The CITI Project: Building Australia's first Cooperative Intelligent Transport System test facility for safety applications

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Abstract

Cooperative Intelligent Transport Systems (CITS) increase the "time horizon", the quality and reliability of information available to the drivers about their immediate environment, other vehicles and road users. This has the potential to greatly improve road safety, reduce greenhouse gases and improve network efficiency. The Cooperative Intelligent Transport System Initiative (CITI) pilot will be the first semi permanent CITS field test site in Australia. The Objective of the CITI project is to construct a 42 km connected freight corridor test facility in the Illawarra Region of NSW south of Sydney. This will be one of the first large scale test facility dedicated to Heavy Vehicles in the world. It is expected that road safety researchers across Australia as well as hardware and software developers from around the world will visit the Illawarra to test and evaluate the safety benefits of their systems. The project proposes to fit in-vehicle Dedicated Short Range Communication (DSRC) transceivers into approximately 30 heavy vehicles that regularly travel the planned route. In future years the project is planned to install the technology into a further 120 trucks as well as passenger buses and light vehicles that regularly travel on the southern section of the route. The paper will outline the expected road safety benefits of CITS for Australia as well as provide details of the facilities being constructed in New South Wales and the opportunities that will be provided for Australasian road safety researchers.

What are Cooperative Intelligent Transport Systems?

Intelligent Transport Systems (ITS) is a term used to describe the use of information and communication technology within the transport sector to improve transport outcomes (NTC 2012). Cooperative Intelligent Transport Systems (CITS) is the term generally defined as a form of ITS in which information is shared amongst vehicles or between vehicles and roadside infrastructure such as traffic signals. An example of a common CITS application is in electronic toll collection where a vehicle mounted toll tag is detected by a road operator who in turn charges the owner of the vehicle for travelling on a section of road.

Unlike electronic tolling, new CITS applications allow two way communications between vehicles and infrastructure many times per second. Sophisticated CITS applications have been developed that increase the "time horizon" as well as the quality and reliability of information available to the drivers about their immediate environment, other vehicles and road users. This has the potential to greatly improve road safety, reduce greenhouse gases and improve network efficiency.

Whilst a number of communication platforms such as the 3G or 4G mobile phone network can be used to carry communications between vehicles and roadside units, specific dedicated short range radio channels in the 5.9 GHz area of the radio spectrum is planned to be used by most major jurisdictions overseas. In Australia, use of the 5.9 GHz band is currently embargoed and the Australian Communications and Media Authority (ACMA) has recognised its future potential use for C-ITS, however a final determination on the use of the spectrum and its licensing is yet to be made (NTC 2012).

What are the benefits of Cooperative Intelligent Transport Systems?

Researchers and manufacturers have suggested that the wide spread implementation of CITS in our vehicle fleet and within roadside infrastructure could have widespread and substantial road safety, environmental and network efficiency benefits.

The Road Safety Benefits of Cooperative ITS

The United States Department of Transport in their white paper on CITS has estimated that up to 82 percent of all crashes by unimpaired drivers could potentially be addressed by vehicle to vehicle (V2V) technology. If V2V were in place, another 16 percent of crashes could potentially be address by vehicle to infrastructure (V2I) technology.

Austroads conducted a study into the potential road safety benefits of vehicle to vehicle dedicated short range communications (DSRC) in September 2011. The report found that the current total of approximately 29,000 annual serious casualties could be reduced to between 18,500 and 21,500, a reduction of 25-35 per cent (Austroads 2012). A serious casualty includes road users that are killed or seriously injured as a result of a road crash.

Other benefits of Cooperative ITS

The National Transport Commission also reports that overseas studies indicate that significant environmental and productivity benefits may also result from the deployment of CITS applications. Signal phase and timing (SPAT) information sent from traffic signals to vehicles may yield fuel consumption savings around 15% as well as associated benefits in terms of greenhouse gas emissions.

Tientrakool (2011) and other researchers from Columbia University researching autonomous vehicles found that vehicle using sensors to avoid collisions could increase the capacity of a highway by about 43 percent. However, if these vehicles were also able to communicate with each other, highway capacity would improve by 273 per cent.

CITS projects across the world

CITS projects are planned or currently being conducted in the United States, Europe, Korea and Japan. The largest projects currently underway are the US Safety Pilot deployment and SIM TD in Germany.

In the United States Department of Transport (US DOT) commenced a 2,800 vehicle pilot of CITS in Ann Arbor, Michigan in the autumn of 2012. The ‘Safety Pilot’ deployment is scheduled to finish in August 2013. Sixty-four vehicles will have embedded devices; approximately 300 vehicles will have aftermarket safety devices; and the remaining vehicles will have simple transmission-only vehicle awareness devices (RITA 2013). The model deployment includes providing equipment to send and receive data along 73 lane-miles of roadway in the northeast Ann Arbor area. Dedicated short-range communications (DSRC) equipment is installed along these routes at:

- 21 signalized intersections,
- 3 curve locations, and
- 5 freeway sites.

Data is being collected from onboard equipment (OBE) and roadside equipment (RSE) during the model deployment which will be used to evaluate potential safety benefits of CITS. Transport for NSW researchers have been working closely with the Ann Arbor Team in the establishment of the CITI project.

In August 2012, the Sim TD Car to X project started in Germany's Hessen Region. The object of this project was to test how V2V and V2I systems would work under real road conditions. Around 120 vehicles are involved in the project. Vehicles share information wirelessly using a custom platform based on Wireless Local Area Network (WLAN) technology. Here, data is passed from vehicle to vehicle via roadside transmitters. Where this is not possible, such as driving through areas where the roadside infrastructure has not yet been developed, researchers have enabled mobile phone networks to be used.

The CITI project

Location

The Sydney to Wollongong Freight Corridor is the key link between Sydney and Wollongong (Australia's tenth largest city), providing the connection between the greater Illawarra region and the south western suburbs of Sydney.

The CITI project is proposed to cover a 42 km length of road that connects the Hume Highway in Sydney's South West to the port of Port Kembla situated two kilometres south of Wollongong Central Business District. The map below shows the proposed route.

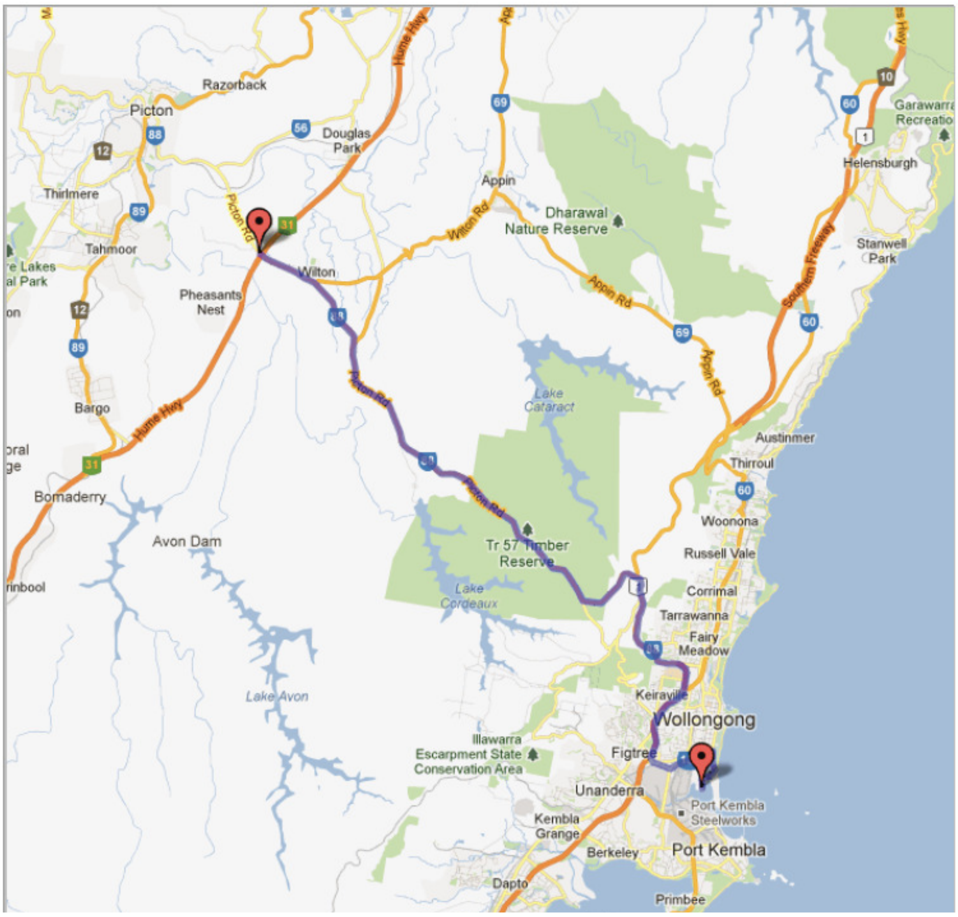

Figure 1. Proposed route for the CITI project

Mt Ousley Road and sections of the Southern Freeway are part of the National Land Transport Network. Mt Ousley Road recorded an Annual Daily Traffic Volume in 2011 of 42,993 vehicles of which 11.8% are classified as heavy vehicles. Having recently undergone a major expansion, Port Kembla has seen a diversification of its trade base to include general and break bulk cargoes, containers and motor vehicle imports. This expansion, which included the construction of three new berths and the development of 53 hectares of land, has allowed the port to become the largest vehicle importing hub in Australia. It is also the principal grain export port for producers in Southern and South-Western NSW. In the 2010/2011 financial year, the port had a record trade throughput of 33.6 million tonnes in volume and $13.5 billion in value for the year. These were increases of 8.2% and 3.2% respectively.

Heavy vehicles were involved in the deaths of 69% of the 13 people killed in fatal road crashes recorded on the proposed route between for the three year period up to 30 September 2011. It has been estimated that the cost of those crashes to the community over the same three year period exceeded $45.5 million (Transport for NSW 2012).

In October 2008, a Road Safety Strategy was developed for the Picton Road between Mount Ousley and the Hume Highway. The Strategy concentrated on physical works with an emphasis on physical separation of vehicles travelling in opposite directions, speed limit reductions and increased automatic and traditional speed limit enforcement.

Type & number of Dedicated Short Range Communication Devices within the project

The first stage of the project proposes to fit in-vehicle dedicated short range communication (DSRC) transceivers into 30 trucks that regularly travel the planned route. In addition, at least one signalised intersections will be equipped with DSRC roadside units which will communicate with the trial vehicles. A 40 km/h truck and bus speed zone warning system is also planned for installation at the top of Mt Ousley to alert drivers about to descend the very steep (up to 12 percent down hill gradient) south bound section of the road.

Initial use cases

Austroads report on the evaluation of road safety benefits lists 18 safety related DSRC applications related to V2I communication and a further 14 through V2V systems. These applications were then evaluated for their potential influence on serious casualty numbers. The most effective DSRC applications according to the 2011 Austroads report are:

- Intersection collision warning (V2I application)
- Left/Right turn assistance (V2I application)
- Cooperative collision avoidance warning (V2V application)
- Cooperative forward collision avoidance warning (V2V application)
- Pre-crash sensing (V2V application)

It is expected that the CITI project will include all of the most effective applications identified by Austroads with the exception of pre-crash sensing which would need to be built into the vehicle by the original manufacturer.

In addition to the applications previously described, the project will also deploy within the first stage of operation:

- Electronic brake light
- Contextual speed limit information
- Adverse weather alerts
- Limited signal phase and timing information.

Funding model

The funding model for this project is unique with just over $1.4 million of funding for the initial project having been sourced on a 33/50 percentage basis by the NSW Government through the NSW Road Safety Program and the Federal Government's Heavy Vehicle Safety Productivity Program under the Nation Building Program respectively. A contribution from National ICT Australia (NICTA) of $250,000 was also received and will come primarily in the form of a Project Manager, and covers the remaining 17 per cent.

Progress to date

Dr Paul Tyler from NICTA was appointed as the project manager for the CITI project in February 2013. He is a Senior Research Engineer who has specialised in Intelligent Transport Systems. Dr Tyler has worked mainly on the Smart Transport and Roads (STAR) project which aims to use advanced information and communications technologies to help solve the world's urban traffic congestion problems.

Funding for the project was announced jointly by the Federal Minister for Infrastructure and Transport and Minister for Regional Development and Local Government and the NSW Minister for Roads and Ports in March of 2013.

A survey has been conducted by the CITI team to establish which Heavy Transport Companies visit the port on a regular basis. These companies have been contacted to gauge their interest in participating in the project. A number of large transport companies have expressed an interest in participating in the project including Toll Holdings, Scotts and Ceva Logistics. A good working relationship has also been established with the Port Kembla Port Corporation of the project team to gain access to roadways within the port which includes rail level crossings. These roads will enable the team to develop small test sites before moving the equipment on to the public road network.

Technical specifications for both the on-board units for vehicles and roadside units for infrastructure are nearing completions. Two suppliers of the DSRC equipment for the US DOT Safety Pilot in Ann Arbor have been identified as operating within Australia. It is envisaged that both will be interested in tendering for the supply of radio units when the request for proposals are released in the second half of this year. Design work has also commenced on the roadside transmission unit housings which will need to be capable of operating in urban and remote rural environments without mains power.

Discussions have commenced with ACMA in regard to having an exemption to the current embargo on the 5.9 GHz frequency band within the radio spectrum and establishing a licensing arrangement for the project. While previous short term trials have been granted similar licenses, the semi-permanent nature of this project is new ground for ACMA. In preparation for licensing of the project the project team engaged the CSIRO to undertake a radio interference study to establish levels of interference within the 5.9 and 5.8 GHz bands of the radio spectrum. This will ensure that unintended emissions from equipment in the area around the port for example will be understood and interference with the DSRC communication system might be foreseen.

The project team is also developing two small permanent demonstrations sites, one in Wollongong and one in Sydney that can be used to demonstrate the technology to potential participants as well as other interested parties.

Conclusion

Cooperative Intelligent Transport Systems offer the promise of increased road safety, improved efficiencies and substantial environmental benefits. However, no semi-permanent facility was available in Australia to test the validity of these claims.

The CITI project will be Australia's first semi permanent test facility for connected intelligent transport systems. The project also differs from others around the world in that it is planned to be available to researchers of Intelligent Transport Systems for up to five years, whereas most other demonstration sites have only been established for a period of up to 18 months.

The CITI project is not only a trial of Cooperative Intelligent Transport Systems Technologies but a platform that road safety researchers and practitioners can use to evaluate and develop what may become known as the road safety 'silver bullets' of the 21st century.

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