

NSW Connected and Automated Vehicle (CAV) Readiness Strategy



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◀ BusBot driverless shuttle on the Northern Breakwall, Coffs Harbour.

Photo Credit: Busways



List of acronyms

ACES	Autonomous, Connected, Electric, Shared	EU	European Union
ADAS	Advanced Driver Assistance Systems	EV	Electric Vehicle
ADVI	Australia and New Zealand Driverless Vehicle Initiative	GHG	Green House Gas
AI	Artificial Intelligence	GPS	Global Positioning System
ANCAP	Australasian New Car Assessment Program	HD	High Definition
AV	Autonomous Vehicle / Automated Vehicle	ITS	Intelligent Transport Systems
BRT	Bus Rapid Transit	NTC	National Transport Commission
CAM	Cooperative Awareness Message	OEM	Original Equipment Manufacturer
CAPEX	Capital Expenditure	POC	Proof of Concept
CAV	Connected and Automated Vehicle	PT	Public Transport
CAVI	Cooperative and Automated Vehicle Initiative	RSU	Road Safety Unit
CBD	Central Business District	SCATS	Sydney Coordinated Adaptive Traffic System
CITI	Cooperative Intelligent Transport Initiative	SPAT	Signal Phase and Time
CVP	Customer Value Proposition	TfNSW	Transport for NSW
DENM	Decentralised Environmental Notifications Message	TMR	Department of Transport and Main Roads (Queensland)
DSRC	Dedicated Short-Range Communications	USDOT	United States Department of Transportation
		V2I	Vehicle to Infrastructure
		V2V	Vehicle to Vehicle
		V2X	Vehicle to Everything
		VMS	Variable Messaging Sign

▲ NSW Smart Shuttle and Road Safety Research Vehicle

Executive summary

Connected and Automated Vehicles (CAVs) present a significant opportunity to address several challenges facing NSW, such as accelerating the shift to zero fatalities on the road network, improving first and last mile connectivity and making NSW a more liveable place.

To take advantage of these opportunities, significant national reforms are underway involving all levels of government to establish a national end-to-end regulatory framework to support the safe commercial deployment and operation of Automated Vehicles (AVs).

In addition to contributing to these reforms, Transport for NSW (TfNSW) has a particular opportunity to put itself in the driver's seat to increase adoption, drive supply and lead global innovation while ensuring that the transition helps shape positive outcomes for our customers, industries and communities.

The importance of CAV technology is established in the TfNSW Technology Roadmap 2021-24, which puts forward an ambitious vision to expand and accelerate the use of technology and innovation across NSW, including through the adoption of CAVs, laying out the vision that NSW will be a world leading adopter of this technology. To achieve this, it will be fundamental for NSW to pursue CAV readiness over the coming years to align with national and international developments in the technology.

CAV readiness means that NSW will have successfully accelerated the real world, commercial application of CAV technologies, and is actively pursuing the integration of CAVs into the NSW transport system.

Being CAV ready will therefore require NSW to both actively contribute to the implementation of the national regulatory framework and proactively pursue a series of NSW specific initiatives across defined priority areas as outlined in this Strategy.

In recent years, TfNSW has delivered a successful program of CAV initiatives, such as the driverless shuttle bus trials and partially automated vehicle trials to understand the capability on Sydney's motorway network. TfNSW has achieved this success largely by working closely with industry partners, and future initiatives will need to extend and expand these partnerships.

CAV technologies are now beyond 'peak hype' and like a lot of technologies will move into a level of commercial realisation in coming years. In practice, this makes the next few years an important period for TfNSW to become 'CAV Ready' and accelerate the real world, commercial application of CAVs as the technology moves from its initial hype to commercialised deployment.

This CAV Readiness Strategy has been created to reflect on the lessons learned, recent research and the strategic drivers for NSW and sets the future strategic agenda for NSW to be CAV ready by proposing a CAV readiness program.



This strategy includes six CAV priority areas with supporting initiatives.

▲ Driverless passenger shuttle in Newcastle – Credit: Keolis Downer Hunter



While the initiatives in this program are subject to future business cases and funding allocations, they establish that CAVs present a significant opportunity to address several challenges facing NSW, such as accelerating the shift to zero fatalities on the road network, improving first and last mile connectivity and making NSW a more liveable place.

Actively pursuing the integration of CAVs into the NSW transport system will help NSW gain an 'early lead' in the

area and ensure that the state gains the maximum benefit out of the transition to CAVs.

The strategy includes six priority areas with supporting initiatives that have been developed as 'key moves' to make meaningful steps to integrating CAVs in the transport system and encourage a strong CAV industry in NSW.



Foreword

Getting NSW ready for Connected and Automated Vehicles

The emergence of Connected and Automated Vehicles (CAVs) is expected to be one of the most significant disruptions to the transport industry in contemporary history, and we are eager to harness the opportunities this step change presents.

We have set an ambition to be a global leader in transport technology to enable convenient, personalised and sustainable mobility solutions for customers and communities. **The Future Transport Technology Roadmap 2021-2024** outlines six priority programs to help us get there, including an ambition for NSW to be a world-leading adopter of CAVs.

We're committed to unlocking the benefits of CAVs which will eventually have profound benefits on the safety, efficiency, cost and sustainability of the transport system and will help shape the cities and regions in which they operate.

Change will not occur without coordinated effort to safely enable these new technologies. We recognise that for NSW to be a world-leading adopter of CAVs, we need to continue our focus on getting ready for tomorrow through actions today. We've made strides in building readiness for CAVs since introducing legislation and enabling trials from 2017, however more must be done.

We're pleased to release this CAV Readiness Strategy which outlines six priority areas to enable this step change. These priorities set out a combination of early testing and deployment at scale, creating the right policy and regulatory settings, providing the necessary road

and connectivity infrastructure, attracting vehicle supply and building a supporting local ecosystem.

Partnerships are at the core of our technology vision and we want to partner locally and globally with industry, communities, researchers and other jurisdictions to harness expertise and bright ideas.

As the world moves towards deploying CAVs we know NSW offers a great integrated testbed for development and early deployments. We have invested in the Future Mobility Testing and Research Centre in Cudal and have strong technology foundations including our Open Data Hub, the world's largest digital ticketing system and our SCATS intelligent traffic management system. SCATS powers traffic lights in 187 cities and 28 countries worldwide and we continue to build out this capability to help establish the digital infrastructure required for CAVs and the technology of tomorrow.

We're committed to accelerating the real-world, commercial adoption of CAVs to benefit the customers and communities of NSW, but we can't do it alone. Our door is always open and we look forward to exploring partnerships that will make this future a reality.

Joost de Kock

Deputy Secretary, Customer Strategy and Technology

Transport for NSW



CAVs present a significant opportunity to address several existing challenges NSW faces and through early action and preparation TfNSW can successfully lead the transition to CAVs.

▲ Automated Vehicles utilise technology to assist or replace the driver of a vehicle.

1 Introduction

1.1 The need for a readiness strategy

The emergence of CAVs is expected to be one of the most significant disruptions to the transport industry in recent history. It was initially predicted to be a revolution in the way we travel, but more recently has come to be understood as a gradual evolution that will occur over many decades. Nonetheless, CAVs present a significant opportunity to address several existing challenges NSW faces and through early action and preparation TfNSW can successfully lead the transition to CAVs.

In addition to NSW actively contributing to the national reform program to establish a regulatory framework for CAVs, this will require NSW to proactively pursue a series of initiatives across defined readiness areas to break down barriers where they hinder the supply, uptake and smooth transition to CAVs.

This document has been created to reflect the lessons learned, recent research and the strategic drivers for NSW and provide a program of initiatives to support NSW becoming 'CAV Ready'.

1.2 NSW strategic drivers and enabling plans

The following documents, while not an exhaustive list, represent the strategic drivers and enabling plans for NSW to become CAV ready:

Document	Overview
<p>Future Transport Technology Roadmap 2021-2024 (2021)</p> 	<p>The Future Transport Technology Roadmap 2021-2024 reveals a major uplift in the NSW Government’s ambition to strengthen its global leadership in transport innovation and to create new uses of technology and data analytics for the safe and efficient movement of passengers and freight. The roadmap outlines six priority programs, one which is to make NSW ‘a world-leading adopter of Connected and Automated Vehicles’.</p> <p>Besides explicitly supporting the adoption of CAVs, CAVs will also help support other priority programs, including integrating CAV rideshare services with Mobility as a Service and playing a key role in transforming regional mobility.</p>
<p>Connecting to the Future – Our 10 Year Blueprint (2018)</p> 	<p>The 10 year blueprint lays out where TfNSW needs to focus in order to best respond to the challenges and opportunities in the coming decade. It sets the state on course to deliver on the NSW Government’s focus area of ‘well-connected communities with quality local environments’ and the long term vision outlined in Future Transport.</p> <p>The Blueprint presents an Outcomes Framework, structured around customers, communities, the people of NSW and the people of TfNSW. The strategy also notes that the transport landscape is likely to change more in the coming decade than it has in the past 50 years – including through the emergence of autonomous vehicles.</p>
<p>Future Transport 2056 (2018)</p> 	<p>Future Transport 2056 is an overarching strategy, supported by a suite of plans to achieve a 40-year vision for the transport system. The strategy recognises that transport is in a period of immense growth, change and disruption and that technology presents opportunities including new ways to travel and plan journeys, and new ways to deliver cutting-edge services to customers.</p> <p>The plan includes a chapter dedicated to the opportunities and challenges posed by a number of technology developments and how these could change customer mobility, and the capabilities of transport providers.</p>
<p>NSW Connected and Automated Vehicle Plan (2019)</p> 	<p>The Connected and Automated Vehicles Plan (or ‘CAV Plan’) supported Future Transport 2056, and also delivered on one of the key strategies in the 2016 Future Transport Technology Roadmap – to enable connected and automated vehicles. It focused on the opportunity for NSW to lead the way in encouraging the use of CAVs on NSW roads.</p> <p>The CAV Plan was framed around five priority areas: laws and safety, infrastructure and planning, transport services, data and customer readiness.</p> <p>This Readiness Strategy builds upon the 2019 CAV plan to support the delivery of outcomes of the current Future Transport Technology Roadmap 2021-2024.</p>

Table 1: Strategic Drivers and Enabling Plans

1.3 What is a CAV?

Automated Vehicles utilise technology to assist or replace the driver of a vehicle. Automation in vehicles is not a new concept and has been around since the late 1950s when cruise control started providing limited automation in vehicles. With adaptive speed control and lane keep assist now available in many new vehicles, greater levels of automation are starting to become more widely adopted. In the coming decade, higher levels of automation, where the human is taken out of the driving task, are expected to become available.

The Society of Automotive Engineers (SAE) defines six levels of driving automation from Level 0 (fully manual) to Level 5 (fully autonomous), as shown in Table 2.

Highly automated vehicles are defined as those with the ability to drive without a driver on a high proportion of full door-to-door urban journeys, as well as on urban and higher volume rural motorways.

Connected vehicles use Cooperative Intelligent Transport Systems (C-ITS) and/or 4G/5G to communicate with other vehicles, road users, roadside infrastructure, transport management systems (such as signals) and customers. This is called Vehicle to Everything (V2X) and can help alert drivers of hazards or disruptions, or directly improve vehicle safety. Vehicles can be either automated, or connected, or both.

We are currently seeing both level 1 and level 2 automation in production vehicles today, ranging from driver assist technologies like lane keeping assist or electronic stability control to more sophisticated autopilot

Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
No Driving Automation	Driver Assistance	Partial Automation	Conditional Automation	High Automation	Full Driving Automation

Table 2: SAE Levels of Automation

systems. This strategy focuses on vehicles that operate at higher levels of automation (Levels 3 to 5) and may have connected vehicle capabilities such as the ability to communicate with infrastructure and other vehicles.

1.4 What are the challenges that CAVs help address?

Becoming a world leading adopter of CAVs is not about the CAV technology solution. Rather, it is about harnessing the benefits of the technology to solve some of the issues and challenges faced by TfNSW and its customers. Some examples include the following:

- Utilising new technologies to support the reduction of crashes and associated injuries, acknowledging that significant progress has already been made on NSW roads;
- Bridging the first and last mile gap in public transport provision, increasing mobility options and encouraging greater usage of sustainable transport modes through CAVs;
- Supporting the growth and productivity of NSW cities and regions as the demand for the movement of people and goods grows;
- Working towards the goal of net zero emissions by 2050, with it being commonly understood that future CAVs will be zero emission vehicles, rather than those produced with traditional combustion engines.



▲ North Coast Regional Botanic Gardens BusBot trial vehicle
Credit: BusWays

2 The CAV readiness program

2.1 What does CAV readiness mean for NSW?

CAV Readiness will mean that NSW will have successfully accelerated the real world, commercial application of CAV technologies and will be actively pursuing the integration of CAVs into the NSW transport system. This will be done by proactively pursuing a series of NSW specific initiatives to break down the barriers and enable the transition to CAVs in NSW.

This work will compliment the establishment of a national end-to-end regulatory framework to support the safe commercial deployment and operation of AVs, which done in isolation won't necessarily mean NSW is CAV ready.

2.2 CAV enablers

Key enablers will be required to support NSW becoming CAV ready over the next few years.

- Policy and regulation will need to support the safe entry and inclusion of CAVs to the NSW road network. While this will mostly be facilitated by the new national regulatory framework, supporting policy work is required to deliver customer outcomes.
- CAV technology and associated communications will need to be compatible, and capable to perform in the real-world, on-road NSW environment.
- Customers must be aware and knowledgeable of the realistic benefits and challenges of CAV technology, having opportunities to experience and engage with CAVs first-hand.
- Physical and digital infrastructure across NSW will need to support the entry and continued operation of CAVs. This will need to include

the full integration of CAVs into the existing transport network and the management and protection of data for safe, efficient and effective operation.

- A local ecosystem that is a thriving, local talent pool of industry skills, partnerships and researchers that support successful businesses across the entire supply chain of CAV technology. This also includes depth of skills and capability within NSW Government to enable scaled CAV deployment and adoption.

These enablers have led to the development of a CAV Readiness Program with six priority areas of CAV readiness and underlying initiatives that are described in the following sections.

2.3 Benefits of CAV adoption

The wide scale deployment of CAVs will have a significant impact on the way people and goods are moved across NSW. Adoption of CAVs could help address many of the key issues and challenges faced by TfNSW and its customers. NSW will have the opportunity to improve on five target outcomes when CAVs are at larger scale deployment, as shown in Table 3. Each of the initiatives aims to support achieving these outcomes to benefit the NSW community.

It is intended that the initiatives contribute to the delivery of these outcomes, providing benefits in three key categories: economic, financial and social.






Target Outcome	Summary
 <p>Mobility</p>	Mobility improvements for the NSW community through better and/or increased public and private transport options and an increased focus on customers' needs and preferences, including CAVs becoming part of Mobility as a Service to deliver seamless and personalised journeys.
 <p>Productivity</p>	Productivity outcomes for commercial operations, customer, public transport and freight are improved for NSW. CAV adoption helps support and enable economic activity to gain a better return on investment in the network and services sectors.
 <p>Safety</p>	Safety outcomes are improved for all road users across NSW due to fewer crashes and associated injuries and fatalities. CAV adoption supports NSW's focus on the 'Towards Zero' goal of no fatalities on NSW roads.
 <p>Place and environment</p>	The quality and sense of place is maintained or improved for the community where CAVs are adopted, and NSW continues to protect the environment while accelerating the switch towards net zero emissions.
 <p>Sustainability of services</p>	Transport services, both public and private, remain viable and better meet the needs of the NSW community and customers through the introduction of new CAV solutions.

Table 3: CAV Scaled Deployment Target Outcomes

Across the initiatives this includes benefits like improving road safety, managing congestion, reducing travel costs, reducing the cost of transport for business, improving value for money for transport services and improving connectivity across the transport network.

The overarching program benefits will be calculated across these key areas as business cases are developed for specific priorities and initiatives, with each initiative expected to deliver positive outcomes.

2.4 CAV initiative timings

To enable NSW to move towards being CAV Ready, 22 CAV Readiness Initiatives have been developed.

These initiatives are based on extensive learnings from past initiatives, industry engagement and global research and expertise. The initiatives are consolidated into six CAV Readiness priority areas that represent an investment in critical elements required to build CAV Readiness for NSW. These Priority Areas are 'key moves' that will make meaningful steps to integrating CAVs in the transport system and encourage a strong CAV industry in NSW.

These have been developed based on the importance, commitment required and the independencies of the different initiatives. It should be noted that initiative timings are not definitive and may be brought forward or back based on many factors.





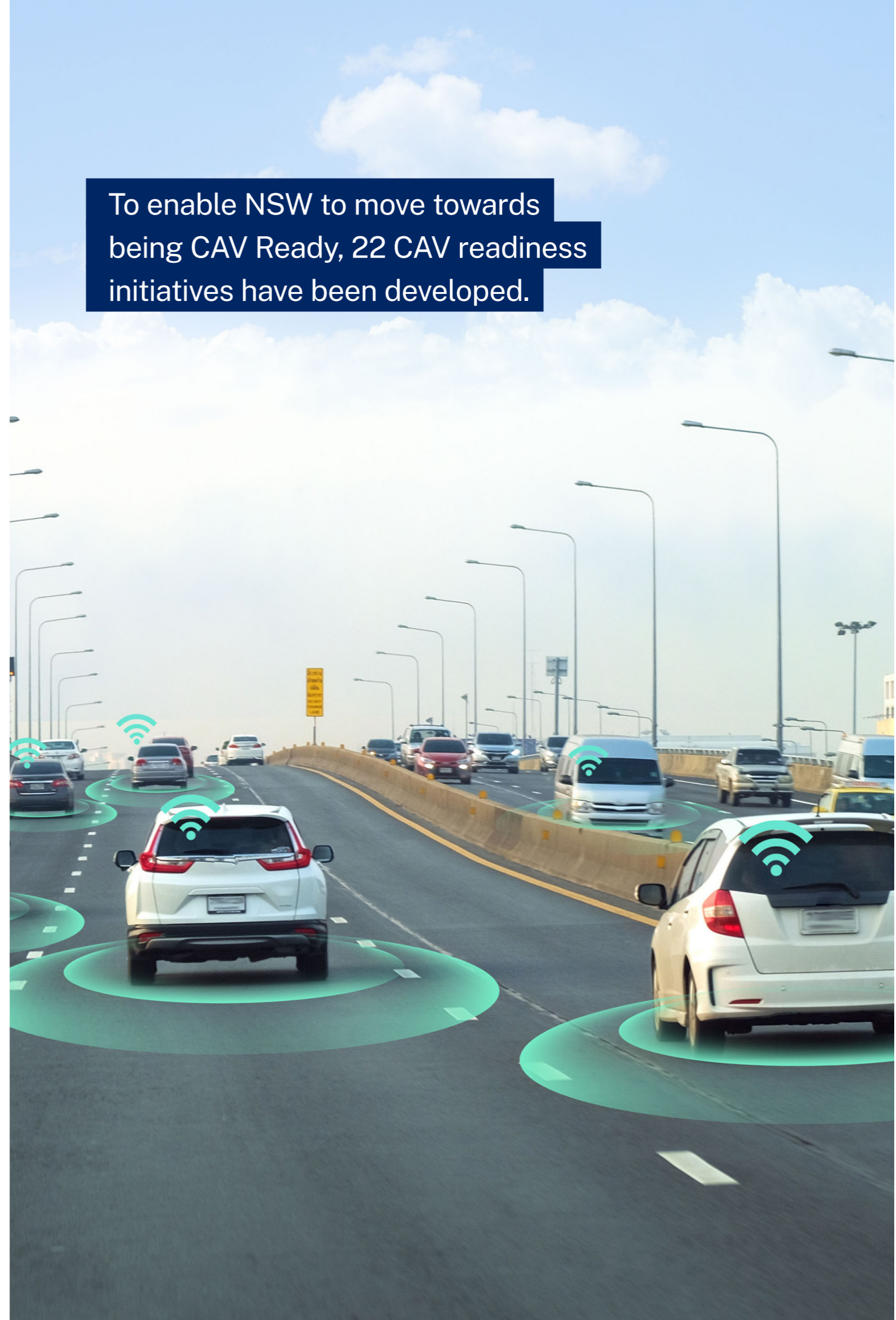
Initiative	Summary
 Foundational Initiatives	These initiatives will establish the foundational elements for successful deployment of CAVs within the NSW transport system. Other initiatives may have strong dependencies and require these to have been started, well underway or in place. Their timing will be dependent on when they are needed by other initiatives.
 CAV Accelerator Initiatives	CAV Accelerator initiatives fast track NSW's ability to becoming 'CAV Ready' and will build excitement, interest and local expertise.
 Early Pipeline Initiatives	Early Pipeline Initiatives will contribute to NSW becoming 'CAV Ready' and should be considered for development and/or implementation early on in the program.
 Future Initiatives	Future Initiatives may not be needed immediately to realise a 'CAV Ready' NSW but will be needed into the future to maximise the benefits and opportunities of the widescale deployment of CAVs in NSW.

Table 4: CAV Initiative Timings

To enable NSW to move towards being CAV Ready, 22 CAV readiness initiatives have been developed.



2.5 The six CAV priority areas

Priority 1: Test and deploy CAVs on the road network

Testing and deploying CAVs on the road network through trials and pilot projects will help engage customers, build a local ecosystem, support infrastructure and lead to an improved understanding of the technical requirements, capabilities and performance of different CAV technologies, including C-ITS. This can be done through CAV buses and rideshare vehicles in regional and urban areas, as well as supporting the rollout of ADAS systems, particularly in regional areas to improve safety.

Priority 2: Shape CAV Policy and customer outcomes

The customer value that CAVs can deliver is a key element in shaping how CAVs will operate in NSW. Through this priority area we will shape the customer value proposition for CAVs in NSW as well as the policy and regulatory frameworks required for successful deployment of CAVs within the NSW transport system. Initiatives within this priority area include the customer value proposition, policies to deliver customer outcomes, modelling and simulating CAVs on the NSW network, understanding and supporting community needs, and integrating CAV data streams. These initiatives will align with and support the national regulatory framework for AVs.

Priority 3: Get the road network ready for CAVs

This priority area aims to have a network of 'CAV Ready' roads. It is expected for roads to be deemed 'CAV Ready' they will have been extensively tested and assessed for Level 3 or 4 autonomous driving, this may include C-ITS enabled infrastructure and

available 5G connectivity. The development of a 'CAV Readiness Framework' would be an initial step to delivering this initiative.

Priority 4: Develop physical and digital CAV testing capabilities

The expansion of a CAV testing and research centre at Cudal, in conjunction with a virtual CAV testbed, could allow for the comprehensive development and testing of CAV technologies in NSW. These initiatives could be supported by a NSW CAV challenge to spur the industry and academia to focus on the development of CAV software and hardware platforms and to attract expertise and knowledge sharing.

Priority 5: Support freight and services automation





Supporting automation in freight, including long-distance, point-to-hub and first/last mile, stands out as a key area in which TfNSW can provide its support to early adopters. This would enable increased productivity and maximised economic benefits from CAVs. Automation can also be explored in the delivery of government services.

Priority 6: Increase local CAV knowledge and skills

Developing knowledge and skills relating to CAVs across various groups is critical to building a strong CAV ecosystem in NSW. For industry and technical professions, this could include training and upskilling courses, for Government this could include stimulating CAV research to ensure that NSW remains at the cutting edge and retains its status as a thought leader.

Delivering on these six priorities will ensure that TfNSW is working towards NSW becoming CAV Ready and being a world-leading adopter of CAVs.

CAV Readiness program timings

Priority				
	Foundational	CAV accelerator	Early pipeline	Future
	Now		Next	2027+
Priority 1: Test and deploy CAVs on the road network	Community engagement and participation	On-Road CAV public bus trials CAV rideshare pilot	Regional – Advanced Driver Assistance trial Cooperative intelligent transport systems	
Priority 2: Shape CAV policy and customer outcomes	Shape the Customer Value Proposition for CAVs in NSW Policy enablement to bring the CVP to life Simulating and Modelling CAVs		CAV data streams and exchange	
Priority 3: Get the road network ready for CAVs	CAV concept of operations and network integration HD mapping and digital twins Digital signage and assets database	“CAV Ready” road network	Future mobility road and street design guidelines	Asset management and predictive road safety
Priority 4: Develop physical and digital CAV testing capabilities		Future Mobility Testing and Research Centre NSW CAV challenge Virtual CAV test bed		
Priority 5: Support freight and services automation increasing			Automated heavy vehicle and freight trials	Freight and Servicing – automated first and last mile
Priority 6: Local CAV knowledge and skills	CAV Research and thought leadership		CAV education, skills development and jobs	

3 CAV readiness initiatives

The six priority areas are supported by 22 CAV readiness initiatives which have been prepared to guide industry and research partners on key activities which TfNSW will seek to partner on and enable. Summary level details on the initiatives are shown on subsequent pages.

Understand and shape the customer value proposition for CAVs in NSW

Customers must be at the centre of any technology vision and solution development. This initiative will understand how CAVs can unlock key outcomes for customers and enable world class customer experience as part of an integrated transport network.

NSW has many diverse use cases and mobility requirements across our cities, regions and remote areas. A focus of this work will help shape the design of technology solutions so that they consider the customer value proposition and how new services will benefit the end user through effective customer experience and service design. Trials and deployment of services should consider gaps in the transport network and test business models which may provide more financially sustainable transport services including in lower patronage markets which are more difficult to service with traditional modes.

This initiative will assist to establish how CAVs will operate as part of a system, interacting with other road users, infrastructure and other forms of public, private and freight transport on the network to deliver customer outcomes. In addition to the physical environment CAVs will also need to integrate with

emerging digital systems and products such as Mobility as a Service offerings and network operational systems including traffic management systems such as SCATS. Effectively establishing the optimal customer value proposition will ensure CAVs unlock key outcomes for customers and provide seamless connected journeys across an integrated and customer focused transport network.

This initiative is a Foundational initiative and supports the enabling area of Customer and target outcomes of Mobility, Productivity, Place and Environment and Sustainability of Services.

Partnerships could include:

researchers, AV rideshare companies, and Mobility as a Service providers.

Community engagement and participation

Community Engagement and Participation involves ensuring that the public is aware of technologies such as Advanced Driver Assistance Systems (ADAS) and is prepared and ready for the transition to CAVs.

Initially, an awareness program on available ADAS technologies could focus on encouraging consumers to



▲ BusBot trials in Coffs Harbour

take up vehicles with active safety features and to use these features when driving.

As technology advances, the focus would shift towards educating and promoting connected features and conditional automation through ongoing customer engagement, either directly or through key projects. This would illustrate the benefits of ensuring the NSW transport system is CAV Ready, both for existing and future technologies. Lastly, it will be important for ongoing interaction by customers with CAV technologies to take place, to grow awareness, appreciation and acceptance of this evolution in mobility.

This initiative is a Foundational initiative and supports the enabling area of Customer and target outcomes of Mobility and Safety.

Partnerships could include: dealership networks and Original Equipment Manufacturers (OEM's), industry and peak bodies, safety stakeholders and Towards Zero partners such as NSW Police, ANCAP and ADVI.

Looking internationally, the Smart Columbus program in Ohio, USA and the Cooper Hewitt Road Ahead in New York City, USA are examples of well received community engagement and participation programs.



▲ Concept of CAV rideshare

CAV rideshare pilot

This initiative involves developing a CAV rideshare pilot which will help pave the way for a larger rollout of automated on-demand shared vehicles in NSW.

The initiative will help NSW explore issues and fill in gaps that are currently barriers to the rollout of autonomous rideshare systems.

The automation of rideshare and on-demand vehicles could be a game-changer in terms of costs and availability of services for customers. Especially for trips that cannot be undertaken by public or active transport or for people with mobility impairments. Automated rideshare pilots would considerably help pave the way for a larger rollout of automated on-demand shared vehicles in NSW.

A trials program would help the industry and government ready itself in terms of legislation, technology and infrastructure, and build a local ecosystem to support the trial(s).

This initiative is a CAV Accelerator initiative and supports the enabling area of Technology and target outcomes of Mobility, Productivity, Place and Environment and Sustainability of Services.

Partnerships could include:

OEMs, rideshare companies, and transport operators.

In the USA, Waymo is offering CAV ride-share services in Phoenix, Arizona and in 2023 Lyft and Motion are partnering to deploy fully automated vehicles in multiple US cities.

On-road CAV public bus trial

The initiative involves the development of a large automated bus trial, with the capability of being fully automated for certain sections of the route. The trial(s) will explore the barriers that are currently prohibiting the rollout of large autonomous buses in NSW.

Automation can increase the service frequency, reliability and efficiency of the NSW bus system. Automated on-road bus trials would help the rollout of automation by exploring potential barriers and issues. Trials could take place on bus routes with lower complexities, such as segregated busways or in less complex on-road environments with a significant amount of bus priority. The initiative will aim for a commercial on-road service to help customers realise the benefits automation presents for public transport services.

This initiative is a CAV Accelerator initiative and supports the enabling area of Technology and target outcomes of Mobility, Productivity, Place and Environment and Sustainability of Services.

Partnerships could include: CAV technology suppliers, transport operators and bus manufacturers.

Internationally, a number of trials of automated buses have been undertaken including the Mercedes-Benz Future Bus CityPilot in Amsterdam, Netherlands and the Volvo Bus Trial at Nanyang Technological University in Singapore.

Automated heavy freight vehicle trials

The initiative will explore how the freight industry can benefit from the adoption of autonomous technology across the supply chain and include trials of automated heavy vehicles.

The freight task is expected to grow substantially in NSW over the next 15 years and this, coupled with increasing costs of transportation (e.g. fuel, wages) is driving up the cost of doing business. The automation of on-road freight has the potential to address these challenges facing NSW and therefore this opportunity needs to be investigated. This initiative will study and trial systems that could speed up the rollout of autonomous systems in the freight industry. The trials could focus both on heavy vehicles on busy metropolitan freight routes and those running in regional and remote areas.

This initiative is an Early Pipeline initiative and supports the enabling area of Technology and target outcomes of Productivity, Place and Environment and Sustainability of Services.

Partnerships could include: freight industry.

Examples of trials related to automated heavy freight include Autonomous Platooning by Cohda Wireless in Adelaide, South Australia and Enide Pod in Sweden which is a truck with autonomous and remote control capabilities.

Cooperative Intelligent Transport Systems (C-ITS)

This initiative will examine how C-ITS could be used to improve the operation of CAVs and increase network efficiency. The initiative will build on the previous C-ITS pilots and extensive work being undertaken to expand the SCATS capability to deploy different technology and C-ITS systems.

C-ITS allows vehicles to communicate wirelessly with other vehicles (V2V), infrastructure (V2I) and other devices (V2X). As defined by Austroads, C-ITS provides real-time information about the road environment with an increased time horizon and awareness distance which is beyond both what in-vehicle technologies and the driver can visualise.

This initiative will test and deploy C-ITS systems to improve the safety and reliability of the NSW transport system and aid the rollout of autonomous vehicles, as C-ITS systems can greatly enhance the performance of CAVs.

This initiative is an Early Pipeline initiative and supports the enabling area of Technology and target outcomes of Safety, Productivity, Place and Environment and Sustainability of Services.

Partnerships could include: OEMs, C-ITS technology Suppliers, SCATS, Geoscience Australia (SBAS), and QLD TMR.

Other projects like this include C-Roads in Germany and Queensland TMR's Cooperative and Automated Vehicle Initiative (CAVI).

Regional – Advanced Driver Assistance System (ADAS) trials

This initiative builds on the previous work undertaken by TfNSW and is a specific trial of ADAS technology in a regional context. It aims to understand the current performance of ADAS in regional areas and whether infrastructure interventions could help improve reliability.

The 2018 trials with Transurban identified several challenges for vehicle manufacturers, infrastructure providers and regulators to consider and overcome to safely introduce CAVs onto NSW roads. Given the higher risks and crash rates experienced by customers in regional areas it will be important to trial ADAS technologies, including retrofit technologies, to understand current performance and whether any infrastructure interventions could help improve reliability. In addition to understanding performance, it will be important to engage with communities to improve awareness, appreciation and uptake of the technologies by customers.

This initiative is an Early Pipeline initiative and supports the enabling area of Technology and target outcomes of Safety, Place and Environment and Sustainability of Services.

Partnerships could include: OEMs and local government.



Automation could potentially allow deliveries and waste collection to occur outside peak hours or reduce the number of large vehicles in sensitive places by using smaller automated vehicles for the last and first mile.

Freight and servicing – automated first and last mile

The aim of this initiative is to support industry in the automation of first and last mile freight tasks and servicing requirements, such as trials of last mile delivery or waste collection services.

First and last mile freight and servicing, such as package delivery and waste/recycling services, can contribute considerably to congestion and safety issues. Automation could potentially allow these deliveries to occur outside peak hours or reduce the number of large vehicles in sensitive places by using smaller automated vehicles for the last and first mile. This could include undertaking trials with partners to automate these services.

This initiative is a Future initiative and supports the enabling area of Technology and target outcomes of Safety, Productivity, Place and Environment and Sustainability of Services.

Partnerships could include: courier and delivery companies, CAV technology suppliers, waste collection companies, local government, and electric vehicle technology providers.

Examples of automated first and last mile freight and servicing trials include a self-driving refuse truck by Volvo in Sweden and drone delivery by Wing in Logan, QLD and Canberra, ACT.

▲ CAV freight and servicing concept

Policy enablement to bring the customer value proposition to life

This initiative will enable the CAV Readiness Program by developing policy to unlock the benefits of CAVs and bring the customer value proposition to life. It will do so while maintaining alignment with the national regulatory program.

Given TfNSW is the largest State authority in financial terms and our progressive approach to CAV readiness, we have an important role nationally to drive collaboration and bring parties to ensure Australia is an attractive place to deploy CAV technologies. It will be important in the short and medium term for NSW to focus on this initiative while the regulatory and governance arrangements for CAVs nationally are established.

This initiative is about developing policy to support the entire CAV Readiness Program, while maintaining alignment with the national regulatory reform program. It will be important to pool resources and collaborate with transport authorities in other jurisdictions to reduce duplication and maximise opportunities to testing, pilots and implementation.

This initiative is a Foundational initiative and supports the enabling areas of Policy and Customer and target outcomes of Mobility, Productivity and Sustainability of Services

Partnerships could include: NTC, State and Territory Transport Authorities, NSW Road Safety Partners, Industry, Industry and Peak Bodies, Austroads, Freight and logistic companies

Both California, USA and Germany, EU have introduced legislation to enable and accelerate the adoption of CAVs.

CAV data streams and exchange

This initiative aims to better understand the data stream and exchange between CAVs and the NSW transport system. In the initial stages, it will consider how TfNSW could both enable relevant data streams to CAVs, and benefit from the data being produced by CAVs out on the transport network.

It is important to identify useful data streams, storage of data, data protocols and considerations of privacy and data security as this allows for the development of mandated and optional data sharing requirements between OEMs and TfNSW. CAV data could then be used by TfNSW to improve transport service delivery, network operations and asset management. Data sharing could benefit CAVs in responding to incidents, hazards and optimal travel routes based on traffic and road conditions.

Extending this further to support collaboration and CAV ecosystem building, the data could be used to run hackathons and challenges to solve particular issues for TfNSW, helping foster collaboration and dialogue and support the development of CAV related start-ups. This initiative should link in with, rather than compete with, other initiatives and industry bodies such as Roads Australia and ITS Australia.

This initiative is a Foundational initiative and supports the enabling areas of Regulation and Policy and Local Ecosystem and target outcomes of Safety, Productivity and Sustainability of Services.

Partnerships could include: OEMs, Industry and Peak Bodies e.g. ITS Australia, Mapping and ITS providers, NTC, and Austroads.

International examples of similar projects include Work Zone Data Exchange (WZDX) in the USA and Sensoris in Europe.

A Movement and Place approach will ensure technology has a positive impact on streetscapes

CAV research and thought leadership

This initiative would help establish the local CAV ecosystem through encouraging and building local thought leadership in the field. Active thought leadership would help signal to industry globally that NSW is capable and ready to deploy CAV technologies.

When considering CAV readiness there is a particular focus on pilots and trials, however, desktop research, investigations and simulation studies will also have a significant role and can be undertaken sooner and at a much lower cost. This could be sponsored, supported and/or driven by TfNSW and include partnerships with various bodies such as academia, industry and peak bodies. In doing so, pathways moving from applied research to more tangible outcomes and possible commercialisation would be encouraged.

This initiative is an Early Pipeline initiative and supports the enabling areas of Regulation and Policy and Local Ecosystem and target outcomes of Mobility, Productivity and Sustainability of Services.

Partnerships could include: Other NSW Departments, Universities, Dedicated research programs, Industry and Peak Bodies.

Examples of CAV research and thought leadership include work facilitated by iMove Australia and the UK Autodrive White Paper Series.

Future mobility road and street design guidelines

The guidelines developed as part of this initiative would demonstrate how to take advantage of new technologies to meet the needs of all road users and illustrate what best practice street design looks and feels like. It would incorporate a Movement and Place approach to ensure technology has a positive impact on the vibrancy and amenity of streetscapes.

A NSW Future Mobility Road and Street Design Guideline would help designers incorporate future mobility considerations into the design of new infrastructure and places. The guide would demonstrate how to take advantage of new technologies to meet the needs of all road users and illustrate what best practice street design looks and feels like. Kerbside design and management would be a central element to these guidelines.

This could include recommendations such as: how to design for the pick-up and drop-off of people and goods by cars and micro-mobility, how to manage kerbside space dynamically responding to changes in demand over time, considerations for parking and CAV holding areas, how to support adoption of new generation vehicles by providing supporting infrastructure such as EV charging stations, how to leverage new technologies to deliver the best outcomes for people including improving safety and access for all ages and abilities. The guidelines could also provide specific guidance for transport projects to account for the risks, opportunities and uncertainties posed by CAVs and other emerging mobility types.

This initiative is an Early Pipeline initiative and supports the enabling area of Regulation and Policy and target outcomes of Safety and Place and Environment.

Partnerships could include: other State transport authorities, Local Government, DPIE, Austroads, State Government Architect, and the Greater Sydney Commission.

International examples include the NACTO Blueprint for Autonomous Urbanism and the Auckland Transport Roads and Streets Framework.



▲ CAV concept of operations

CAV concept of operations

A CAV Concept of Operations (ConOps) would outline the broader ecosystem in which CAVs operate and interact with other intelligent transport systems. The ConOps would assist TfNSW's planning for road infrastructure changes to support the rollout of CAV technology.

The complex nature of CAV operations and their expected integration with the broader transport system will require a well-defined ConOps. The ConOps would help create a clear line of sight between the people operating the transport system on a day-to-day basis and the strategic objectives set for the system. A ConOps would enable TfNSW to consider how CAVs would operate under different operational scenarios that may already exist or could be allowed for in the future. It is expected the ConOps will be an evolving

document to assist TfNSW to plan for road infrastructure changes to support available CAV technologies being used on the road network.

This initiative is an Early Pipeline initiative and supports the enabling area of Infrastructure and Operations and target outcomes of Safety, Mobility, Productivity and Place and Environment.

Partnerships could include:

roadworks contractors, Road operators / authorities, mapping and data companies, and other State Transport Authorities.

Two examples from the USA of CAV ConOps are US Department of Transport's Vehicle-to-Infrastructure Communication for Safety ConOps and Smart Columbus' Connected Electric Autonomous Vehicle Operational Concept.

High-definition mapping and digital twin(s)

High-Definition Mapping allows for CAVs to better identify their location and leads to better reliability and advanced features. This initiative will explore the development of a HD map of NSW to promote a higher uptake of autonomous technology and lower the barriers for OEMs entering the market.

High-Definition (HD) mapping allows CAVs to localise themselves with high precision, mapping their exact location with respect to the surrounding road and built environment. HD Maps can be a crucial component in helping CAVs understand their position, plan beyond sensor visibility and interpret road features and objects.

These maps include lane placement, anticipated curves, and safety conditions, noting that a separate C-ITS message (SPAT) is required to provide dynamic information about traffic signalling. Supplying a centralised HD map which OEMs can use and contribute to will reduce the barriers for the rollout of autonomous vehicles in NSW. The recent announcement of the NSW world leading spatial digital twin for Western Sydney provides a great start to establishing a CAV ready HD map for NSW with Western Sydney as a potential initial trial.

This initiative is a Foundational initiative and supports the enabling area of Infrastructure and Operations and target outcomes of Safety, Mobility, Productivity and Sustainability of Services.

Partnerships could include:

NSW Spatial Digital Twin, TfNSW SCATS Cornerstone, QUT – Centre for Robotic Vision, Sydney University – ACFR, Mapping and data companies.

Example of HD mapping related projects include iMove's HD Mapping for Automated Driving research and Here's HD Live Map.

Digital signage and assets database

This initiative will explore the development of a freely available state-wide database of road signs which would allow CAVs to understand road rules and safety issues without the need to solely rely on vision-based systems.

Early reports of deployment of CAV technologies in Australia by vehicle manufacturers and trials undertaken by Transurban and TfNSW have indicated difficulties with reading Australian traffic signs and the poor availability of data on speed zones. A digitised database could solve these issues. This initiative would build on TfNSW speed limit data and see the program expand to all other types of signage including temporary road signs. The database could be published for free online and be used by CAVs to better understand road rules and safety without the need to rely solely on fallible vision-based systems to read road signage. The database could be integrated into the NSW digital twin.

This initiative is an Early Pipeline initiative and supports the enabling area of Infrastructure and Operations and target outcomes of Safety, Mobility, Productivity and Sustainability of Services.

Partnerships could include: NSW

Spatial Digital Twin, Austroads e.g. RADCAV Initiative, Local Government, OEMs, and Other state transport agencies.

International examples of databases for digital signage and assets include City of Clover's, Traffic Signage Inventory (New Mexico, USA) and the Open Source Road Sign Database in the Netherlands.

“CAV Ready” road network

The aim of this initiative is to have a network of ‘CAV Ready’ main roads and precincts. It is expected that for roads to be deemed ‘CAV Ready’ they will have been extensively tested and approved for Level 3 or 4 autonomous driving, this may include C-ITS enabled infrastructure and available 5G connectivity.

The development of a ‘CAV Readiness Framework’ would be an initial step to delivering this initiative. The framework would continually be updated as the technology, systems and conditions evolve and would be used to deem a road or network of roads as ‘CAV Ready’. It will help customers be confident in using the latest technology in their vehicles and attract international players to NSW. An important feature of this initiative would also be the development of CAV ready precincts to help develop aspects of the infrastructure and technology that would lead to a CAV ready network.

This initiative is a CAV Accelerator initiative and supports the enabling area of Infrastructure and Operations and target outcomes of Safety, Mobility, Productivity and Sustainability of Services.

Partnerships could include: ITS suppliers, research institutions, local and private road operators, Infrastructure NSW, Other State and Territory Transport Authorities, OEMs, and DPIE.

Examples of similar projects in the USA include [33 Smart Mobility Corridor in Ohio](#) and [Cavnue in Michigan](#).

Simulating and modelling CAVs

The focus of this initiative is on understanding the integration of CAVs into the transport system at different stages of their deployment through transport simulation and modelling. This capability could be used to understand the impacts of different CAV rollout scenarios.

Transport simulation is a modelling paradigm that helps policy makers consider the impacts of different scenarios. This technology could be used to study the impacts of different levels of automation or different CAV rollout scenarios, alongside uptake of other emerging technologies. Incorporating this modelling from microsimulation to activity-based modelling, is a key area for consideration in order to start preparing and guiding an integrated transport system for different scenarios. This would help NSW better understand the implications of different policy levers that could be pursued.

This initiative is a Foundational initiative and supports the enabling areas of Infrastructure and Operations and Customer and target outcomes of Safety, Mobility, Productivity, Environment and Place and Sustainability of Services.

Partnerships could include:

Transport modelling software providers, Academia, Infrastructure NSW, and DPE.

Examples from elsewhere include [Melbourne Activity Based Model in Victoria, Australia](#) and [MOMENTUM in the European Union](#).



Asset management and predictive road safety

CAVs have the opportunity to improve Asset Management processes through providing continual road scans, leading to early identification of issues and helping catalogue sites with high numbers of road safety incidents or ‘near misses’. The aim of this initiative is to explore how NSW asset management processes could be improved and help TfNSW to be more predictive in making road safety interventions using automation.

The advanced technologies aboard CAVs and the systems that support them can potentially be utilised to better manage the NSW transport system. For example, CAV technologies and/or the data they produce can be used in asset management tasks, such as automatically detecting defects through machine learning and capturing data about them, the responsible road authority could then prioritise and action the repair without having to send out an inspection crew.

This initiative may be particularly important given the fact that CAV technology can often be reliant on well-maintained infrastructure. Similar technologies could be utilised to notify and record near misses or why road accidents occurred in real-time. For example, if a range of vehicles keep detecting pedestrian ‘near misses’ – this could quickly be investigated.

This initiative is a Future initiative and supports the enabling area of Infrastructure and Operations and target outcomes of Safety, Mobility, Productivity, Environment and Place and Sustainability of Services.

Partnerships could include: Transport modelling software providers, Academia, Infrastructure NSW, and DPE.

Examples of similar concepts include Moreton Bay Regional Council’s [Pothole Hunter Project in Queensland](#) and Mobileye’s [Data Services](#).

▲ Asset management and predictive road safety

Virtual CAV test bed

The aim of this initiative is to create a virtual test bed for testing and training autonomous vehicle driving technology. This initiative will help build the local CAV ecosystem and streamline the rollout of CAVs in NSW by providing data to train CAVs for NSW transport conditions.

The initiative will involve the creation of a machine learning training database with NSW and Australian driving condition-based scenes. Creating a virtual test bed to enable automated driving to be simulated in the lab presents an efficient and lower cost alternative to on-road testing. It can allow software developers to expose the vehicle to a broader range of targeted scenarios and use cases before trying it in the real world. It is expected that being able to provide this platform and data source will open up Australia to the CAV industry, as well as support development locally.

This initiative is a CAV Accelerator initiative and supports the enabling area of Local Ecosystem and target outcomes of Safety, Mobility, Productivity, Environment and Place and Sustainability of Services.

Partnerships could include: CAV Developers, International CAV Test Beds, Universities, Industry and Peak Bodies.

Global examples of CAV testing datasets include [NuScenes](#) and [KITTI Vision Benchmark Suite](#).

NSW Innovation Challenge

A NSW innovation challenge that creates a locally designed, built or operated CAV service, helping support the development of a local CAV ecosystem.

The NSW Innovation Challenge is about giving industry the flexibility to innovate and help build a local CAV ecosystem in NSW and Australia. This initiative would use the lessons learnt from previous innovation challenges, including the CAV trials, to formulate an innovation challenge to create a locally designed, built or operated CAV service. Participants would be encouraged to create a sustainable CAV service focused on meeting customer needs and challenges.

The CAV challenge would help seed the development of CAV software and hardware within NSW and Australia and bring expertise and talent to the region. Importantly, it would create interest and demonstrate the NSW Government's position on making the NSW ready for future and intelligent mobility solutions. The Innovation Challenge could be run on an annual basis and help gradually build up CAV expertise in different focus areas within NSW.

This initiative is a CAV Accelerator initiative and supports the enabling area of Local Ecosystem and target outcomes of Mobility and Productivity.

Partnerships could include: CAV supply chain, CAV manufacturers, Academia and transport operators.

Examples of similar innovation challenges include US Department of Transport's [Inclusive Design Challenge](#) and [Darpa's SubT Challenge](#).



Future Mobility Testing and Research Centre

This initiative seeks to improve the existing Future Mobility testing facilities at Cudal into a world class proving ground for CAVs. This facility will promote the growth and development of the NSW CAV ecosystem.

A world class Future Mobility Testing and Research Centre at Cudal would be used to undertake robust testing of both products and vehicles; and support ongoing research and evaluations of CAV technologies. An expanded facility would enable new and emerging technologies to be tested prior to being used on the wider transport network infrastructure. Cudal would form a focal point for the CAV industry and the research sector.

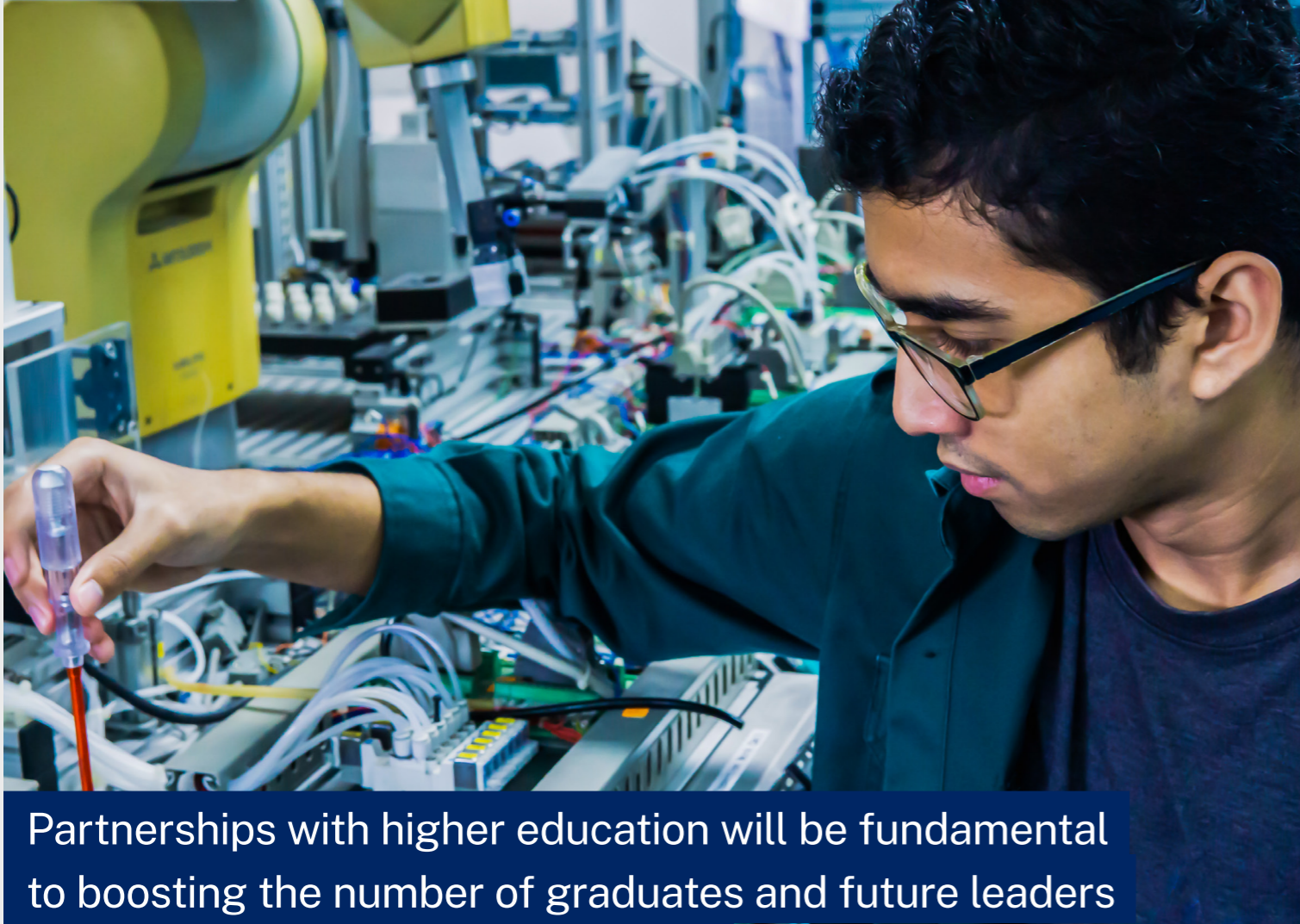
It would sit at the heart of the NSW CAV ecosystem that ties together industry with closed circuit testing and active on-road trials.

This initiative is a CAV Accelerator initiative and supports the enabling area of Local Ecosystem and target outcomes of Safety, Mobility, Productivity and Sustainability of Services.

Partnerships could include: ANCAP, OEMs, Austroads and NTC, Technology Suppliers, Universities, Industry and Peak Bodies.

International examples of CAV proving facilities in [K-City](#) in Hwaseong, South Korea and [M-City](#) in Michigan, USA.

▲ Bus testing at the world class Future Mobility Testing and Research Centre at Cudal



Partnerships with higher education will be fundamental to boosting the number of graduates and future leaders entering the local 'CAV Ecosystem'.

CAV education, skills development and jobs

This initiative aims to partner with industry and academia to identify education and skills gaps, as well as key industry challenges, and make meaningful steps to address them.

This initiative will help the development of a local CAV ecosystem by supporting the development of expertise and skills that are required in the CAV ecosystem. Through industry engagement, it has been highlighted that there is a growing gap in the skills and capabilities available to building the local CAV ecosystem. There are a lot of areas that need to be developed to enable CAV readiness. Partnerships with higher education will be fundamental to boosting the number of graduates and future leaders

entering the local 'CAV Ecosystem'. This will help future proof and prevent a skills shortage.

This initiative is an Early Pipeline initiative and supports the enabling area of Local Ecosystem and target outcomes of Mobility, Productivity and Sustainability of Services.

Partnerships could include:

Department of Education, Australian Universities, CAV Industry, TAFE NSW, Vocational Education Training Sector, iMove CRC, Industry and Peak Bodies.

CAV education and skills development examples include RMIT's Introduction to Self-Driving Cars short course and the University Transport Centres Program which is sponsored by the US Department of Transport.

4. Conclusion

NSW can become a world leading adopter of CAVs and cement its place as a global leader in the use of innovative transport technology. The deployment of CAVs is expected to be one of the most significant disruptions to the transportation industry in coming years. Through early action and preparation, TfNSW can be in the driver's seat to lead the transition to CAVs and take advantage of the benefits that the technology can unlock for the NSW community.

CAV technology provides opportunities to address key challenges such as accelerating the shift to zero road fatalities, reducing dependence on private cars, better connecting regions, improving first and last mile connectivity to create end-to-end journeys, and lowering transport emissions to help achieve the State's net zero emission target.

It will be critical for NSW to pursue CAV Readiness in the coming years in order to become a world-leading adopter of CAVs. CAV Readiness means that NSW has successfully accelerated the real world, commercial application of CAV technologies and will be actively pursuing the integration of CAVs into the NSW transport system.

The 22 CAV readiness initiatives that have been developed are based on extensive learnings from past initiatives, industry engagement and global research and expertise. Based on the program of initiatives, a set of six CAV priority have been developed. These CAV Priority Areas are seen as 'key moves' that will make meaningful steps to building CAV Readiness by integrating CAVs in the transport system and encouraging a strong CAV industry in NSW.

The six CAV priority areas

- Priority 1:** Test and Deploy CAVs on the Road Network
- Priority 2:** Shape CAV Policy, and Customer Outcomes
- Priority 3:** Get the Road Network Ready for CAVs
- Priority 4:** Develop Physical and Digital CAV Testing Capabilities
- Priority 5:** Support Freight and Services Automation
- Priority 6:** Increase Local CAV Knowledge and Skills

Through these six priority areas, TfNSW will be able to shape the roll-out of CAVs and realise the benefits of one of the most significant disruptions to transportation. By using CAV technology, TfNSW will also be able to support its vision of making NSW a better place to live, work and visit.

Next steps and commitment to collaboration

TfNSW is committed to working in close collaboration with local and international industry, researchers and jurisdictions to enable the step change to CAVs. The CAV Readiness Program will be further developed through technical planning and business case activities to unlock funding for individual initiatives and we look forward to partnering to bring these initiatives to life over the coming years.

We welcome feedback on the CAV Readiness Strategy and encourage you to get in contact via Future.Mobility@transport.nsw.gov.au to explore opportunities to partner on future initiatives.

5 Appendix

5.1 CAV learnings and research

Learnings from past TfNSW projects

From 2016 through the **Future Transport Technology Roadmap, Future Transport 2056** and the **2019 CAV Plan**, a number of CAV related projects were planned and undertaken. The learnings from these projects are outlined in this section.

We have worked closely with industry, local government and academia on projects ranging from the deployment of automated shuttles testing customer use cases in regional and metropolitan settings, testing the compatibility of advanced driver assist with our motorway network infrastructure, partnering with universities and automated software developers on research and development projects and working with market leaders on the simulation of automated rideshare services in NSW.

Some of these projects involved Australian and world firsts, creating a strong platform for our future work in CAVs.

Lessons learnt - Future Transport Technology Roadmap

The **Future Transport Technology Roadmap 2021-2024** outlined a number of lessons learnt from past projects. These are summarised below:

- Technology solutions must be developed with a people-first, rather than a technology-first, approach to achieve the best outcomes.
- Regional communities present unique opportunities and challenges. There is significant potential for local jobs

and investment to be linked with technology development, and for basing start-ups in regional locations with lower operating costs and contained testing environments.

- AI has been highly successful for key uses, such as with mobile phone detection cameras.
- There have been challenges trialling and scaling the use of AVs, where industry leaders are not yet based in Australia and travel has been restricted by COVID-19.
- Increased diversity of mobility providers and services has delivered many customer benefits and opportunities.
- Data protection, governance and management are more important than ever.
- NSW has world-leading local start-ups, businesses and researchers that can accelerate and trial emerging technologies, including for high-definition mapping, LiDAR and the use of open data.
- Multi-disciplinary collaboration and partnerships with TfNSW, across government and with industry partners can deliver quick and decisive action.
- Policy and legislation need to remain fit for purpose, outcomes-focused, technology-neutral and responsive to customer needs.
- Intellectual property and data are valuable and must be managed as an asset as part of TfNSW's technology program.
- Digital developments often progress faster than government funding processes and need more flexibility to allow for project learnings.

Learnings from Industry Engagement

To achieve CAV Readiness in the next few years, it will be essential to collaborate and partner with industry. An industry survey was circulated to understand views on the current level of CAV Readiness in NSW. This survey was open to any member of the industry who wished to contribute and consisted of four questions.

In addition to the survey of industry, 21 interviews were also conducted with industry stakeholders to understand their priorities for supporting NSW in becoming CAV Ready.

The survey of industry explored the sentiment on becoming CAV Ready by 2024. The survey showed a large variety of definitions for 'CAV Readiness'. For example, how the community will understand and engage with CAVs, what are the suitable designated parts of the network, how they are part of the public transport network, what does progressive adoption look like, and, most importantly, nationwide clarity around CAV roll-out, data security and public and private responsibilities in the CAV ecosystem.

The common themes from these interviews were:

- A desire for more industry collaboration to strengthen the CAV ecosystem in NSW.

- Trials focusing on specific issues currently preventing the commercially viable deployment of CAVs in NSW, such as trials with remote operators.
- The importance of enabling legislation when choosing a country for CAV deployment and the need for national legislation to reduce the cost of deployment across jurisdictions.
- Inter-state standards around signage and lane markings to reduce the cost of deployment and allow easier integration of driverless systems across borders.

CAV adoption projections

Connected and automated features at a high-level are currently not prevalent in the Australian vehicle fleet but are slowly become more available in the new car market. It is expected that in the coming decades, these features will become more and more widespread, starting with greater penetration of ADAS and eventually moving to more advanced Level 3 and 4 autonomous features.

Past years have seen various automobile manufacturers fail to meet their announced deadlines in connected and automated driving. Given this past trend, the possibility that the pattern of delays will be continued should be considered.



Figure 1: Industry Interview Organisations

Austrroads have recently published a guide predicting the uptake of various CAV technologies in Australia between 2020 and 2030 (Austrroads AP-R623-20). This is the most detailed attempt to quantify the adoption of CAVs for passenger/private use in Australia and it shows that by 2024 we will be at an inflection point for an initial take-up of adoption, creating an initial milestone for CAV readiness. These adoption projections focus on private/passenger cars and key use cases, such as first/last mile rideshare or freight vehicles, may have significantly higher adoption rates depending on industry appetite for the technology.

Austrroads projections showed that in 2030 C-ITS equipped vehicles will be 40 per cent of new vehicles sold, and 5 per cent of new passenger vehicles sold in 2030 will be autonomous, under a medium rate of adoption.

Regulatory overview

Existing road transport laws and regulations enable trials of AVs in NSW. Regulatory reforms are required to:

- remove legal barriers
- manage the safety risks of AVs
- clarify duties and responsibilities
- provide legal certainty to industry and the public.

While NSW made amendments to legislation in 2017 to enable trials work is still underway to develop a national end-to-end regulatory framework to support widespread commercial deployment.

The NSW regulatory landscape

The NSW Government passed the **Transport Legislation Amendment (Automated Vehicle Trials and Innovation) Act in 2017** to enable CAV trials such as shuttle trials in Sydney Olympic Park, Coffs Harbour and Armidale. Organisations undertaking the trials partner with TfNSW to gain approval from the NSW Minister for Transport and Roads following a safety assurance process. Details can be found here: [Conduct a CAV Trial](#).

TfNSW's current responsibilities in CAV regulation include:

- In-service vehicle regulation.
- Vehicle registration.
- Road rules and driver licensing.
- Road management.
- Approval/regulation of automated vehicle trials.

National regulatory framework

The overarching regulatory framework will utilise existing regulatory frameworks (first supply arrangements, access, licensing and registration) and also establish new regulatory frameworks (in-service arrangements). NTC's AV work can be found [here](#).

First supply framework

Complementing the current system used to regulate the entry of vehicles to the market for the first time, the first supply framework for automated vehicles will use a safety assurance approach.

This will require Automated Driving System Entities (ADSEs) – the entities responsible for the automated driving system over its life to self-certify the safety of their Automated Driving System (ADS) against:

- 11 safety criteria
- 3 corporate obligations.

In-service framework

The in-service framework applies once vehicles have entered the Australian market and can be operated on the road.

Key elements of the in-service framework for automated vehicles include a new national in-service safety law for automated vehicles (the AVSL) and a new in-service regulator.

The AVSL will establish a general safety duty on ADSEs to ensure the safe operation of automated vehicles so far as is reasonably practicable. This will be supported by specific prescriptive duties and due diligence obligations on ADSE executive officers to ensure the ADSE's compliance with its general safety duty.

Opportunities and considerations

The timeframe for the national regulatory framework for CAVs provides a good milestone for NSW CAV Readiness, with work undertaken in NSW prior to the establishment of national law both contributing to this national work and also establishing NSW as a leading jurisdiction when this law comes into place.

International regulation examples

Some international jurisdictions have already established regulatory frameworks supporting the deployment of CAVs. Examples of international regulation are shown in Table 5.

International Example	Overview
Germany	Germany is home to several leading automotive companies and is a natural testbed for CAV testing and development. Prototypes for testing on public roads are required to gain a special permit from the relevant authority – up to Level 3 automated driving is currently permitted, although Germany has signed new legislation that will come into effect in 2022 that regulates the use of Level 4 automation.
USA (California)	The United States has a 'state by state' approach to CAVs. While states such as Arizona have taken a hands-off approach to attract testing and investment, others such as California have taken a more hands-on approach to regulating CAVs. This includes a comprehensive regulatory approach setting out procedures for the testing and deployment.
Singapore	Singapore has made a concerted effort to encourage the testing, development and usage of CAVs. Unlike other countries, Singapore has extended its testing area to cover all public roads in Western Singapore, potentially allowing the whole country to be a testbed in the future. It has started the process of retraining bus drivers as AV bus safety operators and aims to serve three new towns with automated buses from 2022.

Table 5: International Regulation Examples

NSW Connected and Automated Vehicle (CAV) Readiness Strategy

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