SHAPING OUR TRANSPORT FUTURE

EASTLINK OPERATIONAL DEPLOYMENT OF SEMI AUTOMATED VEHICLES

PHASE 1 SUMMARY OF FINDINGS

MAY 2018

EXECUTIVE SUMMARY

Under the Smarter Journeys program, managed by VicRoads, Australian Road Research Board (ARRB) in partnership with ConnectEast and LaTrobe University, has completed Phase 1 of Operational Deployment of AVs and C-ITS on Eastlink.

WHO
VICROADS, ARRB, CONNECTEAST & LATROBE UNIVERSITY, WITH ASSISTANCE FROM RACV

VEHICLES PROVIDED BY
VW, BMW, VOLVO, AUDI, HONDA, HYUNDAI, MITSUBISHI, MAZDA, LEXUS, MERCEDES-BENZ & TESLA

WHERE
EASTLINK

TERMINOLOGY

LKA = lane keeping assist

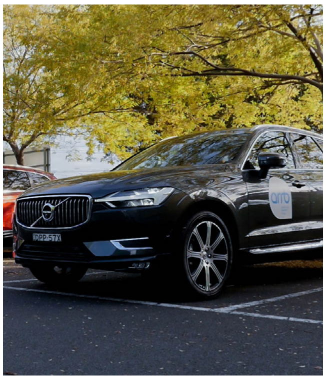
ACC = adaptive cruise control

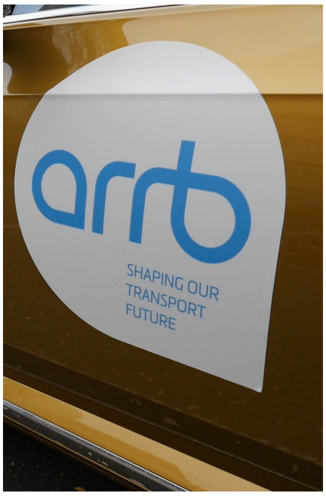
ADAS = advanced driver assistance systems

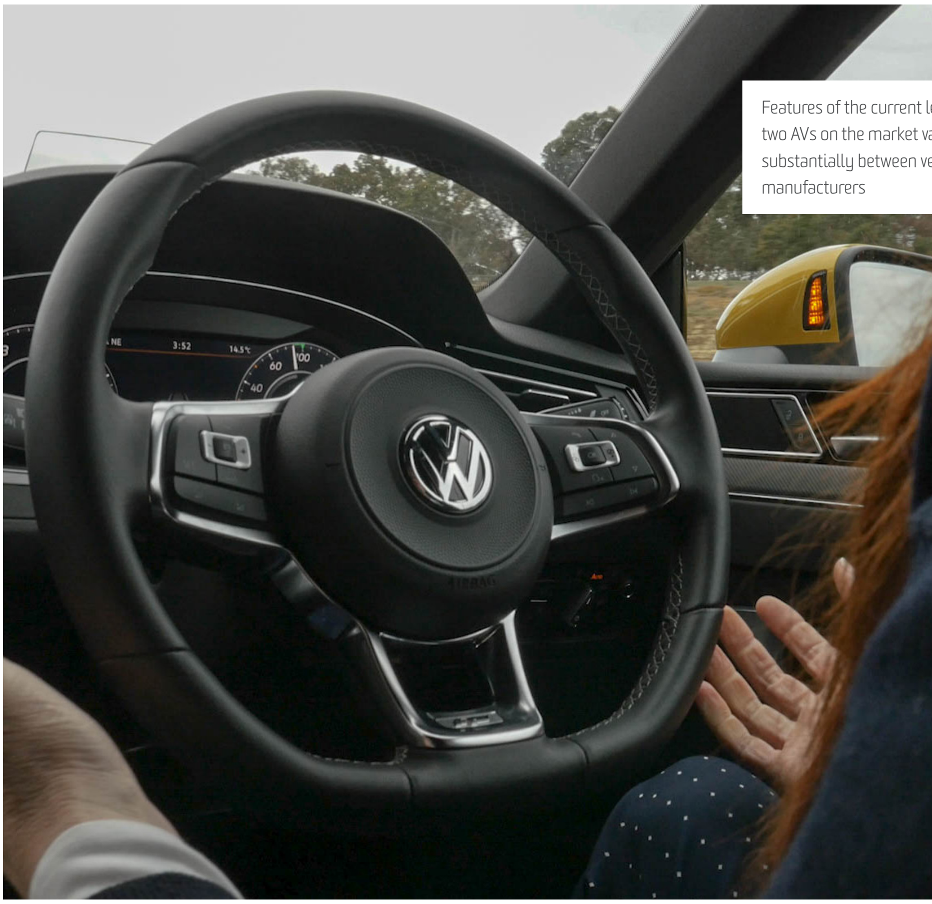
PHASE 1 REPORT

As technology advances and more automated features become available, it is noted that there exists a lack of real life, practical understanding in Australia as to the requirements for, and potential benefits of partial AVs (also known as advanced driver assistance systems) in human to vehicle and vehicle to infrastructure interactions. It is also apparent that media sensationalism and incomplete knowledge of the public at large has given rise to concerns about the safety and trustworthiness of partial AVs. To help address these concerns, this project seeks to understand the capabilities and limitations of current latest generation vehicles, and how road infrastructure impacts on a vehicle's capabilities.

This progress report presents findings from the first phase of the project, in which a series of currently available. Level 2 partially automated vehicles were trialled along a section of Eastlink, between Springvale Rd and the Monash Freeway, including the Mullum Mullum tunnel. In this, the driving experience and performance of each vehicle's automated/driver assist functions (namely ACC and LKA), and their interaction with the surrounding infrastructure, and traffic were noted.







Features of the current level two AVs on the market vary substantially between vehicle manufacturers

OBSERVATIONS

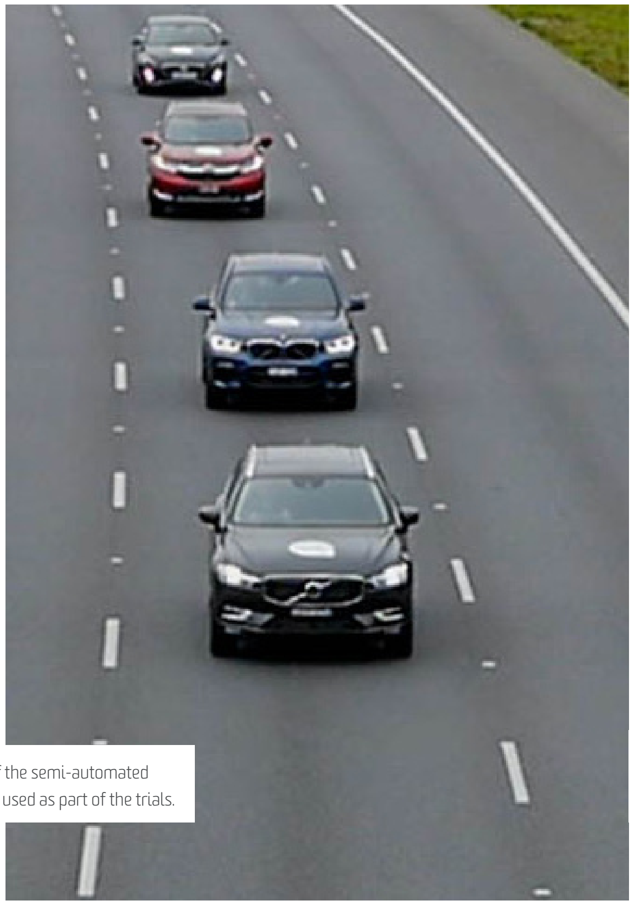
Whilst it was observed, that many of the current Level 2 AVs on the market vary substantially between manufacturers, the performance capabilities of their automated functions (such as ACC and LKA), were generally affected in similar ways. Typically, features were limited by the systems' recognition abilities (e.g. other vehicles, signs, line markings) and further confined by the operational design domains (e.g. not heavy rain), and use cases specified by the manufacturer (e.g. traffic jam assist <30km/h or freeway conditions). Due to limited time, the capabilities were not able to be tested in all weather and time of day conditions.

However, challenges regarding road design and infrastructure, occurred when:

- VicRoads standards showed variation in relation to entry/exit ramp configuration and marking- tight curvature and speed sign position affected vehicle performance.
- Carriageways substantially deviated from a straight path (i.e. ability to negotiate tight curves at speed was limited, this was noted on entry/exit ramps)
- Standard of line marking on main carriageways was impaired (e.g. presence of both yellow and white lines, ghost markings, poor/worn marking condition) or line markings were absent
- Reading speed signs (static or VSLS configuration, and location)

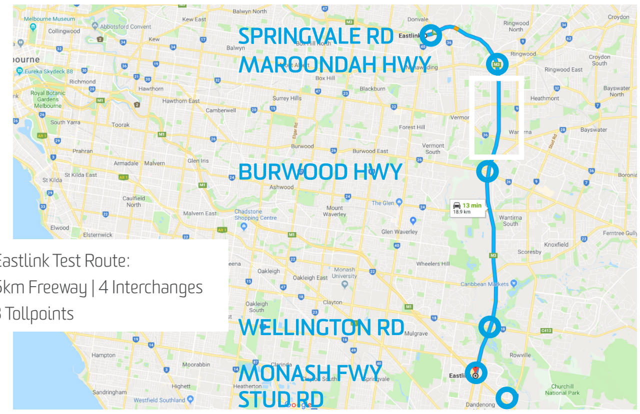
In conjunction with this, both the current physical and digital infrastructure of Eastlink was reviewed. It was noted that while the privately-owned tollway, Eastlink provided a physically sound test bed, with clear lane markings and good signage, there were concerns about the implementation of C-ITS and its effect on the existing digital infrastructure. Preliminary testing, however, showed that there is no interference between Eastlink's tolling system and DSRC from C-ITS using the 5.9GHz bandwidth.

Overall, there exists good potential for Level 2 AV operation on high quality roads such as Eastlink, but current observations assess that the capabilities of existing systems are difficult to pin down without prior knowledge. On the other hand, informal discussions with at least one technical engineer from a vehicle manufacturer revealed that current high-end vehicles are capable of auto pilot (ACC and LKA) in freeway conditions once the right settings are adjusted in the vehicle. In some cases, adjusting the settings progresses system behaviour from the lower end of Level 2 (low quality of required task performance, with high dependence on availability of exact Operational Design Domain (ODD) environment), towards a Level 3 (or Level 2+, where the performance of the task is of higher quality and demonstrates some reliability when operating slightly outside of the specified ODD). The settings, however, like many computer devices are not always clear to the user or driver and may involve a software upgrade. It was found that, in some cases, changes to system programming or settings may be made by the manufacturer upon customer request. Even these conclusions, however, are subject to change as each model released includes more advanced technology and more reliable Advanced Driver Assistance Systems (ADAS).



Some of the semi-automated vehicles used as part of the trials.

Audi S5 showing traffic jam assist turned on



Eastlink Test Route:
5km Freeway | 4 Interchanges
3 Tollpoints

ARRB, ConnectEast and LaTrobe University are greatful for the invaluable in kind contributions of BMW, Mercedes-Benz, Tesla, Audi, Honda, Toyota/Lexus, Mazda, Mitsubishi, Hyundai, Volkswagon and Volvo in providing loan vehicles for trialling on Eastlink.

Whilst the ability to have system settings changed (e.g. for heightened performance) is typically a benefit, it is noted that with concerns surrounding data security, further regulations and safeguards may need to exist around encryption and protection of system programs to ensure unauthorised changes or customisations (i.e. hacking/tampering) cannot occur.

Phase 1 of the project reports that current Level 2 AV technology has a need for high quality lane markings with good visibility in all lighting, minimising of ghost markings, sign technology considerations in respect of refresh rates and readability of LED signs as well as position, minimal curvature of ramps, and real time feeding of traffic and mapping information to data providers. These findings, will be used in the development of operational requirements for safe operation of AVs on public roads, and as input into driver education and public awareness campaigns.

It has been observed that human experience of using driver assist functions highlights the human machine interface (HMI) as a significant transition from standard driving. Standard driving requires a mentally and physically engaged driver, whereas supervised driving (of partial AVs) requires a driver to be mentally engaged and physically ready (to be engaged). This has potential implications for driver education and deployment of Level 2 vehicles, which is beyond the scope of this project but worth exploring in future.

Phase 2 involves testing of C-ITS, infrastructure to vehicle communication, and is currently underway.

BRIEFING SHEET

Project Aims—
Assess and understand the capabilities, operation, and driving experience of currently available semi-AVs, and how they interact with the current road infrastructure. Gain insight into the actual capabilities and limitations of the vehicles (i.e. find the real driving experience, which will vary from driver to driver, in between the marketing claims and the owner manual caveats).

VEHICLES TESTED TO DATE

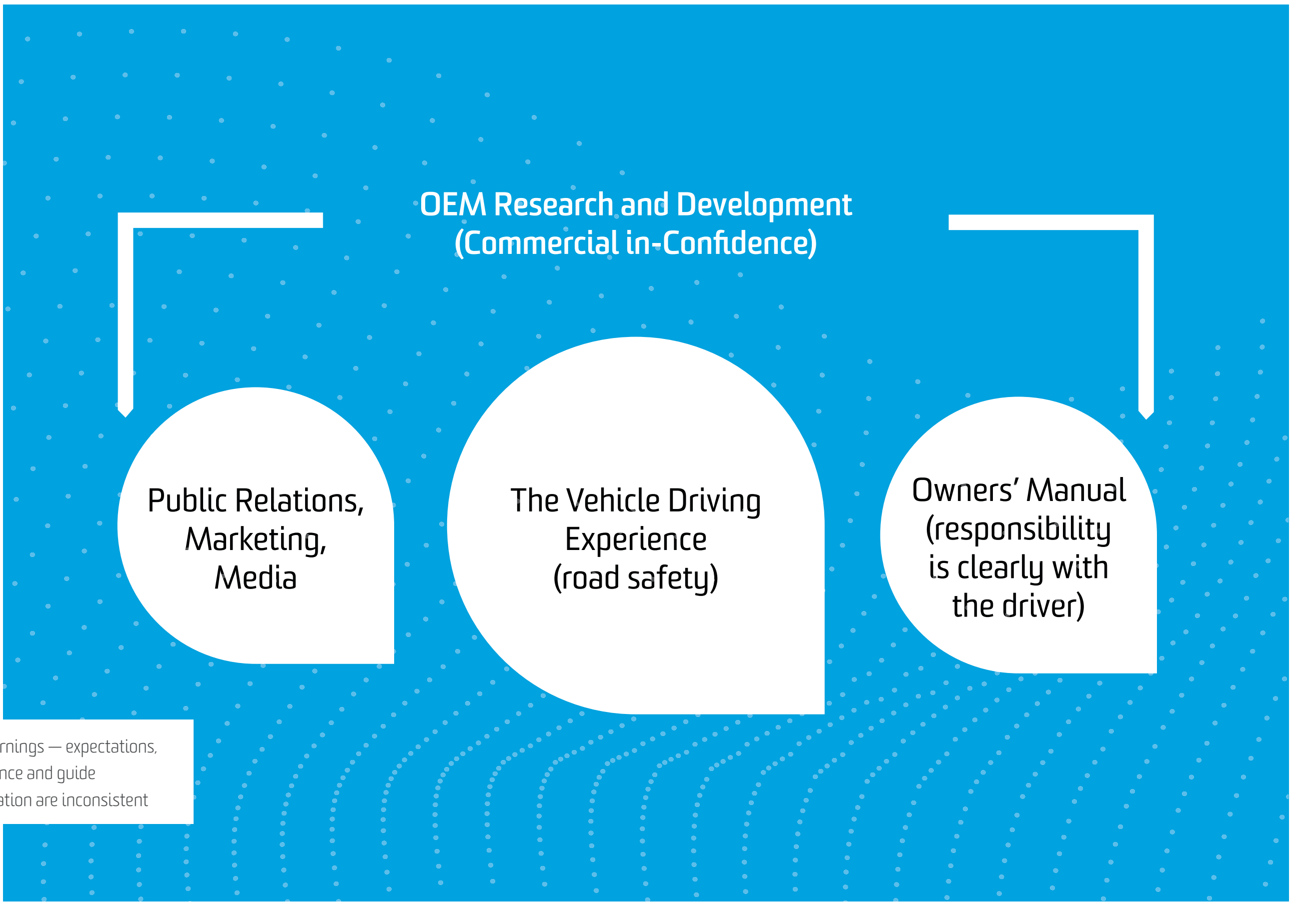
- BMW 530i
- Honda Accord
- Honda Civic VTi-L
- Mercedes Benz E300
- Mitsubishi Outlander PHEV
- Tesla X (limited trial)
- Mazda CX9
- Lexus RX
- Audi S5
- Volvo S90 (limited trial)
- Volvo XC60
- Hyundai i30 SR
- Volkswagen Arteon

METHOD

Qualitative assessment/ trialling of 13 production vehicles from 11 different OEMs, with advanced driver assist systems (ADAS) such as Lane Keeping Assist (LKA), Adaptive Cruise Control (ACC), and Traffic Jam Assist* using cameras, radar and lidar.

- Trialling took place on Eastlink (between Springvale Rd and the Monash Freeway), including the Mullum Mullum tunnel.
- Approximately 28 days of driving along a 5 km test section, with four interchanges, three toll points and two speed limits (80km/h & 100 km/h)
- Observations of capability and performance of the vehicles was recorded by drivers and passengers qualitatively during testing
- Testing took place in a range of driving conditions and it was noted that, as per the provided manuals (examples given in the table below), the ADAS does not work properly/reliably in the rain and other conditions with poor or variable visibility.

VEHICLE	CAVEAT FROM OWNERS MANUAL
MERCEDES-BENZ E300	"If you fail to adapt your driving style, the systems can neither reduce the risk of an accident nor override the laws of physics. The systems cannot take road and weather conditions or traffic conditions into account."
BMW 530I	"Detection capacity is limited, two-wheeled vehicles may not be detected. Does not decelerate for pedestrians, red traffic lights, cross or oncoming traffic." "This system can react incorrectly or not at all due to the system limits." "May not be fully functional in poor weather, when lane markings are unclear/missing/ covered, on tight curves, in narrow lanes or with blinding oncoming light."
HONDA	"Over-reliance on the system may result in a collision". "Do not rely on the system." "The system may not work in poor weather, sudden light changes or poor road conditions"



Key learnings — expectations, experience and guide information are inconsistent

KEY LEARNINGS TO DATE

- Driving skills required for semi-AVs are different to non semi-AV – learning/work-up time required for drivers to understand and feel confident in features, but still remaining engaged with the driving task. The driving style is akin to that of a pilot in an aeroplane, where the systems are capable of performing some of the driving task, but the pilot (or driver) must be mentally engaged and ready to take back manual control at all times.
- Heavy reliance of LKA on line markings, luminosity and reflectivity are essential. Yellow lines able to be detected but capability varies from vehicle to vehicle. (With clear lane markings, both humans and computers can safely drive between the painted lines. Poorly maintained roads are not only harder to navigate, but computers and humans are not able to accurately anticipate where others will drive, thus reducing predictability.)
- "Hands-free" operation allowance (hands off time allowance) and reliability (feeling of confidence in the vehicle's ability to remain safely in control) varies between vehicles.
- Very noticeable differences in ACC and LKA capabilities between vehicles:
  - + Detection of lines, vehicles, objects or other obstacles. Frequency of false readings varies between vehicles.
  - + Accuracy of lane centring (or level of LKA provided is not always clear, varies between bouncing from left-side line to right-side line, to moving around the centre-line of the lane, to tracking consistently in the centre of the lane)
- Human Machine Interfaces (HMI) are not always intuitive and present a learning curve for the driver, varying from vehicle to vehicle.
- Need for consistent and good road maintenance; clear road signs and lane markings. This highlights that the Australian Standards and Austroads guides should be followed and consistent with international standards. Well-maintained roads are also critical for predictability, which is very important in moving traffic and a mix of automated and non-automated vehicles.
- Semi-autonomated vehicles operate & behave differently than traditional cars. Computers read roads differently to humans (sometimes the same, but sometimes different).
- Public education will be essential to assist driver expectations & responsible use of semi-automated vehicles.
- Glare, shadowing and digital capture at sunset/sunrise can give false readings.

HYPOTHESIS

When deployed responsibly, semi-automated vehicles have the potential to reduce:

- rear end accidents in traffic jams &
- run off-road on metro and rural roads
- reduce fatigue & driver load by taking away repetitive tasks