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QUEENSLAND'S INTELLIGENT TRANSPORT SYSTEMS (ITS) PILOT PROJECT

Queensland Department of Transport and Main Roads has developed a pre-deployment and research program for cooperative intelligent transport systems (C-ITS) and cooperative automated vehicle (CAV) technologies, referred to as the ITS Pilot Project. The project will comprise a large-scale field operational test for safety-focussed applications, as well as CAV research and demonstrations.

In the context of the national direction, the pilot is a necessary step towards full deployment of C-ITS, which is ultimately required to enable connected and automated vehicles with optimal benefits realisation. It will also address an important gap in research on the performance and benefits of CAVs. This paper explores the investment rationale, strategic alignment, government's role, and possible impacts moving forward.

1. Introduction

The introduction of cooperative intelligent transport systems (C-ITS) and automated vehicles (AV) to Australia's roads has the potential to provide significant economic, social and environmental benefits. Internationally, billions has been spent to develop and test, measure, and demonstrate the technologies – this investment does not translate locally without some effort from Australian governments and industry.

The automotive manufacturers have not indicated a date for the introduction of C ITS-equipped vehicles into Australia. Japan is the first country with C-ITS equipped production vehicles (the Prius) and it is anticipated that General Motors will release a C-ITS equipped model this year. The United States (US) has proposed a mandate to equip all new vehicles with C-ITS. Both Europe (EU) and the US are forecasting 2019 for large-scale production of C-ITS.

Whilst the development and deployment of automated and cooperative systems is currently occurring independently, there is growing awareness that the cooperative and automated systems will likely need to complement one another in order to create a viable self-driving car. C-ITS provides extended vehicle sensors – allowing the vehicle to see around corners, negotiate with other vehicles when merging and weaving, and obtain infrastructure information, such as the amount of red time remaining at a signalised intersection. C-ITS also provides redundancy for positioning sensors.

Unlike automated vehicles, C-ITS deployment is reliant on a number of actors to stimulate the emergence of the business case for the broader C-ITS opportunity, and government needs to play a greater role in enabling the digital and physical infrastructure required for C-ITS.

In March 2015, the department released "A plan for Intelligent Transport Systems in Queensland", which maps out the future direction and actions for ITS in Queensland. Key initiatives include cooperative vehicles and automation. To support these initiatives, the plan highlights the need for pilot projects, in particular large-scale pilot projects. In May 2016, a business case examining the investment logic of C-ITS and AV, and a pilot of these technologies, was approved.

The Queensland ITS Pilot Project will comprise a large-scale C-ITS field operational test as well as cooperative and automated vehicles (CAV) research and demonstrations. It is a necessary step towards full deployment of C-ITS in Queensland, which is ultimately required to enable 'connected and automated vehicles' with optimal benefits realisation. It will also address an important gap in research on the performance and benefits of CAVs.

This paper explores the investment rationale, strategic alignment, government's role, and possible impacts of C-ITS and CAVs moving forward.

2. Background

Automated vehicle technologies encompass a number of levels of automation, from anti-lock braking systems and adaptive cruise control through to driverless operation. Partially automated vehicles are commercially available today. Developments in vehicle automation are primarily being driven by private sector investment, original engine manufacturers (OEMs), equipment manufacturers, and software developers.

There has been a lot of attention on automation in the media, but perhaps an equal game changer is the connected vehicle. A smart city with smart mobility services is reliant on a highly connected environment. CISCO has indicated that less than 1% of all devices are currently connected, and predict that there will be 50 billion internet connected devices by 2020. It stands to reason that a vehicle will be one of those devices.

IHS automotive predicts that 75% of new vehicles globally will be connected by 2025, or some 90 million new vehicles per year. This is compared with a couple of hundred thousand new driverless vehicle per year in the same period.

Connected vehicle services include consumers, vehicle manufactures, government, and industry driven products. Today, most passenger vehicle services focus on infotainment, traveller information, and vehicle manufactures' services.

C-ITS is a subset of connected vehicle services, and supports safety, mobility and emissions applications. At the core is the ability to share messages ten times per second such that they can be used to generate safety critical messages. This latency is achieved via short range communications that is free of congestion – Australia has embargoed the 5.9 GHz bandwidth for this specific use – which is in line with the EU and US.

A large number of use-case applications are emerging for vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-others (V2X) communication – such as a right-turn collision warning, pedestrian in crosswalk warning, and speed and lane closure information at roadwork sites. Arguably, C-ITS services exist today – emergency vehicle priority and the intelligent access program for freight are vehicle-to-infrastructure services. However, these solutions do not meet the proposed C-ITS standards.

AVs are dependent on governments to maintain the physical asset and provide supportive policy, legislation, and regulation. In addition to these, C-ITS is dependent on government to provide the physical ITS infrastructure, arrangements for radio bandwidth, digital infrastructure such as positioning augmentation, transport infrastructure and traffic data, and critically, security to ensure that the messages can be trusted. C-ITS deployment is reliant on all actors to perform their role in a standardised manner in order to realise the benefits of C-ITS.

Approximately 90% of road crashes are caused by human errors, and it is this statistic that is often quoted as the potential safety benefits of AV. This has been moderated by US studies – who estimate more conservatively 40%, or the number of crashes that involve alcohol, distraction, drug involvement and/or fatigue (1).

Automated vehicles have not yet travelled long enough distances or in all conditions for accurate crash reduction estimates to be made. For the current developmental self-driving vehicles (limited to 40km/hr), an initial study by the University of Michigan Transportation Research Institute (2) observed a higher crash rate per million miles travelled than conventional vehicles – albeit with insufficient data to conclude a reasonable level of conference. In this study, the overall severity of crash-related injuries is lower than for conventional vehicles, and the self-driving vehicle was not at fault in any crashes. According to a more recent study by Virginal Tech (3), "When compared to national crash rates that control for unreported crashes, the crash rates for the self driving car operating in autonomous mode, when adjusted for crash severity, are lower".

There is vigorous debate around the social behaviour of the driving algorithms and if these are intuitive to human drivers in a mixed environment. Furthermore, if vehicle manufacturers are liable, are they more likely to develop conservative algorithms – such as vehicle headways – that could decrease the capacity of the roads. Having said that, there were also concerns that seatbelts would increase fatalities prior to their mandate.

Through field operational tests, European studies (4) have estimated the crash reduction potential of a number of C-ITS applications. These range from 1 to 20 percent – with most individual applications less than a few percent each. The highest benefits are attributed to speed-related applications such as in-vehicle speed including speed reductions for road works, school zones, and back-of-queue protection.

There are also a number of C-ITS application that support mobility and a reduction in fuel and emissions – such as green light optimal advisory speed, and eco-approach and departure advice at signals. Literature suggest reductions between 2 and 30 percent in emissions – with most applications again less than a few percent each.

The big data generated from C-ITS for government and industry's maintenance, operations, and planning activities is likely to be of some benefit, but this is not yet well defined. At this time, it is unclear who owns C-ITS data and what if any data will be readily available to government.

Ideally, C-ITS and AV need to converge. C-ITS advisory messages would be more effective if automated. Similarly, AV have sensor limitations - high speeds, inclement weather - and it is more accurate to be told what another user is doing than to estimate with an algorithm – all of which can be improved with C-ITS. Volvo has also performed tests showing that the headways of an AV can be halved when automated vehicles are connected.

Google have said: *"While we love the idea of V2V and V2X -- that'd be super-helpful for us -- we're not relying on them. You can't have a truly autonomous car if you're reliant on V2V or V2X, because there will be times when those go down (5)."*

In the convergence of C-ITS and AV, it is important that government initiatives remain in alignment with auto manufacturers and other areas of industry. *"The process demands constant coordination and alignment of a lot of different interests. Manufacturers and road authorities may choose to pursue their own course – because they believe that in doing so it will give them more control over their own innovation processes. This approach will limit the benefits* (6)".

And then there is the consumer. The University of Michigan (7) conducted a survey of people's attitudes toward automated vehicle technology. Researchers polled 1500 US, Australian and British citizens. While most surveyed believe that AVs will provide advantages, the biggest concern was a mechanical or computer failure with many still believing that humans are the better drivers.

European field operational tests (4) assessed participants' willingness to pay– after the trials, 42% of the respondents said they would buy C-ITS applications (noting these applications were not mature in-vehicle offerings, with the potential for higher false alarm rates than a mature product). Reliance alone on an aftermarket may limit the benefits of C-ITS, and deployment should ideally be an integrated vehicle solution.

Historically, public acceptance of vehicle safety initiatives takes several years - in the 1970s there was resistance to the introduction of seat belts and more recently the ongoing perceptions around speed cameras, despite their objective to ensure people travel at safer speeds. These concerns are explored and resolved through research, testing, and demonstrations.

3. C-ITS investment rationale

The benefits opportunity for the long-term deployment of C-ITS in Queensland and Australia is fundamental to the investment rationale in the ITS Pilot Project business case, and builds on similar economic evaluations undertaken by other jurisdictions including the US and the EU. The following section provides an overview of international and the departments business cases in support of C-ITS.

3.1 Literature review

As part of their proposed mandate for C-ITS in new vehicles, the US has prepared a review of the benefits of V2V (8) – specifically intersection assistance applications (IMA) otherwise know as red light running warning and right-turn assist (LTA). A preliminary estimate of the non-discounted annual maximum benefits, assuming that all passenger vehicles are equipped with only IMA and LTA and the communication rate reaches 100 percent are as follows:

- 412,512 to 592,230 crashes prevented;
- 777 to 1,083 lives saved;
- 191,202 to 270,011 injuries reduced; and
- 511,118 to 728,173 property-damage-only vehicle incidents prevented.

The EU recently completed their C-ITS platform report (9), which includes a rapid cost benefit assessment. Based on a medium penetration of 20 C-ITS applications within vehicles and personal devices – they estimate a benefit-cost ratio of 3 and a positive return on investment by 2021[1]. The report also highlights the need for continued government support of pre-deployment projects and the urgency of action, noting that other parts of the world are already deploying C-ITS.

3.2 Rapid Cost-benefit Analysis for C-ITS Deployment in SEQ

A rapid cost-benefit analysis was prepared for deployment of C-ITS over 30 years, from 2020, for the Southeast Queensland area. Three penetration scenarios where assumed – as illustrated in Figure 1. In the pessimistic model, penetration peaks at around 2030, before slowly declining. This curve assumes no international mandates; incomplete standards; and a lack of consumer interest that yields a retarded uptake and ultimately the retirement of C-ITS. Alternatively it could capture the scenario where C-ITS is replaced, requiring re-investment. Moderate and optimistic models move towards 100% penetration.

[1] http://ec.europa.eu/transport/themes/its/c-its_en.htm

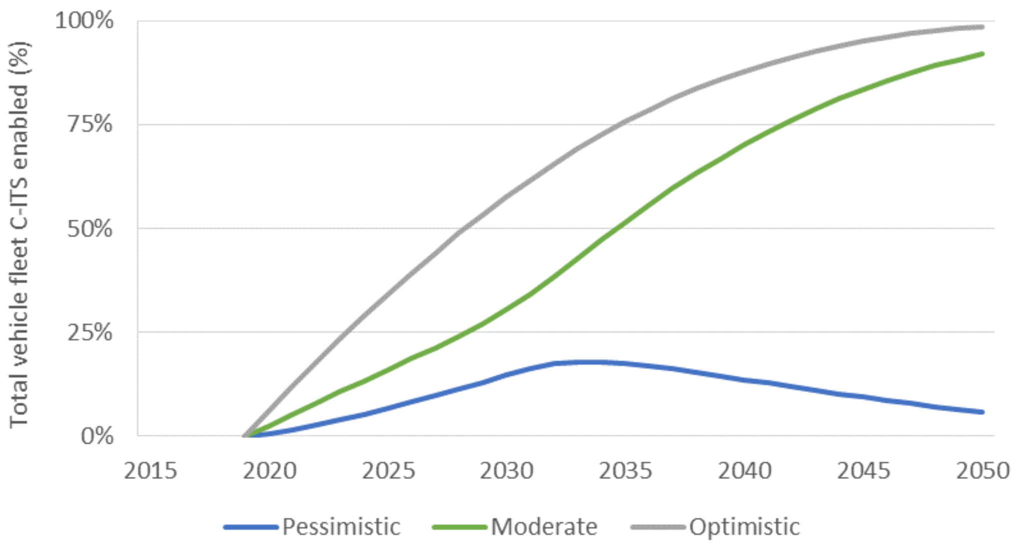

Figure 1 Estimated total vehicle fleet penetration rates

Compared with other Australian and international penetration rates, the SEQ penetration rate curves are lower. This is due, in part, to the assumption that international mandates will take longer to reach Australian vehicles, and Queensland has a slower fleet turn-over. Furthermore, most other studies assume some aftermarket or personal devices, which has not been assumed in the Southeast Queensland model.

In earlier years, when the penetration rate is low, vehicle-to-vehicle application benefits are likely to be retarded due to the lack of vehicle interactions. An EU studies suggests that one-to-one V2V benefits occur when the penetration rate exceeds 20%. However, as project cost-benefit sensitivity testing indicated a negligible impact, no additional reductions have been assumed.

Europe has identified a number of "day one" C-ITS safety applications because of their expected societal benefits and the maturity of technology. Similarly, the US has identified a number of vehicle-to-vehicle applications that they believe have significant societal benefit. These applications have been assessed through field operational tests and simulator studies, and it is this sub-set of safety applications that forms the basis of the opportunity assessment. These applications are summarised in Table 1.

Table 1 C-ITS applications assumed in the rapid cost-benefit analysis

C-ITS application	Type	Fuel consumption reduction
EU-sourced applications		
Roadworks warning	V2I	Provides the driver early notification of road works so that the driver can adjust speed, change lanes, or detour.
In-vehicle speed warning	V2I	Provides the driver with localised speed warning or continuous speed reminders.
Back of queue warning	V2I	Provides the driver early notification of a traffic jam to avoid rear-end crashes at the back of the queue.
Weather warning	V2I	Provides the driver with localised weather-related closures and unsafe conditions information.

C-ITS application	Type	Fuel consumption reduction
Emergency electronic brake light	V2V	Provides the driver with a warning that a vehicle, several vehicles ahead, is braking heavily.
Stopped/slow vehicle warning	V2V	Provides the driver with a warning if they fail to brake when a vehicle in their path is stopped or travelling slowly.
Automatic crash Notification	V2I	In case of a crash, an equipped vehicle notifies emergency response of their location and characteristics of the crash.
US-sourced applications		
Intersection movement assist	V2V	Drivers are warned of a potential collision with another vehicle at a signalised or unsignalised intersection (for example a red-light runner or obscured crossing vehicle).
Right turn assist	V2V	Drivers turning right are warned of an oncoming conflicting vehicle at a signalised or unsignalised intersection.

In addition to these, some secondary benefits in the form of a reduction in incident related congestion, and limited environmental C-ITS application benefits have been included. As Queensland has a mature road operations practice, and given the difficultly measuring the incremental benefits of C-ITS on mobility, mobility benefits have not been captured at this time.

The assumed cumulative benefits of the C-ITS applications under 100% penetration are as follows: 20% crash reduction, 20% reduction in crash related congestion; 3% fuel consumption reduction and 3% emission reduction. These estimated impacts are converted into monetary terms using key assumptions and unit costs outlined in the NGTSM (10) and Austroads Guidelines for Project Evaluation (11).

The costs associated with the deployment of C-ITS can be broadly categorised into vehicle, roadside and central or office systems. The associated costs are as follows:

- In-vehicle cost per year is approximately $34, with an upfront cost of approximately $347 per vehicle.
- Roadside equipment is expected to cost government $13,000 per site, with maintenance cost of $3,696 per site per annum. In total this equates to $36 million (undiscounted based on 2,798 existing ITS sites) upfront costs spread out over a 5 year roll out and $10 million in annual ongoing costs for maintenance and replacements.
- Central system costs consist of specific services for the application. Security, positioning, and automatic cash notification are assumed to be national services, and as such Queensland shares the costs. Applying the penetration between 2020 and 2050, the pessimistic case central ITS system costs are $18 million upfront (undiscounted and $3 million for security) and $3.2 million per year (undiscounted), while the optimistic case $44 million upfront (undiscounted and $29 million for security) and $3.2 million per year.

In-vehicle ITS systems make up around 84% of the upfront costs or $329 million in the moderate scenario, using a 7% discount rate. Likewise, in-vehicle system costs make up the majority of ongoing costs, 74% or $295 million in the moderate case. Government costs generally relate to the whole-of-life costs of the pilot, central and roadside ITS systems. Over the 30 year evaluation period this amounts to $166 million in present value terms. Roadside and central systems represents 37% of the department current operations and maintenance budget.

Under all scenarios, C-ITS is expected to provide significant net benefits to society. The benefit cost ratio (BCR) of the moderate scenario is 3.4 with a net present value (NPV) of $1.9 billion using a 7% discount rate. The benefits of the project start to accrue from 2021, after the roll out of roadside ITS systems is completed in 2020. A break-even NPV is achieved under a much lower crash reduction rate of 8.1% (compared with estimated 20% crash reduction). Even under the pessimistic penetration rate scenario a BCR of 2.1 and an NPV of $0.6 billion is achieved.

There is limited evidence around the incremental benefit of C-ITS to AVs, however, those studies that have been completed suggest that the automation of C-ITS warnings/messages doubles the likely crash reduction. Likewise, it is reasonable to assume that the OEM cost would be larger. Given the limited information available, further investigation is warranted to explore the benefits of cooperative technologies for partial and fully automated vehicles.

The Motor Accident Insurance Commission (MAIC) also prepared an analysis of the impacts of C-ITS on the Queensland Compulsory Third Party (CTP) scheme. The CTP scheme provides motor vehicle operators with an insurance policy that covers their liability for personal injury caused by the use of the insured motor vehicle in incidents to which the Motor Accident Insurance Act 1994 (MAI Act) applies. Based on a 30 year analysis period, a pessimistic penetration of C-ITS has CTP savings of $170m, compared with an optimistic penetration resulting in savings of $1.1 billion.

4. Strategic alignment

Over the last few years, there has been a lot of energy by federal and state organisations to develop policy, strategies, and action plans in support of cooperative and automated vehicles.

In 2012, Austroads' C-ITS strategy (AP-R413-12) identified a roadmap to national deployment. The road map includes a range of tasks - policy, national engagement, technical requirements, platform deployment, pilots, and marketing and communications.

Following the 2014 Austroads review of the *National Road Safety Strategy 2011-2010* (Transport and Infrastructure Council 2015), a three-year road safety action plan for was developed to focus national efforts on activities that would deliver or support significant long-term improvements to the safety of Australia's road transport system. Subsequently, Austroads delivered a number of actions to support C-ITS, including the embargo of 5.9 GHz.

The Australian Federal Chamber of Automotive Industries (FCAI) requested that Austroads develop a C-ITS regulatory framework by 2017– with the expectation that market deployment would occur sometime after this date. Through Austroads, the states have informally agreed to adopt the European C-ITS framework. These align with specific technical vehicles standards and radio frequency spectrum constraints in Australia. A set of core C-ITS standards are currently being harmonised by a global team, which includes Australia.

Moving forward, Austroads C-ITS program includes a number of key C-ITS deliverables:

- allocation and management of 5.9GHz band
- review and establishment of regulatory policies to support deployment compliance
- development of functional requirements and business processes for core functions

- establishment of interim management and operational arrangements for core functions
- input and guidance for local pilots and deployment.

Austroads are also undertaking several AV studies, which include:

- issues road operators will face to support the introduction of AVs
- safety benefits, and
- registration and licencing issues.

In Queensland, the 2016 State Infrastructure Plan (SIP) sets out the Government's infrastructure priorities and a vision to grow the state. Mid to long-term opportunities include cooperative and automated vehicles, specifically:

- Opportunity 9 (Digital) – Harvest the benefits of new and emerging technology digital disruptions that may reduce the demand for future infrastructure (e.g. autonomous vehicles, solar battery storage and telehealth).
- Opportunity 30 (Transport) – Prepare the transport network for connected/autonomous passenger and freight vehicles.

The 2015-2017 Queensland road safety action plan also has a number of relevant actions, including:

- Action 16 – Better manage speed through the trial of innovative technology.
- Action 30 – Facilitate the early deployment of new vehicle technology, specifically in support of vulnerable users.

In 2015, the department released "A plan for Intelligent Transport Systems (ITS) in Queensland (the Plan). The Plan maps out the future direction of ITS in Queensland, and the activities required for the development and adoption of ITS. To enable the acceleration of technology deployment, the plan highlights the need for pilot projects, in particular large scale pilot projects for cooperative and automated vehicle technologies. This plan led to the development of the business case for the ITS Pilot Project.

5. Field operational test

In order to define the technical solution and explore possible applications and their associated benefits, field operational tests have, and continue to be, completed around the world. A field operational test is defined as: *"a study undertaken to evaluate a function, or functions, under normal operating conditions in road traffic environments typically encountered by the participants using study design so as to identify real world effects and benefits* (12)".

Pilot projects are pre-deployment projects occurring last in the chain of projects towards deployment. Examples of recent US and EU initiatives are listed below. These build upon the outcomes of C-ITS FOTs over the last decade, which aim to test the end-to-end solution including user benefits and customer perceptions:

- **Connected Vehicle Pilots** commenced in the US in three locations (New York City, Tampa – Florida and Wyoming). The New York City trial will involve 10,000 city-owned vehicles, including cars, buses and limousines. Applications will include Eco-Speed Harmonisation, Red light Violation Warning, Pedestrian in Signalised Crosswalk Warning, Vehicle Turning Right in Front of Bus Warning and Reduced Speed/Work Zone Warning.

- **Cooperative ITS Corridor** will run between Vienna in Austria, Munich and Frankfurt in Germany and Rotterdam in The Netherlands. The applications include roadworks warning and probe vehicles that will transmit information about current traffic conditions to roadside infrastructure and traffic control centres.
- **Compass4D pilot project** will deploy C-ITS services in seven European cities (Bordeaux, Copenhagen, Helmond, Newcastle, Thessaloniki, Verona and Vigo). Three C-ITS applications - Road Hazard Warning, Red Light Violation Warning and Energy Efficient Intersection - will be piloted for one year using different vehicle types.
- **SCOOP@F** will equip 3000 vehicles and 2000 km of streets, intercity roads and highways in Ile-de-France and Bretagne, the Paris-Strasbourg highway, Bordeaux and its bypass and county roads in the Isère. Applications examined include road hazard signalling and traffic information.

FOT-Net Wiki (13) provides an extensive database of over 70 field operational tests (FOTs) and pilot projects involving cooperative and automated vehicle technologies. These examples alone comprise an investment in excess of AU$700 million (not including specific AV-focussed research). The US has recently announced a 2017 budget proposal of US$4 billion over 10 years on connected (including cooperative) and automated vehicle technologies (14).

In Australia, Transport for New South Wales has established a working C-ITS testbed, Cooperative Intelligent Transport Initiative (CITI) for 60 heavy vehicles in the Illawarra region, south of Sydney. This will is one of the first large scale test facilities dedicated to heavy vehicles in the world. A roadside station broadcast speed limit information to heavy vehicles about the 40km/h truck and bus zone down the Mount Ousley descent. Three intersections are also equipped with C-ITS to provide real time red signal information via displays mounted inside the heavy vehicles' cabins. The freight applications also include forward collision and intersection collision warnings. The project is ongoing and a further heavy-vehicle C-ITS initiative is commencing for freight priority at selected traffic signals in Sydney.

As noted, the Australian states have informally agreed to adopt the European C-ITS framework. This approach still has a range of challenges, some requiring local solutions, as explored below:

Standards
Standardisation is fundamental to the success of C-ITS. An interoperable standardised solution enables a critical mass of users (different vehicle manufacturers) to achieve the societal benefits that government seeks. This in turn creates economies of scale required for a competitive market – with innovation continuing to address user needs and lower the cost of the solution. A range of technical standards have been developed for C-ITS. Many of the FOT projects have used some but not all standards, or older versions of the standards. There is still an ongoing need to test and develop these standards in relation to interoperability.

Access communications
The ETSI EN 302 665 standard has 5.9 GHz communications at the core of C-ITS provision. The 5.9 GHz band is a dedicated short-range communications (DSRC) in the US, G5 in Europe, and M5 by ISO. Short-range communications is desirable due to the low message delay and good reliability. Despite these desirable attributes, coexistence with other industries can result in interference, which may impact the timeliness of the message. "*Co-*

existence between C-ITS and other wireless technologies in the 5.9 GHz band need to be studied thoroughly 1".

Applications that do not require the low latency, high reliability, or significant privacy protection (e.g. mobility and logistics, environmental performance, road weather and traveller information) can use commercial cellular services, such as 3G or 4G, or free to air services such as Bluetooth or Wi-Fi 8, and future services such as LTE direct. The possible provision of data through different communication channels, and the corresponding question on how to validate which message is most recent, relevant, and accurate is also being studied.

Security
"Security is paramount to the deployment of C-ITS - No security, no C-ITS". 1 Cooperative exchange of data to provide warnings to drivers can only work when participants in the system are able to trust the data and warnings issued by others. The EU goal is to develop a common, standardised security model that can be used across the EU. Harmonisation is also required internationally for security. Work is ongoing through the international harmonisation task group, and the security model is still being developed and tested within FOT projects.

Positioning
The ETSI TS 101 539-3 standard requires lane level accuracy (within 1 m with a 95% confidence level) for C-ITS applications. Current positioning give up to 1-10 m accuracy – and even with satellite based corrections a number of FOTs have observed positioning accuracy issues that result in false alarms, or worse, no alarms. As such, positioning remains a focus of the FOT in improving the C-ITS offerings.

"*International cooperation is fundamental for cooperative systems as worldwide markets have global players which therefore require global strategies* (9)". To date, the Transport for NSW CITI project does not specifically examine the European framework, and as such there remains a need for Australia to perform FOT projects to explore these technical challenges in a local context. The success of the department's ITS Pilot Project business case will enable Queensland, and more broadly Australia, to begin to explore the benefits for local road users and the end-to-end technical solution for C-ITS.

In relation to automated vehicles, a FOT would require a substantial commitment from a vehicle manufacturer, and a meaningful study would require a large number of vehicles, or a long study period. Despite these limitations, the business case stakeholders have expressed interest in supporting a CAV pilot, which would be limited in scope.

The specific advantages to Queensland of undertaking a pre-deployment pilot project include:

- building the department's technical and organisational readiness for C-ITS and CAVs
- adapting existing systems, infrastructure, and data (i.e. STREAMS)
- testing that C-ITS standards can be transferred to Australia, and identifying technical issues and solutions where these do not
- providing evidence to support societal debate on the impacts and benefits
- raising awareness and educating the Queensland public, and
- facilitating competition between suppliers for C-ITS/CAV services
- establishing industry partnerships in the C-ITS and AV ecosystem.

6. Impact on government

"Many traditional functions undertaken by government, such as road design, traffic management, network operations, pavement design, and transport modelling, will substantially change, reduce or may even disappear or be replaced with new functions (15)"

Within the department, there are a broad range of possible impacts on funding, planning, construction, maintenance and operations – as summarised in Table 2. These will require new and enhanced skills, services, and standards – and leadership to drive such significant change management exercise within government and industry.

Emerging technologies have potential significant societal benefits, however, they are likely to require new investment while maintaining an environment that supports traditional vehicles during the transitional phase.

Table 2 Unknown impacts to governments business

Funding / Investing	Planning	Constructing/ Maintaining	Operating
▪ revenue models ▪ subsidises to encourage use ▪ shift from traditional investment ▪ enabling industry ▪ new partnerships ▪ insurance	▪ asset demand ▪ travel demand ▪ mode choice ▪ vehicle ownership ▪ shared services ▪ technology adoption rates ▪ consumer demand/ vs need for incentives ▪ models ▪ metrics ▪ policies	▪ design standards ▪ maintenance requirements ▪ ITS and impacted asset phase-out ▪ costs	▪ digital asset / services ownership & management ▪ technical feasibility – positioning, sensors, mapping, security, communications assess, connectivity ▪ legacy systems ▪ regulations, standards, codes of practice for testing

National Transport Commission (NTC) has reviewed the regulatory barriers for automated vehicles – and identified regulation that impact automated vehicles – the next step is for governments to agree on a framework to support evolving vehicle technologies. The implications for driver licensing is also under review. Desirably a driverless vehicle should not require a licenced driver – enabling the disabled, children and the intoxicated road user's access to a driverless vehicle. There continues to be debate around the needs of these vehicles under a fully automated environment.

7. Queensland's ITS pilot project

Within the Pilot Project, the field operational test will be used to deploy and evaluate the selected C-ITS applications in alignment with the project objectives.
Queensland has identified the need for a pilot project for C-ITS and CAV applications. The intent of this pilot is as follows:

- validate the impacts and benefits the C-ITS and CAV, and user perceptions
- demonstrate technologies publically and build public awareness and uptake
- grow the department's technical and organisational readiness, and

- encourage partnerships and build capability in private and public sectors.

The ITS Pilot Project will comprise of two components:

- *C-ITS pilot* – "day 1" safety applications (vehicle-to-vehicle and vehicle-to-infrastructure) will be trialled through a field operational test on public roads with 500 public participants in Southeast Queensland (SEQ). The pilot will also develop and test vehicle-to-vulnerable road user applications that specifically address identified safety issues in SEQ.

- *CAV pilot* – a small number of cooperative and highly automated vehicles will be developed and tested in off-public and on-public roads. The research will include an asset readiness, driver behavioural and vehicle performance assessment.

The Pilot will take place over five years commencing in mid-2016, with the field test starting in 2018.

As part of the ITS pilot project, a change management exercise including development of a 5 year action plan will be prepared.

8. Conclusions

The ITS Pilot Project is a critical step towards C-ITS and CAV deployment in Australia through testing of end-to-end services in an interoperable standards-based environment. Whilst the pilot will not test the final solution, it will provide important learnings for adaption of TMR systems, data and infrastructure to enable C-ITS equipped vehicles to operate in Queensland, as well as inform the development of national solutions for foundational services such as network access, security and positioning. The evaluation of impacts and benefit of C-ITS and CAV technologies will validate the investment logic for government and industry investment.

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