SHAPING OUR
TRANSPORT
FUTURE

Are we ready for mobility solutions of tomorrow, today – how should we improve access to social & economic opportunities?

AUTHOR: Dickson Leow & Dr Ronny Kutadinata

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ARRB – YOUR NATIONAL TRANSPORT RESEARCH ORGANISATION

ABN 68 004 620 651

With offices in Brisbane, Sydney, Adelaide, Perth.

National Transport Research Centre and Head Office: 80a Turner St, Port Melbourne, 3207 VIC, Australia

arrb.com.au

KEY DRIVERS OF CHANGE

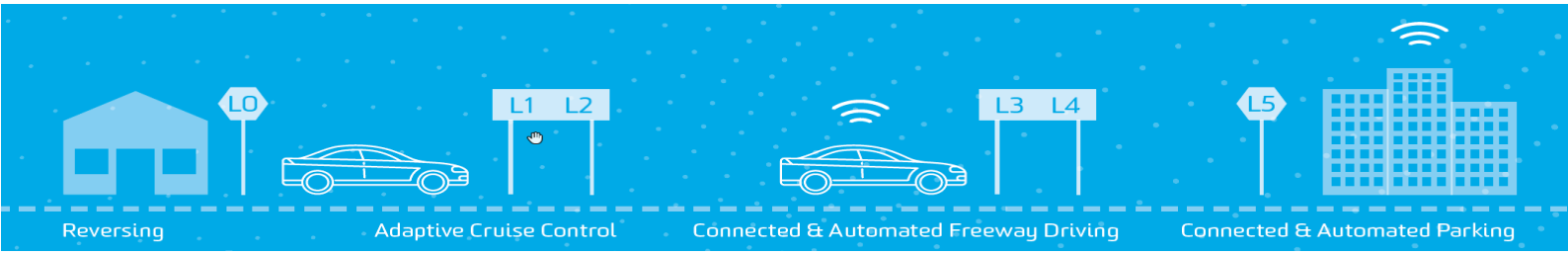
Manhattan depicts an interesting picture on the development of road operation in the past decade. The horses and carriages were still the main choice of transport in 1900, before automobile almost completely took over in just 18 years. Since then, automobile has been the most dominant mode of road transport.

Figure 1: A look on the road in Manhattan throughout the past decade

Beijing interestingly underwent a similar change to Manhattan (or the western world), yet the change occurred more rapidly within the past 40 years.

Figure 2: A similar transformation of roads in Beijing

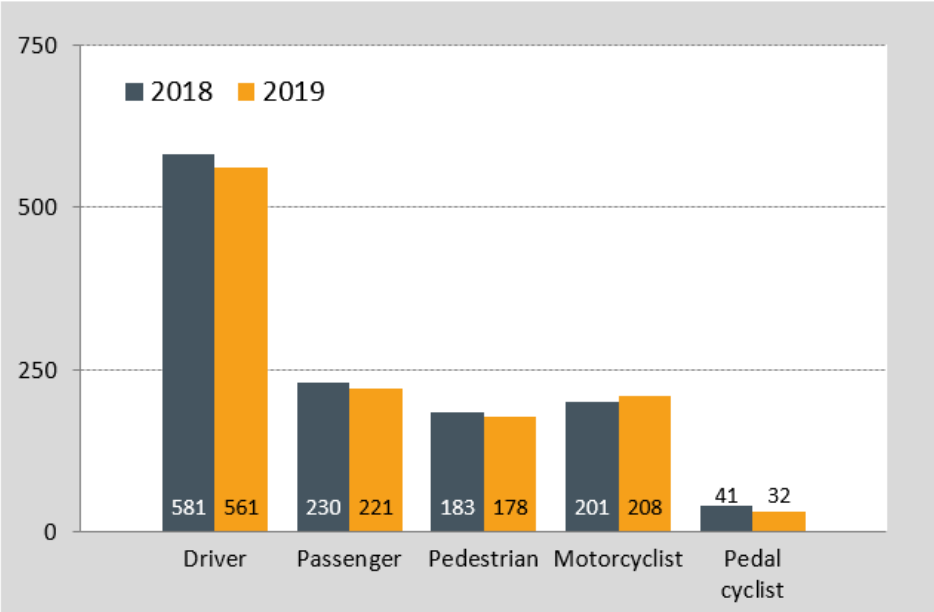
However, a striking observation is that road operations are essentially identical despite the introduction of automobile. Extrapolating the development of CAVs in the recent years, it is likely that a drastic change on how the roads would look is imminent. With some OEMs already predicting deployment in 2030 or earlier, it is imperative that Australia need to take a radical step in transport to accelerate the realisation the benefits that CAV has to offer.



Safety issue is still paramount

Improved safety has always been the top priority for various transport stakeholders. According to BITRE[1], the number of road fatalities in 2018 is (provisionally) 1,140 and, by May 2019, the road deaths has tallied up to 546, 13.3% higher than the same period in 2018. However, the total road toll this year has slightly reduced in total when comparing 12-month period to May (see Figure 3), down from 1,236 to 1,200. It is, nevertheless, 1,200 road deaths too many.

Figure 3: Road deaths by road user group – 12 months to May



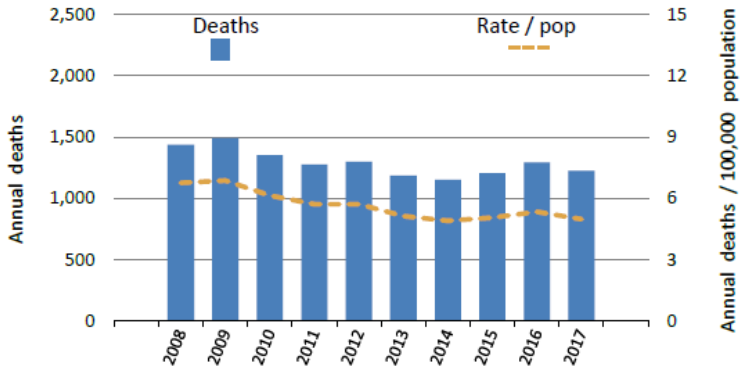
Source: https://www.bitre.gov.au/statistics/safety/

Aligning with Sweden's Vision Zero, Australia created the Towards Zero campaign to increase the safety of our transport sector with the eventual goal to eliminate road fatalities (and injuries) entirely. In this regard, Australia has been making progress (see Figure 4) as evidenced by the decrease of both annual fatalities and rate. Over the ten-year period shown in Figure 4, the reduction in fatalities was 14.7%. However, although the trend shows that we are heading towards the right direction, many of the benefits of better roads and vehicles are being offset by the growth in population[2].

Therefore, there is still a need to develop initiatives to improve road safety, albeit on infrastructure, operation, or vehicle safety.

[1] https://www.bitre.gov.au/statistics/safety/
[2] https://www.bitre.gov.au/publications/ongoing/road_deaths_australia_annual_summaries.aspx

Figure 4: Annual fatalities and rate per 100,000 population 2008–2017

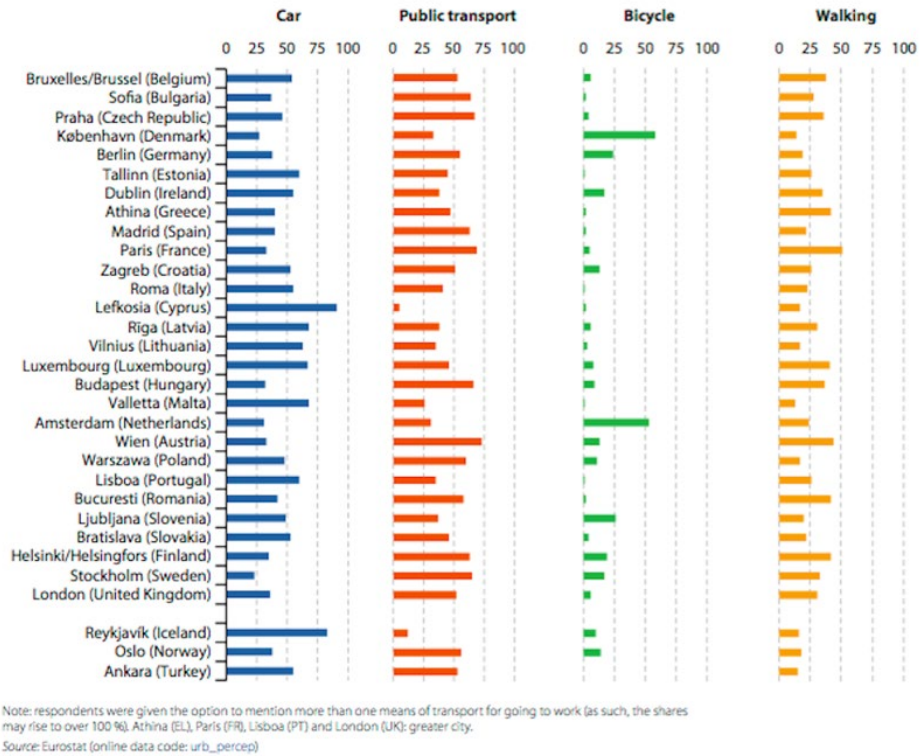


Source: https://www.bitre.gov.au/publications/ongoing/road_deaths_australia_annual_summaries.aspx

Public transport has much room for improvements

Public transport has been the key mode of transport in many urbanised cities, particularly in capital cities in Europe[3] (see Figure 5). However, the same cannot be said for Australian capital cities. In Australia, car use takes up 80% of urban passenger kilometres travelled and only 10% is done by mass transit. The remaining 10% is attributed to travel by commercial vehicles and motorcycles[4].

Figure 5: Distribution of the principal means of going to work, EU captial cities, 2015 (%)

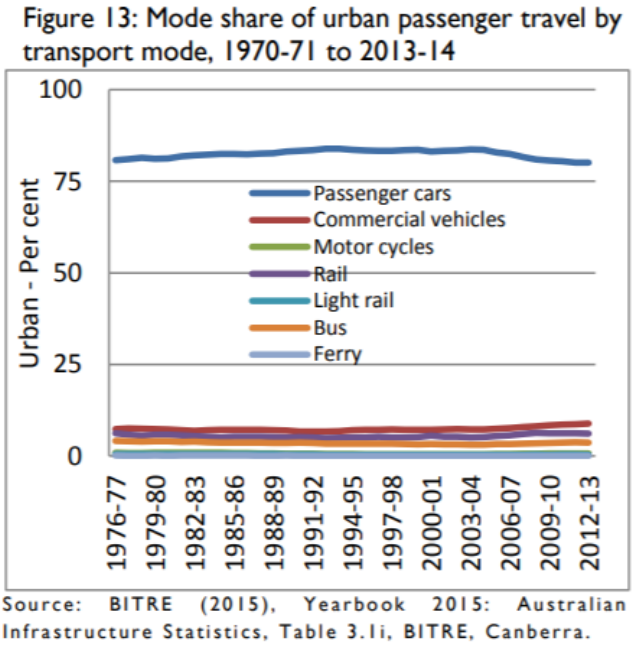


Source: https://www.citylab.com/transportation/2017/10/riding-bikes-buses-trains-in-european-cities/543141/

[3] https://www.citylab.com/transportation/2017/10/riding-bikes-buses-trains-in-european-cities/543141/

[4] BITRE (2015), Yearbook 2015: Australian Infrastructure Statistics, BITRE, Canberra

Figure 6: Mode share of urban passenger travel by transport mode, 1970-1971 to 2013-2014



Source: BITRE (2015)

The main factor attributing to such a travel behaviour is the lack of access to the public transport network, as mode transfers typically diminishes the seamlessness of people's journeys[5]. Levinson & Wu (2019)[6] analysed the accessibility of various modes at Australian capital cities using a 30-minute threshold. They identified that cars give the populations more access to jobs within 30 minutes, while transit comes in third place after cycling.

Figure 7: Population-weighted 30-minute accessibility to jobs; cities ranked by the size of employment opportunities

Rank	City	Automobile	Transit	Walking	Cycling
1	Sydney	342,597	76,617	20,470	143,253
2	Melbourne	380,754	61,932	15,192	135,879
3	Brisbane	293,131	42,196	9,267	81,576
4	Perth	433,116	36,638	7,735	69,796
5	Adelaide	234,902	33,095	6,729	85,267
6	Canberra	171,210	24,000	5,837	45,782
7	Hobart	62,479	10,943	4,142	21,917
8	Darwin	59,853	9,521	3,486	19,403

Source: Levinson & Wu (2019)[6]

Additionally, some experts have had their say on why public transport in Australia is lacking, including: lack of investments (De Guyter, 2019[7]), lack of multi-modal seamlessness

[5] BITRE (2016), A dozen facts about transport in Australia, Information sheet 75, BITRE, Canberra.
[6] https://theconversation.com/access-across-australia-mapping-30-minute-cities-how-do-our-capitals-compare-117498
[7] https://theconversation.com/crowded-trains-planning-focus-on-cars-misses-new-apartment-impacts-116514

(Levinson & Lahoorpoor, 2019[8]), nonoptimal investment strategy (Pittman et al., 2019[9]), and lack of personal security (Whitzman et al., 2019[10]).

The role of public transport in influencing the lifestyles of citizens is undeniable. A better public transport will allow the reduction of environmental impact of car use (Kingston & Aceampong, 2019[11]) and traffic congestion (Feeney, 2019[12]), which in turn will increase the quality of life (Farahani et al., 2019[13]) and create a more sustainable, liveable, and healthy city (Nieuwenhuijsen, 2019[14]).

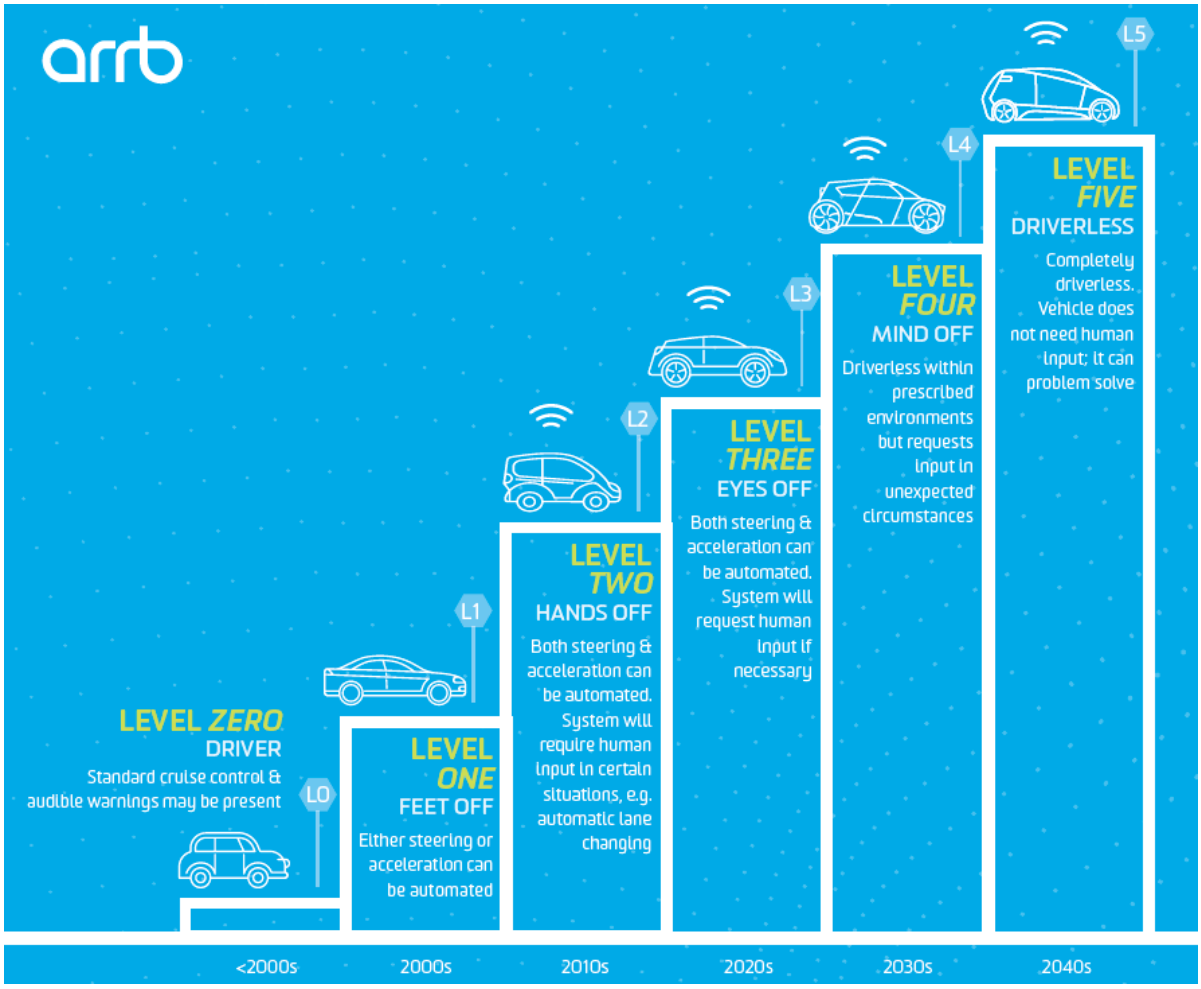
Given the importance of public transport, it is obvious that something needs to be done to improve the public transport in Australian cities, and eventually provide better mobility to all.

ADVANCEMENT OF TECHNOLOGIES PAVES THE WAY TO THE FUTURE

It is said connected automated vehicles are already here and will continue to improve with its automation and connectivity within the next 20 years towards full automation. The following pictogram illustrates the levels of automation and likely timing for adoption.

[8] https://theconversation.com/how-to-increase-train-use-by-up-to-35-with-one-simple-trick-115222
[9] https://theconversation.com/500m-for-station-car-parks-other-transport-solutions-could-do-much-more-for-the-money-114908
[10] https://theconversation.com/students-dont-feel-safe-on-public-transport-but-many-have-no-choice-but-to-use-it-112225
[11] https://theconversation.com/climate-change-we-can-reclaim-cities-from-the-car-without-inconveniencing-people-110917
[12] https://theconversation.com/rethinking-traffic-congestion-to-make-our-cities-more-like-the-places-we-want-them-to-be-111614
[13] https://theconversation.com/living-liveable-this-is-what-residents-have-to-say-about-life-on-the-urban-fringe-111339
[14] https://theconversation.com/seven-steps-melbourne-can-take-to-regain-its-liveable-city-crown-113726

Figure 8: Estimate on timing for adoption of various SAE level of automation



Fundamental change of mindsets

To improve access to social & economic opportunities for mobility, trust on the technology is critical. For example, if an automated shuttle following closely behind another vehicle which had to stop suddenly because of a pedestrian running across the road in front of the vehicle, the shuttle must be able to, at the very least, avoid incidents that are avoidable by human drivers. All automated vehicle (shuttles, cars, SUVs etc) must anticipate the possibility of accidents due to its cognitive intuition and started tracking and manoeuvre the automated vehicle to avoid such incidents.

However, the algorithm needs to decide the safest approach necessary and to make ethical decision. The public in general are still wary and sceptical of the technology. A recent survey coordinated by ADVI (2017) suggests only 25% of the respondents would use a fully automated vehicle.

On a similar note, a recent audit of the landscape in Australia with technology transport trials suggest two key learnings. Firstly, the public are generally not aware of the different technologies available nor the productivity or efficiencies gain. Secondly, they are sceptical of the security, reliability and trustworthiness of the technology.

It is predicted that the realisation of the car-sharing model in Australia will be challenged by the public. Many Australians love their cars and this type of people is unlikely to allow strangers to hop into their cars, let alone allow them to ride the cars unattended (unless the paradigm shifts the concepts of private ownership to fleet based public vehicle). Thus, there are still some efforts required to shape the mindset of the public to accommodate a fully shared transport model.

Promise of a better transport future

CAV has been heralded as a means to drastically reduce on-road crashes. By removing the human element from driving, it was initially predicted that CAV will eliminate all human-error related crashes, which (LawInfo,2017)). Despite being unreasonably optimistic (see for instance the discussion by CAV Safety Hub), that rough estimate provides the notion that CAV will improve road safety and, ultimately, reduce the number of fatalities and injuries on the road.

A recent report by NTC (2019) had reported that AV will provide an estimated reduction of 65-68% of fatalities, translating to a saving of up to AU$3.7 billion. Additionally, various research works had shed some lights on the potential safety benefits of AV, although typically these investigations were feature-specific (such as Active Emergency Braking, Forward Collision Warning, and Adaptive Cruise Control, among many others).

However, in recent years, many experts have started to form a view that realising the safety benefits of AV may prove to be a challenge, mainly due to the complexity of the operating environment in the current situation: road users disobedience, different driving behaviours of human drivers, and the sheer number of driving situations that will be encountered by the AV. The benefits of active safety feature, such as Lane Keep Assist and Adaptive Cruise Control, are very pronounced due to that fact that the drivers are still “in the loop”. When the drivers are disengaged from the driving task, their reaction time to take back control in case of fallback request from the vehicle extends significantly (Li et al, 2019). Thus, operation of AV at SAE Level 2 and/or 3, which still relies on the drivers as fallback, is expected to be counterproductive to safety when considering current road situation.

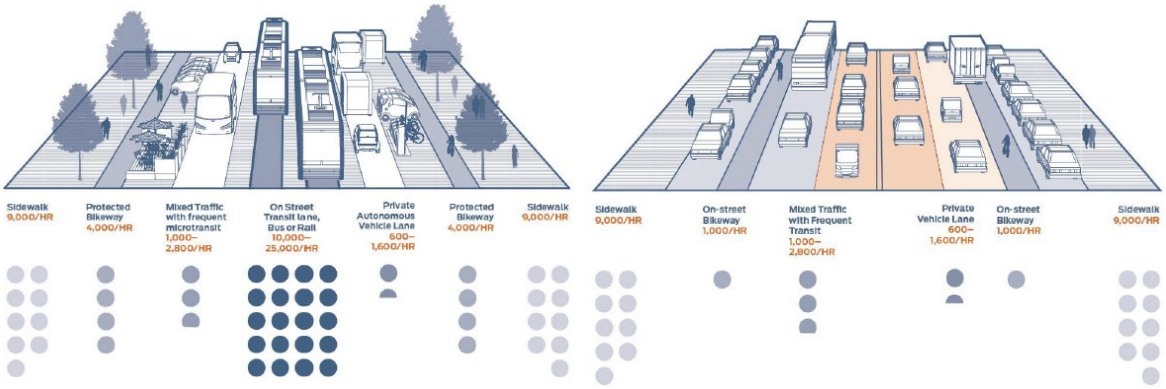
Therefore, the above discussion highlights the second important aspect of potential benefits of AV: a new operational paradigm.

CAV enables the potential to more efficiently operate the roads. Firstly, close-gap platooning will be able to increase the road capacity (van Arem, van Driel & Visser, 2006), in addition to already-proven fuel saving benefit (Tsugawa, 2013; Lammert et al., 2014; Humphreys, Batterson & Bevly, 2016; Bishop et al., 2017; Turri, Besselink & Johansson, 2017). Secondly, a complex intersection management strategy can be deployed in a 100% driverless traffic environment, reducing travel delay of up to 40% (Fajardo et al., 2011; Mladenovic & Abbas, 2013). Finally, a more uniformly spread traffic / route assignment (both spatially and temporally), which may help reduce network-wide congestion (LeBlanc, Morlok & Pierskalla, 1975; Daganzo & Sheffi, 1977; Papageorgiou, 1990; Peeta & Mahmassani, 1995; Cagara, Bazzan & Scheuermann, 2014; Bagloee & Sarvi, 2015; Patriksson, 2015), can be more easily implemented with the help of fully automated vehicles.

The concept of ride-sharing or Mobility as a Service maybe expanded to incorporate driverless vehicles, thus, the vehicle is better utilised compared to the current operational model, where a typical private vehicle may be unused 96.5% of the time (Bates & Leibling, 2012). Proposed by Czioska et al. (2019), a novel fully-shared CAV operation model may reduce the number of vehicle up to 90% in a city centre environment.

There are already several discussions on how to redesign street layout that efficiently utilises automated vehicle to increase road capacity. For one, Lyft in collaboration with Perkins & Will and Nelson & Nygaard proposes a new concept of 10-lane Wilshire Boulevard in LA that is estimated to more than double the capacity (Figure 3). Similarly, NACTO (2017) proposes a higher capacity road operation concept that relies on mass transit coupled with CAV operations for a more controlled environment to provide safety for pedestrians traffic.

Figure 9: A street redesign concept that emphasises on mass transit coupled with CAV for a more controlled environment (NACTO 2017)



This drastic change in road operation is theoretically achievable right now without requiring much infrastructure investment. Having said that, it is unreasonable to think that this can practically be achieved within a short timeframe. Such a radical change requires a careful planning and a holistic approach. In fact, it can be argued that Australia lacks a national roadmap that outlines a holistic strategy in facing the advent of CAV. Additionally, each state and territory is often working and running trials independently without a substantial effort to collaborate.

Therefore, Australia needs a paradigm shift into a more national and holistic mindset to be able to improve Australia readiness for CAV deployments and mobility alternatives.

PARADIGM CHANGES ARE NECESSARY

Thinking about safety and the issues faced by people, whether they drive, ride or walk to their place of destination. Whether we, the public, like it or not, we are in transition of the technology to fully automated driving. It might be some years away, decades even, but the disruption will change how we interface with each other on the road, be it; vehicle to infrastructure (V2I), vehicle to venerable road users (VRU) and/or vehicle to vehicle (V2V).

In order to manage these disruptions, we have identified the following two key aspects in preventing another “surprised disruptor” and ensuring that the advancement of technologies serve the goods of the public.

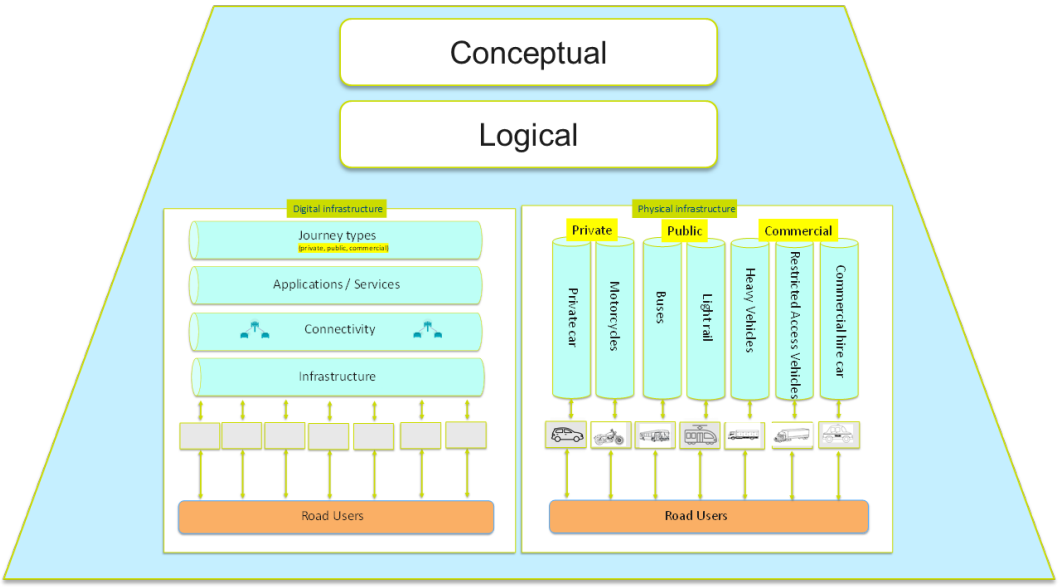
User centric and mobility focused

The aim of transport services is to move people from one activity location to another. The more “traditional” approach is to tackle specific cases of improvements, such as improved traffic corridor management, better intersection control, on-road public transport prioritisation strategy and scheduling optimisation. However, this creates some gaps in a sense that these transport services, although performs well, sometimes do not seem to “gel” with each other and thus introduces inconveniences to the users.

The future transport landscape would also need to emphasis on serving the needs of the user. The key learning from the recent popularity of various shared economy business models (such as Uber) is that, despite the disruption they bring, these new models better serve the needs of the users, in terms of better access to opportunities and typically at more affordable costs. In transport, this means an improvement on the accessibility to the vast array of opportunities, such as jobs, events, education, among many others[6].

Considering the above points, in recent years, the focus of the transport community has been placed in the integration, i.e. to create a seamless, and quite possibly, multi-modal mobility service. For instance, the increasing trend in MaaS demonstrated the importance of this seamlessness in servicing people’s journeys. The concept of mobility breaks the boundaries of the traditional transport business, which was often siloed (as illustrated in the “Physical Infrastructure” diagram in Figure 10 below). The rapid development in the IT field has disrupted this siloed approach and provided a more “horizontal” perspective (as illustrated in “Digital Infrastructure”). In order to provide the integration, there is a need for an overarching “Logical” and “Conceptual” architecture to ensure a holistic approach.

Figure 10: Hierarchy of future mobility management



Source: ARRB analysis (2019)

In order to achieve this integration, better planning and coordination will be required. It was stated that “a carefully planned and managed system can reduce the total number of private vehicles drastically, as well as reducing the distance they travel by 22%, and CO2 emissions by 27%” (Future of Transport, 2018). The planning in particular needs to consider the advancement of technology as discussed above – How do we integrate AV to fully realise its potential benefits? How do we future proof the transport systems from technology and digital disruptions?

A roadmap for a holistic approach

A plan inherently requires the identification of goals; an end point which we want to achieve. Many had not shy away from proposing such end-goals for the future transport, with various idealistic visions and/or hypothetical scenarios of the future being conceptualised. However, what usually missing is the roadmap describing how we could achieve these end goals.

For the roadmap to be useful, it needs to address several issues. Firstly, the roadmap would identify milestones and provide a realistic plan to achieve the end goal. By having a clear plan and direction, OEMs and technology suppliers would be more attracted to invest in Australia, particularly those that have the same goal, since they will be more confident that they will get some form of support from the government. In turn, this would provide more opportunities to form a more comprehensive strategic group that involves the OEMs and technology providers, who can provide a realistic timeline to implement the roadmap.

As suggested by Pitkanen et al (2018), “the risks facing future cities’ infrastructure and energy requirements all stem from taxes. A better way is having diverse, resilient solutions that enable cities to distribute access across a ‘menu’ of mobility options. Mobility must provide citizens with holistic alternatives that support city-specific goals. Aiming for ideals such as improved citizen health, better schools and education providers, a rich cultural offering and the best opportunities for business development and liveability in general”. A holistic mobility solution of tomorrow stems from a vision which embraces the public’s requirements.

Furthermore, a clear goal and plan enables the government to better educate and inform the public to increase their confidence and acceptance of new technologies. It had been demonstrated that public education and exposure to new technologies will improve their acceptance of the technologies[15]. Therefore, a more concrete roadmap allows for a more targeted public education strategy to bring the public along the journey of our transport transformation.

CONCLUDING REMARK

Mobility of the future has already arrived. It is inevitable now that connected and automated vehicles (CAV) are fast becoming a reality. It is known that technology will certainly play a critical role in future smart cities, but it should not be the focus. The smart cities of the future

[15] ARRB, KD, LTU, HIM, RACV, VicRoads 2018, *Future-driven Autonobus pilot project at La Trobe University*, KD, Australia, url: https://www.keolisdowner.com.au/wp-content/uploads/2018/08/KDR-Autonobus-Report.pdf

are one which is integrated into the lives of all people, anticipate and ensure a safe environment. Flexibility, safety, security and cost-effective mobility are paramount for citizens of any cities. As the population of cities around the world increases, the smart cities of the future will ensure a robust approach to mobility.

The way we use our vehicles in the future will be significantly different. The concept of smart mobility is already within our grasp. The next step is to have a holistic approach to mobility – shared responsibility by the government, suppliers and the people. Service-related investments and their establishment needs to be considered just as policies and regulatory standards (if any) for services to operate within the jurisdiction. The traditional thinking of building, operating and managing transportation needs to change. Transportation system needs to be a holistic system and not separate systems, especially Public Transport.

Australia is in the face of a big challenge to “reset” its transport paradigm. Despite its challenge, this is not an impossible task, especially since Australia already has the relevant expertise across different jurisdictions and organisations in the transport sector. Such undertaking is best facilitated by a trusted and independent national transport research organisation, such as ARRB.

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[2] LawInfo, “Human Error Causes 94 Percent of Car Accidents,” Thomson Reuters, 9 June 2017. [Online]. Available: https://blog.lawinfo.com/2017/09/06/human-error-causes-94-percent-of-car-accidents/ .

[3] Li. S, Blythe P, Guo W, Namdeo A., “Investigating the effects of age and disengagement in driving on driver’s takeover control performance in highly automated vehicles,” 2 May 2019. [Online]. Available: https://www.tandfonline.com/doi/full/10.1080/03081060.2019.1609221?af=R&.

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