GTAconsultants

AV Discussion Paper

It is now generally accepted that Automated Vehicles (AVs) and related technologies will disrupt our transport systems.

Introduction

AVs are one example of a number of emerging technologies which will impact on demography and the ways we think about infrastructure funding. Together with evolving social norms and changing personal preferences these developments are combining to change the way people live, cities operate and agencies deliver their services.

The exact detail of how these trends will play out is unclear, but two things can be asserted with some certainty: their impacts will be substantial and they will be broad ranging.

Changes in transport technology will not just affect the way we travel, but will affect the way we spend our time, how we spend our money, the way we live and, where we live. They will have knock on impacts on how urban areas operate, and the way transport infrastructure is provided and managed.

This paper looks at those potential impacts and our responses will vary at a global, regional, local and human level.

How should we think about this?

AVs and other emerging transport technologies will create significant challenges for road and transport agencies. To meet those challenges and make appropriate investments for the long-term – agencies need to understand the nature of the changes prompted by these technologies.

To generate insights into how our cities may evolve in the presence of new transport technologies we have considered the following questions:

- What transport modes will be available?
- How will people choose their mode?
- What triggers and thresholds will drive mode shift?
- What investment is called for in AVs and who will make it?
- How might funding of infrastructure and cost recovery change in the presence of AVs?
- Will innovations such as Bridj DRT - which describes itself as the worlds first pop-up transit system - be competitive with point-to-point AVs?

Given the scale and breadth of the potential impacts of these technologies, existing travel demand models are of little value. By their nature such models are underpinned by a range of assumptions that may not apply and the models may not include all the choices relevant in exploring the impacts of AVs on the transport system.

Comprehensive approach

A sufficiently broad and comprehensive evaluation and decision making framework is a crucial element of any successful effort to build a considered response in an ill-defined area like this. Just as we have seen a move from 'road system' thinking to 'transportation system' thinking, to address the impact of AVs we need to progress to an 'urban-system' mindset.

It is possible to focus on a small subset of these issues and assume those outside one's focus do not change or change in predictable ways. This is effectively what underpins conventional transport modelling – its focus is on the decisions that directly affect travel, and all other decisions with an indirect impact on travel are assumed either to remain fixed or change in ways specified outside the modelling process.

This approach ignores the workings of the broader context within which travel choices sit. It is a reasonable approach in a stable environment, but inadequate in a dynamic environment marked by disruptive change such as that likely to occur in the wake of the arrival of AVs.

In contrast, an urban-system approach is characterised by a willingness to step back, and not make any initial assumptions about what is or is not relevant to the inquiry. Planners need to consider micro behaviours and macro trends, explore subject matter and perspectives that may at first seem only remotely related, and understand the evolutionary trajectory of the system through time.

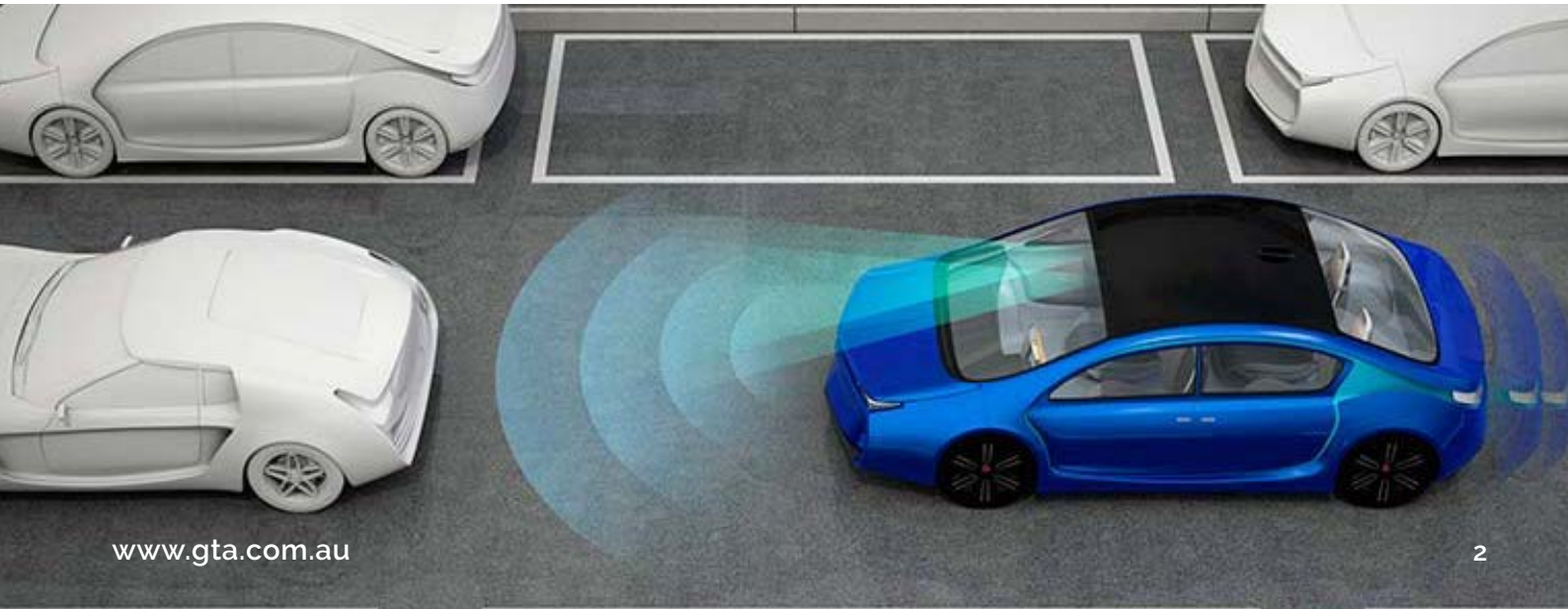
Given the far-reaching impacts of AVs on broader infrastructure, such thinking will benefit from the consideration of a broader range of urban-system custodians such as rail, planning, health, education, tourism, and other stakeholders, together with local government and various state and even federal government agencies.

Together, custodians of the system need to consider a range of implications of autonomous and connected vehicles, the emergence of a sharing economy, user pays, distributed energy networks, automation of workplace and household functions.

By taking this approach, road and transport agencies can provide leadership in facilitating an integrated and inclusive thought process.

GTA advocates a three-step process to understand and prepare for the impact of AVs on city transport systems:

1. Mapping the current system
2. Creating and exploring scenarios
3. Identifying and evaluating possible interventions



1. Mapping the current system

As a first step, is important to understand the broad nature of the complex urban-system in which transport agencies are operating and which AVs will impact. This may sound daunting but there are well-established ways of doing this.

Key elements include:

- Convening a group of participants who between them bring sufficient diversity of insight to cover all broadly relevant aspects of the system
- Facilitating in-depth conversations that deliberately seek to look beyond business-as-usual thinkingand what is already in front of us
- Creating visual representations of the system in all its complexity, taking time to iteratively improvethese representations

As an example of the outputs from this step, we have produced a concept map that identifiesa small number of the possible issues and linkages in the transport system. This step deepensshared understanding, and creates reusable outputs for future inquiries.

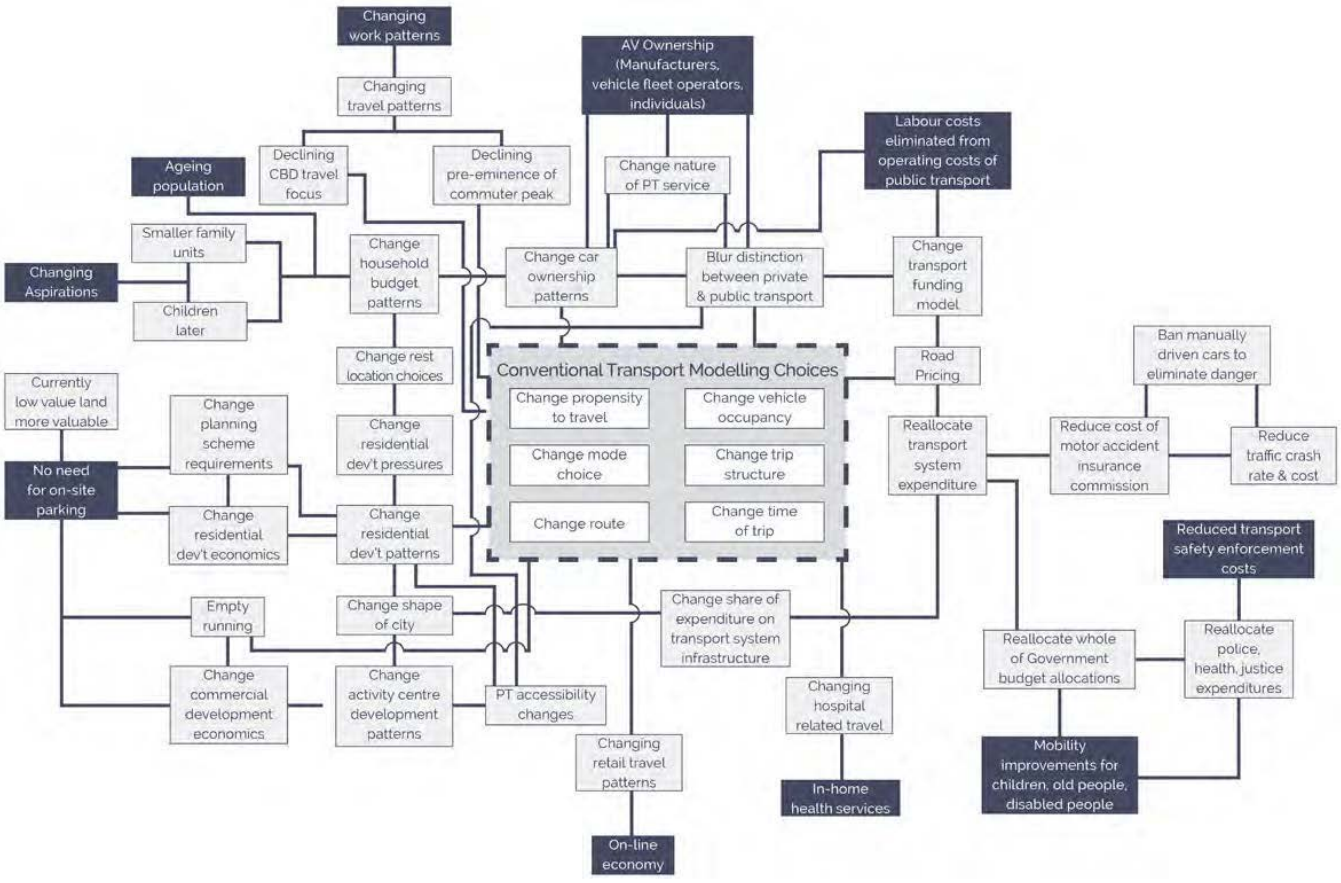


Figure 1: AV Issues and Linkages

2. Creating and exploring scenarios

Using the insights from Step 1, participants work together to create a small set of scenarios – usually four – that represent different ways in which the system might change, given the current state of the system. This provides the group with a common framework and language that allows them to agree on which of the possible futures are most likely, and to understand how they might influence the current system to arrive at that future.

Urban systems are a product of the opportunities presented to people, the choices they make, and how those choices interact. Scenario creation and exploration therefore often includes stepping into the perspective of different key players in the system, such as government agencies, industry players, or everyday citizens. In the case of transport systems, a focus on the trip-maker is likely to be critical.

The following hypothetical 'day in the life' case study provides an insight onto the type of lifestyle and travel choices that might occur.

Day-in-the-life.

It is November 19 2040. Lisa and Gary live in the Perth suburb of Floreat in a nice apartment.

Lisa works at a large legal practice based in the CBD, overseeing the output of its autonomous AI division;

Gary works as a health outreach technician for a local healthcare node, servicing a patch of the city near their home. They have two school-age kids, Bobby and Kate. Neither Lisa nor Gary has a driver's license and of course they don't have a car; - their transport needs are met by their go cards, which provide access to any type of AV they might need – cars, utes, buses – as well as Perth's segway and bike share scheme.

While Lisa's job is nominally located in the CBD, the work happens in the cloud and she can supervise its outputs anywhere. She needs to interact with the practice's partners each week, but apart from that her major interaction occurs at the start of each day as she is briefed by her opposite number in Auckland and its end when she hands off to Dubai. This of course can happen anywhere. Because of the commercial-in-confidence nature of some of the conversations, she used to make these calls at a local co-working space with virtual reality capabilities, but since she and Gary invested in a VR booth she tends to do these at home. She still spends some of each day at the local co-working space, Collaboratorium, as she has a bunch of friends there and also helps out as a counsellor.

So today, she heads off to Collaboratorium at 10am after the daily on-board from Auckland and dealing with a knotty precedent problem that the

AI could not resolve. The AV she ordered was waiting for her downstairs; it detected that her VR call was running over time, so it took itself off to pick up a co-passenger while it was waiting and gets back to her door as she emerges. She knows ahead of time that she is sharing the AV with Barry, one of the people whose company she enjoys at Collaboratorium.

She has an appointment for lunch with Gary at Elizabeth Quay at 1pm, so she has decided she will set off at 12pm and just set herself up in a different co-working space there before meeting him for lunch. This is easily accessible on a rapid transit route from Collaboratorium, so she selects the Bridj option and walks to the Bridj stop for a short wait and trip to Elizabeth Quay. Afterwards her dynamic trip planning app will arrange for an AV to meet her at the Bridj stop closest to home, so she can get there promptly for a bit more supervision and hand off to Dubai.

The nature of Gary's job means that he travels around his local area ensuring that the in-home health care provided by his employer is working and its patients have no urgent and critical needs that are not being

met in-home. He needs to set up some minor in-home surgery for one of his elderly patients before lunch and supervise her recovery. He thinks her bed is advanced enough and she has sufficient supplies on hand to allow the surgery to occur as scheduled, but has flagged the possibility with the surgical team in Brisbane that things may need to be rescheduled to tomorrow. Depending on how this goes, he hopes he won't be too late for lunch with Lisa.

The hospital routinely arranges an AV to ferry him around and wait while he attends to his clients. Given the potential time he may take with the surgery patient, he sends it off to do other things, knowing that the AV scheduling AI can work out when he will be ready for a new AV. In the event, the surgery is delayed until 3pm when new supplies will have been delivered, so he makes his lunch appointment comfortably. There is a bit of a smell in the AV that takes him to Elizabeth Quay so he flags this with the app and the AV takes itself off to be washed inside and out.

After lunch he heads back to his surgery patient's apartment in a different AV. The new surgical supplies have been delivered by the autonomous hospital supplies delivery and he grabs them from the delivery bin on the way in. Things proceed according to plan; in fact, the post-op social worker has already arrived by the time he is ready to go. He takes advantage of this overlap by jumping in the AV she used in order to go home. The system copes with this without a problem.

Although they are 9 and 12, Bobby and Kate are pretty independent. Their go cards give them unlimited access to AVs as part of the public transport system and so they come and go as they please, subject to some conventionally tight parental constraints. Lisa is a bit of a geek, so she monitors them at all times; Gary thinks her insistence on personally checking their physical and emotional state at regular intervals is overkill and thinks it would be perfectly fine to allow their home AI to keep a (virtual) eye on the kids and simply send out an alert if necessary.

Today Kate has cricket practice after school and she and her mates decide to ride shared bikes to the oval. After practice, she is running a little late, so one of the other parents, who has been watching practice, gets his AV to drop Kate off at home on the way past. Bobby has a play date at a friend's house. Having ridden to school, he rides his own bike to his friend's place but clips it onto the rack of the AV he arranges for the short trip home.

One of their strong rules as a family is that they have dinner together each night. Tonight it is Gary's turn to cook and he has something nice planned. He has done the shopping on-line and the autonomous delivery should be in the insulated parcel storage at their front door by the time he gets home.

3. Identifying and evaluating possible interventions

Having developed a comprehensive understanding of the transport system and our preferred future for it, we can begin to identify interventions we might make (e.g. regulations, incentives, infrastructure). These interventions should be sufficiently flexible, adaptable and robust to be functional in all scenarios. At the same time, they should be oriented towards delivering the preferred future.

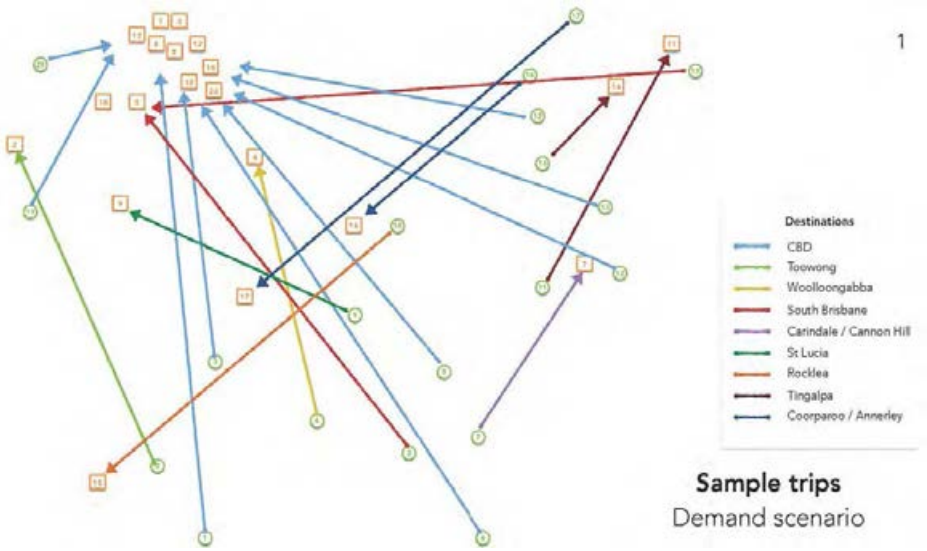
Once candidate interventions have been identified, we can then determine the best way to evaluate their desirability, viability and feasibility. This may include detailed models or a more hands-on approach as outlined below, as well as further engagement and testing with end users and system stakeholders.

Because of the time taken to achieve a comprehensive shared mental model, it is more likely that follow on in-depth evaluative and planning exercises such as modelling and feasibility studies will not be wasted.

It is tempting to regard detailed transport modelling as the only or best approach to evaluating change. However, given the exploratory nature of any assessment at this stage, a more effective approach involves consideration and mapping of a sample of qualified 'trips'. This would be informed by deep insights provided by the urban systems approach and consideration of 'real' behavioural choices. This intuitive approach would quickly build a picture of potential patronage and infrastructure impacts that can guide smarter, more targeted sample analysis and evaluation.

The following text and images outline this kind of intuitive approach applied as an example to Brisbane's South-East suburbs.

Step 1



Task to develop representative scenario

Trip Demands

Establish origin, destination, purpose, departure and arrival times and other characteristics of the sample of trips that each AV scenario would service. (Figure 2)

Follow on work for the transport network

We need to expand the sample to represent a full set of trips accounting for variation in location, schedule and purpose of activities and make-up of households. This could be done using a sample enumeration model.

Step 2

Task to develop representative scenario

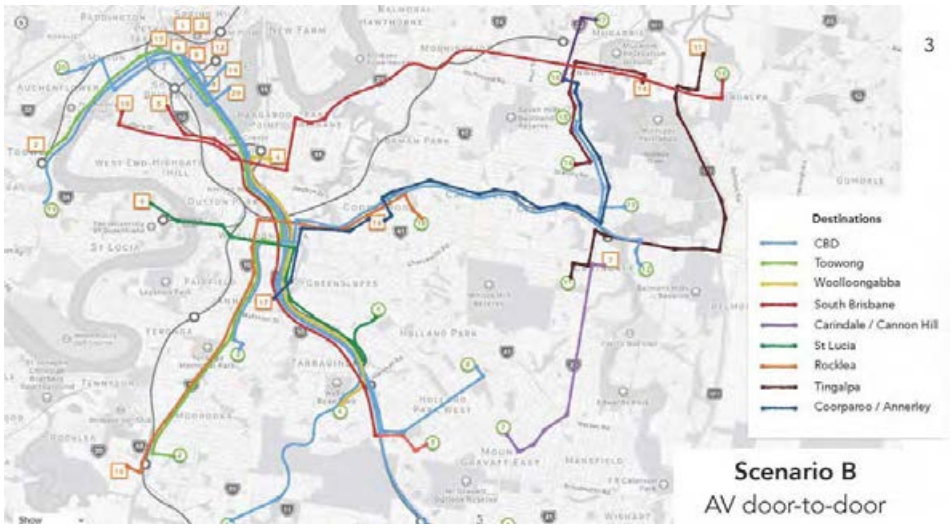
AV connection to MRT (Scenario A)

With AV providing first/last mile connection to Mass Rapid Transit (MRT), determine where each trip will connect to or from the MRT and consider opportunities for ride-sharing. In the example for Southern Brisbane (Figure 3), we have focused on the railway and busway corridors, connecting selected stations on the regional network with high frequency services.

Follow on work for the transport network

This is likely to increase use of MRT, with demands drawn from PT patrons that currently access via walk, bike, drive, drop-off or local bus connection, as well as from private car drivers and passengers. The shift in demand would be proportional to the benefit for the trip offered by the AV connection at either end. This could be explored further using an extended mode-choice model.

Step 3



Task to develop representative scenario

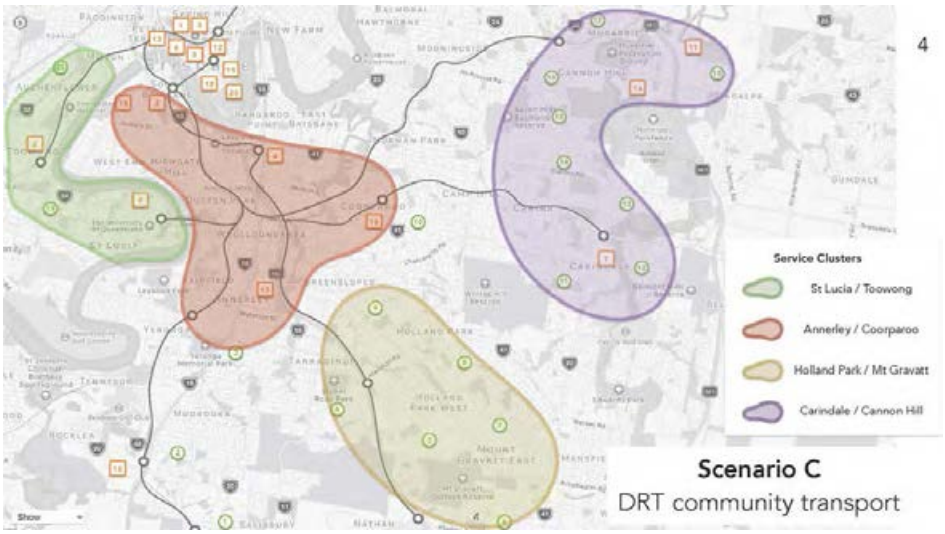
AV for door-to-door travel (Scenario B)

AV transporting passengers from origin to destination offers a similar service to private cars, without the need to drive, and with the possibility of more efficient travel via a managed network. This also gives rise to further opportunities for ridesharing. (Figure 4).

Follow on work for the transport network

This would lead to reduced use of MRT and other PT, with AV offering a more direct service. This would appeal particularly to those with reduced access to private cars. A managed or dedicated network for AV could also provide a more efficient journey and draw demands from private cars. This could be explored using an extended mode-choice and assignment model.

Step 4



Task to develop representative scenario

Define DRT service clusters (Scenario C)

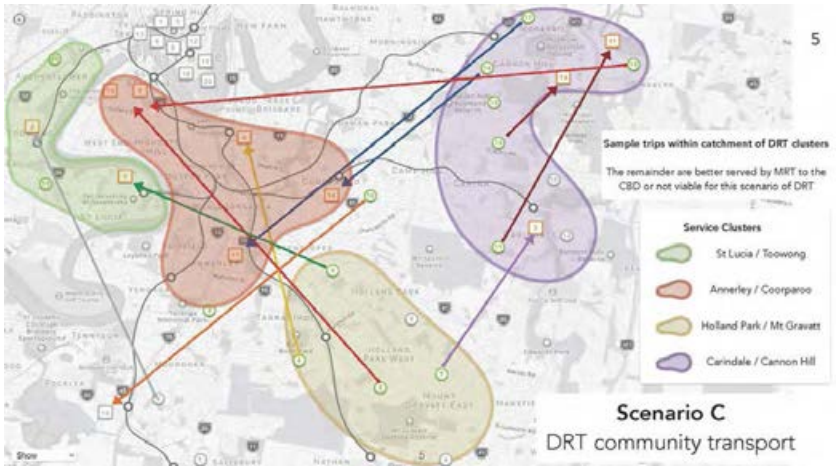
DRT can provide a viable service that complements MRT between areas that are not within easy reach of the network, but where demands are sufficiently high to support operation. (Figure 5) A DRT service would be provided within and between defined community clusters, with coverage expanding with demand over time.

Follow on work for the transport network

The example in Figure 5 shows four clusters in southern Brisbane covering communities and activity centres that lie between MRT corridors.

Exploring the full potential of DRT requires defining such clusters across South East Queensland, estimating demands within each cluster and ranking them by viability. This could be explored using a DRT clustering model.

Step 5



Task to develop representative scenario

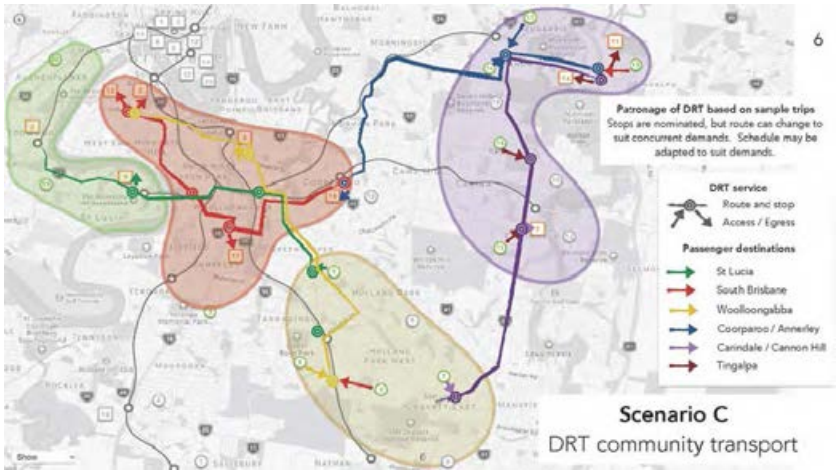
Identify trips within DRT coverage (Scenario C)

Identify trips with origins and destinations falling within nominal DRT clusters. (Figure 6) Sample trips can at this stage be assumed to occur concurrently.

Follow on work for the transport network

The example in Figure 5 shows four clusters in southern Brisbane covering communities and activity centres that lie between MRT corridors. Extend analysis with allocation of trips to time intervals for scheduling DRT services. This could be done using a demand time choice model.

Step 6



Task to develop representative scenario

Estimate DRT patronage (Scenario C)

Identify the stops that best serve the highest number of boarding and alighting passengers during the nominated service window (Figure 7).

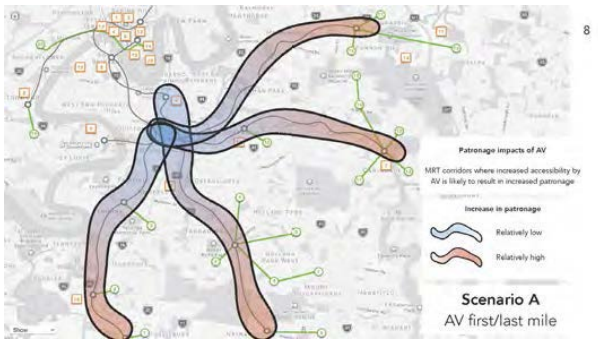
Determine the routes that maximise patronage and minimise the number of services and stops.

Follow on work for the transport network

Estimates of full demand for South East Queensland requires consideration of desired arrival and departure times so that services can be scheduled most efficiently throughout the day. This could be done using a DRT service optimisation model.

Such analysis can help explore:

- What is the role of MRT and on which corridors?
- What are the impacts of AV on PT patronage?
- Which routes are most impacted by AV?
- What changes to lane management are required?
- How can private and public AV work together?



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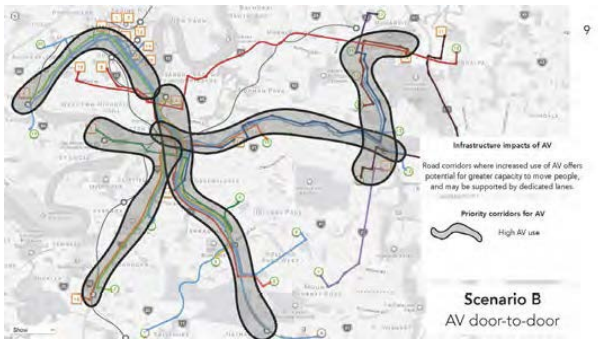

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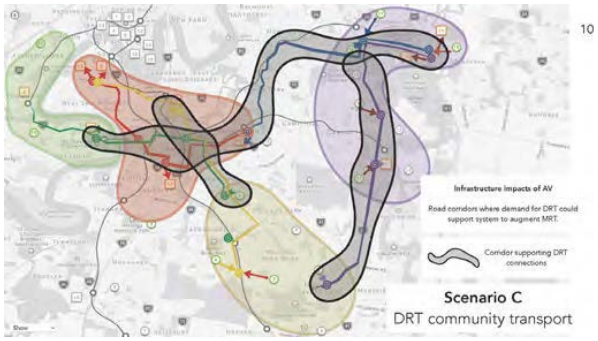

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Illustrative Impacts of AV on MRT patronage

AV connection to MRT (Scenario A) could lead to significant increases in patronage on MRT services. This increase is likely to be greatest in middle suburban areas, outside the walk-in catchment of MRT stations, and smallest in high density areas within easy reach of MRT stations. However, AV for door-to-door travel (Scenario B) could lead to a significant reduction in MRT patronage mirroring the increases in Scenario A, particularly for trips where both origin and destination are outside the walk-in catchment of MRT services.

Illustrative Impacts of AV on infrastructure

AV connection to MRT (Scenario A) leads to a concentration of AVs around MRT stations, which may point to a benefit from dedicated access links and controls, and passenger loading facilities. AV for door-to-door travel (Scenario B) may benefit from encouraging use of selected routes to connect districts, along which facilities could be provided to increase the efficiency of AV travel. This may also involve provision of managed or dedicated lanes and access controls on major roads.

Illustrative Impacts of DRT on infrastructure

Understanding the impacts of DRT on network infrastructure is perhaps the most challenging question, as it requires a balance between commercial and transport engineering objectives, and is by its nature, highly dynamic. DRT offers the potential for reduced public transport service on less frequent routes with lower patronage, or consolidation of multiple routes otherwise needed to provide suitable service coverage. Providing a mix of dedicated and shared lane facilities along these secondary routes, combined with dynamic (vehicle-responsive) access controls could enhance the efficiency, viability and patronage of DRT services within and between clusters.

Progressing the approach

This review addresses the implications of emerging technological advances such as AVs and outlines an approach to addressing the challenges and opportunities they present. It represents the result of a discussion between GTA and Collabforge. A number of other organisations could contribute to this discussion, not least road and transport agencies.

For more information and to initiate this discussion, please contact

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