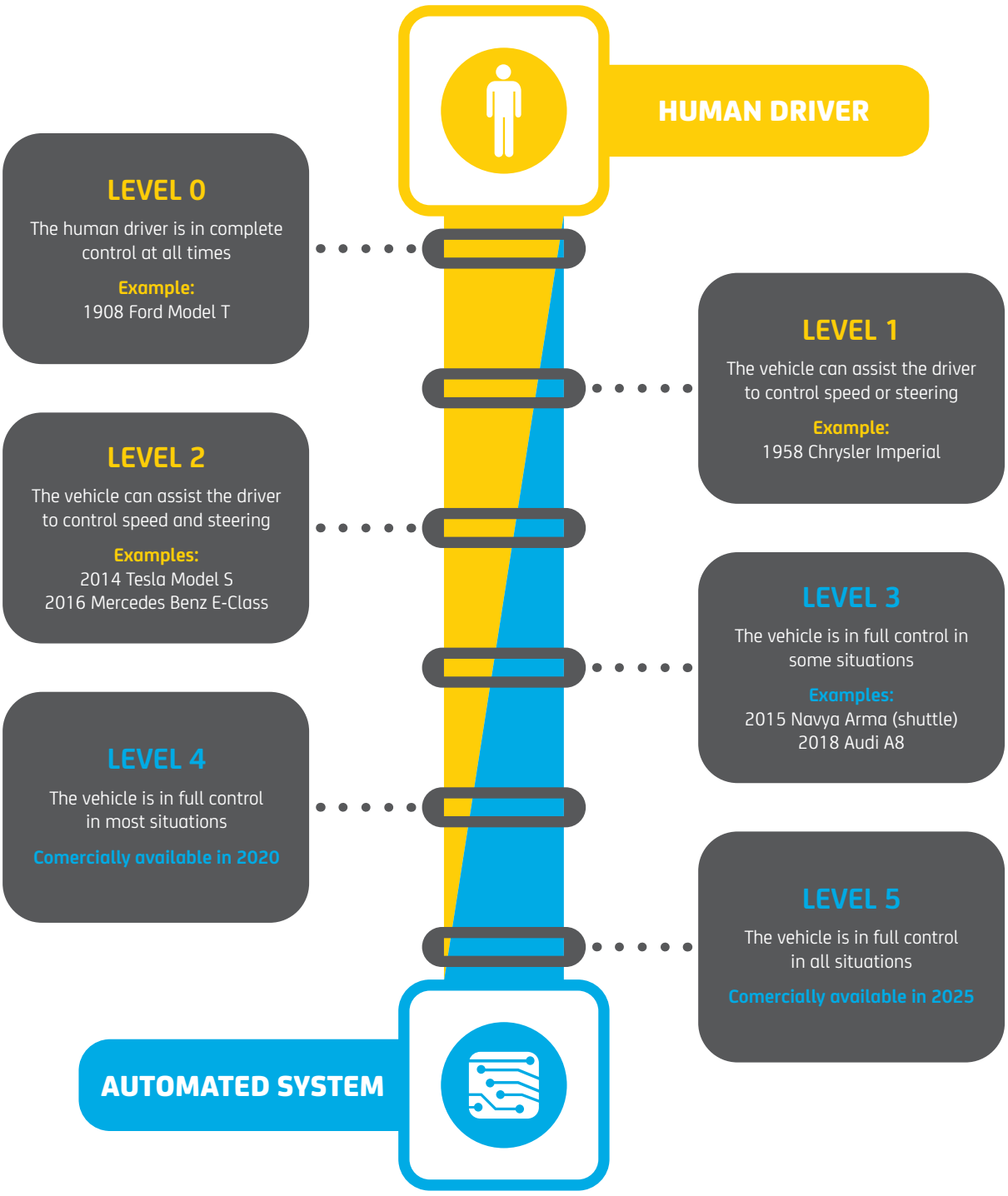
Levels of automation

There are many developmental points on the road to fully automated vehicles. SAE International developed six levels describing the road from a traditional vehicle to a fully automated Level 5 vehicle. The SAE index is now globally accepted as the standard for automated vehicle development:[12]

- **Level 0 (No Automation)** demands the full-time performance by the human driver of all aspects of the Dynamic Driving Task (DDT).[13]
- **Level 1 (Driver Assistance)** technologies such as electronic cruise control are capable of overseeing either the steering or acceleration/braking task.
- **Level 2 (Partial Automation)** technologies are capable of controlling the steering and acceleration/braking tasks, but a driver must perform the Object and Event Detection and Response (OEDR) sub-task (i.e. watch the road).[14]
- **Level 3 (Conditional Automation)** technologies are capable of overseeing the entire Dynamic Driving Task in limited environments. The fallback-ready user will be able to perform non-driving tasks while the vehicle is navigating the road.
- **Level 4 (High Automation)** technologies remove the need for a driver in some environments. While capable of overseeing the entire Dynamic Driving Task, Level 4 vehicles cannot be considered fully automated while limitations are in place regarding the environments in which the vehicle can operate in Level 4 mode.
- **Level 5 (Full Automation)** technologies completely negate the need for the steering wheel and pedals, fully removing the driver from the Dynamic Driving Task in all environments.

12. https://www.driverless.id/news/definitive-guide-levels-automation-for-driverless-cars-0176009/
13. See page 35 for the components that comprise the Dynamic Driving Task as presented by SAE International's new standard J3016
14. Object and Event Detection and Response is defined is SAE International's new standard J3016 as the perception by the driver or system of any circumstance that is relevant to the immediate driving task, as well as the appropriate driver or system response to such circumstance

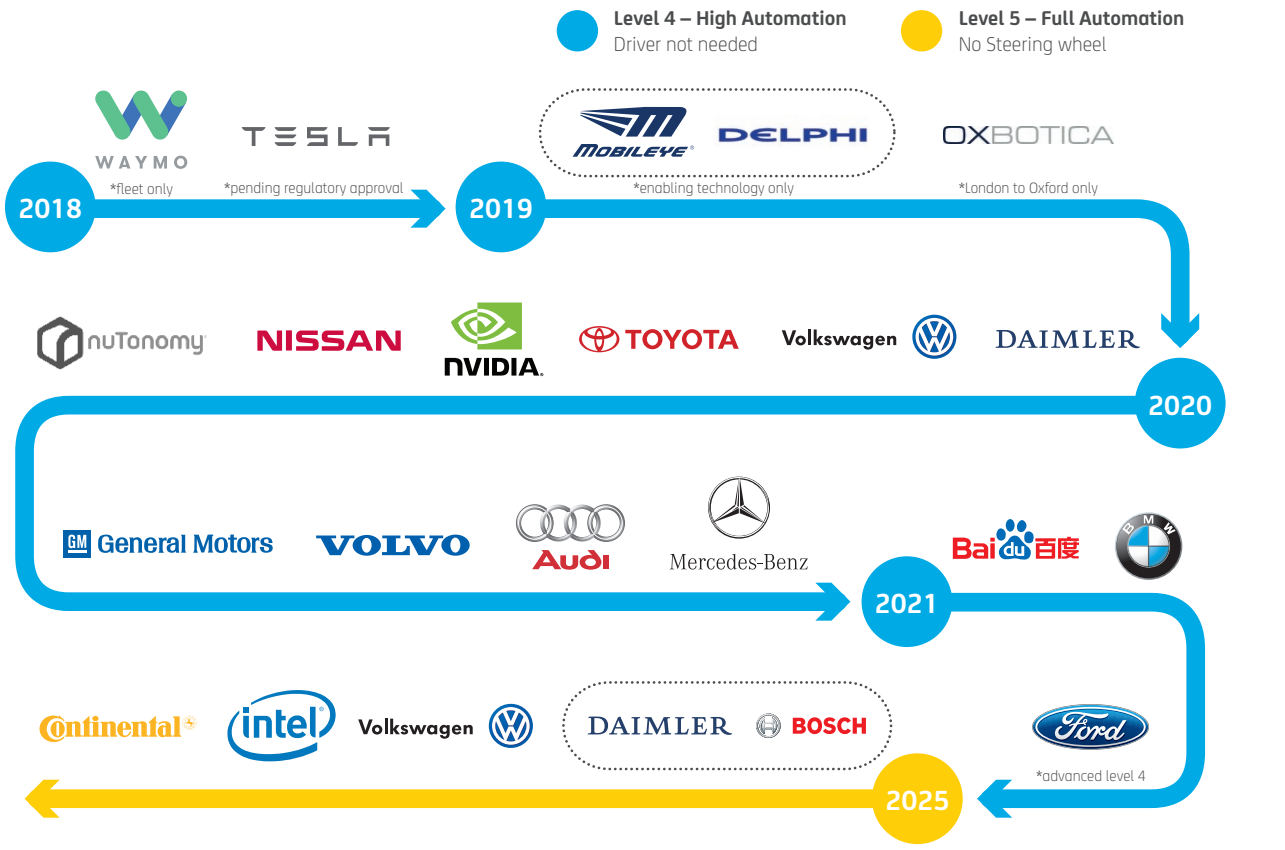
FIGURE 3: SAE LEVELS OF AUTOMATION – HUMAN DRIVER TO AUTOMATED SYSTEM



When will automated vehicles be here?

The 2018 Audi A8 is the world's first production car capable of Level 3 automation – it is anticipated to go on sale in Australia mid-2018.

FIGURE 4: A TIMELINE TO FULL AUTOMATION



NVIDIA, who are developing artificial intelligence for connected and automated vehicles recently announced that they will introduce a Level 5 enabling system by 2018.[15] They expect highly automated Level 4 vehicles to be operational by 2020.[16] NVIDIA's predictions are particularly important because they partner with several major OEMs.

Fully automated vehicle capability – where no human driver is needed and cars do not possess a steering wheel or pedals – could be here as early as 2025. On-demand shuttles and taxis capable of Level 5 automation could arrive even earlier.

OEMs, start-ups, dedicated technology companies, academics and automobile organisations around the world have entered the debate around when connected and automated vehicles will be on the road.

The most aggressive predictions come from Waymo (Google), Mobileye (Intel), Delphi and Oxbotica, who see Level 4 technology a reality by as early as 2018 or 2019. However, most OEMs believe Level 4 technology will become available around 2020. Daimler, Volkswagen, Toyota, Nissan, GM and Volvo all agree that Level 4 systems and cars will arrive in 2020.

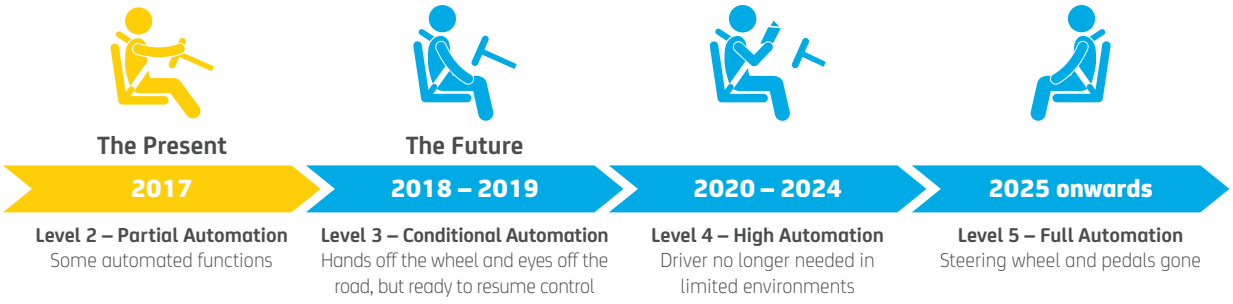
15. http://www.roboticstrends.com/article/nvidia_drive_px_pegasus_ai_computer_powers_level_5_autonomous_vehicles
16. http://spectrum.ieee.org/cars-that-think/transportation/self-driving/nvidia-ceo-announces

Daimler, Volkswagen, Continental and Intel have hinted that fully automated Level 5 cars will be released by 2025.

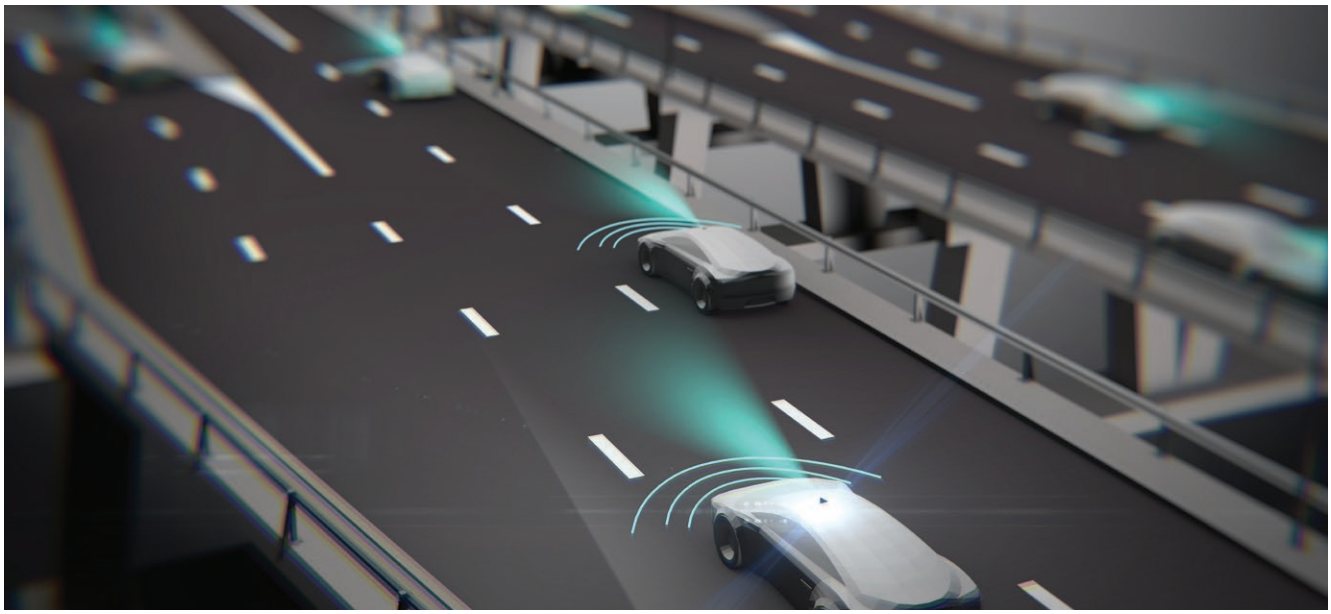
The Australian Driverless Vehicle Initiative (ADVI) has also developed timelines as to when they expect the various levels of automated technology to be available in Australia. ADVI suggests the arrival of Level 3 technology prior to 2020, Level 4 technology between 2020 and 2025, and Level 5 technology between 2026 and 2030.[17] This view aligns with timeframes previously identified by the NRMA.

While challenging to predict the future, the following is a guide to connected and automated vehicle introduction in Australia.

FIGURE 5: CONNECTED AND AUTOMATED VEHICLE INTRODUCTION IN AUSTRALIA



It is worth noting that even if the technology is ready for Australian roads by these indicative times, the local regulatory environment may not be. If the regulatory environment is not ready, this could result in Australians being deprived of the benefits compared to citizens of other nations that have been more proactive in preparing their laws for an automated vehicle future.



17. http://advi.org.au/wp-content/uploads/2016/05/Narrative-Position-Paper-1.pdf

Barriers to adoption

The regulatory environment

The regulatory environment that manufacturers and users of automated vehicles must navigate is complex. Parts of some legislation do not presently provide scope to consider driverless vehicles on roads, and all current state and territory road rules assume that a human being is in control of a vehicle at all times – so what happens when control is transferred to an automated system?

Road rules and legislation have been amended in the past to accommodate changes in technology. For instance, when mobile phone use started to become prevalent, legislators were required to act to ensure road safety.

The West Australian Government adopted the Australian Road Rules for mobile phone use on 1 March 2011.[18] This adoption effectively banned hand-held use in vehicles and put in place disincentives for using a mobile device while on public roads.

The Australian Road Rules are updated periodically and will require amending to accommodate automated vehicles.

Road rules

Each state and territory maintains a set of road rules that define the rules for driving on shared roads. In NSW, the rules are known as the *Road Rules 2014*. To ensure the road rules are mostly uniform with those applicable in other states and territories, the rules are based on the model *Australian Road Rules*, which were developed by the National Road Transport Commission (now the National Transport Commission or NTC) and first published in 1999.

Road transport and safety legislation

Each state and territory maintains its own road transport and safety legislation.

In NSW, the primary pieces of legislation are:

- The *Road Transport Act 2013*, which regulates road users and road safety, including driver licensing and vehicle registration.
- The *Roads Act 1993*, which regulates activities on public roads including the rights of members of the public and adjoining land owners to access public roads.
- The *Passenger Transport Act 2014*, which regulates the provision of public passenger services, including those provided by buses, taxis and private hire vehicles.

In ACT, the primary pieces of legislation are:

- The *Road Transport (Vehicle Registration) Act 1999,* which regulates vehicle registration.
- The *Road Transport (Safety and Traffic Management) Act 1999*, which regulates safety and traffic management.
- The *Road Transport (General) Act 1999,* which regulates the administration, enforcement and review of decisions under road transport legislation.
- The *Road Transport (Public Passenger Services) Act 2001*, which regulates the accreditation of operators of public passenger services and transport booking services, and the licensing of taxis, ride share vehicles and hire cars.

18. http://www.keepyoureyesontheroad.org.au/pages/WA-laws

Liability for injury, death and property damage

Negligence, contract and consumer protection laws govern liability for injury, death and property damage arising out of the manufacture, sale and use of automated vehicles. There are also laws governing Compulsory Third Party (CTP) insurance in respect of liability arising from motor accidents. In NSW, the CTP insurance scheme is designed to cover drivers against liability for personal injury or death caused by the fault of the driver.

Privacy and data

Laws concerning privacy could apply to information and data generated by automated vehicles. With advanced detection and communication technologies potentially generating a significant amount of data about persons travelling in automated vehicles, the *Privacy Act 1988* (C'th) may be applicable should the data contain personal information.

Consumer law and design rules

Australian Consumer Law prohibits a person from supplying consumer goods of a particular kind if the goods do not comply with a safety standard that is in force for goods of that kind. Safety standards for road vehicles are prescribed in the Australian Design Rules (ADRs), which are administered by the Australian Government under the *Motor Vehicle Standards Act 1989* (C'th).

Australian Road Rules

The model Australian Road Rules impose obligations on the "driver" of a vehicle. For example:

- *"A driver must not drive at a speed over the speed limit…."*
- *"A driver making a U-turn must give way to all vehicles and pedestrians"*
- *"A driver approaching or at traffic lights showing a red traffic light must stop…."*

However, the rules also assume that the driver will be a human sitting in the driver's seat – the rules don't allow for the scenario where automated driving technology is doing the driving. For example, the road rules make reference to the driver's arm, hand, palm and lap. They also make reference to the driver wearing a seatbelt, and the driver stopping at the scene of a crash and giving particulars to other drivers or persons involved.

With vehicle manufacturers and technology companies continuing to quickly progress automated driving technology, it is necessary to amend the model Australian Road Rules to remove this out-dated assumption.

Clarifying control

In April 2017, the National Transport Commission released a discussion paper entitled *Clarifying control of automated vehicles* with the explicit aim of clarifying several regulatory concepts for automated vehicles.

From an enforcement perspective, four key issues were raised:

- **Who is in control?** It is currently unclear who should be responsible for an automated vehicle if the driving task is undertaken by an automated driving system, but a human is the fallback and must be receptive to system errors and intervene if requested.
- **What will it mean to have proper control of an automated vehicle?** The road rules require a driver to have proper control of a vehicle. Police currently interpret proper control to mean that the driver is in the driver's seat and has at least one hand on the steering wheel. This may need to be updated to recognise automated functions and different safety-related behaviours required from human drivers.

- **How should proper control apply to the automated driving system?** It is currently unclear whether it is appropriate or relevant to apply the proper control test to an automated driving system when the automated function is engaged.
- **How do enforcement agencies interact with automated vehicles?** There is no single automated vehicle or automated driving technology being developed, and it remains to be seen how enforcement agencies will interact with automated vehicles and know what level of automation is engaged at a particular time.[19]

Proper Control

Rule 297(1) of the NSW Road Rules provides:

"A driver must not drive a vehicle unless the driver has proper control of the vehicle."[20]

The meaning of proper control is not further defined, however police generally interpret it to mean that the driver must be in the driver's seat and have at least one hand on the steering wheel. This interpretation, however, is not the law, and it is debatable whether a court would adopt such an interpretation in relation to a vehicle that is capable of safely steering itself without human assistance.

If an automated driving system is capable of safely steering a vehicle, there is no need for the driver to have his or her hand on the steering wheel in order to have proper control of the vehicle.

Driver and Driving

The model Australian Road Rules impose obligations on the "driver" of a vehicle. The rules define a "driver" as the person who is driving a vehicle.[21]

Drive is defined as follows:

"drive includes be in control of."

Accordingly, the term has its ordinary meaning, and it also includes being in control of a vehicle.

The SAE International Standard J3016 breaks the task of driving a vehicle into the following components:

- The **Dynamic Driving Task**, comprising:
  a. controlling the lateral movement of the vehicle via steering;
  b. controlling the longitudinal motion of the vehicle via acceleration and deceleration;
  c. monitoring the driving environment via object and event detection, recognition, classification, and response preparation;
  d. object and event response execution;
  e. maneuver planning; and
  f. enhancing conspicuity via lighting, signalling and gesturing etc.
- The **Strategic Driving Task**, comprising:
  a. trip scheduling; and
  b. selection of destinations and waypoints.

Subtasks 1(a) and 1(b) are considered to be operational functions. Subtasks 1(c) – 1(f) are considered to be tactical functions. Subtasks 1(c) and 1(d) are collectively referred to in the Standard as **Object and Event Detection and Response (OEDR)**.

Driving also includes the performance of the Dynamic Driving Task after the occurrence of a malfunction in a vehicle system that prevents the driving automation system from reliably performing the Dynamic Driving Task on a sustained basis. The SAE International Standard refers to this as **Dynamic Driving Task fallback**.

As vehicles become increasingly automated, more and more of the driving task will be performed by the automated driving system, and less will be performed by a human driver.

19. https://www.ntc.gov.au/current-projects/clarifying-control-of-automated-vehicles/
20. https://legislation.nsw.gov.au/~/view/regulation/2014/758/historical2017-01-06/part18/div1
21. Except a motor bike, bicycle, animal or animal drawn vehicle. The Australian Road Rules also apply to a "rider" of a motor bike, bicycle, animal or animal drawn vehicle, by virtue of Rule 19 which provides that each reference in the rules to a "driver" includes a "rider" and each reference to "driving" includes "riding".

The following chart summarises who or what is responsible for the Dynamic Driving Task (DDT) and DDT fallback at each level of driving automation:

FIGURE 6: SAE LEVELS OF AUTOMATION – WHO OR WHAT IS DRIVING?

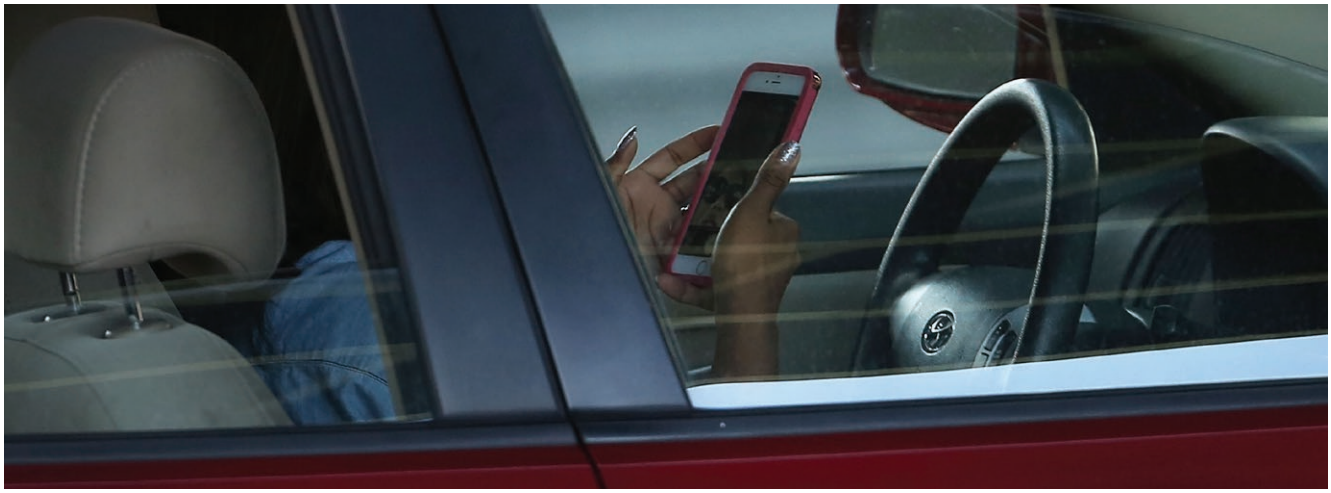
SAE level	Name	Narrative definition	DDT		DDT fallback	ODD
			Sustained lateral & longitudinal vehicle motion control	OEDR		
Driver performs part or all of the DDT						
0	**No Driving Automation**	The performance by the driver of the entire DDT, even when enhanced by active safety systems.	Driver	Driver	Driver	n/a
1	**Driver Assistance**	The sustained and ODD-specific execution by a driving automation system of either the lateral or the longitudinal vehicle motion control subtask of the DDT (but not both simultaneously) with the expectation that the driver performs the remainder of the DDT.	Driver and system	Driver	Driver	Limited
2	**Partial Driving Automation**	The sustained and ODD-specific execution by a driving automation system of both the lateral and longitudinal vehicle motion control subtasks of the DDT with the expectation that the driver completes the OEDR subtask and supervises the driving automation system.	**System**	Driver	Driver	Limited
ADS ("System") performs the entire DDT (while engaged)						
3	**Conditional Driving Automation**	The sustained and ODD-specific performance by an ADS of the entire DDT with the expectation that the DDT fallback-ready user is receptive to ADS-issued requests to intervene, as well as to DDT performance-relevant system failures in other vehicle systems, and will respond appropriately.	System	**System**	Fallback-ready user (becomes the driver during fallback)	Limited
4	**High Driving Automation**	The sustained and ODD-specific performance by an ADS of the entire DDT and DDT fallback without any expectation that a user will respond to a request to intervene.	System	System	**System**	Limited
5	**Full Driving Automation**	The sustained and unconditional (ie not ODD-specific) performance by an ADS of the entire DDT and DDT fallback without any expectation that a user will respond to a request to intervene.	System	System	System	**Unlimited**

It can be seen from this chart that responsibility for the Dynamic Driving Task and Dynamic Driving Task fallback progressively shifts from the (human) "driver" to the "system" as the level of automation increases.

Who should be responsible for ensuring that a vehicle complies with the road rules when the "system" is performing some or all of the Dynamic Driving Task or Dynamic Driving Task fallback? Put another way, who should pay the fine if the vehicle doesn't comply with the road rules when the system is performing some or all of these tasks?

Under current road rules, these responsibilities fall on the "driver." For Levels 0, 1 and 2, the driver is understood to be the human driver, even if the system is performing elements of the Dynamic Driving Task.

For Level 3, the system performs the entire Dynamic Driving Task, on the basis that a human remains ready to perform Dynamic Driving Task fallback. The human



driver becomes responsible for the Dynamic Driving Task during Dynamic Driving Task fallback.

For Levels 4 and 5, the system is responsible for the entire Dynamic Driving Task and Dynamic Driving Task fallback. These vehicles will also be able to operate without the need for anyone to be in the vehicle. For these vehicles, it is clearly the system that is "driving" the vehicle. But a system is not a legal entity and therefore can't be held responsible for compliance with the road rules.

The National Transport Commission has suggested that the legislated meaning of driver could be expanded to include the legal entity responsible for the automated driving system. This could be one of a number of possible legal entities – such as the registered operator of the vehicle, the manufacturer of the vehicle, or the service provider that maintains the automated driving system.

It's also possible that different components of the automated driving system will be supplied by different suppliers, and that ultimate responsibility for the safe operation of the system will be shared between a number of different legal entities. But shared legal responsibility for compliance with traffic laws would be confusing and uncertain, not least for the police – who would they issue the infringement notice to?

The registered operator approach

Make the "registered operator" responsible for ensuring compliance with the road rules

The time has come for the road rules to recognise that a vehicle can be "driven" by an automated driving system. Road rules and other driving laws should be amended to separate the concept of driving the vehicle (i.e performing the Dynamic Driving Task) from the concept of ensuring the vehicle complies with the road rules. The road rules should be amended to:

- acknowledge that a vehicle can be driven by a human or an automated driving system.
- allow the police and enforcement agencies to issue traffic infringement notices to the registered operator of a vehicle when the vehicle is being driven by the automated driving system.

If the registered operator of a vehicle receives a traffic infringement notice as a result of a failure of the vehicle's automated driving system through no fault of the owner, the registered operator should be able to bring a claim against the party that is responsible for the fault in the automated driving system, including the supplier/manufacturer of the vehicle, the maintainer of the vehicle, or any party that the registered operator has engaged to modify the vehicle.

To achieve these outcomes:

- driving would be defined as the performance of the Dynamic Driving Task (i.e. steering, speed control and Object and Event Detection and Response).
- a new concept should be introduced into the model Australia Road Rules – the concept of the "vehicle operator." The vehicle operator would be defined as:
  - when a human is performing, or is required to perform, part or all of the Dynamic Driving Task, the human occupant; or
  - when an automated driving system is performing the entire Dynamic Driving Task, the registered operator of the vehicle.
- the road rules would be amended to shift the obligation to ensure that the vehicle complies with the road rules from the "driver" to the "vehicle operator." This can be achieved by:
  - adjusting each road rule so that it applies to the vehicle, rather than the driver. For example "a driver must not drive a vehicle at a speed over the speed limit..." would become "a vehicle must not travel at a speed above the speed limit..."; and
  - introducing a new rule that requires the "vehicle operator" to ensure that the vehicle complies with the road rules.

Under this approach, the vehicle operator of a Level 4 or Level 5 vehicle would be the registered operator of the vehicle.

For Level 2 vehicles and below, the vehicle operator would be the human driver, even when the automated driving system is assisting with aspects of the Dynamic Driving Task.

For Level 3 vehicles, the vehicle operator would be the registered operator of the vehicle (as per Level 4 and 5 vehicles), until such time as the fallback-ready user is required to take control of part of the Dynamic Driving Task.

With South Australia the first state to introduce automated vehicle trialling legislation, a marked up copy of the South Australian Road Rules showing all of the required amendments to facilitate automated vehicles on South Australian roads over the longer term has been prepared (see *Amended South Australian Road Rules*, an annexure to this white paper).

Like the road rules in every state and territory, the South Australian Road Rules are based on the model Australian Road Rules. Accordingly, the road rules in other states and territories can be amended in a similar manner.

The police can pursue the registered operator – just like fixed camera speeding fines

This suggested approach would simplify processes for police. Similar to the current situation for fixed camera speeding and red light fines, the appropriate authority would simply issue an infringement notice to the registered operator of a vehicle. The registered operator would then be responsible for paying the fine (and incurring any demerit points), unless the registered operator could demonstrate that someone else was "driving" the vehicle at the time of the offence.

Corporate multipliers should apply to fines when the registered operator of a vehicle is a corporation, such as a corporate ride provider, to deter non-compliance with the road rules. Corporate multipliers exist in other legislation, such as legislation concerning environmental operations and fair trading practices.

The registered operator can pursue any remedies it has against the manufacturer

If a vehicle fails to comply with the road rules because of a defect in the automated driving system, the purchaser or owner of the vehicle will almost certainly be entitled to raise a legal claim against:

- the manufacturer, if the automated driving system was defective at the time of sale; or
- the maintainer or modifier of the vehicle, if the maintainer or modifier did something, or omitted to do something it ought to have done, that caused the automated driving system to become defective.

Volvo has already acknowledged that it will accept liability for traffic offences and accidents caused by its vehicles when operating in automated driving mode.[22]

Accordingly, ultimate liability for traffic offences will flow through to the vehicle's manufacturer, maintainer or modifier if they are at fault. This will motivate such parties to design, program, manufacture, maintain and/or modify the automated driving system so that it remains capable of complying with the road rules.

Placing the onus for complying with the road rules on a manufacturer or certifying entity directly (without involving the registered operator) bypasses traditional channels for allocating liability between product users/owners and manufacturers.

Under any alternative approach that would involve manufacturers or certifying entities from the outset, those parties would become directly liable for infringements incurred if a vehicle failed to comply with the road rules, even if the failure or defect in the vehicle's automated driving system was due to poor maintenance of the vehicle, a post-sale modification, or some other intervening conduct of the registered owner or third parties.

An automated driving system may be fit for purpose when sold, but subsequently become defective or unfit due to the actions of others.

Faced with this prospect, manufacturers may insist, as a condition of sale, that all maintenance and modifications are performed by the manufacturer (or entities endorsed by the manufacturer). This would mean that owners won't have the ability to engage third party maintainers or modifiers as the manufacturer's sale contract will seek to prohibit this. In addition, manufacturers could be less inclined to supply connected and automated vehicles to the Australian market. Consumers will end up losing out under this liability model.

The registered operator approach to liability issues simplifies processes and will not require significant resources to manage. The registered operator of a vehicle is in the best position to ensure that an automated driving system is maintained, updated and operating correctly. If the system does fail for a particular reason, the operator will have the ability to bring a claim against the manufacturer, maintainer or vehicle modifier, who currently are strongly encouraged to provide worthy products to the Australian market.

22. https://www.media.volvocars.com/global/en-gb/media/pressreleases/167975/us-urged-to-establish-nationwide-federal-guidelines-for-autonomous-driving

Pursuing the registered operator is efficient and removes complications

Maintaining a central point of contact for pursuing infringements removes complications that may be associated with other entities potentially held liable for breaches.

There is a range of driver obligations that do not relate to the dynamic driving task and cannot be, or may not be able to be, included in the design and programming of the automated driving system. Many of these relate to safety. They assume that the driver is human. Examples are:

- Requirements that involve a mental element such as knowledge – for example, a driver of dangerous goods must not drive if they know, or ought reasonably to know that a situation applies that means transporting the goods is unsafe.
- Requirements that drivers carry documentation – for example, dangerous goods documentation.
- Requirements for a driver to check something – for example, drivers of vehicles transporting a placard load (which are loads carrying over a certain amount of dangerous goods that are required to display placards) may not drive the load if it is not equipped with compliant fire extinguishers and portable warning devices that are correctly stowed.
- Various duties for drivers of public passenger transport that require the driver to assess a situation or take an action – for example, ensuring the vehicle is clean, treatment of lost property, taking action about dangerous passenger conduct, and accepting hiring for taxis.
- Requirements that a driver must report in person to a police station if a person is injured and no police attend the crash.
- Requirements to pay parking fees and tolls.

The driver duties described do not relate to the dynamic driving task and in many cases are not possible for an automated driving system to carry out. While technology may replace existing practices, these duties are not core to the dynamic driving task.

If the obligations are not appropriate for the automated driving system to undertake, consideration needs to be given to whether there is a gap. This will require analysis of legislation to see if other entities currently have the same or a similar obligation or whether the obligation should be placed on another entity.[23]

Ensuring individual protections under the registered operator approach

While private car ownership will decline under the future mobility model, individual owners and operators will still exist – at least for the foreseeable future.

To provide protections for individuals, strict regulatory measures and processes will need to be put in place to ensure that users have the ability to access insurance and shift liability quickly and easily when other parties have been negligent. No artificial barriers should be put in place to restrict individuals accessing insurance or dispersing liability to third parties when necessary.

An important component of the framework to protect individuals and ensure equity between users/owners and manufacturers is vehicle data access. The data collected by connected and automated vehicles relating to an incident should be available to registered operators, manufacturers, road agencies, police, insurance providers and approved repairers. Transparent practices around data access and supply are crucial to ensuring that liability can be quickly determined and transferred.

A regulated and simple process that includes strong fair trading practices and protocols should be established for determining liability when an incident occurs. Individuals should not be burdened unnecessarily due to the inability to access and analyse vehicle data.

If a registered operator has complied with maintenance and operating procedures and an incident occurs due to an error with the automated driving system, shifting liability to the responsible entity should be rapid and seamless. Vehicle data reading to determine liability should be conducted through either a regulated department or approved third party. Consideration should be given to ensuring that generated vehicle data is stored within Australian borders.

Peace of mind and protection for consumers is paramount to the uptake and acceptance of connected and automated vehicle technology and should form the basis for a liability model along with vehicle safety.

23. https://www.ntc.gov.au/about-ntc/news/media-releases/ntc-seeks-feedback-on-changing-driving-laws-to-support-automated-vehicles/

What legislation is potentially impacted?

It is not just the road rules that need to be amended to allow highly and fully automated vehicles to operate on Australian roads. Other legislation that refers to the "driver" of a motor vehicle will require amending:

Commonwealth

- *Australian Design Rules*
- *Australian Light Vehicle Standards Rules 2015*
- *Model Legislation – Transport of Dangerous Goods by Road or Rail Regulations 2007*
- *Heavy Vehicle National Law*
- *Heavy Vehicle (Vehicle Standards) National Regulation*

New South Wales

- *Road Transport Act 2013*
- *Roads Act 1993*
- *Roads Regulation 2008*
- *Passenger Transport Regulations 2007*
- *Tow Truck Industry Act 1998*
- *Crimes Act 1900*

Queensland

- *Transport Operations (Road Use Management) Act 1995*
- *Transport Operations (Road Use Management - Road Rules) Regulation 2009*
- *Transport Operations (Road Use Management – Vehicle Standards and Safety) Regulation 2010*
- *Transport Operations (Passenger Transport) Act 1994*
- *Transport Operations (Passenger Transport) Standard 2010*
- *Transport Infrastructure Act 1994*
- *Criminal Code Act 1899*
- *Australian Light Vehicles Standards Rules 2015*

Victoria

- *Road Safety Act 1986*
- *Transport (Compliance and Miscellaneous) Act 1983*
- *Transport (Compliance and Miscellaneous) (Conduct on Public Transport) Regulations 2015*
- *Transport (Buses, TaxiCabs and Other Commercial Passenger vehicles) Regulations 2005*
- *EastLink Project Act 2004*
- *Melbourne City Link Act 1995*
- *Crimes Act 1958*

South Australia

- *Road Traffic Act 1961*
- *Road Traffic (Light Vehicle Standards) Rule 2014*
- *Road Traffic (Miscellaneous) Regulations 2014*
- *Road traffic (Road Rules – Ancillary and Miscellaneous Provisions) Regulations 2014*
- *Passenger Transport Act 1994*
- *Passenger Transport Regulations 2009*
- *Motor Vehicles Act 1959*
- *Criminal Law Consolidation Act 1935*

Tasmania

- *Vehicle and Traffic Act 1999*
- *Road Rules 2009*
- *Passenger Transport Services Act 2011*
- *Police Powers (Public Safety) Act 2005*

Western Australia

- *Road Traffic Act 1974*
- *Road Traffic (Vehicles) Act 2012*
- *Road Traffic (Vehicles) Regulations 2014*
- *Road Traffic (Administration) Act 2008*
- *Road Traffic Code 2000*

Australian Capital Territory

- *Road Transport (Public Passenger Services) Act 2001*
- *Road Transport (Public Passenger Services) Regulation 2002*
- *Road Transport (Safety and Traffic Management) Act 1999*
- *Road Transport (General) Act 1999*
- *Road Transport (Vehicle Registration) Act 1999*
- *Dangerous Goods (Road Transport) Act 2009*

Northern Territory

- *Motor Vehicles Act*
- *Traffic Act*
- *Criminal Code Act 1983*
- *Australian Vehicle Standards Rules*

Some of these Acts place obligations on drivers that are not related to the Dynamic Driving Task, on the assumption that the driver is a human and is available to undertake tasks associated with the vehicle, such as managing the vehicle's passengers or load, or responding to emergencies and directions from authorised people. These obligations will need to be recast or reassigned so that the original purpose of the obligation is achieved for vehicles that are driven by an automated driving system.

As highly and fully automated vehicles appear on Australian roads in larger numbers, and as future transport options and technologies progress, other associated legislation may require consideration. Shared services, connected infrastructure, point-to-point transport and existing transport business models will likely affect the regulatory environment into the future. As technology progresses, it will become more important for legislators to be agile and open to amending legislation when necessary.

The process for achieving legislative change is outlined in Appendix B.

Liability, insurance and ethical considerations

Liability

Considerable discussion surrounding automated vehicles has focused on the question of liability where an automated vehicle is involved in an accident causing personal injury, death or property damage. Liability questions are closely related to insurance considerations, which are discussed separately.

Australian product liability law offers a proven framework for resolving questions of liability arising out of product defects, including products involving new technologies. There is good reason to be confident that liability questions arising out of defects or deficiencies in automated vehicles will be appropriately responded to.

Insurance

Establishing legal liability is one thing – obtaining swift access to compensation is another. It is for this reason that all states and territories have established CTP insurance schemes, and the National Injury Insurance Scheme (NIIS). Both schemes prioritise early access to treatment and care to support optimal injury recovery. The NSW CTP scheme is embodied in the *Motor Accidents Compensation Act 1999* (NSW) which will shortly be replaced by the *Motor Accident Injuries Act 2017* (NSW). This scheme provides compensation for personal injuries caused by motor accidents and financial protection to those who cause injury on a cost effective basis. The NIIS is complementary to the NSW CTP scheme and is designed to provide lifetime care for catastrophic motor vehicle accident personal injuries.

In NSW, the NIIS is legislated in the *Motor Accidents (Lifetime Care and Support) Act 2006*. Equivalent legislation exists in the other states and territories.

In NSW, the CTP scheme provides limited benefits for at fault drivers and comprehensive benefits for those who are able to demonstrate that their injury was sustained in a motor vehicle accident that was caused by the negligence of an owner or "driver" of a motor vehicle. It is presently unclear whether these schemes will respond to personal injuries sustained as a result of accidents caused by a defect in a vehicle's automated driving system.

The National Transport Commission has recommended that state and territory governments undertake a review of CTP and national injury insurance schemes to identify any eligibility barriers to accessing these schemes by occupants of an automated vehicle or those involved in a crash with an automated vehicle. The National Transport Commission has also recommended that, subject to the review of CTP insurance schemes, state and territory governments amend their CTP insurance schemes in close consultation with each other and industry, and that the resulting reforms are nationally consistent wherever possible.

Victims of personal injury caused by motor accidents should not be worse off as a consequence of a vehicle being driven by an automated driving system rather than a human driver. However, it is important to ensure that future compensation schemes for personal injuries arising in a mixed fleet, including vehicles with different levels of automation, are appropriately funded by the parties responsible.

Due to dispersed liability in a connected and automated vehicle future, insurance premiums for individual consumers should be lower than that of today.

Insurance will continue to play a pivotal role in helping individuals protect the things they value. For the foreseeable future, where a mixed fleet of automated, semi-automated and non-automated vehicles are on the road together, injuries and damage will continue to occur. The majority of accidents involving automated vehicles to this point have been caused by human operators or third party vehicles. Insurance will need to change and evolve as the fleet does, however it will remain key to protecting people when incidents occur.

More connected and automated vehicle trials are necessary to properly understand the grey areas where varying levels of automation intersect with human intervention – this will influence the development of driverless technology and further understandings around insurance and liability.

As the interaction between humans and automated technology becomes increasingly blurred, there will be a need to ensure people are protected and covered under an insurance policy to provide consumers with certainty of protection and compensation.

Determining fault and liability

Determining fault and liability when an incident occurs involving an automated vehicle will be a significant issue for manufacturers, technology providers, insurers and users. As the transition to a fully automated vehicle future occurs, automated vehicles (with varying levels of automation) and traditional vehicles will share the road. With human interaction and responsibility changing with different levels of automation, this scenario creates challenges when needing to decisively determine fault and liability.

In June 2016, German Transport Minister Alexander Dobrindt proposed new legislation to require manufacturers of cars equipped with an autopilot function to install an Event Data Recorder (or black box) to help determine responsibility in the event of an incident. Under the proposal, manufacturers would be required to install a device that records when an autopilot system was active, when a driver drove, and when the automated system requested that a human take over control of the driving task.[24]

In all likelihood, manufacturers will want to do this anyway so that they can prove the human driver or others were at fault where this was the case. The real issue will be access to the black box data by police, the human driver, passengers, insurers and others, especially if the data isn't favourable to the manufacturer's legal position.

Ethical considerations

While safety is seen as a major benefit of connected and automated vehicles, it is perhaps unreasonable to assume that incidents will immediately cease altogether; rather, it can be expected that incidents will lessen over time as technology continues to advance.

With spiking road tolls and increasing injury numbers on Australian roads, there is an obligation to adopt connected and automated technology.

But what happens when a human driver is not in control and the automated driving system is met with a moral dilemma?

The classic thought experiment (known as the trolley dilemma) developed by philosopher Philippa Foot (later adapted by Judith Jarvis Thomson) has explored human moral intuitions and consequences for decades.

The Trolley Dilemma

Scenario 1: Imagine you are standing beside some tram tracks. In the distance, you spot a runaway trolley hurtling down the tracks towards five workers who cannot hear it coming. Even if they do spot it, they won't be able to move out of the way in time.

As this disaster looms, you glance down and see a lever connected to the tracks. You realise that if you pull the lever, the tram will be diverted down a second set of tracks away from the five unsuspecting workers. However, down this side track is one lone worker, just as oblivious as his colleagues.

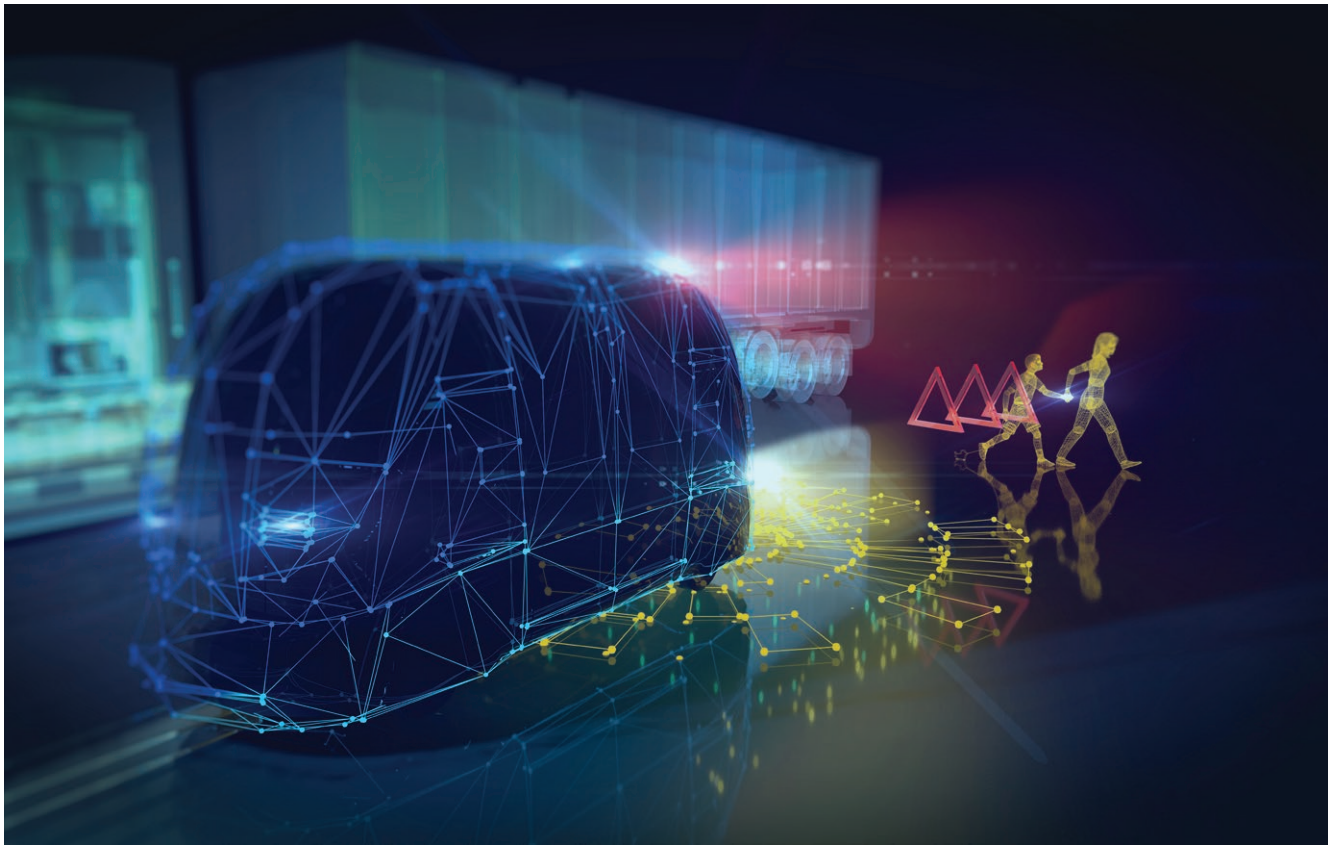
So, would you pull the lever, leading to one death but saving five?

Scenario 2: Imagine you are standing on a footbridge above the tram tracks. You can see the runaway trolley hurtling towards the five unsuspecting workers, but there's no lever to divert it. However, there is large man standing next to you on the footbridge. You're confident that his bulk would stop the tram in its tracks.

So, would you push the man on to the tracks, sacrificing him in order to stop the tram and thereby saving five others?

Source: Laura D'Olimpio, Senior Lecturer in Philosophy, University of Notre Dame Australia

24. https://www.media.volvocars.com/global/en-gb/media/pressreleases/167975/us-urged-to-establish-nationwide-federal-guidelines-for-autonomous-driving



Automated driving systems are not human and will more than likely never match the unique complexity of the human mind. This may be a good thing, however, as human intuitions are not always logical, reliable or consistent.

Automated driving systems won't make decisions based on feelings or beliefs; rather, computer programming and artificial intelligence will form the backbone of the decision-making process in automated driving systems, even when tricky or unusual situations are presented.

But is it possible for an automated driving system to determine what the lesser of two evils is if an incident cannot be avoided?

In June 2017, the world's first ethical guidelines for driverless cars were released by the German Ethics Commission on Automated and Connected Driving. The guidelines unsurprisingly state that human safety must take precedence over animals and property. While this may seem obvious, certain situations throw up unique challenges leading to ethical dilemmas.

When presented with a unique situation, automated driving systems should take the course of less harm – this again seems obvious, however providing all of the necessary information to the automated driving system so that a clear distinction between right and wrong can be made is highly complex and challenging.

There is a significant amount of work and learning to occur in this space. Ultimately, automated vehicles may never perfect the decision-making process in certain situations, but if they are safer overall compared with the human equivalent driver, less deaths and injuries will be sustained on roads.

Privacy and data

Concerns relating to privacy and data will need to be resolved before the new mobility future can be fully realised. Indeed, privacy and data issues are among the most significant concerns for consumers, and will potentially affect vehicle take-up and acceptance. The adoption of good industry practices will go a long way to alleviating consumer concerns.

OEMs currently have little incentive to allow external access to the vast amounts of data they collect on driver and trip usage (even to the user), which is no different to that of current ride share apps such as Uber.

However, as technology progresses and a greater need for data becomes mandatory for proper connected and automated operation and interaction, consumers will become increasingly more wary about what information is collected, and what transpires as a result.

Connected and automated vehicles require a myriad of passive and active sensor devices operating in unison to maintain full vehicle control. These devices collect and rely on information from the external environment and continually relay some of that information to complementary systems required to ensure safety and proper vehicle operation across a connected network.

Public education about the need for data and information collection and use will help to establish an understanding around why this is necessary. However, for this to be successful, operators need to be transparent about data collection, handling, disclosure and security.

While operators must comply with Australian Privacy Laws, Australian Consumer Laws and application specific laws, good industry guidelines and practices will be crucial in gaining consumer understanding and consent.

In Canada, as the government begins to study regulatory options pertaining to automated vehicles, the Privacy Commissioner, Mr Daniel Therrien, raised the following data access concern:

"Modern cars are more than simply vehicles. They have become smartphones on wheels – mobile sensor networks, capable of gathering information about, and communicating with, their internal systems, other vehicles on the road, and local infrastructure."

Mr Daniel Therrien – Canadian Privacy Commissioner

The main concerns expressed by the Privacy Commissioner are that there is no real accountability for the flow of data.[25]

With connected and automated vehicles having the capacity to collect information and data relating directly to individuals, including favoured travel routes and stops, driving habits and shopping preferences, it is possible that a significant proportion of that information and data could be classified as "personal information" for the purposes of the *Privacy Act 1988*.

The significance of how information and data is classified should not be underestimated – the Privacy Act regulates how information may be used, accessed and disclosed, and puts in place strong information sharing protections for data captured under its scope.

Taking these protections into account, manufacturers or operators may seek to gain the consent of purchasers or users so that personal information collected can be commercially utilised.

In addition to privacy laws, federal, state and territory surveillance device laws aimed at prohibiting the surveillance of individuals will add to the potential framework that may govern how user privacy and data information is collected, used and transferred.

In the medium to long term, as car ownership begins to decline and subscription-based services become the norm, concerns relating to privacy and data access will turn into concerns about the amount of data collected, and the amount of information held or retained.

25. http://betakit.com/privacy-commissioner-of-canada-concerned-about-data-collection-in-connected-cars/

In any event, future users of connected and highly automated vehicles should have access to the data generated as a result of undertaking a journey, and maintain the right to control its availability and use wherever reasonably practical. Users should also have the option to provide generated data to third parties, including nominated data custodians.

Further, to promote competition and market fairness, users should not be unduly impeded in exercising choice and in exercising an ability to switch between multiple providers of products and services when desired.[26]

The Internet of Things Alliance Australia (IoTAA) recently published a business to consumer good data practice guide to promote industry and consumer awareness as to good practice in dealing with data associated with the provision of business to consumer services.

Good Data Practice Principles

1. **Australian Privacy Principles and Consumer Protection Benchmark Principle.** Provider terms of service or use should not override Australian Privacy Laws and Australian Consumer Laws.
2. **Accountability Principle.** Providers should exercise end-to-end accountability in relation to all flows of relevant information associated with the provision of services.
3. **Customer Empowerment Principle.** Providers should not unfairly or unreasonably shift data accountability responsibilities to consumers.
4. **Cyber Protection Principle.** Providers and their delivery partners should implement security by design in all devices and services.
5. **Customer Data Transparency Principle.** Providers should implement good information handling practices that meet reasonable expectations, and communicate these practices in plain English.
6. **Data Minimisation Principle.** Collection and handling of relevant information by providers should be minimised to the point that solely enables proper service provision.
7. **Customer Data Control Principle.** Providers should take reasonable steps to inform consumers of their rights to access relevant information.

These principles set the benchmark for consumer protection and good business practice in the evolving Internet of Things world.

Application specific principles to guide data availability and use for connected and automated vehicles should now be established by government and industry to supplement this framework.

26. IoT Alliance Australia, Good Data Practice: A guide for business to consumer internet of things services for Australia V1.0 (Leonard, Peter), November 2017

Consumer acceptance and trust

When the first automobiles arrived on the scene, red flag laws were introduced to warn bystanders that a vehicle was approaching.

Red flag laws throughout the world generally required that a person walk well ahead of an approaching automobile yielding a red flag or lantern to increase bystander awareness and promote vigilance – so unpredictable were these new machines.

Today, populations have accepted automotive technology and placed their trust in manufacturers and drivers. Such caution in the early days of the automobile seems preposterous now, but concerns would have been quite legitimate at the time.

Perhaps society faces a similar psychological dilemma with the impending arrival of connected and automated vehicles. Car travel will be offered in a fundamentally different way than that of today, and widespread adoption will rely on people trusting the technology and handing over control.

It is not the manufacturers, policy makers or legislators who are in control of automated vehicle adoption – uptake rates will primarily rest with the consumer. Markets exist and flourish when products and services are in demand, and that will be true of connected and automated vehicles.

The appetite for automated vehicle technology in Australia appears to be healthy. According to a 2016 study by ADVI, 70 per cent of Australians would trust automated vehicles to take over the driving task when they feel tired, bored, or physically and mentally incapable of driving manually. The same number said they would rather a driverless car take the lead when driving was "boring or monotonous."

These findings suggest that Australians are quite accepting of automated vehicle technology.

While legislative and operational barriers to connected and automated vehicles can be addressed by government and industry through planning and procedure, consumer acceptance and trust will be what really drives this transformational component of the future mobility model.

Societal issues

The arrival of connected and automated vehicles will profoundly change the way people live and move around, and a number of broad associated societal issues will pose significant challenges to government, industry and individuals.

Fully automated vehicles represent a giant leap forward in automotive technology and will disrupt and alter many sectors of the economy.

There will always be numerous benefits and challenges associated with any major technological advancement – the important thing is that society is prepared.

Contrasting views on automated vehicle technology

It is important to acknowledge that while change may be of benefit to one person, it may create real or perceived concerns to another.

Perspectives of benefit:

- *My safety will be improved*
- *Economic growth will progress*
- *My cost of living will be reduced*
- *The environment will prosper*
- *My child will have greater independence*

Perspectives of concern:

- *My job will be in jeopardy*
- *Congestion will worsen*
- *My right to drive will be removed*
- *Travel costs will increase*
- *I can't trust that I'll be safe*

Following is a snapshot of some areas that will more than likely be significantly impacted by automated vehicle technology.

Land use and planning

If connected and automated vehicles negate the need for a human driver and improve the flow of people and goods, then in-vehicle productivity will increase. People can get back to reading books, catching up on the phone with friends and getting ahead of deadlines.[27] If trips can be more productive, commute times all of a sudden become less of an issue.

These types of changes will dramatically alter people's life choices, and force planners to rethink what a future with driverless vehicles may look like. The impending transformation of cities and regions is very real. Parking is one area that will surely be impacted as the need for close proximity structures diminishes. Petrol stations may eventually become irrelevant or repurposed as electric vehicle charging stations, and some infrastructure may be re-engineered for multipurpose use.

Governments should immediately give consideration to how an automated future integrates with current land-use and planning policies – significant reforms will likely be necessary.

Parking

Car sharing and ride sharing have the potential to free up car parking capacity by removing privately-owned vehicles from the road. With private vehicle ownership set to decrease as automated vehicles become accessible and accepted, parking and associated infrastructure will be impacted.

Densification and congestion are affecting many urban areas, and trends towards the removal of parking spaces (particularly on-street) are evident – one example is the City of Sydney, where projects such as the construction of bicycle paths and light rail have claimed dedicated parking spaces. With fewer spaces available, jurisdictions should consider prioritising shared vehicles by offering parking incentives or benefits.

27. http://www.businessreviewusa.com/technology/5647/How-autonomous-vehicles-could-improve-human-productivity

Current commercial parking providers must consider how their current business models will adapt to accommodate automated vehicles. They must also give consideration to vehicle-to-vehicle and/or vehicle-to-infrastructure communication technologies.

Automated vehicles will transform cities and architecture, and should therefore be recognised as a central element in future planning.

Car sharing and ride sharing

Car sharing and ride sharing provide commuters with mobility options and financial savings. By sharing the cost of commuting with others, significant savings can be had depending on frequency of use, as well as a myriad of other variables.

Car sharing and, more recently, ride sharing have grown in popularity due to congestion, densification and technology. With the advent of automated vehicles, the popularity of car sharing and ride sharing will likely increase exponentially.

Most planners and transport experts believe that private vehicle ownership will decrease drastically as automated vehicles become accessible and accepted – this will result in vehicles being offered to users as a service, which will more than likely be accessed through a paid subscription.

Access

The introduction of highly and fully automated vehicles is expected to dramatically improve access for less mobile users such as the elderly and those with disability. Users who have been restricted and reliant on others for transport will all of a sudden be presented with options.

People with a range of disabilities will be able to use point-to-point transport that meets their needs. In addition, low income earners unable to own a vehicle and those who are presently unable to hold a traditional driver licence will be presented with a world of new possibilities.

Equitable mobility access is one of the major benefits that autonomy will bring to society – simply improving access for many users will mean that lifestyles are positively impacted.

Jobs

If we look back to the horse and buggy as the predominant form of mobility prior to the mass introduction of the automobile, some jobs existed in far greater numbers than they do today. Farriers, blacksmiths, horse trainers, stable hands, coach builders, coach drivers – they are jobs that still exist today, but exist in significantly smaller numbers compared to 100 or so years ago. A move to motor vehicles created new jobs such as mechanics, automotive engineers and component manufacturers.

Firms and occupations are only relevant if a demand for their services exists. It is possible that in the future the skills needed by mechanics will be highly complex electronic and software skills, vastly unlike the skill requirements of today. Traffic police, couriers, truck drivers, chauffers, taxi drivers and valets may also not be needed in the same numbers as today, but service technicians and digital programmers may grow in demand.

In the short term, as connected and automated technology continues to develop, new skills will be required and new jobs will be created. In addition, new businesses will form offering new products and services. While this is a positive impact, jobs and businesses currently servicing the needs of conventional automotive technologies may see reduced demand. It is difficult at this point in time to definitively predict the overall impact that connected and automated vehicles will have on the labour market over the medium and long terms.

Conclusion

The significance of a transition to connected and automated vehicles and a new form of mobility must not be underestimated. Technology is about to revolutionise the way people move around.

Connected and automated vehicles and public transport will play complementary roles in the future, working in unison to deliver door-to-door transport solutions.

While open to debate, this looming transition may be greater than the transition from horse and buggy to motor car, potentially impacting not just individuals, but virtually all industries.

To fully benefit from the new mobility model underpinned by connected and automated vehicles, Australia must be prepared to proactively advance trialling and policy work, as well as the processes for ensuring that supportive regulatory frameworks are in place.

It will be necessary for governments, industries, regions and cities to work together as disruption throws up enormous challenges and opportunities.

There needs to be open dialogue on societal issues to ensure that individuals and industries are not caught off guard and significantly disadvantaged.

Connected and automated vehicle technology must be considered in all future plans and strategies, especially those relating to transport, land use, planning and regional development.

A move to shared mobility will undoubtedly raise many questions and demand strong leadership as challenges arise, however the opportunities and benefits that can be realised in a shared, automated and clean powertrain future far outweigh the short term problems society will face as deployment commences.

Appendix A – Policy Principles

In August 2016, the Transport and Infrastructure Council published policy principles for government action in relation to land transport technology.

National Policy Framework for Land Transport Technology – Policy Principles

1. Government decision-making on transport technologies will be based on capacity to improve transport safety, efficiency, sustainability and accessibility outcomes.
2. New technologies should be implemented in a way that is consumer centric (i.e. designed to meet the needs of those using the service). This includes consideration of:
    a. options to deliver transport information and services in a way that is consistent and familiar, and
    b. the diverse needs of travellers, in particular travellers with a disability, vulnerable road users such as cyclists and pedestrians, and users of multiple modes of transport.
3. Where government investment is required to support the deployment of new technologies, that investment will be evidence based, consistent with long-term strategic planning and will deliver value for money.
4. Where feasible, government agencies will avoid favouring particular technologies or applications, in order to encourage competition and innovation. New applications should support interoperability, backwards compatibility and data sharing, and should account for possible future transitions to other technology platforms.
5. Planning for transport technologies will build on existing infrastructure networks (including public transport) and seek to leverage existing consumer devices (such as smart phones) where appropriate.
6. When considering regulatory action, governments will consider low cost approaches such as collaborative agreements or self-regulation before pursuing formal regulation.
7. If required, best practice regulatory approaches will be adopted to ensure regulation is cost efficient, transparent, proportionate to the risk, fit for purpose and done in consultation with affected stakeholders. This includes adopting relevant international or regional standards, unless there is a compelling reason for a unique Australian requirement.[28]

Proposed amendments

The Future of Car Ownership research paper by the NRMA proposes the following amendments to the *National Policy Framework for Land Transport Technology – Policy Principles* to improve choice, convenience, accessibility and productivity:

2a. options that support informed choice for transport consumers to optimise their journey;

2b. the diverse needs of travellers, in particular travellers with disability, non-English speakers, vulnerable road users such as cyclists and pedestrians, and users of multiple modes of transport; and

2c. access to, travel of and storage of automated vehicles and associated technology.

28. https://www.ntc.gov.au/Media/Reports/(32685218-7895-0E7C-ECF6-551177684E27).pdf

Appendix B – The passage of legislation

To establish or change a state or federal law, a bill must be put to the relevant parliament and passed by both houses (in a bicameral system) in identical form; the bill is then assented by the Governor (in Australian states) or Governor-General.

Australia's parliamentary system is a mix of parliamentary (United Kingdom) and presidential (United States) systems – it is often referred to as the Washminster system (a mix of both the Westminster [UK] and Washington [US] systems of government).

Following are the steps required for a bill to pass parliament and become an Act or law in the Federal Parliament:

Federal Parliament

Government Bill (originating in the House of Representatives)

1. Bill preparation and drafting
   - A proposal to establish or change a law originates from the government.
   - The Office of Parliamentary Counsel prepares the bill as a draft Act.
2. Scheduling
   - The Parliamentary Business Committee of Cabinet determines introductory timing.
   - The Clerk of the House arranges for the bill to be put on the Parliamentary Agenda.
3. Parliamentary introduction and first reading
   - The bill (along with an accompanying explanatory memorandum) is introduced.
   - The Clerk of the House reads the full title of the bill to the House.
4. Second reading and second reading debate
   - The member who introduced the bill explains its purpose to the House.
   - The House debates the bill's principles and subsequently votes on the bill.
5. Detailed consideration
   - The text of the bill and all clauses are considered in detail by the House.
   - Amendments and alterations to the bill are debated and voted on by the House.
6. Third reading
   - The bill is given final consideration by the House.
   - The Clerk of the House subsequently reads the full title of the bill to the House.

THE BILL HAS NOW PASSED THE HOUSE OF REPRESENTATIVES

7. House transfer and senate introduction
   - The Clerk of the House issues a certificate and the bill is transmitted to the Senate.
   - The bill is delivered to the Senate by the Serjeant-at-Arms.
8. Senate readings and house transfer
   - The bill goes through three readings in the Senate where it may be amended.
   - When the bill passes the Senate, it is returned to the House of Representatives.
9. Concurrence
   - If the Senate has passed or requested amendments, the bill will be negotiated.
   - The bill must pass both Houses in identical form prior to being assented.
10. Assent
    - The Clerk of the House certifies the bill and presents it to the Governor-General.
    - When assented, the bill becomes an Act of Parliament and is law.

Case study: Parliament of New South Wales

Transport Legislation Amendment (Automated Vehicle Trials and Innovation) Bill 2017

The *Transport Legislation Amendment (Automated Vehicle Trials and Innovation) Bill 2017* was introduced to the Parliament of New South Wales on Tuesday 1 August 2017 to provide for automated vehicle trials to be carried out on NSW roads with permission of the Minister.

Type:	Government
Origin:	Legislative Assembly
Member:	Pavey, Melinda (Blair, Niall)
Long Title:	An Act to amend the *Road Transport Act 2013* to provide for automated vehicle trials; and to amend the *Transport Administration Act 1988* with respect to the functions of Transport for NSW.
Legislative Assembly:	
Notice of motion	Tuesday 1 August 2017
Introduced	Tuesday 1 August 2017
First reading	Tuesday 1 August 2017
Second reading speech	Tuesday 1 August 2017
Second reading	Tuesday 8 August 2017
Third reading	Tuesday 8 August 2017
Passed	Tuesday 8 August 2017
Legislative Council:	
Introduced	Tuesday 8 August 2017
First reading	Tuesday 8 August 2017
Second reading speech	Wednesday 9 August 2017
Second reading	Thursday 10 August 2017
Third reading	Thursday 10 August 2017
Passed	Thursday 10 August 2017
Returned to LA	Thursday 10 August 2017
Passed Parliament:	Thursday 10 August 2017
Assented:	Monday 14 August 2017

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