PROJECT NO: 3-014

Australia's Disability Standards for Accessible Public Transport and Connected and Automated Vehicles - Main report

Australian Government
Department of Infrastructure, Transport, Regional Development and Communications

This research is funded by iMOVE CRC and supported by the Cooperative Research Centres program, an Australian Government initiative.

LA TROBE UNIVERSITY
Centre for Technology Infusion

Contents

SUMMARY 4

FINDINGS 10
1. Limitations of the current Transport Standards 10
2. Non regulatory actions 18
3. Regulatory actions 21
4. Regulatory considerations 26

APPENDIX 29
Appendix 1: Full table of CAV challenges and opportunities for PWD 29
Appendix 2: Definition of Public Transport 40
Appendix 3: Definitions of CAV 42
Appendix 4: Definition Digital Infrastructure 46
Appendix 5: Stakeholder engagement overview 50
Appendix 6: Useful resources 51
Appendix 7: Glossary 52

This is report one out three reports. The other two are reports are:
- Australia's Disability Standards for Accessible Public Transport and Connected and Automated Vehicles – Stakeholder Engagement Report
- Connected and Automated Vehicles: Barriers and Opportunities for People With Disability

“My big thing is that I want to be able to get on to this vehicle without assistance. I want to be totally autonomous in an autonomous vehicle. So, I don't need to rely on other people to get down a ramp or put my bag up or tie down my wheelchair or anything like that. I want to be able to get on and off in the flow just like able bodied people, I guess. I need it to be simple so the simplicity of it means that I just get on and the payment is taken care of somehow without me having to arduously get a card out or tap my watch or whatever.”

Summary

Introduction

Anyone should be able to use public transport. However, despite considerable efforts and progress, for many People with Disability (PWD), taking public transport is far from easy or not even an option. Emerging transport technologies – such as Connected and Automated Vehicles (CAVs) – have the potential to alleviate the hurdles but may also introduce new challenges.

To realise the benefits of CAVs, governments are actively considering what impact CAV public transport, and especially driverless public transport, would have on people with a disability. Because, what defines public transport and how public transport is delivered is being challenged by these emerging technologies and new operational models.

Without concrete action, there is a risk that the regulatory framework consisting of legislation, standards, and guidelines, will not keep pace with changes in technology and transport choices made by customers.

The Department of Infrastructure, Transport, Regional Development and Communications (DITRDC) is currently reviewing the Disability Standards for Accessible Public Transport 2002 (Transport Standards) and is seeking advice about how the Transport Standards could be adapted in the context of emerging CAVs.

In response to these challenges and with the objective of delivering improved access to our cities and regions for people with disabilities, DITRDC has engaged La Trobe University to:

- clarify the extent to which the current Transport Standards can integrate CAV and associated technologies,
- assess the challenges that PWD will encounter with these emerging technologies, and inform the defining of a framework, and
- recommend amendments to the Transport Standards that can be implemented through the current reform process.

La Trobe's Centre for Technology Infusion has undertaken an international regulatory and legal review; conducted focus groups with PWD and representative bodies of PWD at the beginning and towards the end of the project, engaged with the CAV industry globally (with a focus on CAV shuttles and Connected and Automated Air Taxis) at multiple points throughout the project (incl. Singapore, USA, UK, Netherlands), and consulted internationally with the United States Access Board[1] and here in Australia with Universal Design Australia.[2]

Limitations of the current Transport Standards

CAV and associated technologies can be integrated in the current Transport Standards.The Transport Standards have no regard for the driving task or the driving performance of a public transport vehicle, the standards are neutral as to how the vehicle is driven. However, CAV do create clear gaps, in particular if there is an absence of a human driver or a steward and we will recommend amendments below.

Making amendments is urgent. Even if forecasts show a modest 10% penetration of CAVs by 2030[3], manufacturers are building CAV shuttles and Air Taxis now and operators are ordering them. Hence the Transport Standards need to be updated as soon as possible.

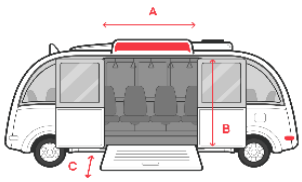
The challenges that PWD will face using CAV are not exclusively tied to level 5 automation.[4] In the next few years, PWD will already be confronted with level 3 or 4 autonomous shuttles in simple scenarios and protected traffic contexts, such as airports, sports parks, and industry precincts. These shuttles will soon have variable routes, allowing a rider to

1 U.S. Access Board – Inclusive Design of Autonomous Vehicles. (2021). Retrieved 1 August 2021, from https://www.access-board.gov/av/
2 Home – Universal Design Conference. (2021). Retrieved 1 August 2021, from https://universaldesignconference.com.au/
3 Somers, A., & Wall, J. (2020). Vehicles and Technology – Future States 2030. Presentation, Webinar.
4 See NTC definitions: Full automation (SAE level 5) means all aspects of the dynamic driving task and monitoring of the driving environment are undertaken by the ADS. The ADS can operate on all roads at all times. No human driver is required. Full automation is also referred to as level 5 automation. Automated Vehicle Program. (2021). Retrieved 1 August 2021, from https://www.ntc.gov.u/transport-reform/automated-vehicle-program

choose to go from A to E, instead of following a linear pattern, from A, to B to C, etc. This seemingly simple change in the service has significant consequences for PWD because, at the moment, the main interaction with the vehicle to determine destination is through a touch screen.

Through our research with PWD and manufacturers, we have identified four areas that require CAV guidelines or standards. Much of the attention of CAV industry and accessibility forums is on the vehicle design, however, our engagement with PWD, CAV Manufacturers and operators has identified three additional functional areas of CAV services:

Vehicle design



Several standards relating to the vehicle design and layout already apply to CAVs. CAV shuttles that are currently being trialed in Australia are an improvement compared to buses and trams and will meet the requirements of the Transport Standards, such as access pathways, automated doors and floor space provided. However, there are amendments to the Transport Standards required, for instance to assure consistency for the blind and ensure a standard approach for wheelchair users. The opportunity is to get it right from the start.

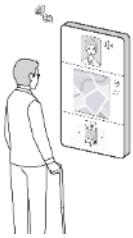
Application areas: Seating availability, Wheelchairs, Controls (Design), Colours, Seating design, Handles and support, Signage

Monitoring and Direct Assistance

Many PWD rely on direct assistance when using public transport. However, given that the presence of a human driver will diminish or disappear, 'direct' assistance may not be available. Some functions typically performed by the driver that are important to PWD have not yet been included in the Transport Standards and will have to be delivered otherwise. Most industry representatives are planning to deploy remote monitoring or a steward (either on board or on the platform) which requires specification and consistency.

Application areas: Direct assistance, Passenger identification, Safety monitoring, Conflict resolutions, Stewards, Platform assistance, Emergency management plans, Emergency communications, Emergency training and consistent responses, Emergency phones, Customer service

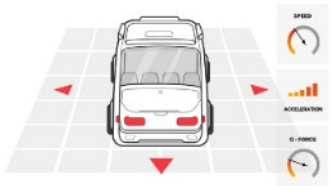
Human Machine Interface (HMI)



Given that the face-to-face interaction with a human driver will diminish or disappear, the need for a universally accessible communications is required. For instance, currently shuttles rely on a touch screen which poses a challenge even in simple linear routes. Variable routes increase the challenge to ensure the right route is chosen and the PWD arrives at the correct stop.

Application areas: Touch screen, Controls (Functionality), Communication of trip progress and other announcements, Auditory, Planning, Hailing, Paying, Booking, Identification of correct vehicle and boarding location, Payment, no reliance on smart phones, Privacy, Reducing stress and anxiety

Operations



CAVs have an opportunity, and in some cases a necessity, to standardize operational aspects providing a more consistent experience to PWD. For instance, the gap distance between the platform and the vehicle can be programmed (necessity), as can the acceleration and deceleration speed (opportunity).

Application areas: Easy entry and exit practices, Safe departure, Safe vehicle movements, Easy Transfer

Once applied to the Whole Journey Guide it becomes visually apparent what is needed to ensure Whole Journeyaccessibility of CAV modes and services (Figure 1).

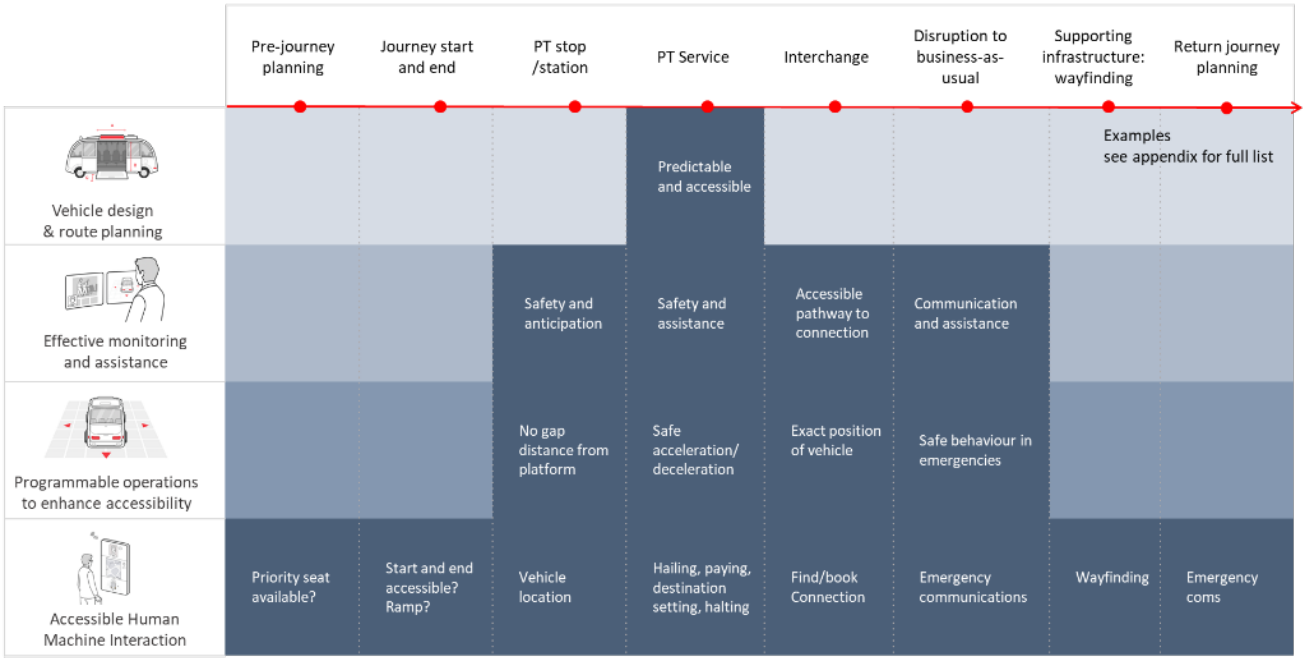


Figure 1. Framework: CAV standard gaps (examples) across the Whole Journey

Non regulatory actions

The question is how to reach industry agreement with the standards and ensure implementation of the solutions. A high level of agreement is apparent on the needs of PWD among operators and manufacturers. There is growing awareness among manufacturers that the business case of automated shuttles may well depend on elderly and PWD and the commercial success of these shuttles depends on them being able to function fully automatically for everyone.

The level of agreement on the framework is higher among representatives of CAV Shuttles, compared to Vertical Takeoff and Landing (VTOL) or Advanced Aerial Mobility representatives: their current priority is to create a functional and then a viable business. However, this project has helped influence a large UK based competition to improve accessibility of VTOL.[5]

There are limitations on what can be achieved in the short term. Some solutions that are key for PWD, have not technically or operationally matured.

The accessibility of the HMI must be one of the highest priorities. Manufacturers expect this can be solved in the short term. However, to develop a full suite of accessibility methods to cater to a broad variety of disabilities could take several years. Standardizing the role and responsibilities of the remote operator is another essential factor. The remote operator will be taking over some of the duties of the driver when it comes to monitoring and assistance, but the responsibilities, processes and operational mechanics have not yet been defined. This could be solved in the short term. Another example is the solution to secure wheelchairs. Solutions exist, but this requires all wheelchair users to accept one solution that can be back integrated into all wheelchairs. It also requires investigation of how such a solution can be integrated into the vehicle without it becoming a liability for other passengers.

[5] Creating an Accessible Future Flight Workshop – KTN. (2021). Retrieved 1 August 2021, from https://ktn-uk.org/events/creating-an-accessible-future-flight-workshop/

To address these limitations, we recommend two non-regulatory actions:

1. *Industry collaboration platform*

We recommend establishing a platform for industry to exchange and agree on a more agile process to agree on standards. At the moment, according to the major manufacturers, there is no formal co-ordinating body for industry to work on issues such as the above mentioned and reach agreements. This platform could be established by the department and can include global organizations with working groups dedicated to the issue such as, disability specialists, ISO (standards and definitions) and W3C (web standards), manufacturers, operators, and regulators.

2. *CAV accessibility guidelines*

We recommend creating a separate guideline for CAV that can serve as a live document until agreements about the specificities have been reached. Once these agreements are made and if they are ready to be deployed, consistency could be achieved before the agreement reaches the Transport Standards.

Regulatory actions

To progressively incorporate CAV unique standards into the Transport Standards, it is necessary to create a new class of conveyances. Secondly, to prepare the Transport Standards for the future of Mobility as a Service (MaaS)[6], we also recommend modernising the definition of Public Transport to better cater to the context in which CAVs will be used. And lastly, given the increasingly important role that digital infrastructure plays in MaaS and the journey of PWD, we recommend expanding the scope of the Transport Standards to include digital infrastructures.

1. *Include CAV in the Transport Standards: Create a separate class of 'conveyances': driverless*

When a CAV has a driver or a steward on board, the existing standards apply. The Transport Standards need to account for the situation that there is no driver or steward on board, because a complex set of tasks delivered by either the driver or a steward then needs to be delivered otherwise. Hence for the Transport Standards we recommend the following definition:

> *For the Transport Standards, a driverless CAV is any connected and automated conveyance whereby the driving task is conducted without a human representative on board.*

This will allow the introduction of specific standards for driverless conveyances. For the definition of CAV, the National Transport Commission's (NTC's) definition can be used.

2. *Update the definition of Public Transport*

The current section 1.23 of the Transport Standards does not represent modern public transport well as, for example, it excludes modern MaaS business models and excludes the fact that people may now convey themselves with E-bikes and other modes. We recommend the following definition for Public Transport of the ISO TC204 WG:

> *Public Transport is a service that is publicly available enabling a person to move or to be moved from an origin to a destination based on the use of transport means for collective, shared, or individual use.*

Using this definition would also mean that Public Transport services are not defined by being licensed as such, which would broaden the applicability.

3. *Include standards for digital infrastructure*

Digital technology will permeate premises, infrastructure and conveyances, the current scope of the Transport Standards, and increasingly determine the end user experience. The digital infrastructure enabling this digital user experience will become more and more critical. That is why we recommend adopting the definition proposed by Digital.NSW which focuses on the outcomes of digital infrastructure:

6 "The future of mobility is customer-focused, data-enabled and dynamic. In the future, personal mobility packages will bundle traditional 'modes' with technology platforms and new service offerings like on-demand, car share, rideshare and smart parking." Essential to the concept is the idea of a single interface through which customers create and manage their total journey. Future Transport Strategy 2056. (2021). NSW. Retrieved from https://future.transport.nsw.gov.au/future-transport-strategy

Digital infrastructure includes, without limitation, the technology, equipment, and systems used or enabled by operators that provide linkages, networks and pathways to connect people and communities with data, metadata, products, and services.[7]

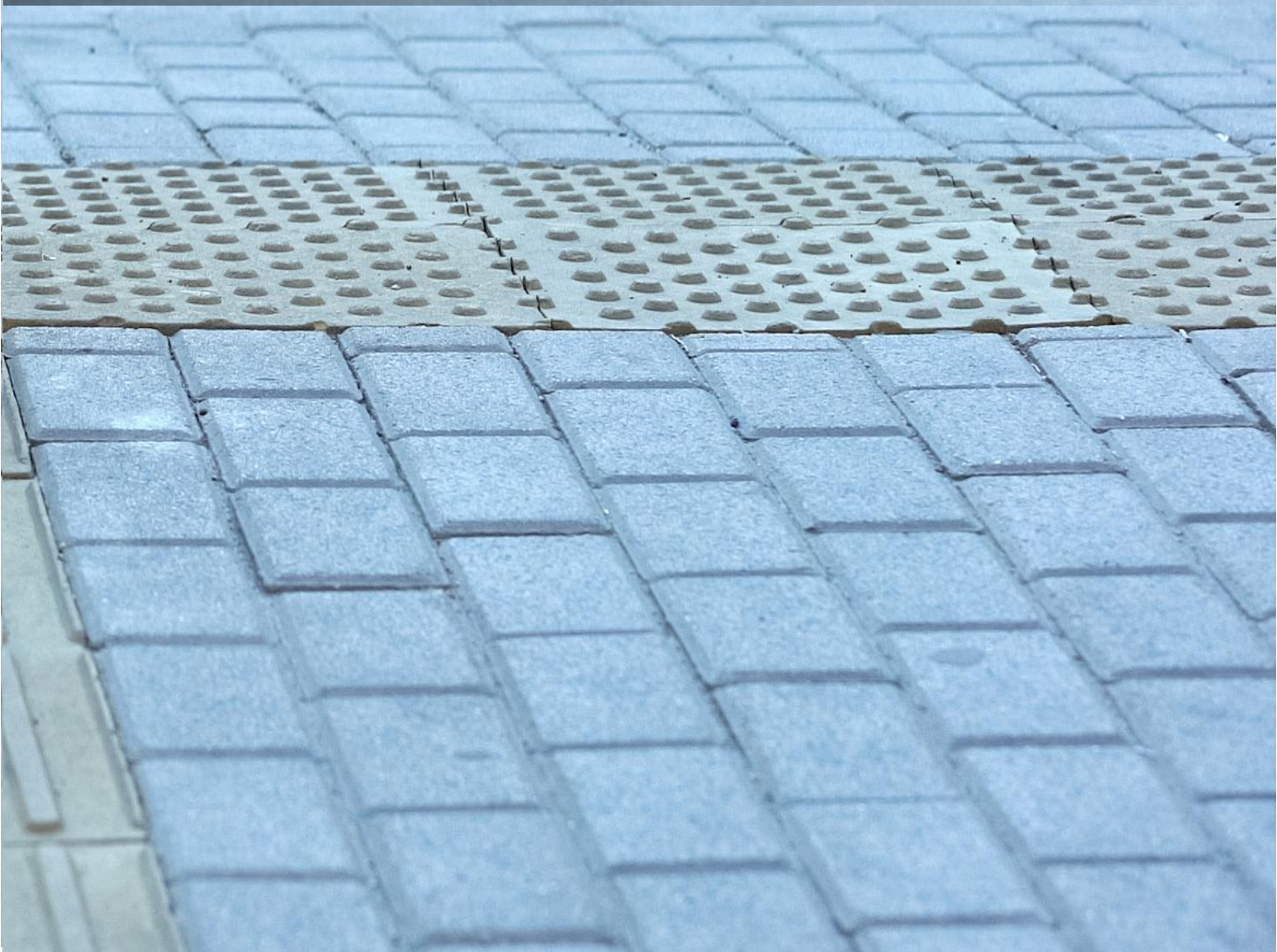
Many aspects of the digital infrastructure are governed separately – for instance, there are the privacy Act, the Radio Communications Act and under the Strengthening Australia's cyber security strategy, new regulations are being developed to ensure companies provide a secure experience to their customers. In the body of the report, we suggest a Digital Infrastructure model to break down the essential aspects. The Transport Standards, at a minimum, need to refer to the applicable regulations, and there will be cases where the interests of PWD are not sufficiently specified in these regulations' which can be specified in the Transport Standards.

Regulatory considerations

MaaS and CAV will increase the complexity of Public Transport, leaving PWD in a weaker position when it comes to industry compliance to the Transport Standards. We propose that the government consider a review of the way compliance is driven by looking at the way other countries drive compliance and by looking at the future requirements for Public Transport regulations. In the not-too-distant future, machines will be making real time decisions that are not fully pre-programmed. Real time input – compliance through design - will be required to ensure these decisions are within regulatory boundaries.

7 Public Digital Infrastructure | Digital NSW. (2020). Retrieved 1 August 2021, from https://www.digital.nsw.gov.au/transformation/public-digital-infrastructure

“I'd like to close as well by saying that what a lot of us are putting to you and whoever else wants to listen is that this is 2021. This is the chance to get it right at last for a properly totally inclusively designed vehicle from beginning to end, from top to bottom at the procurement stage, at the design stage and the outcome. That's where we're at with this.”



Findings

1. Limitations of the current Transport Standards

Updating the Transport Standards is urgent

Several forms of CAVs are already deployed, others are still in development. In Australia the introduction of two new forms of CAVs seems to be eminent: CAV Shuttles have been and are being trialled extensively around Australia. In late 2020, Melbourne Airport signed a contract with Uber Elevate making Melbourne one of the early adopters.

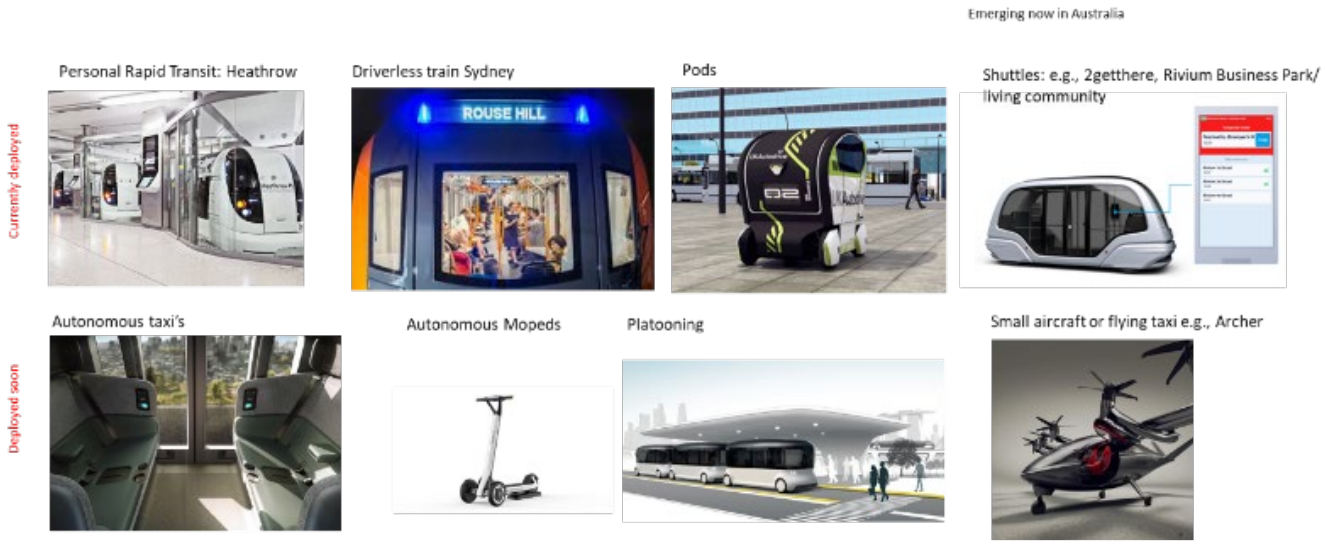


Figure 2. Examples of currently deployed CAVs and vehicle designs and concepts to be deployed soon.

When it comes to CAV shuttles, a common understanding (Figure 3) is that level V will be driverless.

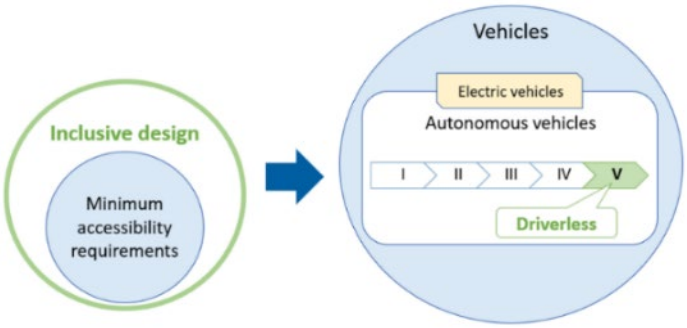


Figure 3. US Access board: Standards (Source: www.access-board.gov/av/)

However, based on conversations with the leading CAV Shuttle manufacturers, level IV automation will also be deployed without drivers. Figure 4 shows a roadmap of the use cases and circumstances in which they will be deployed. Driverless CAV are already deployed and will be deployed even at level 4 without a driver in fixed route use cases with limited traffic.

In summary, what PWD will experience in the next 5 years is a new type of vehicle, in situations where there is no direct assistance available, routes may not be linear and there may be a need to book and hail a vehicle using a digital HMI. This will be first at private road environments, and as the regulation of CAV Shuttles develops, also on public roads. As a result, much more interaction with vehicles and/or services will be required, and assistance models will need to be developed to deliver on the promise of CAVs. Note that the above near-, and medium-term use cases are level 4 automation, which means: not fully automated, but nevertheless driverless.

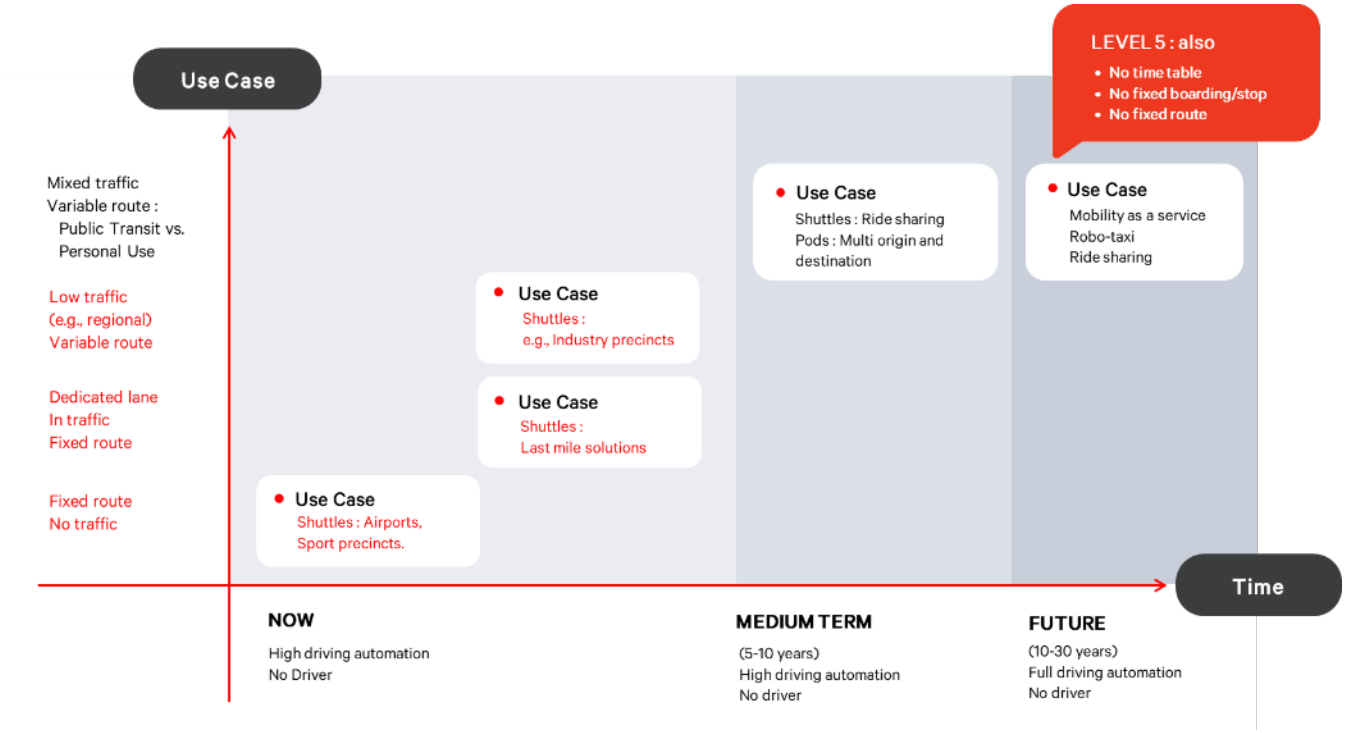


Figure 4. Deployment of Autonomous Vehicles based on different Use Cases. (Source: Industry consultation, CTI analysis)

The current Transport Standards cover CAVs

The current Transport Standards can support public transport services that are automated or driverless. From a regulatory and legislative perspective, the Transport Standards:

- can support CAVs
- have no regard for the driving task or the driving performance of a public transport vehicle
- are silent as to if or how the vehicle is driven, and
- apply to all conveyances an operator may use to provide public transport services (subject to the exemptions set out in the Standards). This means that:
  - the definition of a conveyance does not mandate a human driver,
  - the list of conveyance types (Part 1.12) is not exhaustive, and
  - both public and private operators are captured as public transport services simply by virtue of whether an enterprise 'conveys members of the public by land, water or air' (Part.1.23).

Furthermore, the Transport Standards allow operators to provide direct assistance when they cannot otherwise meet a specific standard. There is nothing in the Transport Standards that precludes an operator supporting an automated public transport service with customer service representatives in circumstances where the design or technology of the CAV inadequately meets the standard (e.g., assistance with boarding or alighting the vehicle) and they are actively considering this option. However, the benefits of driverless vehicles will lie in a lower cost of operation, so a lack of need for assistance will be enabled to leverage CAV to the fullest.

Gaps in the Transport Standards

Direct assistance is an important safety-net. Many articles in the standard provide 'direct assistance' as a fallback option if the standards can't be met, or to overcome hurdles PWD may face. In addition to the responsibilities that are explicitly mentioned, the driver performs many other tasks, which are not captured in the Transport Standards.

Table 1. Parts and articles in the Transport Standard that include direct assistance or in practice depend on direct assistance (source: Transport Standards and Focus Groups)

Part		Part		Part	
Part 2	Access paths	Part 12	Doorways and doors	Part 26*	Hearing augmentation listening systems
2.8		12.1		Part 27	Information
2.9		12.6		27.2	
Part 3	Manoeuvring areas	Part 15	Toilets	Part 28*	Booked services
3.2		15.5		28.4	
3.3		15.6		Part 29	Food and drink services
Part 6	Ramps	Part 16*	Symbols	29.1	
6.4		Part 17*	Signs	29.3	
Part 8	Boarding	Part 19*	Alarms	Part 31*	Priority
8.2		19.1		Part 33	Equivalent access
8.3		Part 21*	Controls	33.3	
8.4		Part 22	Furniture and Fitments	33.6	
8.7		22.3		33.7	
8.8		22.6			
Part 9 *	Allocated space	Part 25	Payment of Fares		
		25.2			

*This standard does not specify direct assistance, but our research shows that drivers often need to provide direct assistance in this situation.

It is not only the absence of the driver and the ability to provide direct assistance that creates gaps. Based on our research and collaboration, four aspects require attention to address all the barriers for PWD throughout theWhole Journey, which include vehicle design, monitoring and direct assistance, HMI and operations.

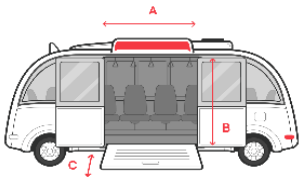
Often the major focus is on the vehicle design, with wheelchair accommodation as one of the central points. Much less attention is given to the other three factors. Note that safe and easy wheelchair accommodation is critical but is only a one example among other factors.[8]

Among the shuttle manufacturers and the operators, there is a high level of agreement on the principles as outlined below. (Please refer to the appendix for a complete list of challenges associated with these principles that PWD disability will face with CAV).

The manufacturers and operators have provided very high-level timeline indications. Overall, the vehicle design aspects as well as the monitoring and assistance are viewed as a short-term necessity to get right, whereas the HMI and operational aspects may require some time to agree and develop. Please refer to the appendix for a more detailed overview.

8 In this report we do not prioritize based on the number of people with a particular disability. When it comes to PWD, we have taken the view that the classic marketing prioritization of segments doesn't hold true. For instance, if there are more people with disability X than disability Y, then that should not automatically make that segment of a higher priority, hence we have refrained from further prioritization. Disability Statistics (2021). Retrieved 1 August 2021, from https://www.and.org.au/pages/disability-statistics.html

Vehicle design



Several standards relating to the vehicle design and layout already apply to CAVs. CAV shuttles that are currently being trialed in Australia are an improvement compared to buses and trams and will meet the requirements of the Transport Standards, such as access pathways, automated doors and floor space provided. However, there are amendments to the Transport Standards required, for instance to cater to blind or deaf public transport users and ensure a standard approach for wheelchair users.

Seating availability

- **Principle:** With the connected nature of CAV, seating availability does not need to be the concern for PWD that it is today.

Wheelchairs (see also operations)

- **Principle:** CAVs should provide independence for wheelchair users, i.e., truly not require an attendant to secure the wheelchair, and be simple. Independent and safe use of occupant protection and mobility aid device restraint system - wheelchair tiedown and occupant restraint systems should accommodate low levels of functional mobility /dexterity and provide a high level of safety.

Controls

- **Learn the controls once, apply everywhere.**

Colours

- **Principle:** The colour scheme of the vehicle should help, not hinder, visually and cognitive impaired people. This includes seat outlines.

Seating design

- **Principle:** The seating design – height, shape and material - matters for PWD whose needs are to be taken into account.

Handles and support

- **Principle:** PWD should be able to reach out for support rails and handles instinctively, handles and bars should be implemented in a consistent fashion across makes and models.

Signage

- **Principle:** PWD should be able to view signs and announcements from their wheelchair or seats even if the shuttle is crowded with standing passengers or when it is dark or very bright.

Monitoring and Direct Assistance

Many PWD rely on direct assistance when using public transport. However, given that presence of a human driver will diminish or disappear with CAVs, 'direct assistance' may not be available. Some functions typically performed by the driver and important to PWD have not been included in the Transport Standards. Most industry representatives are planning to deploy remote monitoring or a steward (either on board or on the platform) which requires specification and consistency.

Monitoring and Direct assistance

- Principle: A driver's role is diverse and complex. The CAV experience is set to become more seamless and have less friction, however, not all the functions of a human driver can be automated (yet). When there is no human directly at hand, other forms of assistance are required.

Identification of Passenger (needs)

- Principle: Today, a bus driver can identify the passenger [Card used by deaf-blind people] and, recognize their needs, for instance, know the place that they need to alight. A CAV should be able to identify a passengers needs.

Safety monitoring

- Principle: Safety is paramount and CAV should be able to provide that. The driver of a vehicle is often attributed with the responsibility to look after the passengers' safety, including PWD.

Conflict resolutions

- Principle: Unfortunately, PWD do sometimes encounter conflicts in public transport, in which case a driver or platform personal can assist. A CAV should have the ability to intervene in conflict.

Stewards

- Principle: For many PWD, traveling in public transport without any form of human assistance is not possible. CAV may have to provide some form of human assistance.

Platform assistance

- Principle: Help on platforms or stop overs is often required.

Emergency management plans

- Principle: There should be emergency plans for PWD in case of an accident or other emergency specific to PWD

Emergency communications

- Principle: PWD should not be the last to know what happened in case of emergency and what actions are to be taken

Emergency training and consistent responses

- Principle: Across operators, remote control personal and stewards need to agree on consistent procedures and training to help PWD in emergency situations.

Emergency phones

- Principle: Independence could mean providing access to mobile phones in vehicles.

Customer service

- Principle: Despite automation and accessibility, some PWD may need customer service as a backup.

Human Machine Interface

Given that face-to-face interaction with a human driver will or diminish or disappear, the need for truly and universally accessible communications increases.

Touch screen

- Principle: Everyone should be able to easily interact with the service. The 'touch screen' in current shuttle designs raises many concerns.

Controls (Design)

- Principle: Allow user to learn the control once only and apply it universally.

Controls (Functionality)

- Principle: Controls enable the journey and provide assurance. The functionality of controls should be consistent and PWD should be able to assume that the same controls are present at the places where they expect them.

Communication of trip progress and other announcements

- Principle: When CAVs are not taking a fixed predictable route, understanding trip progress becomes even more essential than it is today. The availability of crucial information by multi modal platforms allow the PWD to respond in sync with the other passengers espcially during alerts.

Auditory

- Principle: PWD who can't see or who can't see the sign boards, should be able to rely on auditory messages to understand the actions the vehicle takes, and they need to take.

Planning, hailing, paying, booking

- Principle: Hailing, booking, and paying/entering a CAV vehicle should be the same or better compared to a vehicle with a human driver. Hailing and booking are aready challenge for many PWD today.

Identify correct vehicle and boarding location

- Principle: The mobility options available are set to become more fluid. To identify the correct vehicle and boarding location is already a concern today, and technologies exist to overcome this challenge.

Payment

- Principle: The less physical efforts in the process, the better – swiping a card can be impossible for some PWD.

No full reliance on smart phones

- Principle: Even with accessible apps, some PWD cannot use phones at all.

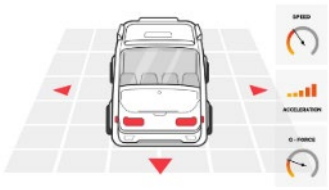
Privacy

- Principle: Appropriate data collection. There is an understanding that the exchange of information can be valuable, such as reserving a seat. However, PWD have poor past experiences with providing identity and information on their disability and in some cases have had negative experiences as a result of sharing personal information.

Reducing stress and anxiety

- Principle: For some PWD the absence of a driver increases the level of anxiety (Air Taxis in particular). Reducing stress and anxiety in general related to travel in autonomous public transport services.

Operations



CAVs have an opportunity, and in some cases a necessity, to standardize operational aspects.

Easy entry and exit practices

- Principle: CAVs should provide easy access experience, without the need for assistance. While access is also covered in the design section, there are operational aspects as well that present a clear opportunity for CAV.

Service Customization

- Principle: One service does not fit all, and modern technology can adjust to the passenger if it is aware of the needs of the person (e.g., drive a little bit slower around corners when there is a wheelchair).

Safe departure and arrival

- Principle: A driver can take the passenger's needs into account e.g., ensure they are properly seated. How will CAV ensure safe departure and arrival?

Safe vehicle movements

- Principle: Considerate driving can now be programmed. CAV have a unique opportunity to deliver a consistent travelling experience by managing G-forces.

Easy Transfer

- Principle: CAV have the potential to overcome an important PWD barrier, which is to change mode of transport. One of the promises of CAV, especially in a context of MaaS is to provide easy transfer between multimodal services (e.g., rideshare to bus to train).

“Just thinking about I guess in my point of view automated vehicles because I have a hearing loss and a vision impairment called Usher syndrome and I have to tell you I struggle with machines, I struggle with audio voices, like announcements, I struggle understanding what's being said because the computerized voice doesn't work well with my hearing aids.

So, I'm wondering whether technology would work in with the automated vehicles with my hearing aid with Bluetooth that could connect right into the hearing aid, it could be an option, and also with announcements with TV screens I don't see very well and I'd like to know where I am and when I need to get off because it could be 20 stops, or something like that. If I could have an app that's connected to that automated vehicle, like a public transport system, that would just tell me what stop I'm approaching, like ’The next stop is Flinders Street’. So that's something that would be valuable for me.”

2. Non regulatory actions

Most industry representatives agreed with the principles as set out, the needs for PWD as well as the proposed solution directions.

However, there are several critical issues for PWD, on which CAV representatives do not provide a unanimous response and that require development. Examples include:

- The Priority seat: A universal placement of the priority seat (e.g., always at the right-hand side of the entrance) has not been agreed, nor the way disputes are resolved and whether this seat can be reserved/booked.
- Securing wheelchairs. Most operators and manufacturers are looking for automation when it comes to accommodation of wheelchairs so that the operational efficiency can be maintained, but not all operators agree. Some manufacturers are preparing ramps, some lifts, and some count on the crabbing ability of the vehicle to the platform so that ramps and lifts are not needed.
- Colour schemes could be standardized on a nationally consistent colour scheme for all public transport, but not all operators/manufacturers agree with the proposal.
- Most manufacturers agree on an automatic ramp; however, some manufacturers count on platforms and the CAV crabbing ability of the shuttle (crabbing = driving almost sideways) to provide accessibility.
- Reducing the cost of operation compared to driver operated vehicles will be key for operators as driver salaries represent approximately a third of the operating costs. Most of the operators and manufacturers are counting on the remote operator to undertake some of the complex set of functions of the driver. Other assistance could be provided by roving stewards or stewards on the busier platforms. The role and responsibilities of remote operators vs. the potential of (roving) stewards are critical for PWD but have not been ironed out yet. Emergency scenarios and break downs clearly do require these plans.
- There is no debate that the HMI requires to be fully accessible, however, the interaction with the vehicle and the authority of the user is a topic of debate where some manufacturers allocate less authority – limited to a stop button and door override only – whereas others can envision that users could have extended authorities. For instance, access to an emergency button that activates an emergency protocol to the nearest medical facility or indicate that they would like the shuttle to drive with moderate speeds (e.g., when in a wheelchair).

Establish a (inter)national collaboration platform to keep pace with change

To resolve the above-mentioned and other accessibility issues for PWD, we recommend the establishment of a collaboration platform. Manufacturers including Navya, HMI, and 2getthere mentioned that there is a need for this. This platform can perform a co-ordinating role and a focal point for change between both industry and disability groups.

By establishing a platform to exchange and agree on common issues and approaches, the Department would be supporting a streamlined, agile, and faster mechanism to deliver coordinated, national outcomes, even before agreements can be formalized in the standards, they could be deployed. Staying ahead of the curve will be especially vital given the speed, diversity and complexity of CAV technologies and operating models.[9]

A national collaboration platform could consist of semi-formal, regular forums to progress the identification and resolution of accessibility issues for PWD, with a targeted focus on CAVs but also taking into consideration challenges associated with the broader public transport journey – such as MaaS and the digital economy.

A national collaboration platform could be implemented under the current National Accessible Transport Taskforce (the Taskforce), for instance jointly led by the Australian Government and Queensland. The Taskforce is currently driving the reform and modernisation of the Disability Standards for Accessible Public Transport 2002 (Transport Standards) and reforms are to be based on four principles that have been endorsed by the COAG Transport and Infrastructure Council:

- people with disability have a right to access public transport
- accessibility is a service, not an exercise in compliance

9 This was first recommended in August 2017, Recommendation 10 8.34. Parliament of Australia. (2017). Social issues relating to land-based automated vehicles in Australia (ISBN:978-1-74366-678-4). Canberra.

- solutions should meet the service needs of all stakeholders and be developed through co-design
- reform should strive for certainty without sacrificing best functional outcome.

This collaboration platform could include a range of topics, including, vehicle design, operations, HMI, remote observation, and assistance[10] and launch initiatives such as grants as competitions to stimulate the industry such as what the US Department of Transportation[11] organized in 2020.

Guidelines

Developing CAV Guidelines is an opportunity for communities, industry, and government to comprehensively consider CAV public transport from the perspective of PWD. Engagement with PWD and CAV manufacturers has already resulted in the development of key areas requiring standardization that have a high degree of support across stakeholder groups.

The CAV Guidelines should act as a living document – creating the framework or 'depository' for addressing disability requirements in the context of CAVs that can be updated as specific technologies and accessibility solutions are deployed. It could in fact establish consistent deployment across various manufacturers even if the standards haven't been formalized yet.

10 For example, the NTC has noted that *'vehicle-generated data is still at the nascent stage of development in Australia and that stakeholders remain unclear on priorities, there is an opportunity for governments to adopt a new policy approach.'* National Transport Commission. (2020). Government access to vehicle-generated data.

11 Inclusive Design Challenge Semi-finalists | US Department of Transportation. (2021) Retrieved 1 August 2021, from https://www.transportation.gov/inclusive-design-challenge/inclusive-design-challenge-semifinalist

“I would say pretty much on almost every trip I will at some point rely on human interaction. Even though I use technology on my phone, inevitably for every trip I will at some point rely on another human being just to fill in the gaps. “

3. Regulatory actions

Include CAV in the Transport Standards: Create a separate class of 'conveyances': driverless

There is currently no one space where CAVs "sit" in the Transport Standards and where specific standards might be introduced to address specific needs. The definitions of a conveyance and public transport in the Transport Standards are broad but the examples and coverage are narrow and do not contemplate driverless scenarios.

On the surface of things, the current Transport Standards do not provide any barrier to CAVs because none of the standards specify roles or responsibilities for a human driver. But the potential for invisible discrimination, confusion or service fragmentation exists because operators today meet numerous standards through direct assistance provided by the human driver.

The problem being that, unless CAVs are addressed in the Transport Standards, challenges specific to CAVs (many, perhaps, unknown at this early stage of emerging use cases and technologies) will not be able to be addressed in the standards. Without identifying CAVs as their own form of public transport conveyance, there is a risk that they will be inadequately covered.

This raises a second problem: A Connected and Automated Bus is still a bus, and many existing standards will continue to apply to a bus regardless of whether it is driverless or not. There is a risk that if a Connected and Automated Bus is carved out of the general bus conveyance, general but fundamental requirements could unintentionally not apply to a Connected and Automated Bus. The solution, therefore, needs to marry continued coverage of relevant existing standards with any specific standards required by virtue of a conveyance being Connected and Automated. In this regard, a solution has been developed that can cover both general and specific requirements.

Define a driverless CAV as a conveyance

When a CAV has a driver or a steward on board, all the existing standards apply. The Transport Standards need to account for when there isn't a driver or steward available to provide direct assistance. Therefore, the lower levels of automation are mostly inconsequential from the perspective of the Transport Standards until there is no driver on board. A complex set of tasks that would be delivered by either the driver or a steward now needs to be delivered otherwise.

In the US, the National Highway Traffic Safety Administration in 2016 amended its position on automated vehicles by explaining how it was considering non-human drivers as 'drivers' under the Federal Motor Vehicle Safety Standards. It may be argued that existing standards relating to the help and assistance required for persons with disabilities when using public modes of transport (public and quasi-public) – would also extend to autonomous vehicles in order not to cause a bottleneck to the rolling out (and disability-accessibility obligations) of autonomous vehicles.

For the sake of clarity, we recommend treating *driverless* CAVs, including automated shuttles and advanced aerial mobility, as separate conveyances in the standards. Should Transport Standards move away from the debated practise of defining specific conveyances, to favour mobility options in a more general sense, there would still be a 'driverless' class of mobility for options where the passenger isn't also the driver. It could be reviewed to what extent the Transport Standards would cover 'driverless trains' which have been in operation for some time already. Based on our review, for the Transport Standards, we recommend the following definition which gives a new, more accurate meaning to the term 'driverless'

> *To this standard, a driverless CAV is any connected and automated conveyance whereby the driving task is conducted without a human representative on board.*

How 'Driverless CAV' conveyance would be applied

The below example shows how "Driverless CAV' could be added to the list of conveyances

> ***1.13*** *Conveyance*
>
> *A conveyance includes any of the following, to the extent that they are used to provide a public transport service:*
>
> *(…)*
>
> *A driverless conveyance includes any rolling stock, vehicle or vessel under this Part 1.13 that is operated in a connected and automated manner, i.e., the driving task is conducted without a human representative on board*
>
> *Unless stated otherwise, a Standard that applies to a conveyance will also apply to that conveyance if it is a connected and automated vehicle*

Having established CAVs in the Transport Standards, the existing definition of a 'conveyance' would need to be updated so that specific sections or articles can be added, to apply exclusively to CAV:

In addition to these changes, *Section 1.7 Applicability of the Standards* could be updated. This section explains how the standards may apply to all infrastructure, premises, and conveyances, or only apply to conveyances or a specific conveyance. It currently provides four examples. An additional example could be included that shows how a standard could only apply to a subset of a conveyance that is connected and automated.

For illustrative purposes, we have provided four examples of how a driverless CAV could be reflected in the Transport Standards (or initially the CAV Guidelines) – thereby providing the regulatory framework to introduce CAV-specific standards as an adjunct to conventional standards and ensuring that those conventional, existing standards continue to apply to CAVs (where relevant).

> *Hailing a connected and automated service*
> *A passenger using a driverless CAV that does not have scheduled stops and is not a booked service must be able to hail the vehicle through an accessible software application or through another means.*
> *Operators should provide passengers with an accessible mechanism to be able to notify the operator that they are a person with a disability and their intended destination.*
>
> *Conveyances*
> *Driverless buses*
> *Driverless shuttles*
> *Driverless taxis*
>
> *Ramps*
> *8.3.2 An available boarding device must be deployed if a passenger requests its use.*
> *New article: The boarding device must be automatic and deployable in an accessible manner by the passenger if direct assistance cannot be provided*
>
> *Conveyances:*
> *Driverless buses*
>
> *Information about a booked connected and automated service*
>
> *A passenger that has booked a driverless service must be able to receive or access information about trip destination and the progress of the vehicle's arrival through an accessible software application or through another means. Information should be accessible in both an audio and visual format.*
>
> *An alternative information channel must be available for passengers that do not have access to the internet.*
> *Conveyances*
>
> *Driverless taxis*

1. Update the Transport Standards: Update the definition of Public Transport

The current section 1.23 of the Transport Standards defines a public transport service as follows:

(1) A ***public transport service*** is an enterprise that conveys members of the public by land, water, or air.

This definition doesn't reflect the future of public transport. In our consultation process we proposed a new definition of public transport which was supported, however, based on industry feedback, we would endorse the below approach from ISO TC 204 WG8, which provides a simple and accurate definition. In addition to the definition provided above, we propose to add the sentence (b) to emphasise that for example public transport booking apps are also a public transport service and hence need to be accessible.[12]

> *Public transport:*
> *A transport service that is publicly accessible enabling a person to either move or to be moved from an origin to a destination, based on the use of transport means for collective, shared, and individual use.*
>
> *A public transport service includes:*
>
> *(a). (…)*
>
> *(b) digital services that enable public transport services. For example, for members of the public to plan, book or pay for a public transport service and/or members of the public to offer public transport services*
>
> *(c). (…)*

This reflects emerging modal and transport choices and takes into consideration the Whole Journey approach to public transport that recognises that journey planning, pricing, modal choice and beginning- and end-of-trip journeys all form part of the public transport experience. Any component of the Whole Journey that fails to meet the Transport Standards are a "weak link" that reduces the capability of a person with a disability to use public transport, thereby diminishing personal choice and independence.

In Finland they seem to be most advanced in adopting the above notions:

In respect to available legal frameworks, Finland is considered to have made the most significant advancement in establishing a comprehensive legal basis through its Act on Transport Services 2017. It heavily focuses on the promotion of digitalization of transport services and use of data - for instance the opening of Application Programming Interfaces (API) of public and private passenger transport service providers for third party use (such as MaaS operators).

The 2017 Act provides the following definitions in section 2: (from Finnish to English):

> 1) transport services mean a public or private service or a combination of services related to transport that is offered for the general public or for private use;
> 2) mobility services mean transport services and brokering and dispatch services, data services, parking services and other support services directly related to these;
> 3) integrated mobility services mean formation of travel chains and other service packages in return for remuneration by combining the mobility services offered by different service providers.

2. Update the Transport Standards: Include standards for digital infrastructure

Public transport will become more and more dependent on the digital infrastructure. Given the unique characteristics of digital infrastructure – which are considerably different to physical infrastructure – we recommend capturing digital infrastructure as a standalone category in the Transport Standards.

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12 As a consequence, the definition of a conveyance as anything classified as 'public transport' would probably be redundant: *cl 1.12: any other rolling stock, vehicle or vessel classified as public transport within its jurisdiction by regulation or administrative action of any Government in Australia.* Disability Standards for Accessible Public Transport 2002 (2002).

This would support increased coverage of the Whole Journey in the Transport Standards at a future time and, like changes recommended to the definition of public transport, is an enabling reform that sets the standards up for the future when or if the Department seeks to transition CAV Guidelines into the standards.

We recommend adopting the NSW Government's definition of digital infrastructure which focuses on the outcomes of digital infrastructure rather than by specific technologies or design aspects:

> *Digital infrastructure includes, without limitation, the technology, equipment, and systems used or enabled by operators that provide linkages, networks, and pathways to connect people and communities with data, metadata, products and services*.[13]

We suggest the below Digital Infrastructure model to break down the essential aspects. The Transport Standards, at a minimum, need to refer to the applicable regulations, and there will be cases where the interests of PWD are not sufficiently specified in these regulations' which can be specified in the Transport Standards.

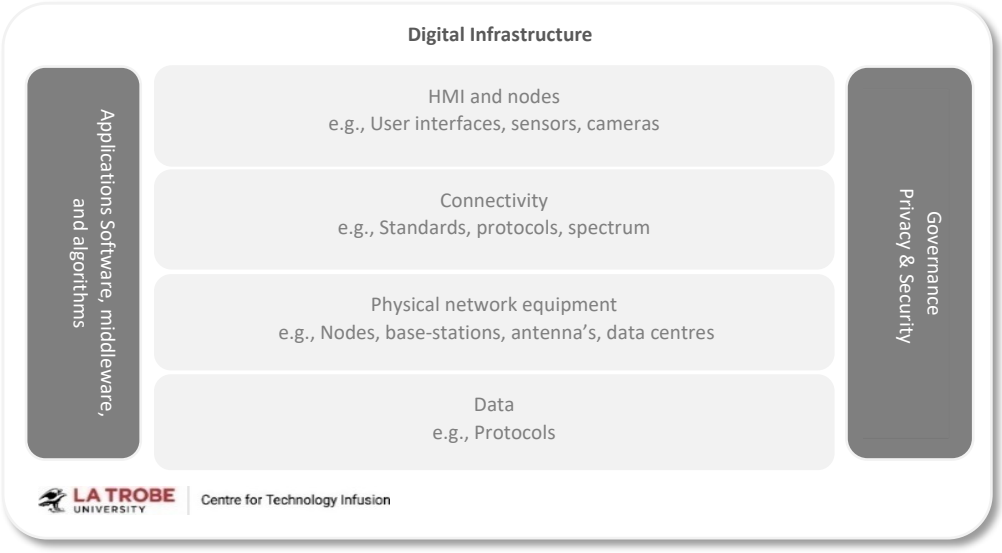


Figure 5: Digital Infrastructure, CTI proposed elements.

We also suggest that section 1.12(2) be amended so that the Standards also apply to digital infrastructure (<u>proposed changes are underlined</u>).

> *These Standards apply to all operators and the conveyances they use to provide public transport services. They also apply to providers and supporting premises, infrastructure, <u>and digital infrastructure</u>.*

This amendment would:

- Enable the regulation of critical digital enablers of public transport services
- emphasise the requirement for consistent digital experiences across the Whole Journey
- ensure that enabling digital technologies such as wayfinding apps, journey booking apps, touch screens are accessible for people with a disability.

Each element of the digital infrastructure has its own specific requirements for people with a disability: For interface devices it is about being fully accessible to all. Data capture requires to be proportionate and ethical. Applications will need to follow universal end user logic and the hardware, and its connectivity will need to be seamlessly interoperable, especially when it is connecting with assistive technologies. Governance and security are especially sensitive when it is managing sensitive health and personal data.

13 Public Digital Infrastructure | Digital.NSW. (2020), Retrieved 1 August 2021, from https://www.digital.nsw.gov.au/transformation/public-digital-infrastructure

Below are three examples of how Digital Infrastructure could be subsequently applied in the Transport Standards

Touch screens
Touch screens used at platforms, in conveyances or elsewhere must be accessible and/or provide alternative means to access the functionality and achieve the desired outcome.
Digital Infrastructure

Data governance
Data captured to provide accessibility for PWD, [for instance to roll out a ramp] classifies as sensitive personal information and appropriate data governance protocols need to be in place.
Digital Infrastructure

Beacons
Beacons used for wayfinding shall be placed such that blind people will find the entrance to the vehicle.
The connectivity shall be interoperable with wayfinding technologies used by PWD.
Updates and new versions of the software will be installed universally as soon as they come available.
Digital Infrastructure

It is noted that the Transport Standards can be updated to include digital infrastructure in the immediate term as a means of establishing a regulatory framework for the future: specific standards related to digital infrastructure could be first embedded in the CAV Guidelines.

Many aspects of the digital infrastructure are governed separately – for instance, there are the Privacy Act, the Radio Communications Act and under the Strengthening Australia's Cyber Security Strategy, new regulations are being developed to ensure companies provide a secure experience to their customers. NTC has provided guidelines with regards to government access of c-its and AV data. The Transport Standards can refer to these. In cases where the interests of PWD are not sufficiently specified in the 'general regulations' it can be specified in the Transport Standards, for instance with regards to the appropriate capture and exchange of data.

4. Regulatory considerations

A comprehensive legal audit of Australian legislation by NTC identified over 700 barriers to deployment of AVs in 2016, the National Transport Commission (NTC) has been mapping out a pathway to deliver a nationally consistent regulatory framework that will support the safe commercial deployment of AVs in Australia.

On 5 June 2020, Transport Ministers agreed to work towards establishing a single, national approach to regulating AVs with a national regulator and a national law, supported by a general safety duty. The NTC is committed to 'Nationally-consistent reforms that support innovation and safety. This will allow Australians to access the benefits of this technology.'

Among the many issues that still are required to be solved, in the context of this report, we recommend reviewing the options to achieve compliance with the Transport Standards in the market.

Why is this urgent? In a MaaS future where shared services mix boundaries between private and public transport and the payment and booking provider may be segregated from the delivery of the service, it will be (even) harder for PWD to pursue the current regulatory processes to drive compliance.

Questions that will arise include for example: If a PWD has booked and paid a CAV trip using a MaaS platform,

- and requires to be transferred from an Automated Shuttle, operated by X, to a Train operated by Y, who will be responsible for the assistance?
- but the platform fails to book a priority seat resulting in commuter being unable to use CAV, who is responsible?
- but when alighting a CAV, steps into a dangerous roadwork zone, is that a failure to ensure passenger safety at destination platform (hazard)?
- and gets harassed while on the shuttle, will the remote operator be considered negligent for not calling police assistance in time?

Assuming that CAV guidelines for accessible Public Transport can be agreed upon by stakeholders, we propose three actions to consider with regards to legal compliance of the Transport Standards in which they would need to be incorporated:

1. **Co-regulation.** Industry should participate in the regulation process. Co-regulatory policies are especially successful when there is general commitment for the implementation of the equal opportunities principles and the rights of PWD with the aim of creating the shape and scope of a new market. Collaboration between industry and government is required to ensure the framework and the digital infrastructure for the successful development and implementation of CAVs.

2. **Certification and legal audit.** As the Standards operate in the context of the Disability Discrimination Act 1992, a compliance certification scheme could be created by amending the Standards as well as the Act. The amendment would not prescribe accessibility certification but would enable and regulate it. Like providers can apply for a temporary exemption under s55 of the Act, they should be able to apply to the Commission or other empowered body or party for certification that a proposed design element or course of action is complying or will comply with the Standards. Alternatively, the process could combine self-certification by the operator with an audit of the certification by the Commission. Legal and ethical audits (and algorithm impact assessments) are increasingly used to review and determine the legality of technical toolkits. A third party or independent authority certification is required to avoid the subjectivity and uncertainty of the current system.

3. **Legal enforcement.**
   The EU is embedding its disability rights in legislation, combined with regulatory enforcement. Regulatory enforcement is also evident in the UK.

   In Australia, however, the standards themselves or any consequential breaches of the Discrimination Act, are infrequently enforced. In addition, the framework is dependent on the filing of complaints which places PWD at a disadvantage. This disadvantage can worsen with the increasing complexity of the public transport ecosystem. We therefore recommend formalising the current Transport Standards obligations in legislation

that empowers agencies to enforce compliance—e.g., with the capacity to issue fines, to carry out audits, or/and to review licenses. In addition, as set out below, the regulatory framework should provide a more legal certainty.

Australia could review the regulatory frameworks and their effectiveness in other countries:

Enforcement of the UK Accessibility Regulations[14] is a role undertaken by two bodies – the Office of the Traffic Commissioner and the Driver and Vehicles Standards Agency. In the event that the operator of a vehicle in use fails to comply with the Accessibility Regulations, a fine may be levied against the transgressor. A noteworthy aspect of the Regulations is the ability to hold company officers including company directors and secretaries, and managers personally liable in the event that the transgression has occurred with their consent, neglect or connivance.

Recently the EU published *'Union of Equality: Strategy for the Rights of Persons with Disabilities 2021-2030.*[15] This document follows the *European Pillar of Social Rights* jointly proclaimed in 2017 by the European Parliament, the Council, and the European Commission, taking it as 'compass for employment and social policies'.

The key point for this study is that, under the new framework, disability rights will be embedded into legislation. Should this happen, compliance will not be optional and will be enforced. This will be achieved by (i) explicitly introducing these rights into the next Regulations (i.e., the accessibility rights introduced into the next EU Regulation on Artificial Intelligence), (ii) reinforcing the Better Regulation toolbox to enhance disability-inclusiveness, (iii) ensuring the coherent inclusion and assessment of disability matters in impact assessments and evaluations, (iv) and fostering the inclusion of these rights into the legislation and policies of the State Members.

Future opportunity: Compliance through Design

With CAVs and MaaS, services will be offered by many providers and in a not-too-distant future, machines will be taking real time decisions which requires real time verification of these decisions to ensure that CAVs and MaaS operate safely and in compliance with regulations. Compliance through Design (CtD) – a more sophisticated version of Compliance by Design – will be required to automate compliance in this environment.

CtD allows for responses to a more complex regulator environment formed by laws and regulations but also by case law, standards, protocols, and best practice. CtD enables regulatory information processing to be combined with human decisions and interventions. This is called 'hybrid intelligence', where human intelligence is augmented with collaborative and adaptive artificial intelligence.

However, before standards and compliance can be coded, clarity is required, starting with a set of guidelines for the accessible deployment and operation of CAV. Future enactment of rights and the protection of vulnerable people in the CAV and MaaS context using CtD will require a more structured regulatory framework. This is one of the reasons why in Europe, US and UK, stricter regulation is now pursued.

[14] The Public Service Vehicles Accessibility Regulations 2000 is now part of the Equality Act 2010. The Public Service Vehicles Accessibility Regulations 2000 (2000)

[15] European Commission. (2021). Communication from The Commission to The European Parliament, The Council, The European Economic and Social Committee And The Committee Of The Regions. Brussels.

“I'm looking sort of like with the dots with beacon location, so where you can if you choose to, you can track your journey, but also when a bus does stop at a bus stop, because the bus won't always stop at a bus stop, that when it does stop at a bus stop, then there needs to be something there that sends that the bus is there and how long it's going to be there for. Because if you are running a couple of seconds late and you know the bus isn't going to be there for another three or four minutes, then if you've got to get your wheelchair out, or whatever it may be, it allows you that little bit of a heads up time.”

Appendix

Appendix 1: Full table of CAV challenges and opportunities for PWD

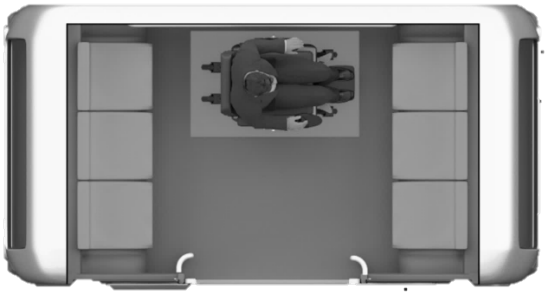
Challenges and opportunities that CAVs represent for PWD that should be addressed as part of the driverless CAV Guidelines.

<table>
<tr><td colspan="2">Vehicle design</td></tr>
<tr><td colspan="2">Several standards relating to the vehicle design and layout already apply to CAVs. CAV shuttles that are currently being trialed in Australia are an improvement compared to buses and trams and will meet the requirements of the Transport Standards, such as access pathways, onboard maneuvering requirements, automated doors and floor space provided. However, there are amendments to the Transport Standards required, for instance to cater to blind and the deaf public transport users and ensure a standard approach for wheelchair users.</td></tr>
<tr><td></td><td>Seating availability</td></tr>
<tr><td rowspan="4">Seating availability</td><td>CAV PWD principle
With the connected nature of CAV, seating availability does not need to be the concern for PWD as it is today.

WJG 3.5: PWD have highlighted that priority seating is often unavailable on busy public transport services, and at times priority seating is also shared with other customers such as parents with prams.</td></tr>
<tr><td>Opportunity: Agree on position of the priority seat.

Transport Standard 31.1. Operators must designate at least 2 of the seats provided on their unbooked conveyances as priority seating for passengers with disabilities and other groups in need of assistance (for example, the ageing).
Consider accessibility to the touch screen or buttons inside the vehicle, to make sudden changes to their travelling path (without having to stand up).</td></tr>
<tr><td>Opportunity: The connected opportunity is to provide real time data about the availability of seats. As an example, make seat-availability visible online in real time, for instance by placing sensors on seats/use camera to determine availability and allow disability seat reservation.</td></tr>
<tr><td>Opportunity: Communication and conflict resolution.
The remote operator can intervene if someone able doesn’t give up their seat for PWD.</td></tr>
<tr><td rowspan="2">Wheelchairs
(see also operations)</td><td>Principle:
CAVs should provide independence for wheelchair users, i.e., truly not require an attendant to secure the wheelchair, and be simple. Independent and safe use of occupant protection and mobility aid device restraint system where wheelchair tiedown and occupant restraint systems should accommodate low levels of functional mobility /dexterity and provide a high level of safety.

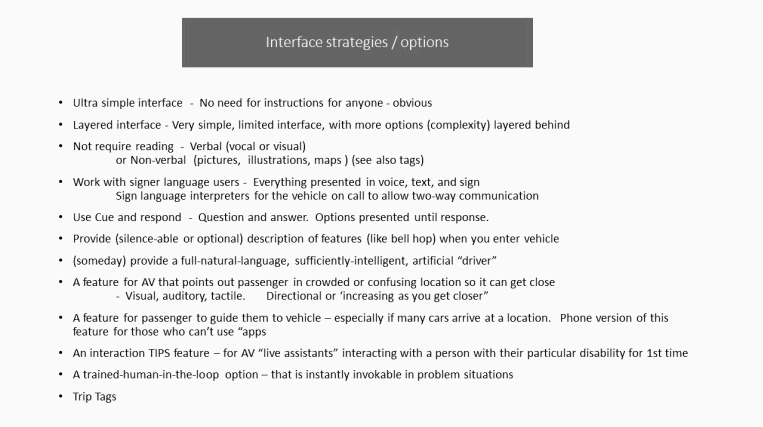
Transport Standards 1.22 Safety
The Disability Standards do require that all passengers be able to travel with the same level of safety.</td></tr>
<tr><td>Opportunity: Being able to place the wheelchair with the rear facing driving direction is a step in the right direction, but perhaps insufficiently safe.</td></tr>
</table>

	Transport Standard 9.4.2 At least one allocated space must be provided in each bus with less than 33 fixed seats.  *Figure 6. Potential wheelchair placement (Source: United States Access Board)*
	Opportunity: Universal, manual wheelchair tie downs.
	Opportunity: Automatic securement is ideal; vehicle detects that securement is done correctly.
	Opportunity: Clearance for wheelchair or mobility scooter and person to fit and manoeuvre within vehicle. Provide access to a growing variety of wheelchairs and scooters which are getting larger.
	Opportunity: Provide passenger with guidance on how to secure wheelchairs, e.g., identify which type of securement mechanism.
	Opportunity: Secure wheelchair AND the person. Movement restrained systems for wheelchairs with the arrangement of seat belts for wheelchair passengers, and the ability to do it effortlessly. For restraints, consider "roll in" systems like Q'STRAINT for users that may be unable to self-secure restraint. Protect the occupant in both low and high g environments.
	Opportunity: Allocate space to store mobility aid or to sit a Dog Guide. This includes mobility aids such as crutches and other walking aids.
	Opportunity: Allocate consistent position of this space.
Colours	Principle: The colour scheme of the vehicle helps, not hinders visually and cognitive impaired people. This includes seat outlines.
	Opportunity: Contrasting and illuminating colours in the vehicle design aid visually impaired people to navigate the vehicle.
	Opportunity: Agree on symbolics of colour controls and signs, for instance red equals emergency, blue a request to stop, green opening of the doors.
	Opportunity: Agree on colours of the grab rails.
	Opportunity: Agree on colours of wayfinding signs and messages.
Seating design	Principle: The seating design – height, shape and material - matters for PWD whose needs are to be taken into account.
	Opportunity: For example, curved designs provide more support than flat designs.
	Opportunity: Pull down chairs need to be easy to pull down.
	Opportunity: Seatbelt design needs to be flexible to accommodate a variety of people including children. *Transport Standards: 1.22 Safety: (3) Regulations that require passengers to wear safety belts apply equally to all passengers.*
Handles and support	Principle: PWD should be able to reach out for support rails and handles instinctively, handles and bars should be implemented in a consistent fashion across makes and models. *Transport Standards 11.2.1: Handrails must be placed along an access path wherever passengers are likely to require additional support or passive guidance. Grabrails that comply with AS1428.2 (1992) Clause 10.2, Grabrails, must be provided in all allocated spaces.*

	Opportunity: Handrails and other supportive infrastructure are positioned consistently across makes and models in easily accessible locations such as the door and towards and near accessible seats.
Signage	Principle: PWD should be able to view signs and announcements from their wheelchair or seats even if the shuttle is crowded with standing passengers or when it is dark or very bright.
	Opportunity: Agree on contrast standards and anti-glare screens.
	Opportunity: Leverage communication technology to deliver the same on multiple platforms.

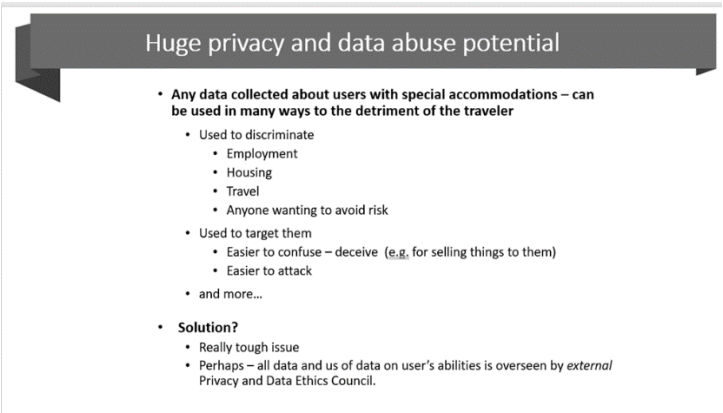
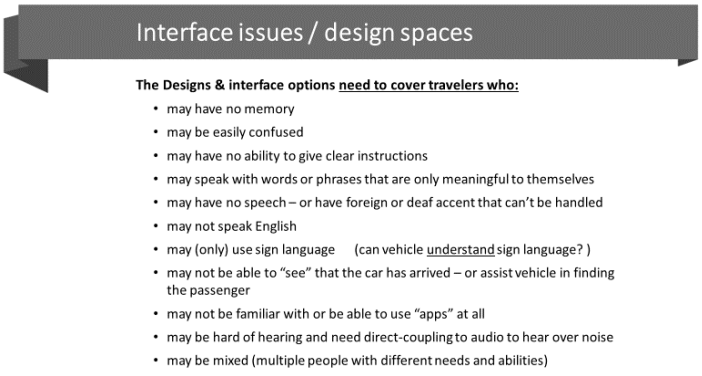
Monitoring and Direct Assistance	
Many PWD rely on direct assistance when using public transport. However, given that presence of a human driver will diminish or disappear with CAVs, 'direct assistance' may not be available. Some functions typically performed by the driver and important to PWD have not been included in the Transport Standards. Most industry representatives are planning to deploy remote monitoring or a steward (either on board or on the platform) which requires specification and consistency.	
Direct assistance	Principle: A driver's role is diverse and complex. The CAV experience is set to become more seamless and have less friction, however, not all the functions of a human driver can be automated. When there is no human directly at hand, other forms of assistance are required. *WJG 3.4.1 Limit the need for assistance* *Wherever possible, planners and designers should aim to eliminate the need for ramps and accessibility aids when people enter and exit a public transport vehicle.*
Passenger (needs) identification	Principle: Today, a bus driver can identify the passenger [Card used by deaf-blind people] and, for instance, know the place that they need to alight.
	Opportunity: A remote operator can help solve boarding, payment and destination setting.
Safety monitoring	Principle: Safety is paramount. The driver of a vehicle is often attributed with the responsibility to look after the passengers' safety, including PWD.
	Opportunity: Passenger safety monitoring during trip. This can be done by the remote operator.
Conflict resolutions	Principle: Unfortunately, PWD do sometimes encounter conflicts in public transport, in which case a driver or platform personal can assist.
	Opportunity: Resolving conflicts/requesting access when an able-bodied person is occupying that space (or a person with a pram). Also resolving social tensions, e.g., when another passenger is afraid of a Dog Guide. This can be monitored by the remote operator, however, also requires a contingency plan. *WJG 3.4 Fellow passengers and staff are courteous and respond to requests for assistance from people with disability.*
Stewards	Principle: For many PWD, traveling in public transport without any form of human assistance is not possible.
	Opportunity: Customer service. There is a role for stewards in the CAV service model. *WJG 3.3.6: People with disability highlighted the importance of having customer service staff available to assist them, especially in busy, complex environments. For stops/stations that aren't staffed, help points should be available for more than just emergency situations, and clear contacts provided for those who need help and assistance.*
Platform assistance	Principle: Help on platforms or stop overs is often required.
	Opportunity: CAV operators to consider how to provide staffed platforms or provide staff assistance, e.g., 'on demand.'
Emergency management plans	Principle: There should be emergency plans for PWD in case of an accident or other emergency specific for PWD.
	Opportunity: Emergencies – Presence of reliable and consistent emergency plans and emergency communication methods for PWD can be agreed. *WJG: 3.7 People with disability are more impacted by a disruption than their fellow travellers.* *WJG: 3.7.1 Disruption management planning processes should be implemented so that any change to the environment within the vicinity of public transport infrastructure is assessed to*

	determine its impact on accessibility. This should not presume any degree of familiarity with the environment and be equally accessible to a new, intermittent, regular, and overseas user.
Emergency communications	Principle: PWD should not be the last to know what happened in case of emergency and what actions are to be taken.
	Opportunity: Communicate/educate about contingency plans so that there is no delay for PWD in finding out what's going on. *WJG: 3.7.2 Communication - Ideally communications systems need to integrate the disruption notification across the whole journey and its parts—journey start to end and back to the start again. In practical terms, this would integrate notification of pathway disruptions due to council road works, or utility company works, which result in public transport system and interchange disruptions.* *WJG: 3.5.7 Real time information alerts, particularly in relation to safety matters, need to be provided in formats that ensure all users receive necessary information. For example, a person with a significant hearing impairment will need a visual alert, as standard audio alerts will not work.*
Emergency training and consistent responses	Principle: Across operators, remote control personal and stewards need to agree on consistent procedures and training to help PWD in emergency situations.
	Opportunity: The remote operator and public safety officials and personnel are trained for emergency situations that involve PWD, e.g., calling in police or health personal.
Emergency phones	Principle: Independence could mean providing access to mobile phones in vehicles.
	Opportunity: Subsidised smart phones or communication facilities available during the trip to communicate with caregivers or for emergency purposes.
Customer service	Principle: Despite automation and accessibility, some PWD may need customer service as a backup.
	Opportunity: Whole Journey customer service will be a necessity. *WJG 3.7: Hard infrastructure generally provides a framework that commuters can travel within independently. It includes facilities (bathrooms, seating etc.) and signage to assist them along their journey. But the soft 'people' infrastructure is also key to a successful journey. Customer service staff, drivers and other support people often make or break the travel experience.*

Human Machine Interface	
Given that face-to-face interaction with a human driver will diminish or disappear, the need for truly and universally accessible communications increases.	
Touch screen	Principle: Everyone should be able to easily interact with the service. The 'touch screen' in current shuttle designs raises many concerns.  *Figure 7. Suggestions for the CAV Interface (Source: United States Access Board).*
	Opportunity: All touchscreens are placed at the same (accessible) height, have the same dimensions and the same user interface.
	Opportunity: Screens that are placed on the platform and can take inputs prior to boarding the shuttle.
	Opportunity: Screens that are 'glare' resistant.

	Opportunity: Provide a variety of communication methods apart from touch screens, such as voice activation commands, etc.
	Opportunity: Have the ability to contact the remote operator when the PWD is not able to operate the touch screen (either in the vehicle or outside the vehicle).
Controls (Design)	Principle: Learn the controls once, apply everywhere. *WJG: 3.4.3 Consistency of essential accessibility features across the whole journey is important. Features such as exit buttons, priority seating and the location of allocated spaces should be as consistent as possible. PWD have highlighted that vehicles can have differences in this regard, such as exit buttons located in different places. These differences can significantly impact a person's ability to travel independently.*
	Opportunity: All controls are consistent across all modalities - including CAV shuttles. There are: stop buttons, which stops next station and triggers a light and a tone, an emergency button which triggers contact with the remote operator and door open override button.
	Opportunity: All controls are consistently positioned and at a level accessible to wheelchair users.
	Opportunity: Must be operable by persons of all ranges of motion and strength as well as most levels of cognition.
	Opportunity: Provide multiple input modes (audio, visual, tactile).
	Opportunity: All controls to have braille and raised lettering.
	Opportunity: All controls must be audible.
	Opportunity: Use of different shapes for controls (shapes within shapes) and different contrasting colours.
Controls (Functionality)	Principle: Controls enable the journey and provide assurance. The driver of trams and buses sometimes perform the role of a control – e.g., stopping at a particular stop because the driver knows the person needs to alight. PWD should be able to assume that the same controls are present at the places where they expect them.
	Opportunity: Must be consistent across vehicles of various makes/brands: - stop next stop - emergency door open - speak to operator
	Opportunity: Provide a means for passengers to signal an emergency using multimodal input (e.g., voice, button). Multiple emergency buttons fixed at different heights throughout the vehicle. This feature is particularly important if the passenger is travelling alone.
	Opportunity: Provide a way for PWD to obtain feedback from the control, that the control has recognised input (sound, light, message, etc.).
Communication of trip progress and other announcements	Principle: When CAVs are not taking a fixed predictable route, understanding trip progress becomes even more essential than it is today. The availability of crucial information by multi modal platforms means, especially during alerts, that the PWD can respond in sync with the other passengers. *Transport Standards 27.4: If information cannot be supplied in a passenger's preferred format, equivalent access must be given by direct assistance. All passengers must be given the same level of access to information on their whereabouts during a public transport journey.* *WJG 3.4.2: Audible announcements: The importance of communication increases as routes become more complex, such as when stops are frequent (for example, 300 metres apart), as does the difficulty in using audible announcements. For example, Apps such as the Stop Announcer (NSW)38.*
	Opportunity: Tuneable and multi-modal interfaces for persons with sensory disabilities to receive trip progress communications, hearing loop, and other real time wireless communications.
	Opportunity: Ability to receive communication to own device which is customised to personal needs.
	Opportunity: Placement of screens with trip progress visible to all passengers. Line of sight issue for those using wheelchairs when seated in a vehicle which inhibits the passenger's ability to understand where they are going, particularly when other passengers are standing.
	Opportunity: Clear audio and visual announcements of vehicle departing, trip destination and progress.
	Opportunity: Vehicle can identify the passenger [Card used by deaf-blind people] and the place that they need to alight.
	Opportunity: Acknowledgement that the passenger is on the right vehicle.
Auditory	Principle:

	PWD who can't see the sign boards, rely on auditory messages to understand the actions the vehicle takes, and they need to take. *Transport Standards 25.2: People who are deaf or have a hearing impairment must be able to receive a message equivalent to the message received by people without a hearing impairment.*
	Opportunity: All auditory messages and sounds are consistent across various vehicles.
	Opportunity: Non-audio interfaces for people with auditory disabilities (e.g.: providing Assistive Listening Devices (ALDs), Augmentative and Alternative Communication devices (AAC) and using alternative devices such as sound, light, vibrations, or combination of all those).
Non-Auditory	Principle: PWD who can't hear messages, rely on visual or tactile messages to understand the actions the vehicle takes, and they need to take. Opportunity: Non-visual interfaces for persons with visual disabilities (e.g., Using screen readers, Braille displays, tactile etc.) Apart from that visually impaired people can use various tech equipment such as Tongue interfaces, Bionic eyes to understand the surrounding.
Planning, hailing, paying, booking	Principle: Hailing, booking, and paying/entering a vehicle without a driver is a concern, as at the moment, for buses, they are regularly scheduled and PWD rely on the driver to see them waiting on the platform. *Transport Standards part 25: For passengers who have difficulties with standard fare payment systems, operators and providers must offer a form of payment that meets equivalent access principles.* *WJG 3.1: Increase the confidence of public transport users that their journey will be seamless and safe. Providing a richer set of information/data in journey planning tools in range of formats.* *WJG 3.3.8: Ticketing - electronic ticketing, Digital connectivity and big data: the increasing digitalisation of transport information, and services is leading to techno-reliance and reduced staffing levels both on public transport ticketing services (with the introduction of driverless trains for instance) as well as the introduction of new transport modes such as car-sharing services and autonomous vehicles.*
	Opportunity: Accessible apps to hail the vehicle. This would help notify the vehicle that a person with disability is at a particular station thus prepare to stop.
	Opportunity: Planning: PWD specific data filtering options to get the necessary information quickly: e.g., platform accessibility, Dog Guide toilets, steep hills for wheelchairs, etc. *WJG 3.2.1 Transparent information about accessing stops/stations/terminals.*
	Opportunity: Provide real time vehicle and trip information. *WJG 3.3.3: For people with hearing impairments, there should be visual indications of the arrival of a train or bus, particularly in high traffic situations such as larger train stations. For example, whenever a train approaches a platform, flashing lights could indicate the train's imminent arrival.*
	Opportunity: Provide accessible apps or other means to hail the vehicle. This would help notify the vehicle that a person with disability is at a particular station thus prepare to stop.
	Opportunity: Extended communication with the vehicle prior to boarding, beyond hailing e.g.: Indicating that wheelchair user is attempting to board, will allow time for the vehicle to prepare to board the passenger such as starting to extend the ramp.
	Opportunity: Contactless or toolless payment options would address a friction point for many PWD.
Identify correct vehicle and boarding location	Principle: The mobility options available are set to become more fluid. To identify the correct vehicle and boarding location is already a concern today. *WJG 3.5.2: Wayfinding - This could include for example a range of communication and accessibility features such as Braille, audio loops, sound and lighting with 'changing places' premium toilets nearby. This includes looking for known landmarks, knowledge from previous experiences at that (or a similar) location, indicators such as signage or tactile ground surface indicators (TGSIs), maps, apps, sounds, textures, contrasts, temperature, interaction with other people (including customer service staff) and other cues. People with disability may rely heavily on some of these cues and find others to be of no use. For example, a person who is blind or has low vision may find they rely heavily on sounds, texture, temperature and TGSIs to navigate their way.*
	Opportunity: Integrate vehicles with digital wayfinding solutions so that the vehicle, the doors, and front and rear of the vehicle can be found. This includes orientation and wayfinding inside the vehicle. This helps to find the location of the door, seated direction, traveling direction, etc.

	Orientation and wayfinding to and from the vehicle. Studies have shown two important elements to meet the requirements in wayfinding applications, which are the data must be compliant to agree upon available standards and it should be free and presented in an open platform, to be used by developers to develop personalized wayfinding applications.
	Opportunity: Ability to use same pass/ticket across metro, regional and interstate travel.
Payment	Principle: The less physical efforts in the process, the better – even swiping a card can be impossible for some PWD.
	Opportunity: Seamless payment options – such as auto identification of the passenger without swiping for instance a Myki card and easy recharging of the card.
	Opportunity: Payment methods may be limited, consider options for unbanked (e.g., CVS offers a service) and children.
No reliance on smart phones	Principle: Even with accessible apps, some PWD can't use phones at all.
	Opportunity: Provide options for those who do not or cannot use a digital app (affordability, skill, intellectual capacity, memory issues) such as control button access to remote operators.
Privacy	Principle: There is an understanding that the exchange of information can be valuable, for instance to reserve a seat, however, PWD have poor past experiences with providing identity and information on their disability and in some cases have had negative experiences as a result of sharing personal information.  *Figure 8. Potential to breach privacy (Source: United States Access Board).*
	Opportunity: Ensure that data is used and treated as per an industry accepted and relevant legal standard.
Reducing stress and anxiety	Principle: For some PWD the absence of a driver increases the level of anxiety (Air taxis in particular). Reducing stress and anxiety in general related to travel in autonomous public transport services.  *Figure 9. Points to consider in the design phase (Source: United States Access Board).*
	Opportunity: Optional, detailed travel commentary or progress updates.
	Opportunity: Collaborate between PWD and Industry in order to identify further sources of anxiety.
	Vehicle Punctuality: important in reducing stress and anxiety for some PWD.

Vehicle Operations	
CAVs have an opportunity, and in some cases a necessity, to standardize operational aspects. Predictability is one of the highest sought-after factors by PWD.	
Easy entry and exit practices	Principle: While access is also covered in the design section, there are operational aspects as well that present a clear opportunity for CAV. CAVs should provide an easy access experience, without the need for assistance.
	Opportunity: Given the automated nature of CAVs, parking distance between the vehicle and the platform can be standardised, allowing for a defined maximum gap.  *Figure 10. Driving sideways to park very close to the platform: Crabbing. Source: US Access board: Standards (Source: www.access-board.gov/av/)*
	Opportunity: If level platform access can't be assured, automated ramps or lifts should be available.  *Figure 11. Wheelchair ramp. (Source: www.access-board.gov/av/)*
	Opportunity: Lifts and ramps need to be able to cater to variety of assistive vehicles (size-wise and capacity-wise) that should be available at the boarding locations. Ramp seems to be preferred over lifts.
Service Customization	Principle: One service does not fit all, and modern technology can adjust to the passenger if it is aware of the needs of the person.
	Opportunity: Smart vehicles will be able to adjust services to the person that is being transported. Extended communication with the vehicle prior to boarding, beyond hailing. E.g., Indicating that wheelchair user is attempting to board will allow time for the vehicle to prepare to board the passenger, such as starting to

	extend the ramp. Many other automated customization opportunities exist that can be based on an automated exchange of data.
Safe departure and arrival	Principle: A driver can take the passenger's needs into account e.g., ensure they are properly seated. How will CAVs ensure safe departure and arrival?
	Opportunity: Vehicle does not depart until passenger is ready, as determined by the remote operator or HMI to accommodate users (audio and/ or non- visual methods for communication) and using motion sensors to provide with some additional time to enter or exit the vehicle.
	Opportunity: Provide information about potential hazards outside the vehicle, e.g., cars approaching near entry / exit points. Special devices or cameras can aid in knowing whether all the passengers have safely alighted from the vehicle.
Safe vehicle movements	Principle: PWD need predictable vehicle operations.
	Opportunity: CAV have a unique opportunity to deliver a consistent travelling experience by managing G-forces. Agree on maximum g-forces under normal operations – except for emergency procedures.
Easy Transfer	Principle: One of the promises of CAV is to provide easy transfer between multimodal services (e.g., rideshare to bus to train). *WJG: 3.5 Transfers need to be efficient as delays may cause customers to miss their next service, or a specific accessible service, impacting their confidence and level of stress.* *WJG: 3.5.4 Journey planning needs to be supported by tools that identify where lifts, escalators, ramps, and assistance are available. This should also consider the need for a different route or use of an alternative entrance/exit at an interchange.*
	Opportunity: Drop off at a location where there are accessible doors, direct accessible pathways and that considers space and safety.
	Opportunity: The connected aspect of CAV offers opportunity to help identify the best pathway for next destination during trip.

Indicative timelines

CAV aspect	Timeline	Priority Item
Vehicle design	Short term	• Location of priority seats, real time data provision about the availability of seats and conflict resolution • The colour scheme of the vehicle can be adapted upon purchase and deployment by an operator • Signage: contrast standards and anti-glare screens • Controls to have braille
	Mid term	The following require development time: • Wheelchair securement, securing wheelchair and the person not only depends on manufacturers and operators but also on wheelchair users. • Multi modal access to controls is a technically sensitive matter with high reliability requirements • Allocate a consistent space to store mobility aid or to sit a Dog Guide • Seating design related issues • Handrails and other supportive infrastructure including seating are positioned consistently across makes and models • Leverage communication technology to deliver messages on multiple platforms • Provide training on securement, vehicle layout, signs, etc. to build confidence.
	Long term	• To have all controls are consistent across all modalities - including CAV shuttles requires all modalities to be adapted
Human Machine Interface	Short term	• Manufacturers and operators indicate that HMI issues can be resolved in the short term, including real time data to phones for trip progress, however, multi modal delivery of message beyond the current screen, signboards and audio as the technology and the solution requires longer development.

		• Human assistance in case PWD cannot use an app or other technology options requires short term agreement • Signalling emergency situations using multimodal inputs and immediate feedback from controller • Reliable booking and hailing system • Ensure that data is used and treated as per an industry accepted and relevant legal standard.
	Mid term	• Multi modal delivery of messages via other assistive technologies (e.g., hearing aids) • Integrate vehicles with digital wayfinding solutions so that the vehicle, the doors, and front and rear of the vehicle can be found. • Frictionless payments • Ability to communicate with the vehicle / operator using own device which would be customized to meet client's needs
	Long term	• Reducing stress and anxiety – the problem and possible solutions require further definition
Monitoring and assistance	Short term	• The monitoring and assistance opportunities are indicated to be agreed and deployed in the short term. This includes defining and agreeing on the role of the remote operator and the agreement on emergency procedures, which are a necessity. • Support on platforms or roving stewards will depend on the success of business model and is hence seen as a short-term development when it comes to initial introductions, but as a mid-term development depending on the location.
Operations	Mid term	• Operational aspects, such as parking distance to the kerb, fixed acceleration and deceleration, lifts and ramps are considered mid-term developments. • Provide a consistent and reliable travel experience including transfers between multimodal services • Ensuring safety of the passenger during Whole Journey • Providing other services such as charging stations for passengers

Priorities

When it comes to priorities, the below table represents the priorities as we have noted them in our discussions with Peak Body Representatives and our two focus groups with PWD. The status of the below is therefore not definitive but does provide a qualitative indication of what matters most to a variety of PWD. When it comes to PWD, we have taken the view that the classic marketing prioritization of segments doesn't hold true. For instance, just because there are more people with disability X than disability Y, does not make that segment of a higher priority, hence we have refrained from further prioritization.

	Priority Item
Vehicle design	Accommodation of wheelchairs and scooters including easy boarding and alighting, space allowance and securement
	Colour contrast to identify buttons on doors and handle, seat outlines, signage
	Different shapes (and shapes within shapes) used for buttons
	Space allowance for Dog Guide including safety aspects
	Tactile markings and lights for navigation inside the vehicle
	Space allowance for prams including child safety aspects, securement, etc.
	Independence – use of service without or with minimal assistance from people
Human Machine Interface	Other options for people unable to use apps and touch screens, and options when phone batteries die
	Multi modal systems for communication – Visual, auditory, tactile
	Ability to hail the vehicle
	Reliable, convenient booking system
	Real time feedback to commuter on bus journey, delays, how long bus will be at the stop for, disruptions
Monitoring and assistance	Ability to contact the operator in case of an emergency
	Reliable emergency procedure with constant feedback using accessible systems
	Safety
	Assistance during the journey such as knowing when to alight when traveling to a new destination
Operations	The location where the vehicle stops – ensuring that there are no obstacles on the path such as garbage, construction work, water, other tripping hazards, etc.
	Punctuality
	Training to build confidence
	Real time feedback to commuter on bus journey, delays, how long bus will be at the stop for, disruptions
	Charging stations to charge equipment and devices

	Ability to receive communication to own device which is customized to personal needs
	Ability to use pass/ticket in metro, regional and interstate travel
	Cost effective

Appendix 2: Definition of Public Transport

Below, the full note of the ISO TC 204 WG8 working group:

What is public transport?

"We once limited the definition of public transport to mass public transport, combining public access and collective youth, but it's only one element of that definition, which now encompasses every collective, or shared mobility solution. In other words, public transport should include all collective and shared modes moment." Mohamed Mezghani, UIDP, Secretary General in the public transport trends 2019 introduction.[16]

The term public transport has been defined, interpreted, and used in many ways, and it has very often been related to mass transport based on transport routes like bus, metro, ferry, and train, as stated by the UITP Secretary General in the introduction in public transport trends 2019.

However, digitalization in transport means a new actors in the provision of transport and transport related services have challenged the old understanding and use of the term public transport. Now, it is more a question about 1) Whether your transport service is accessible to anyone at any time, or 2) whether it is a transport service limited to persons that are, for example, member of a pool, association, user club, or limited to the use of individual transport means that in most cases are owned by the driver or user. Walking is included in this last group.

The old understanding of public transport based on mass transport means like bus, tram, metro, ferry, etc, is now to yield for an expansion of the transport means covered under the PT umbrella. The transport means are not any longer limited to transport means meant for collective use but include now also transport means there are meant for shared individual use.

This is if transport means are publicly accessible for anyone, fulfilling the requirements related to the use of transport means, for example, driver license or age. Hence, there are now two categories of transport means use for public transport, as shown in Figure 12.

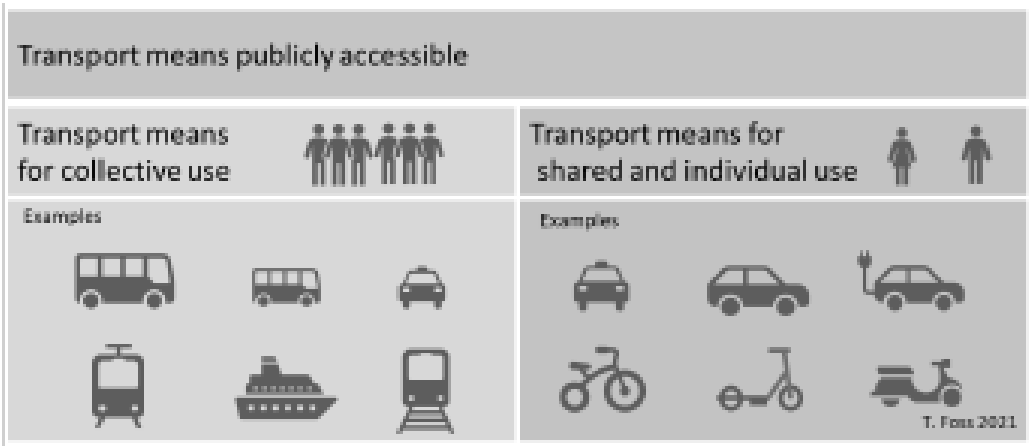


Figure 12. Accessible public transport means.

Taxi is shown both in transport means for collective use, and for shared and individual use. Collective use could cover scenarios where taxes are used for on demand services, enabling a collective use of taxis, or it could be used by an individual transport means for a person traveling from A to B. The minibus (shuttle bus), shown in the collective use category, could be used in regular schedules in fixed routes, its fixed stops, and it could be used in an on-demand service, optimizing, and fulfilling the user request for origin destination and time for departure or arrival.

Hence the term public transport is not necessarily related to fixed routes with fixed stops. A typical mass transport means that covers, also on demand concept, independent of route and stops based on publicly accessible transport

[16] Public Transport Trends 2019. (2019). Retrieved 1 August 2021, from, https://utip.org/publications/public-transport-trends-2019

means for shared an individual use. This also implies that transport means that traditionally have been related to private transport, for example, an E-scooter or person car could also be related to public transport, if they are publicly accessible. For example, shared E-scooters and shared cars.

There is often a need for a one sentence definition of a term. For example, in standardization, but also otherwise. Considering the UITP description of what public transport should be, a possible one sentence definition could be:

> *Public transport*
> *a transport service that is publicly accessible, enabling a person to either move, or to be moved from an origin to a destination based on the use of transport means for collective shared an individual use.*

Note one: Publicly accessible bus, tram metro train, and ferry, are examples of transport means for collective use.
Note two: Publicly accessible shared bikes, shared e-scooters and shared cars are examples of transport means for shared and individual use.

Appendix 3: Definitions of CAV

The NTC writes in its extensive policy paper[17] 'In its submission to the inquiry by the House of Representatives Standing Committee on Industry, Innovation, Science and Resources into Social issues relating to land-based automated vehicles in Australia, the (then) Department of Infrastructure and Regional Development stated: Authorities in Europe, the United States and Australia have adopted the Society of Automotive Engineers' (SAE) International Standard J3016 as a common language for describing the capabilities of an automated vehicle. (Department of Infrastructure and Regional Development, 2017, p. 7) The committee's inquiry report recommended that: … the Commonwealth adopt as standard terminology the use of 'automated vehicles' and formally accept that the standard definition for the automation level of vehicles is that used by the Society of Automotive Engineers' (SAE) International Standard J3016. (Parliament of the Commonwealth of Australia, House of Representatives Standing Committee on Industry, Innovation, Science and Resources, 2017, p. iii) The United States National Highway Traffic Safety Administration has noted the importance of using internationally supported terminology and adopted applicable SAE terminology (United States National Highway Traffic Safety Administration, 2017, p. 1)'

In its recent 2056 future transport plan[18], NSW describes Automated vehicles as

> *using technologies including robotics, sensors, and advanced software to automate one or more elements of driving, such as steering, accelerating or braking. Vehicle automation is not new. Features such as electronic stability control and electronic brake assist have been part of a gradual increase in automated systems over many years.*
>
> *Connected vehicles use wireless technology to communicate with other vehicles, the road and other infrastructure, and even personal devices. These communications use a mix of technology – including commercial telecommunications networks (4G and 5G), global navigation and satellite technologies, and Dedicated Short Range Communications (DSRC) – depending on the operating area and use.*
>
> *By combining these communication technologies with Intelligent Transport Systems (ITS), such as smart traffic signal controls and sensing technologies, this connectivity is a powerful tool for gathering and processing data into timely information and services for people, businesses, and network operators. This means vehicles can operate more safely and intelligently by sharing information or alerts on safety hazards and congestion.'*

Other definitions

It is worth noting that from the IEEE Vehicular Technology Society, connected vehicles represent the intersection of its three fields of interest: mobile radio, automotive electronics, and transportation systems.[19]

> *In connected vehicle is basically the presence of devices in a vehicle that connect to other devices within the same vehicle and/or devices, networks, applications, and services outside the vehicle. Applications include everything from traffic safety and efficiency, infotainment, parking assistance, roadside assistance, remote diagnostics, and telematics to autonomous self-driving vehicles and global positioning systems (GPS).*
>
> *Thus, "it refers to applications, services, and technologies that connect a vehicle to its surroundings" (ibid.). She distinguishes between vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications.*
>
> *Autonomous 'Autonomous vehicles' are those in which operation of the vehicles vehicle occurs without direct driver input to control the steering, acceleration, and braking and are designed so that the driver is not expected to monitor constantly the roadway while operating in self-driving mode.*

[17] National Transport Commission. (2018). Changing driving laws to support automated vehicles. Retrieved 1 August 2021, from https://www.ntc.gov.au/transport-reform/ntc-projects/changing-driving-laws-support-AVs.

[18] Future Transport Strategy 2056. (2021). [eBook]. NSW. Retrieved from https://future.transport.nsw.gov.au/future-transport-strategy

[19] Uhlemann, E. (2015). Introducing Connected Vehicles [Connected Vehicles]. IEEE Vehicular Technology Magazine, 10(1), 23-31. https://doi.org/10.1109/mvt.2015.2390920

Connected 'Connected vehicles' are vehicles that use any of a number vehicles of different communication technologies to communicate with the driver, other vehicles on the road (vehicle-to-vehicle [V2V]), roadside infrastructure (vehicle-to-infrastructure [V2I]), and the "Cloud."

CAV definitions in other countries

The UK Automated and Electric Vehicle Act 2018[20] s, 1(b) states: The Secretary of State must prepare, and keep up to date, a list of all motor vehicles that—may lawfully be used when driving themselves, in at least some circumstances or situations, on roads or other public places in Great Britain. Further, at s. 8(1)(a): a vehicle is "driving itself" if it is operating in a mode in which it is not being controlled, and does not need to be monitored, by an individual.

Autonomous 'Autonomous vehicles' are those in which operation of the vehicles vehicle occurs without direct driver input to control the steering, acceleration, and braking and are designed so that the driver is not expected to monitor constantly the roadway while operating in self-driving mode.

Connected 'Connected vehicles' are vehicles that use any of a number vehicles of different communication technologies to communicate with the driver, other vehicles on the road (vehicle-to-vehicle [V2V]), roadside infrastructure (vehicle-to-infrastructure [V2I]), and the "Cloud."

U.S. National Highway Traffic Safety Administration[21] (NHTSA) defines CAVs as

Vehicles for which "at least some aspects of a safety-critical control function (e.g., steering, acceleration, or braking) occur without direct driver input.

Transport Canada[22] (the Canadian federal ministry) defines an autonomous vehicle as one that

Uses a combination of sensors, controllers and onboard computers, along with sophisticated software, allowing the vehicle to control at least some driving functions, instead of a human driver (for example, steering, braking and acceleration, and checking and monitoring the driving environment).

Connected vehicles are defined as ones that 'Use different types of wireless communications technologies to communicate with their surroundings.' This will eventually include vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-everything (V2X) platforms which will allow the vehicle to obtain information such as traffic and weather conditions, nearby construction, and accidents.[23]

The term driverless

The term 'driverless', which we are re-introducing, has been a topic of debate:

In 2017 the recommendation to the commonwealth with regards to social issues relating to land-based automated vehicles in Australia[24] reads:

The Committee heard that there is considerable debate regarding the preferred terminology for driverless cars. While 'driverless vehicles' is the phrase most-readily understood and recognised, several witnesses and submitters argued that it is misleading and potentially off-putting to members of the public.

1.6The National Transport Commission explained the rationale for using the term 'automated':

We have used the term 'automated' rather than 'driverless' or 'autonomous' to recognise that it is a spectrum of automation and that there are different policy issues as we move along that spectrum. We are already on that journey today with today's cars (Burke 2017, NTC).

1.7The Department of Infrastructure and Regional Development (DIRD) uses the term 'automated vehicle', meaning 'a vehicle that does not require a human driver for at least part of the driving task' and notes that this

[20] Automated and Electric Vehicles Act 2018 (2018). United Kingdom.
[21] Retrieved 1st August from: from: https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety
[22] Understanding connected and automated vehicles. Transport Canada. (2019). Retrieved 1 August 2021, from https://tc.canada.ca/en/road-transportation/innovative-technologies/connected-automated-vehicles/understanding-connected-automated-vehicles.
[23] The Future of Connected Vehicles. Verizon Connect. (2020). Retrieved 1 August 2021, from https://www.verizonconnect.com/resources/article/future-of-connected-vehicles/.
[24] Parliament of Australia. (2017). Social issues relating to land-based automated vehicles in Australia (pp. ISBN: 978-1-74366-678-4). Canberra.

term captures a broader range of vehicles than the more specific descriptor 'driverless' (Department of Infrastructure and Regional Development).

1.8In contrast, the Australian Driverless Vehicle Initiative (ADVI), a peak advisory body comprised of a range of organisations across government, academia, and industry, noted that:

We use the term 'driverless' because we had a focus group and a number of discussions with our key people about what language the community would understand and relate to and, whilst our technological experts like 'automated', 'driverless' is the language that we use. We refer to everything as 'driverless' across the spectrum.

In this report, in the context of the Transport Standards, we recommend reserving the term 'driverless' for when there is truly 'no driver' on board so that it can trigger a new set of standards to be applicable for that situation.

Other definitions

It is worth noting that from the IEEE Vehicular Technology Society, connected vehicles represent the intersection of its three fields of interest: mobile radio, automotive electronics, and transportation systems.[25] According to Uhlemann (2015),

In connected vehicle is basically the presence of devices in a vehicle that connect to other devices within the same vehicle and/or devices, networks, applications, and services outside the vehicle. Applications include everything from traffic safety and efficiency, infotainment, parking assistance, roadside assistance, remote diagnostics, and telematics to autonomous self-driving vehicles and global positioning systems (GPS).[26]

Thus, "it refers to applications, services, and technologies that connect a vehicle to its surroundings" (ibid.). She distinguishes between vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications.

Autonomous 'Autonomous vehicles' are those in which operation of the vehicles vehicle occurs without direct driver input to control the steering, acceleration, and braking and are designed so that the driver is not expected to monitor constantly the roadway while operating in self-driving mode.

Connected 'Connected vehicles' are vehicles that use any of a number vehicles of different communication technologies to communicate with the driver, other vehicles on the road (vehicle-to-vehicle [V2V]), roadside infrastructure (vehicle-to-infrastructure [V2I]), and the "Cloud."

Other countries

The UK , s, 1(b) states: The Secretary of State must prepare, and keep up to date, a list of all motor vehicles that—may lawfully be used when driving themselves, in at least some circumstances or situations, on roads or other public places in Great Britain. Further, at s. 8(1)(a): a vehicle is "driving itself" if it is operating in a mode in which it is not being controlled, and does not need to be monitored, by an individual.

Autonomous 'Autonomous vehicles' are those in which operation of the vehicles vehicle occurs without direct driver input to control the steering, acceleration, and braking and are designed so that the driver is not expected to monitor constantly the roadway while operating in self-driving mode.

Connected 'Connected vehicles' are vehicles that use any of a number vehicles of different communication technologies to communicate with the driver, other vehicles on the road (vehicle-to-vehicle [V2V]), roadside infrastructure (vehicle-to-infrastructure [V2I]), and the "Cloud."

U.S. National Highway Traffic Safety Administration (NHTSA) defines CAVs as 'Vehicles for which "at least some aspects of a safety-critical control function (e.g., steering, acceleration, or braking) occur without direct driver input."' NHTSA, Automated Vehicles for Safety.

Transport Canada (the Canadian federal ministry) defines an autonomous vehicle as one that 'Uses a combination of sensors, controllers and onboard computers, along with sophisticated software, allowing the vehicle to control at least

[25] Javier Gonzálvez, "Welcome New Column Editor", in Uhlemann, E., 2015. "Introducing connected vehicles [connected vehicles]". *IEEE Vehicular Technology Magazine*, *10*(1), pp.23-31.

[26] Uhlemann, E., 2015. "Introducing connected vehicles [connected vehicles]". *IEEE Vehicular Technology Magazine*, *10*(1), pp.23-31.

some driving functions, instead of a human driver (for example, steering, braking and acceleration, and checking and monitoring the driving environment).' Transport Canada, Automated Connected Vehicles 101, July 18, 2019.

Connected vehicles are defined as ones that 'Use different types of wireless communications technologies to communicate with their surroundings.' This will eventually include vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-everything (V2X) platforms which will allow the vehicle to obtain information such as traffic and weather conditions, nearby construction, and accidents. Verizon Connects, Connected Vehicle Technology, Feb 2, 2020.

Appendix 4: Definition Digital Infrastructure

Internet access for all is today well within reach, but efforts are required to make it truly accessible for all across its applications – for instance Public Transport.

Examples of digital infrastructure include:

- Internet backbone, broadband
- Mobile telecom and digital communication suites, including apps
- Data centres and networks
- Enterprise portals, platforms, systems, and software
- Cloud services and software
- Operational security, user identity and data encryption
- APIs and integrations

Reports on inclusive technologies and disabilities underline the relevance of information infrastructure:

> *Information infrastructure is the backbone of smart city architecture and effectiveness, with the aim not only of solving complex urban problems, but also of preventing them, through integrated IT systems, wireless infrastructure, service-oriented systems, real-time awareness, believed to be trustworthy (i.e., confidence-building and caring) empowering consumers and service providers.*[27]

John Spacey posted an even broader definition in October 2017 on *Simplicable*, offering thirteen different examples of "digital infrastructure" (Internet backbone, fixed broadband, mobile telecommunications…):[28]

> *Digital infrastructure are foundational services that are necessary to the information technology capabilities of a nation, region, city, or organisation. By extension, digital infrastructure is necessary to the economy and quality of life of a modern nation.*

The International Telecommunication Union (ITU) has published several reports on the topic. In Digital Infrastructure Policy and Regulation in the Asia-Pacific Region, Digital infrastructure[29] is defined as:

> *Digital infrastructure is the key to enabling the benefits of the digital economy and society. Digital infrastructure is the physical hardware and associated software that enables end-to-end information and communications system to operate.*
>
> *Digital infrastructure includes:*
>
> *Internet backbone including national and trans-oceanic fibre cables;*
>
> *Fixed broadband infrastructure such as analogue coaxial and optic fibre cable networks;*
>
> *Mobile communications infrastructure and networks including FWA, transmission towers, radio and optic fibre backhaul networks;*
>
> *Broadband communications satellites;*
>
> *Data and cloud computing facilities;*

End user equipment such as mobile handsets, PCs, modems and local Wi-Fi and Bluetooth networks;

Software platforms including computer and mobile device operating systems as well as application programming interfaces; and

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[27] Bricout, J., Baker, P., Moon, N., & Sharma, B. (2021). Exploring the Smart Future of Participation. International Journal Of E-Planning Research, 10(2), 94-108. https://doi.org/10.4018/ijepr.20210401.oa8

[28] Spacey, J. (2017). 13 Examples of Digital Infrastructure. Simplicable. Retrieved 1 August 2021, from https://simplicable.com/new/digital-infrastructure.

[29] Scott W Minehane (2019). Digital Infrastructure Policy and Regulation in the Asia-Pacific Region, retrieved 1 August 2021 from https://www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/SiteAssets/Pages/Events/2019/RRITP2019/ASP/ITU_2019_Digital_Infrastructure_28Aug2019FNL.pdf

Network edge devices such as sensors, robots, autonomous and semiautonomous vehicles, and other Internet of things facilitating devices and software.

A ubiquitous infrastructure by itself isn't sufficient guarantee that everyone can access it, hence the ITU also starts to propose a regulatory overview to understand what it takes to regulate such an infrastructure.

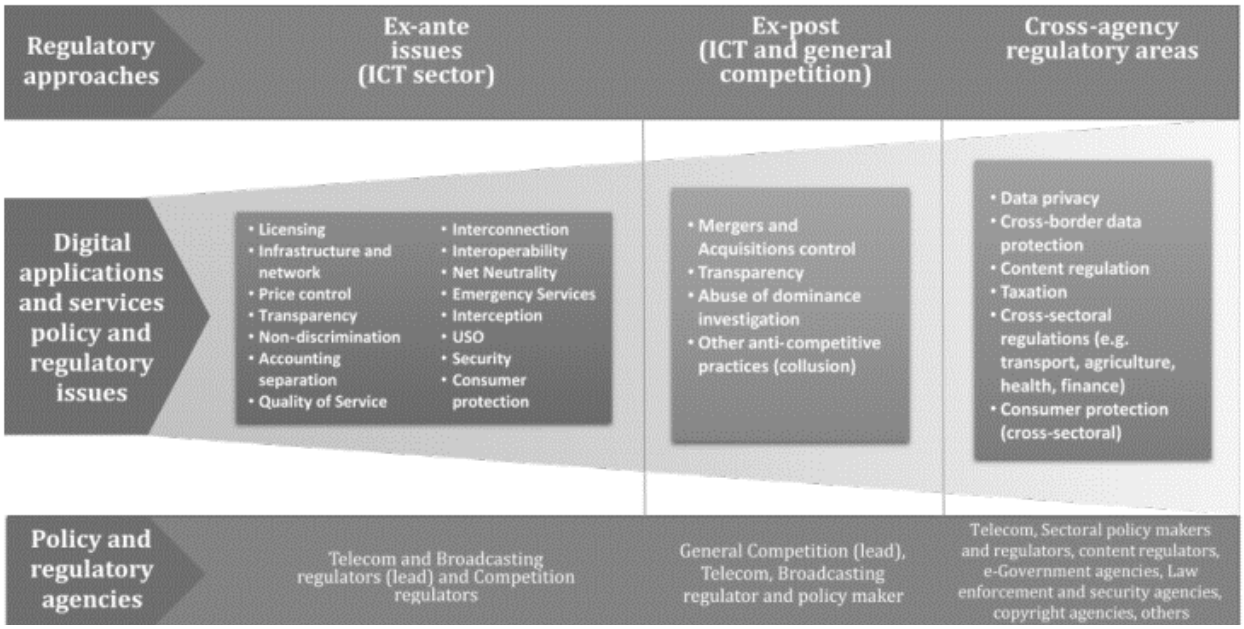

Figure 13. Regulatory and legislative responses to digital applications and services (Source: ITU, 2018).

Australia's NTC provides an overview of the various types of data that may need to be considered for regulation, of which data from Biometric, biological or health sensors are of particular interest in this context. In the context of this report about CAV and PWD, this is interest as data enable customized services.

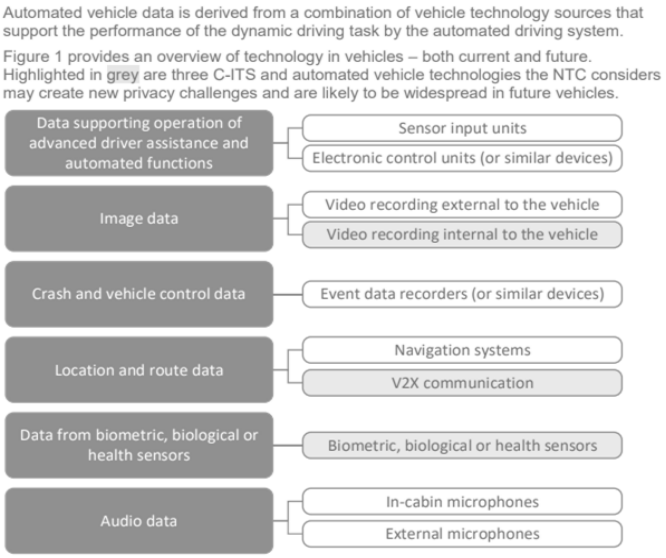

Figure 14. Overview of data technology in vehicles. (Source: NTC, 2018)

Digital infrastructure also has a political dimension, a "policy perspective". For instance, the recent EU Report on this subject directly links the concept with the notion of *legal sovereignty* as "the topic of European digital sovereignty has gradually emerged as a result of the increasing dominance of non-European actors in the so-called platform economy"

and “digital infrastructure control and data regulation are complementary and can be combined in various ways”.[30] Hence:

The topic is complex. It spans from personal data governance to networks: mobile and fixed communication (spectrum, coverage, roll-out of 5G), Internet (net neutrality, domain name systems), data storage and management systems, cloud computing and data centres, applications, artificial intelligence (AI), Internet of Things (IoT), cybersecurity, and platforms. We need to delimit the scope and will focus on personal data governance (protection, sovereignty, security) and broadly defined digital infrastructures (selectively on 5G, IoT, Clouds, AI, and platforms, with cybersecurity considered horizontally).

After quoting several definitions of ***digital infrastructure*** used by economists[31], the report choses the comprehensive term, in plural, ***digital infrastructures*** to refer to “fixed and mobile networks, IoT, applications and platforms, artificial intelligence”[32] The Report considers them as “the key driver of competitiveness, since it is the central and connecting infrastructure that enables gains in most other areas” through a variety of mechanisms:

> expanding capacity by increasing the efficiency of other existing structures and leading to the emergence of new ones,
>
> saving time and simplifying operations, leading to more informed decisions,
>
> saving costs by decreasing waste and increasing efficiency allowing for more flexibility in the provision of goods and services, improving reliability and reducing uncertainty.

Digital infrastructures are then situated at the centre of other infrastructures. They enable their interconnectivity, and the interrelation and operation of its different stakeholders. Borrowing it from a recent cluster of the World Economic Forum, the Report distinguishes among them:

Makers (technology innovators, developers and solution providers, communication services, hardware, and software manufacturers),

Shapers (governments and other public sector actors, industry associations, standardisation bodies, multiple stakeholder associations such as the World Wide Web Consortium (W3C), the Internet Corporation for Assigned Names and Numbers (ICANN) and the International Telecommunication Union (ITU),

Users (including a wide range of players: from private individuals, ICT using firms, as well as governmental agencies).

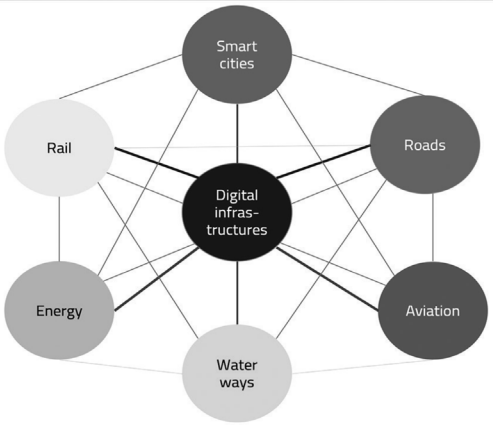

Figure15. Digitization as key connecting infrastructures. (Source: EIT Digital, 2020)

[30] European Digital Infrastructure and Data Sovereignty. (2020). Retrieved 1 August 2021, from https://www.eitdigital.eu/fileadmin/files/2020/publications/data-sovereignty/full-report/EIT-Digital-Data-Sovereignty-Full-Report.pdf.
[31] For instance, ‘digital infrastructure’ is defined as “longer-lived capital-intensive systems and facilities” (Stupak 2015), or by two dimensions, ‘capitalness’ and ‘publicness’, referring to the social significance of the infrastructure and not necessarily to ownership (Fourie 2006).
[32] Ibid. p. 9

We recommend including digital infrastructure as its own regulatory area in future Transport Standards as accessibility to public transport will become more and more dependent on the digital infrastructure. We recommend adopting the NSW Government's definition of digital infrastructure which focuses on the outcomes of digital infrastructure rather than by specific technologies or design aspects:

Digital infrastructure includes, without limitation, the technology, equipment, *and systems used or enabled by operators that provide linkages,* networks, *and pathways to connect people and communities with data, metadata,* products, *and services.*[33]

To regulate and formulate standards in this area is a complex and multi-disciplinary task. Many initiatives have started and with this report we advocate to include the significance of this Digital Infrastructure for the accessibility of PWD (Figure 5).

[33] Public Digital Infrastructure | Digital.NSW. (2020). Retrieved 22 August 2021, from https://www.digital.nsw.gov.au/transformation/public-digital-infrastructure

Appendix 5: Stakeholder engagement overview

Phase 1: Issue identification

Engagement PWD	Phase 1: Two focus groups with people with disability - 23 participants in total with a mix of physical, sensory, and intellectual disabilities, which took place online between the 11th and 18th of February, organised by AFDO, captioned, and translated in Auslan and was conducted by Erik van Vulpen. A workshop with Peak Body Representatives of people with a mix of physical, sensory, and intellectual disabilities which took place online on the 22nd February, organised by Serena Ovens of PDCNSW, translated in Auslan and was conducted by Erik van Vulpen. Feedback and co-ordination support by ATSA, David Sinclair. Phase 2: Two focus groups with people with disability - 23 participants in total with a mix of physical, sensory, and intellectual disabilities, which took place online between the 1st and 3rd of June, organised by AFDO, captioned, and translated in Auslan and was conducted by Erik van Vulpen. One workshop with Peak Body Representatives of people with a mix of physical, sensory, and intellectual disabilities which took place online on the 31st of May, organised by Serena Ovens of PDCNSW, translated in Auslan and was conducted by Erik van Vulpen.
Industry engagement	Interviews and correspondence with manufacturers and operators of Connected Automated Vehicles and several EVTOL representatives: 4 major CAV manufacturers: • 2getthere • HMI • EasyMile • Navya Operators • SMRT (Singapore) • Keolis Downer • Yarratrams Air Taxi: Industry • EASA - European Union Aviation Safety Agency • VTOL.org (USA) • The Vertical Flight Society (USA) • EVTOL Insights (UK) • Advanced VTOL Technologies (Melbourne) Feedback on the regulatory proposals from: • Dean Zabrieszach, CEO ITS Australia and HMI • Paul Rajan - Territory perspectives • Greg Giraud – GM Easy Mile – Asia Pacific

Appendix 6: Useful resources

https://www.ntc.gov.au/transport-reform/automated-vehicle-program

https://austroads.com.au/drivers-and-vehicles/future-vehicles-and-technology/trials.

https://www.transport.nsw.gov.au/projects/programs/point-to-point-transport

https://imoveaustralia.com/maas-australia/.

https://imoveaustralia.com/project/maas-on-demand-transport-consumer-research-report/.

https://www.transport.wa.gov.au/On-demandTransport/on-demand-transport.asp.

https://www.ptv.vic.gov.au/more/travelling-on-the-network/accessibility/.

https://www.infrastructure.gov.au/transport/disabilities/review/files/Review_of_Disability_Standards_for_Accessible_Public_Transport.pdf

https://www.infrastructure.gov.au/transport/disabilities/whole-journey/files/whole_of_journey_guide.pdf

https://www.uber.com/us/en/transit/horizons-paper/

https://www.infrastructure.gov.au/transport/disabilities/review/files/The-Third-Review-Disability-Standards-for-Accessible-Public-Transport.pdf

https://www.transportation.gov/inclusive-design-challenge/resources

https://mumbrella.com.au/travel-without-limits-australias-first-disability-specific-travel-magazine-launches-571830

https://autoalliance.org/wp-content/uploads/2019/10/AVs-Accessibility-Workshop-Series-Report-16OCT2019.pdf

https://www.access-board.gov/av/

https://pavecampaign.org/avs-for-all-inspiring-solutions-for-accessible-design-additional-resources/

https://www.inclusivemobility.com/

https://austroads.com.au/publications/connected-and-automated-vehicles/web-r623-20

https://nationalcenterformobilitymanagement.org

https://www.transportation.gov/accessibility/inclusivedesign

https://www.rca.ac.uk/research-innovation/projects/inclusive-design-shared-autonomous-vehicles/

Appendix 7: Glossary

Connected and Automated Vehicle (CAV)	Any vehicle where the driving task is not performed by a human driver for some or all of the time.
Vertical Take-off and Landing (VTOL)	This acronym refers to Vertical Take-off and Landing aircrafts, which are electric aircrafts that can take off and land vertically. The term has not fully settled yet, as in some cases eVTOL and AVTOL is used referring to either electronic, advanced, or automated. Advanced Aerial Mobility is also used to refer to the same.
Digital infrastructure	Includes, without limitation, the technology, equipment, and systems used or enabled by operators that provide linkages, networks, and pathways to connect people and communities with data, metadata, products, and services.
Driverless	A subset of CAVs where the driving task (including navigational, situational, or fallback tasks) is not performed by a human driver at any time and there is no requirement for a human driver to be located in the vehicle. A driverless vehicle may still have humans located in the vehicle and performing steward, safety, or customer service roles.
Mobility as a Service (MaaS)	An emerging customer-centric view of transport that seeks to utilise technology and digital infrastructure, such as data sharing platforms, to offer customers tailored, cross-modal mobility options that are flexible and price sensitive. TfNSW Technology Roadmap defines Mobility as a Service (Maas) as “a framework for offering a full range of multimodal mobility services that enables customers to plan, book, pay and provide feedback for a full range of mobility services using integrated digital channels, enabling flexible, seamless and personalised services.”
On-Demand	A non-scheduled, bookable service that provides a passenger with flexibility around the route they take and the time they travel and could be provided by a taxi, charter vehicle or regular passenger transport vehicle. On-Demand could be understood as a type of point-to-point service.
Point-to-Point	A choice of transport that provides flexible, convenient options for customers who can choose a preferred route and a time and fare that suits them. The term is not specific to any single vehicle-type and captures a diverse mix of modes and services, including taxis.
Ridesharing	A service that is an arrangement in which a passenger travels in a private vehicle driven by its owner, for free or for a fee, especially as arranged by means of a website or app. Ridesharing could be understood as a type of point-to-point service.
Touchpoint	Points of physical interaction in the transport journey actioned by the customer. For example, pulling a cord to stop a vehicle, or pressing a button to communicate with the operator of a service.
Whole Journey	Not a specific transport service but a way of thinking about transport from a customer’s perspective: encouraging policy makers, planners, designers, builders, certifiers, and operators to think beyond compliance and the physical and governance boundaries of services and infrastructure to focus on people's accessibility needs across their whole journey.

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We thank for their collaboration: 2getthere, ADVI, EasyMile, Navya, Keolis Downer, YarraTrams, eVTOL.org, SMRT (Singapore), EASA - European Union Aviation Safety Agency, VTOL.org (USA), The Vertical Flight Society (USA), EVTOL Insights (UK), Advanced VTOL Technologies (Melbourne)