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Autonomous Vehicle Systems for Public Transportation in Australia

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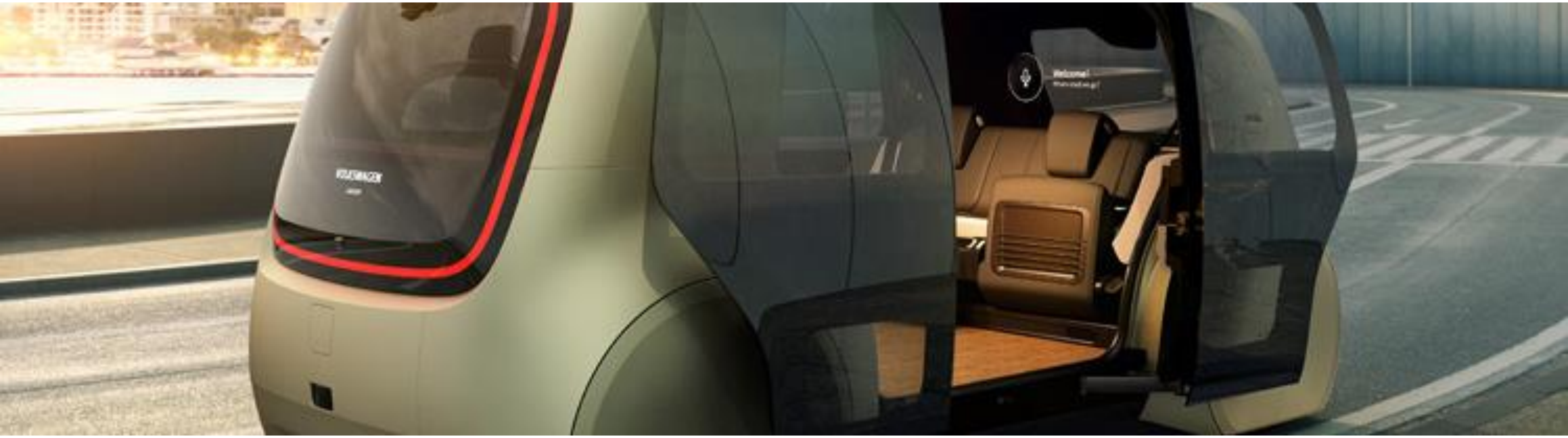
SYSTRA Scott Lister



SYSTRA SCOTTLISTER

Introduction

- Over 70% of the world's population doesn't own a car and millions of people are still reliant on public transport on a daily basis.
- Autonomous Vehicles (AVs) have the potential to fundamentally alter the way we move around our cities and transform the cities themselves by allowing them to grow beyond their current limitations.
- The challenges in the transport system of the future such as increased congestion and greater fatalities, coupled with the various benefits of Autonomous Vehicles make self-driving vehicles the future of mobility and public transport.
- The widespread adoption of connected AVs has the potential to bring about great improvements in the efficiency of our transport networks, and reduce the overall impact on the environment.
- AVs will further have a wide reaching impact on many aspects of the society itself.

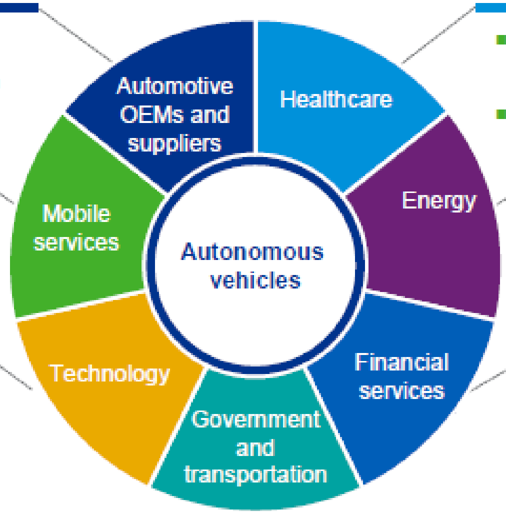
Autonomous Vehicles

Ecosystem

- Increased demand for sensors and equipment would increase revenues.
- Additional experience-based features such as infotainment systems and interactive gadgets could see a higher demand.

- Fewer auto-related accidents and fatalities could reduce the costs for emergency medical services.
- In case of accidents, vehicles would be able to raise an alarm.

- Increased demand for connectivity and reliability could result in additional bandwidth requirements.



- Increased mobility and rise in the number of individuals traveling could lead to greater gasoline usage.
- Increased efficiency could reduce demand for gasoline.
- Transition to alternate fuels could adversely impact the petroleum industry.

- AVs would require a highly accurate and efficient mapping technology.
- User data and analytics could be used to enhance the entire AV experience.
- Greater time availability could increase multimedia and information consumption.
- It could lead to increased advertising and subscription revenue opportunities.

- Growth in fleet financing presents opportunities for financial firms.
- Shift away from personal vehicles could lead to decrease in auto loans and leasing.
- There are potential opportunities for experience-based insurance products.
- Reduction in accidents could lead to a decrease in insurance sales.

- Reduced number of vehicles could decrease the current revenues (e.g., fuel tax, licensing fee, road fines, etc.)
- New taxation models, such as consumption-based dynamic taxation, could offset tax revenue decline.
- Potential change in use of public transportation — while some analysts speculate that rise in AVs would reduce public transport usage, authorities could supplement public transport through AV adoption, solving the first-mile/last-mile problem.
- Requirement of smart cities could result in greater government spending in improving infrastructure.
- Real-time data could be analyzed to improve traffic conditions, infrastructure and public experience.
- To facilitate AV adoption, authorities need to review and implement new regulations and policies as well as collaborate with industry players.

Effect/impact categorization:

- Positive
- Neutral
- Negative

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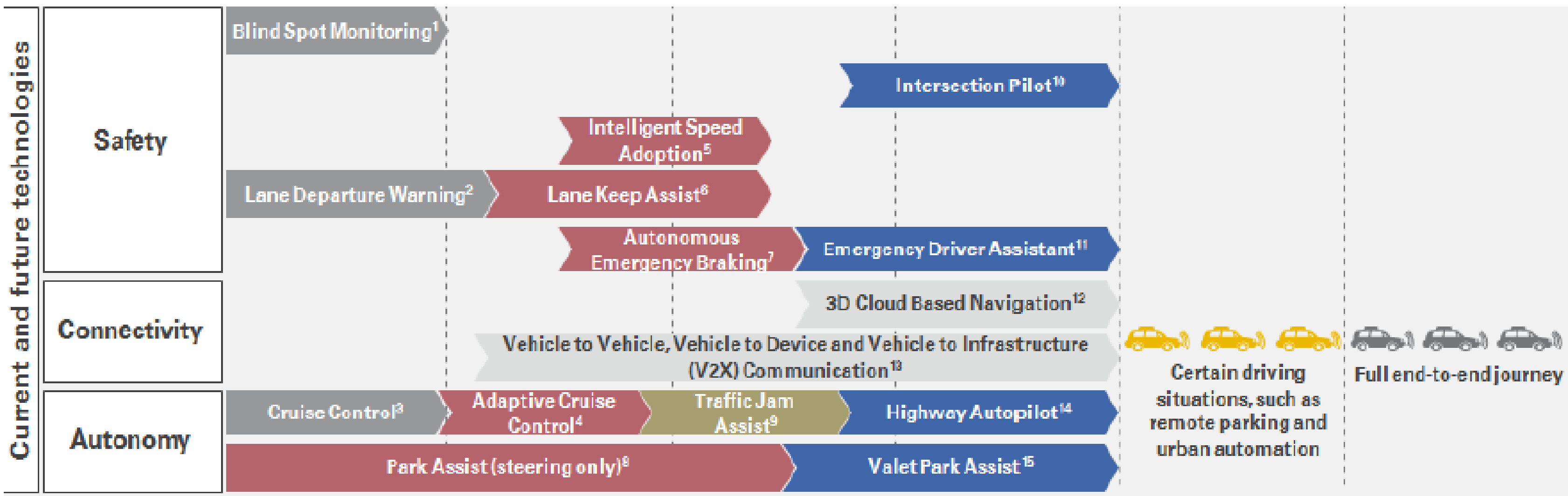
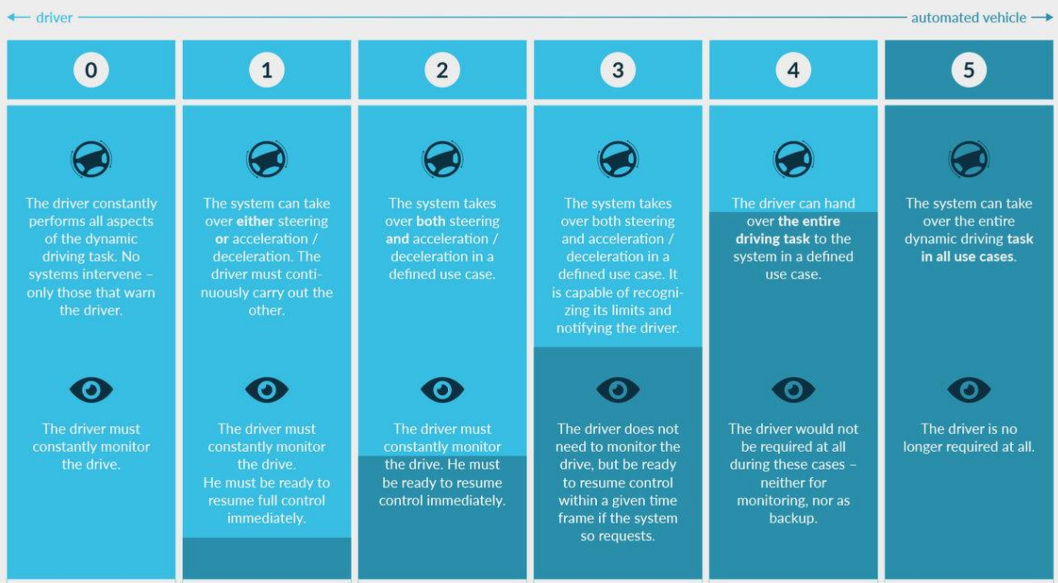
AV Technology

Current and Future



Automation Levels

Levels of Autonomy



TERMINOLOGY	0	1	2	3	4	5
SAE (J3016)	No Automation	Driver Assistance	Partial Automation	Conditional Automation	High Automation	Full Automation
VDA*	Driver only	Assisted	Partly automated	Highly automated	Fully automated	Driverless
BASt	Driver only	Assisted	Partially automated	Highly automated	Fully automated	——
NHTSA**	0	1	2	3	3/4	

* used on this platform
** only roughly corresponding with the other taxonomies

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Past Presentation 1 – Driverless Cars

- Clive Boughton and Kevin Anderson, facilitated a series of three workshops at ASSC2016 based on ISO 26262 – Functional safety of road vehicles.
- Workshop 1 posed a number of ethical questions relating to the runaway trolley problem – the choice of the lesser evil.
- Workshop 2 considered the Mission computer Safety Integrity level (SIL)
  - Inputs comprised of: Radar, LIDAR, GPS, Odometry, Computer Vision and Software
  - Outputs consisted of: control accelerometer /brakes and steering
- Workshop 3 used the HAZOP technique to identify unwanted events in the various phases:
  - Start up /shutdown, start /move off
  - Sighting /visibility, position / distance, navigation
  - Acceleration /movement /steering /speed /braking
  - Stop /stationary
- In conclusion, it was debated whether driverless cars are reasonable – when the risk is expressed in terms of exposure and controllability – could 100 million new cars be wrong?

Past Presentation 2 - TLOS for AVs

Target Levels of Safety (TLOS)

Autonomous Systems

- Risk frameworks were defined in terms of safety principles including SFAIRP as embodied in the risk triangle, Individual Risk (IR) and Collective Risk (CR) criteria and the ubiquitous risk matrix.

- The TLOS approach to establishing risk criteria for autonomous vehicle operations comprised of four steps:
  - Literature review
  - Individual risk criteria based on worker and general public exposures for
    - Automated Trains, Driverless Cars, Unmanned Aircraft Systems (UAS)
  - Selection of the most common criteria
  - Conversion from per annum to per hour criteria

- This focus on IR & CR discounted catastrophic outcomes as negligible.

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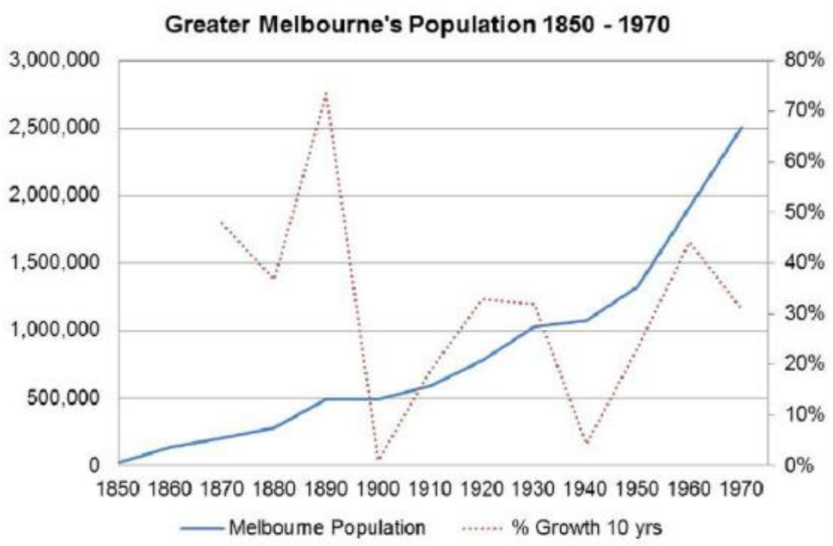
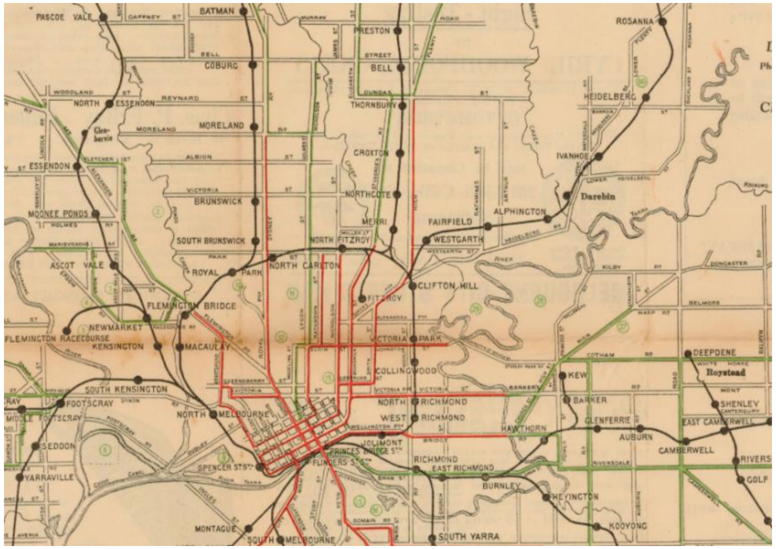
Urbanisation & Transportation

Urban growth in Melbourne & corresponding transportation corridors

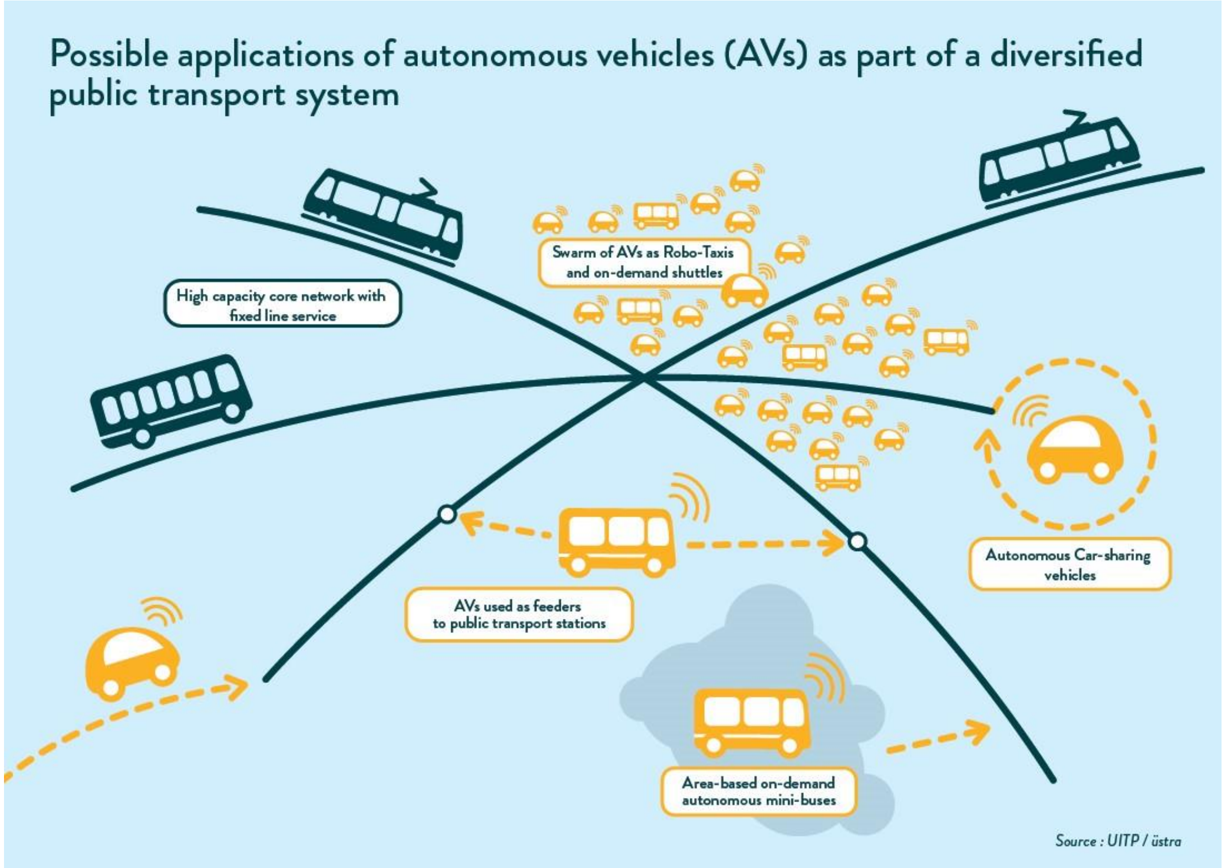




AVs for public transport

Applications of AVs

Public Transportation

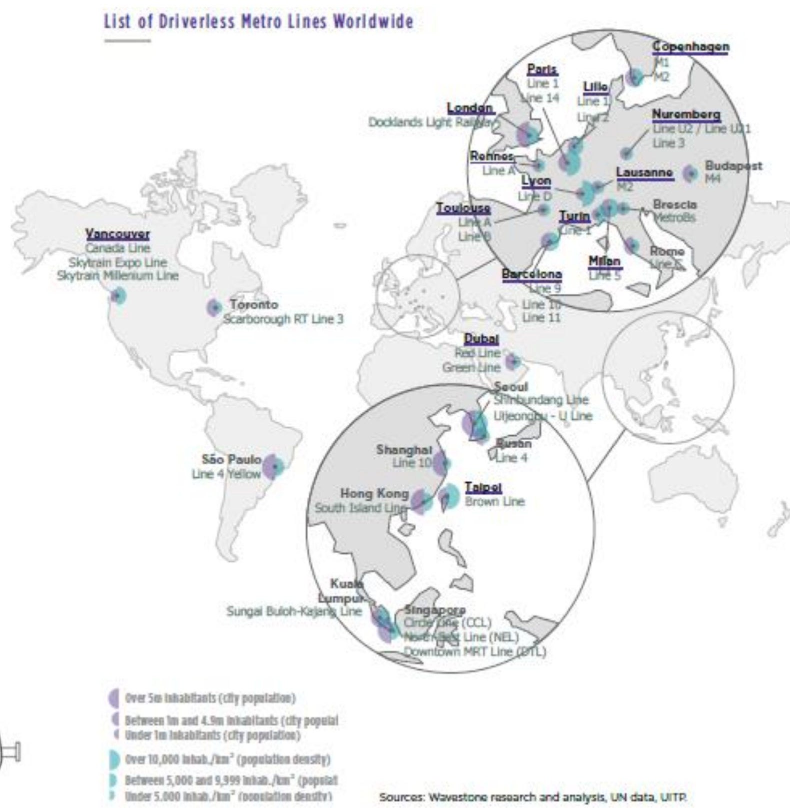


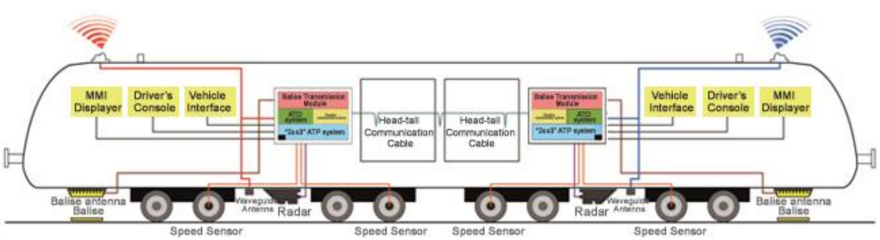
Rail

Driverless Trains

Metro & Shuttles

- Automation in the rail industry is ‘a mature technology’
- Over 50 driverless metro lines in operation across 37 cities worldwide
- In Australia, ONRSR accreditation requires:
  - Demonstration of competence & capacity in managing risks to safety
  - Assessment and mitigations of all risks SFARP

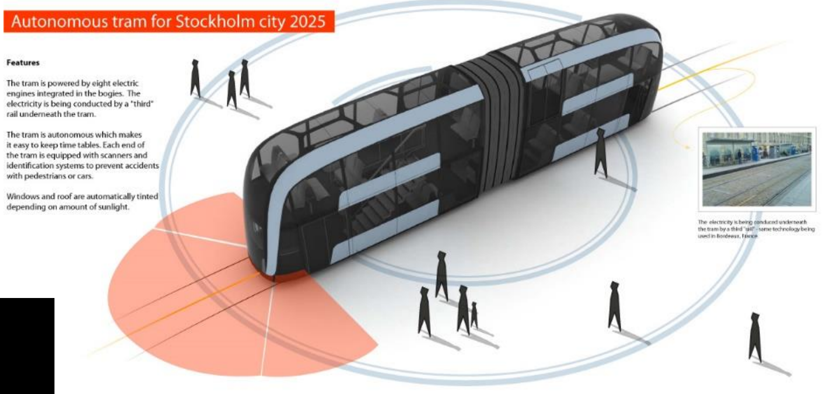


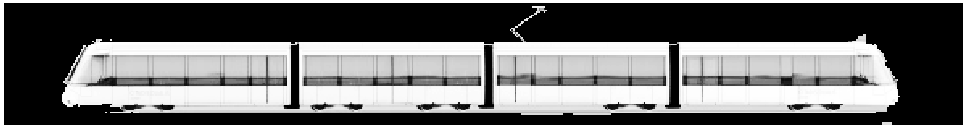


Automated Light Rail

Tramways

- A tram network is an open system, often integrated with a city’s infrastructure.
- Trams are heterogeneous networks – interact with all modes of transport that operate at surface level & pedestrians.
- Driverless technology is available but it’s a forced trade-off between safety and availability that a metro system does not have to make.
- Systems
  - Dubai
  - Montreal (mid-2021)





SYSTRA SCOTTLISTER

Road

Autonomous Road Vehicles

- Numerous Modes/Combinations
  - Buses
  - Shuttles
  - Pods
  - Shared fleet
- Operated on both dedicated laneways and on shared roads

Hybrid Systems

Hybrid Solutions

- Combination of buses, trains and/or trams
- Concept: Autonomous Rail Rapid Transit
  - Trackless & Driverless “Rail Bus”
  - Follows marking painted on the road
  - CRRC trial in Zhuzhou
  - Driver present for safety reasons

Common Themes

Usage, Operations & Maintenance, Interfaces

- Trains and Buses, travelling on high volume routes and utilising exclusive infrastructure such as busways or dedicated lanes are best suited for automation.
- When segregated from the general traffic and travelling along a fixed route, the number of potential obstacles (and hence the required complexity of automation solutions) is greatly reduced.
- Operations in shared road space such as light rail systems (trams) are more difficult to automate.
- As both the capital acquisition and maintenance costs of automated bus operations are significantly higher than for private passenger vehicles, bus operators are more unlikely to be willing to absorb the cost for higher levels of automation.
- Autonomous buses/trams would require significant changes to the existing infrastructure.

Benefits

AVs for Public Transportation

- Improved capacity
- Lower running costs (in part due to reduced staffing costs)
- Increased Safety
- Increased Access and Mobility
- Use of time
- Congestion and use of urban space
- Environment

Barriers

Uptake of AVs for Public Transportation

- Safety
  - Equivalent or more (by what factor)?
  - Ethics (runaway trolley problem)
- Data security and privacy
  - Connected vehicles
- Public perception
  - Unfamiliarity
  - Lack of experience
  - Trust factor
- Other issues
  - Jobs

Factors

Introduction of AVs

Public Acceptance and Engagement

- system failures (including safety and security)
- riding a vehicle with no driver controls
- automation of commercial vehicles and public transport
- legal liability
- automated vehicles getting ‘confused’
- unoccupied trips by automated vehicles
- interactions between automated vehicles and vulnerable road users
- data privacy

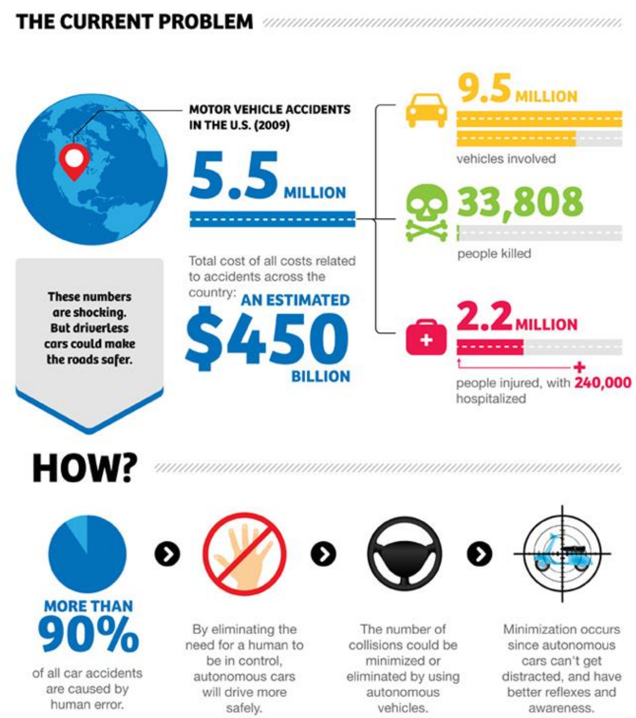
Safety

Safe State

- An autonomous vehicle must be aware of its current performance capabilities.
- An autonomous vehicle must be aware of its current functional limits in relation to the current situation.
- An autonomous vehicle must always be operated in a condition in which the level of risk is reasonable for the passengers and other road users.
- A vehicle that is standing stationary and is not blocking traffic is in a safe state.
- A vehicle that has come to a stop on a traffic lane is only in a safe state if some critical conditions are met.
- A vehicle moving with a high level of risk or one that has come to a standstill at a dangerous location must be capable of sending an emergency signal and requesting help.

Safety

- Human Factors
  - Driver error / Driver fatigue
- Costs
  - Insurance
- Advance Technology
  - Autobrake systems
- Regulations
  - Safety Assurance
- Ethics
- Mixed Fleet
- Accident Data



Applications

Possible Public Transport Applications

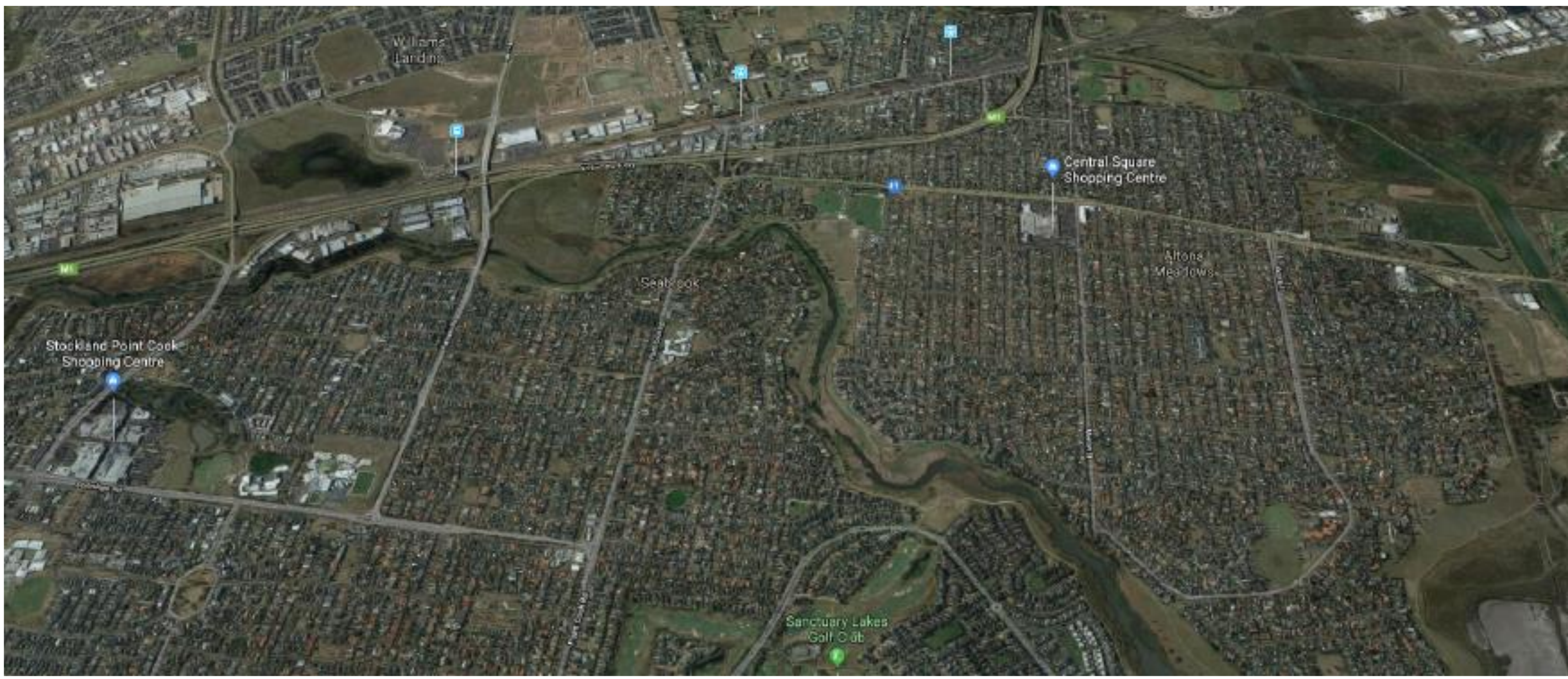
Criteria – QoS, Trip time, Capacity, Availability, Reliability, Safety

- Improved first and last mile connections to existing services, particularly if autonomous vehicles are deployed as a low-cost, on-demand (anywhere, anytime) service
- New mobility options in areas not linked by public transport and in areas of low patronage
- Potential reductions in the need for investment in new services and infrastructure (if autonomous vehicles create large efficiency benefits)

Case Study – Aircraft Station

First and Last mile connection

Low-cost, On-demand



Recommendations

- Facilitate and Encourage trials of autonomous vehicles in Australia, with a particular focus on trials that enable members of the public to experience travel on such vehicles
- Investigate autonomous vehicles (and associated transport systems) to address potential vulnerabilities relating to automation
- Investigate the issue of data rights for consumers, vehicle manufacturers and third parties such as insurers and relevant government agencies
- Work with industry and academic stakeholders to identify industry needs regarding the development of autonomous vehicles and support services
- Implement regulations to ensure that Australia is best placed to exploit emerging opportunities

Ensure sufficient compensation for those who are injured	
Expand public insurance	Facilitate private insurance
Force information-sharing by the private sector to enhance regulation	
Privilege the concrete	Delegate the safety case
Simplify both the technical and the regulatory challenges in coordination	
Limit the duration of risk	Exclude the extreme
Raise the playing field for conventional actors along with automated systems	
Reject the status quo	Embrace enterprise liability

Future way

Government & Regulatory Authorities

Considerations

- Consider funding of trials of automated vehicles with a public transport application, in both metropolitan areas and regional locations
- Consider the needs of people with disability, older Australians and those in regional and rural areas can be met via autonomous vehicles
- Ensure consistent regulations and policy settings
- Standardise road infrastructure in Australia, particularly as it relates to signs and road/rail markings
- Work with vehicle and software manufacturers, to coordinate Australia's preparation for the introduction of autonomous vehicles for public transport needs

That's it!