NACOE

NATIONAL ASSET CENTRE OF EXCELLENCE

FINAL REPORT

Project Title: R61 Investigating the use of Telematics to Deliver Messages to Drivers (Heavy Vehicles)

Project No: PRJ17145

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AN INITIATIVE BY:

arrb GROUP

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SUMMARY

The Australian Road Research Board (ARRB) was engaged by the Department of Transport and Main Roads Queensland (TMR) as part of the National Asset Centre of Excellence (NACoE) research program to undertake a literature review which investigates how technology may be used to deliver access condition information into the vehicle en route, using available in-vehicle telematic devices. The purpose is to provide drivers with access to practical information on permits, operating conditions and bridge restrictions.

The literature review and stakeholder consultations looked at various aspects related to background, messaging and information to drivers, technologies, role of TMR, opportunities and key issues.

In relation to the provision of access condition information the following key points were noted:

- There is a range of access condition types and information.
- There are several telematics providers.
  - Some are starting to provide truck-related information that they are obtaining themselves.
- Road agencies are exploring pilots to set up a data portal to provide road agency heavy vehicle access condition data to telematics providers.
- All local, state and territory road agencies access condition data should be made consistent, so that in-vehicle units can be used nationally.
- There is a need for standardised delivery of network access conditions that can be utilised in the telematics devices.
- Jurisdictions need to make access condition data available for use by in-vehicle units.
- There needs to be a clear incentive for users to take up in-vehicle technology, including avoiding using it for direct enforcement.

In relation to the messaging and provision of information to drivers, key points noted included:

- There is a need to set up a data web portal for in-vehicle units to obtain access condition information.
- Delivery of messages to motorists can occur via various third-party service providers such as:
  - in-vehicle navigation devices
  - third party map displays on the internet
  - in-vehicle telematics units/applications
  - in-vehicle C-ITS units/applications.
- Access condition data must be accurate as it will be used for route decision making and indirect enforcement.
- TMR should work with local, state and territory road agencies to ensure that data is consistent. This will help to maintain integrity.

The section discussing the various technologies required to deliver information to vehicles noted the following:

- In-vehicle units should be set up by commercial entities. Road agencies (such as TMR) should provide the legislative framework.
  - There should be a process to type approve devices.
- Communication providers are responsible for the communication of messages and in most cases the cellular network is adequate for the delivery of messages on road networks that TMR controls.

Based on the literature review and stakeholder consultation the role of TMR in the use of telematics to deliver messages to drivers was found to be as follows:

- Road agencies (such as TMR) need to establish and maintain the accuracy of permit conditions. This includes closing out permit conditions in a timely manner that are no longer relevant.
- Road agencies (such as TMR) should set up the standards for minimum level of compliance for telematics devices.
  - This is to ensure users can rely on the device.
  - The standards should allow for flexibility in the delivery of information.
- Road agencies (such as TMR) need to ensure that telematics providers are using accurate information, not just from when it was certified, but day to day.

Opportunities for TMR due to making access condition data available in-vehicle include:

- improved safety (excluding any potential for the in-vehicle telematics device to result in driver distraction or result in the human interacting with it in a non-desirable manner)
- improved productivity
- quicker determination of access routes
- improved compliance to access conditions.

It is noted that the opportunities are reliant on the data portal set up by TMR being scalable.

Key issues associated with the use of telematics to deliver messages to drivers include:

- For access condition data to be delivered in-vehicle requires that the following be implemented successfully:
  - data
  - information
  - delivery.
- The primary domain area of interest for TMR is the provision of data.
- Telematics providers can then access the data and develop systems to turn the data into meaningful information, for example route guidance.
- Telecommunication providers enable the data to be delivered.

There are three key recommendations for TMR:

- Recommendation 1: TMR to develop a policy on making their road access condition data for heavy vehicles available for use in-vehicle via telematics providers. The policy should not specify the technology to be used and remain technology agnostic. It should however specify the desired outcomes. The policy should also refer to the need for local government to provide road access condition data applicable to their network.

- Recommendation 2: TMR standardise their access condition information.
- Recommendation 3: A concept of operations needs to be developed to outline how TMR can make their road access condition data available.

ACKNOWLEDGMENTS

This project would like to acknowledge the contributions of various personnel who have contributed to this project through making themselves available for consultations. A list of those people is contained in Appendix A.

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1 INTRODUCTION

The Australian Road Research Board (ARRB) was engaged by the Department of Transport and Main Roads Queensland (TMR) as part of the National Asset Centre of Excellence (NACoE) research program to undertake a literature review which investigates the use of telematics to deliver messages to drivers (of heavy vehicles). This document outlines the findings associated with this project.

The National Heavy Vehicle Law defines access conditions in three categories: vehicle, road and travel. The vehicle conditions are primarily the responsibility of the National Heavy Vehicle Regulator (NHVR) and the travel and road conditions are primarily the responsibility of the road manager. Generally, vehicle conditions should include the following:

- how the vehicle should be configured (e.g. trailer type)
- general requirements to mitigate risks subject to a mass or dimension
- installation and use of certain components (including safety features or other equipment)
- limiting the vehicle to a speed.

The NHVR Guidelines list the following examples of road conditions:

- not use bridges or sections of the otherwise approved route
- be limited to a speed
- travel at a speed under the posted speed limit
- operate in a specified position on the road (e.g. travel in certain lanes may be restricted)
- have the operator participate in the Intelligent Access Program and requirements to install on-board mass technology.

Travel conditions may require that the movements of heavy vehicles are undertaken at stated times or in a stated direction.

It is the responsibility of the heavy vehicle driver and operator to be aware of the access conditions for the road they are travelling on for the type of vehicle they are driving and obtain the necessary permits where required. The permits will then contain the necessary conditions of the permit issued.

Advancements in technology offer new opportunities to communicate access conditions to vehicles while on the road. This can provide more timely and cost-effective ways of communicating information which can potentially aid in the heavy vehicle driver and operator’s ability to better comply with the conditions. Advancements in technology in recent years include:

- advancements in information and communication technology
- increased network coverage and bandwidth
- increasing penetration of in-vehicle and personal devices.

Use of technology to communicate information can provide TMR with new and more timely avenues to deliver road access condition information and therefore enable better compliance.

The structure of this document is as follows

- Section 2: Background

  This section discusses the various access conditions and provision of access condition information currently available.

- Section 3: Messaging and Information to Drivers

  This section discusses issues around the messaging and provision of information to drivers.

- Section 4: Technologies

  This section discusses the various technologies required to deliver information to vehicles including in-vehicle units, communications and message management systems.

- Section 5: Role of TMR

  This section discusses the key findings associated with the literature review that pertain to the role of TMR in the use of telematics to deliver messages to drivers.

- Section 6: Opportunities

  This section discusses the key findings pertaining to the opportunities associated with the use of telematics to deliver messages to drivers.

- Section 7: Key Issues

  This section discusses the key findings associated with the use of telematics to deliver messages to drivers.

- Section 8: Conclusions and Recommendations

  This section discusses the conclusions and recommendations arising from this project.

1.1 Project Scope

This project came about through the identification of the need for the NACoE program to investigate the use of telematics to deliver messages to drivers. A project proposal was submitted to the NACoE program and subsequently approved.

The project was assigned to the heavy vehicle section of TMR, and a decision was made to focus the investigation on the provision of the information to heavy vehicle drivers.

An inception meeting was held on 25 August 2017 with representatives of TMR and the National Heavy Vehicle Regulator (refer to Table A 1 – TMR (1) for the list of attendees). At the inception meeting it was decided that the project should focus on the relaying of heavy vehicle access conditions.

As a result, the aim of the project was redefined to investigating through a literature review, how technology may be used to deliver access condition information into the vehicle en route, using available in-vehicle telematics devices. The purpose is to provide drivers with access to practical information on permit, operating conditions and bridge restrictions. The redefined scope of the project was confirmed to be as follows:

- Heavy vehicles in general are the primary vehicle of interest to this project.
- The literature review should lead to a blueprint for the provision of information that TMR could then apply to deliver information to service providers.
- The literature review should lead to a process which TMR can apply to get the right information to drivers and operators in a timely manner.
- The literature review should explore any legal versus voluntary information requirements.

- The focus should be on the provision of heavy vehicle access information pertaining to heavy vehicle access to bridge structures and flood-affected pavements (the driver should be forewarned of flooded/post-flooded roads which need protecting at key decision locations). For this investigation, the focus is on the provision of static information. Any system developed as part of this project should be scalable to include dynamic real-time information.
- The literature review should not extend into enforcement and instead be focussed on access information.
- It was noted that any solution to get access information to HV drivers should be agnostic on the technology but specify the requirements. It is noted that the Intelligent Access Program (IAP) specifications could potentially outline how to communicate information.
- It was noted that telematics providers would be interested in HV access information. Ultimately this project could lead to the development of a TMR portal in which navigation providers could access this information for provision to HV drivers and operators.
- Any access condition information contained within a portal would likely need to comply with traffic information protocol and standards around the delivery of information.
- The information is advisory in nature and therefore not regulated.

This document provides findings of the literature reviewed and from consultations undertaken with key experts. A list of the key experts consulted is in Appendix A. Key points noted from the consultations are identified in this document by the name of the person consulted followed by the date of the consultation.

2 BACKGROUND

This section discusses findings from the literature that relate to:

- Road Access Conditions – Types – Queensland: Section 2.1
- Road Access Conditions – Information – Queensland: Section 2.2
- Telematics Providers: Section 2.3
- Provision of Road Access Conditions In-vehicle and Other Jurisdictions – Locally and Internationally: Section 2.4.

2.1 Road Access Conditions – Types – Queensland

There are many types of road access conditions and restrictions in Queensland. TMR (2016) uses the following:

- length
- width
- height
- mass
- road or district
- condition type (i.e. temporary, short term, permanent).

The access condition information and restrictions the truck drivers need to follow to drive on Queensland roads are discussed in Section 2.2.

In addition to the information from TMR, the National Heavy Vehicle Regulator (n.d.) gives information on road access conditions through its journey planner. To access the information the truck type is chosen through a check box. The information that is supplied is discussed in Section 2.2.

ARRB (2013c) outlines that there is another method of determining access to roads even if vehicles do not meet the road access conditions. This method is through the Performance Based Standards (PBS) scheme, in which the vehicle is assessed based on its performance instead of its dimensions and axle masses.

2.2 Road Access Conditions – Information – Queensland

TMR (2016) provides the road access conditions and restrictions in a PDF document. The tabulated information relates to the following:

- district
- road
- structure/location (if applicable)
- restriction type
- measurement for restriction
- restriction and duration.

This gives the user the location of the restriction, what the restriction is, the conditions of the restriction and any additional information that may be required. Examples of restrictions include height restriction associated with the height clearance to drive under a bridge, mass restriction due to a bridge not being built to take certain loadings and width restriction due to the width of the road or due to roadworks.

In addition to the road access conditions, TMR has the Queensland traffic and travel information rich site summary (RSS) feeds which give information, in either a visual representation or tabulated form, about road and traffic incidents and roadworks. More importantly for trucks, this service gives information regarding load limits and restrictions on Queensland's roads as well as dynamic conditions that could impact access, such as flooding.

TMR is exploring the development of telematic applications (apps) for specific and general vehicle classes such as freight. Developed and released apps could be leveraged off to deliver permit condition access information to heavy vehicle drivers. (Noted in discussion with Mark Mitchell, Geoffrey Smith, David Wilson, Mark Jones and Shiven Shah of TMR (1 March 2018).

National Heavy Vehicle Regulator (n.d.) shows the access routes based on vehicle type in a geographic information system (GIS) representation, indicating the routes on which trucks can drive. This does not give information on specific limitations that could apply to a heavy vehicle regardless of type (e.g. height of a bridge). This means that it should be viewed in conjunction with road restrictions as specified by TMR when planning a route.

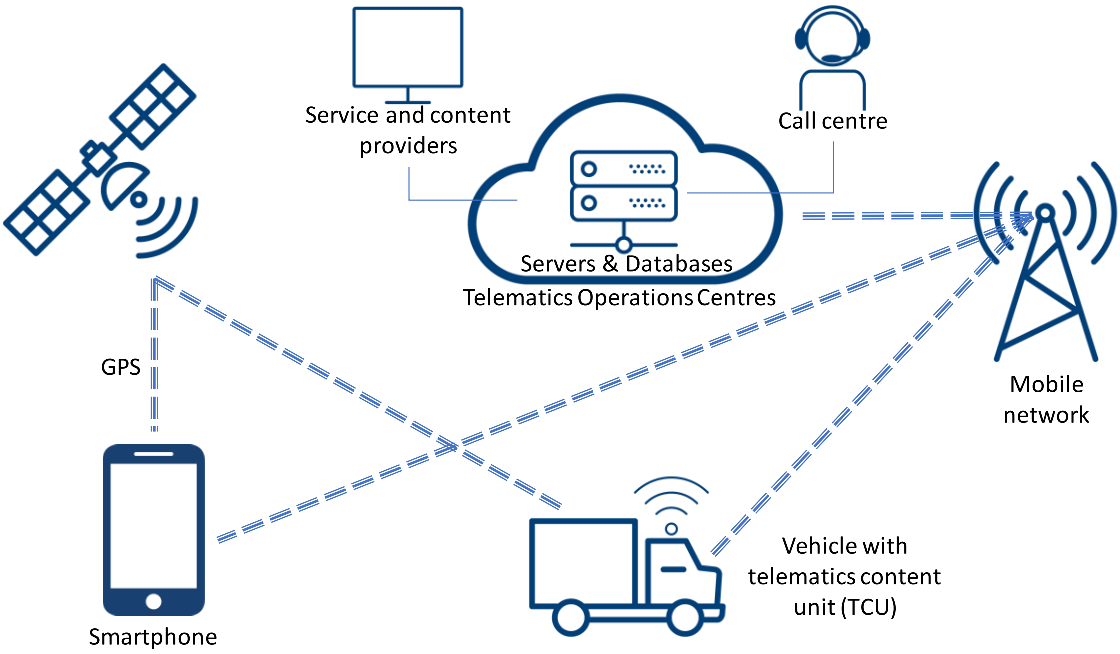
2.3 Telematics Providers

Alonso Raposo et al. (2017) provide a good overview of telematics identifying that telematics is a composition of telecommunications and informatics which encompasses the computer and electronics in a car. The key components that can be found in a vehicle telematics system are:

- an in-vehicle telematics content unit (TCU) connected to the vehicle CAN bus
- a GPS receiver that is attached to or forms part of the TCU
- a Telematics Operations Centre, that processes data from the TCU, combines it with other gathered data and delivers telematics services
- a wireless communications system over which data and voice communications are exchanged between the TCU and the Telematics Operations Centre
- service and content providers who provide information, entertainment and other services (e.g. traffic information, music) to the Telematics Operations Centre
- a call centre with customer service representatives who can communicate with vehicle occupants.

An overview of the components is shown in Figure 2.1.

Figure 2.1: OEM Telematics architecture



Source: Based on Alonso Raposo et al. (2017).

Companies such as HERE (Navmart n.d.) can provide a database of relevant road attributes to the logistics management industry and truck drivers. The database of road attributes enables heavy vehicle route mapping by truck routing systems that take the road attributes into consideration. The route mapping with road attributes enables:

- truck navigation
- strategic optimisation
- carrier route maps generation
- warning information
- truck routing and dispatching
- application of carrier route codes to make delivery more efficient.

Benjamin Wilson of HERE (26 October 2017) noted that HERE create and manage a database of the road network, including heavy vehicle restrictions. These restrictions exclude IAP data as this is on an as needs basis and not managed digitally. HERE have investigated trials relating to IAP which involved looking at using IAP map data in a digital format.

The heavy vehicle road attributes that are incorporated into the HERE route mapping include (Navmart n.d.):

- Physical restrictions: The location of physical restrictions to a heavy vehicle such as height (including bridge height), width, weight, weight per axle and length restrictions.
- Information on warning signs: Includes detailed information on the exact location of signs and warning of certain road conditions that apply to trucks (e.g. lateral wind, risk of grounding). The information is sortable based on truck type within truck routing software.
- Legal restrictions: Contains detailed information on exact areas and roads where certain legal restrictions apply, from material limits to areas where specific trucks or trailers are forbidden.

- Hazardous materials: Information on locations where restrictions for the road transportation of dangerous goods (hazardous materials) (i.e. HAZMAT) are in place.
- Networks where B-doubles can drive.
- Points of interest: Information on locations of interest to heavy vehicle drivers. This includes information such as petrol stations and rest areas.
- Distance markers: Includes detailed information on the exact location and number of signs indicating road distance along carrier route maps.
- Environmental zones: Includes information on areas where access restrictions apply to certain vehicles or trucks due to environmental reasons, plus it provides route data to support audits if vehicles travel through zones that require information to be stored and provided to local governments.
- Preferred truck routes: Includes details on preferred truck routes.

The key benefits of providing heavy vehicle road attribute information are considered by HERE (2017) to include:

- optimise routing with data specific to the heavy commercial fleet
- increased asset utilisation with real-time data
- help customers meet their service level agreements with better estimated time of arrival
- lower operational costs with efficient routing
- enhanced driver experience and safety with onboard features.

Benjamin Wilson of HERE (26 October 2017) advised that while HERE obtain their traffic data from connected vehicles and personal network devices (PND) on the network, HERE obtain their road closure information from the TMC of road agencies.

Gavin Hill of Transport Certification Australia (TCA) (30 October 2017) noted that VicRoads, TCA and a telematics company (Teletrac Navman) undertook a pilot at the 2016 ITS World Conference in Melbourne, later launching the product as SmartNav. The pilot took the road asset information, which was codified to be able to be accessed in-vehicle. Asset information included road access, permissions and entitlements, vehicle configuration, load and time of day. The vehicle configuration, weights, load height etc. were entered prior to driving.

Gavin Hill confirmed that TCA is undertaking similar work with other agencies as the information that road agencies have is not always in a format that can be used by navigation agencies (such as text fields). The information, which is in a format that best suits internal purposes, needs to be formatted so that it can be used externally. In addition, all jurisdictions' data should be made consistent, so that in-vehicle units can be used nationally. The aim is to create and use a common language.

Gavin Hill also noted that TCA along with Main Roads Western Australia undertook a pilot which looked at providing information in real time to drivers in remote areas, alerting them of dangerous events such as bushfires. This has led to a new initiative, which uses data feeds from the Port of Fremantle to transmit information to drivers on when there is currently a delay. This is to allow drivers to be aware of the delay and stagger their arrival. This information shall need to be in a format that can be pushed to drivers (non-static information).

A range of navigation devices for trucks are available on the Australian market. Among the traditional navigation features they contain the ability to input the metrics of the vehicle, including weight, height, length and width. Based on the input data the units provide warnings for low bridges, narrow roads and weight-restricted streets. Some of the units delivering this service in-vehicle through various mediums are:

- ALK – ALK Technologies (2018) has a navigation product, available in America and United Kingdom, which can be used in-cab or can be bought as a single user application for smart phones. Some of the reported benefits that the system can achieve are the reduction in risk of bridge strikes, allowing connection to the back office and guidance of routes which are legal for trucks.
- Garmin – Garmin (2018) has a truck navigation device designed for trucks which is available in Australia. The unit states that it can give customised truck routing based on the size and weight of the heavy vehicle, with alerts for upcoming bridge heights, weight limits, sharp curves and steep grades. It notes that the truck routing information based on the truck characteristics is not available in all areas. To account for old data, it also states that the user should always defer to all posted road signs and conditions.
- TomTom – TomTom (2017) details a truck navigation device available in Australia. The unit can provide routes based on the dimensions, weight, cargo and maximum speed of the heavy vehicle. It notes that the truck routing information based on the truck characteristics is not available in all areas. To account for old data, it also states that the user should always defer to all posted road signs and conditions.
- Navman – Navman (2018) details a truck navigation device available in Australia. The unit can provide Australian B-double heavy vehicle routing which includes HAZMAT restrictions to help avoid roads with weight restrictions, narrow bridges and height restrictions. Warning for winding roads, hairpins and sharp ascent/descents are also given.
- SmartNav – Teletrac Navman (2017b) allows for navigation of routes using mapping data provided from road managers and converting it into a turn-by-turn navigation. The driver is alerted if they leave a planned route or the designated truck network and directs them back to the compliant route or network. The system can work in rural areas as it has an offline mode, which does not require cellular communication. It is identified that Transtech, a subsidiary of Teletrac Navman is working with the state-based road agencies which include VicRoads, Main Roads Western Australia and New South Wales Roads and Maritime Services to enable SmartNav mapping capabilities in their relevant states.

It is noted that the navigation services made little or no mention about the access conditions and the type of heavy vehicle.

Anthony Laras from Transtech states that compliance and permit data is available, however there is a need to dig through road agency websites and use PDF documents, which does not help in making an efficient decision (Trade Trucks 2016).

SmartNav is designed to alert the driver and the back-office if a heavy vehicle moves off the allowable network, and helps the heavy vehicles get back onto the network as safely and quickly as possible. Peter Anderson of the Victorian Transport Association (VTA) noted in Trade Trucks (2016) that SmartNav is about getting the heavy vehicles to travel where they are supposed to travel in the safest way possible. The aim of SmartNav would be to provide an improvement in average travel time, reduction in road crashes, and increase capacity of heavy vehicles. Trade Trucks (2016) indicates that Gavin Hill of Transport Certification Australia stated that the technology seems so obvious and simple that it begs the question why this has not been undertaken already. It is highlighted that with coupling and decoupling being prevalent in Australia a driver may be running under a variety of restrictions across a week. With technology such as SmartNav, a tailored route can be defined based on the vehicle type operating on that day.

2.4 Provision of Road Access Conditions In-vehicle and Other Jurisdictions – Locally and Internationally

ARRB (2013a) and ARRB (2013b) identified that as of 2013 access conditions varied across the Australian jurisdictions. Marc Paglia (VicRoads) and Jose Arredondo (NHVR) noted in separate consultations that the current method of delivering access conditions to vehicles is through permits, (which include time of operation, travel direction, weight, dimensions) and mapping of allowable truck routes by class of vehicle (it is up to the driver to ensure they comply).

The National Transport Commission (2014b) noted that telematics can improve compliance and enforcement practices. The measurable benefits of telematics will depend on what applications are used, and how operators use the information to change systems, behaviour and culture. The potential benefits of regulatory and commercial telematics as identified by the National Transport Commission are different for industry as opposed to the community. For industry the anticipated benefits include optimised routes, more efficient vehicles, more efficient driving, agile supply chain and more efficient operations. For the community the anticipated benefits include safer vehicles, better infrastructure utilisation, driver alertness, compliance assurance and safer roads.

Jose Arredondo (24 October 2017) noted that there are no known technical developments for in-vehicle access conditions in Australia. However, in America and Europe heavy vehicles can have information broadcast through the radio.

Peter Girgis of Bigmate (25 October 2017) went further by saying that while no technical developments of delivering access conditions in-vehicle are known, there are systems in place to deliver documents, including access conditions in the form of pdf (and other formats) to their telematics device in-vehicle screen (noting this may not be compliant with all legislation currently, as legislation can require carrying of hardcopy). Peter also added that currently some telematics devices can alert drivers if they deviate from the route or other conditions such as time on the road, based on commercially defined conditions.

James Williams of the National Transport Commission (NTC) (25 October 2017) noted that the integration of permit information as an overlay onto the in-vehicle navigation would be worth investigating in the future. The primary access condition information of use to drivers is:

- conditions of access for the routes
- mass access – this could potentially be linked to on-board mass or integrated into other on-board systems. However, these systems may potentially need to be calibrated to standard requirements to be of use.

ARRB (2013a) undertook a review of access decision-making processes. The report noted that the diversity of the heavy vehicle fleet poses a challenge for developing a nationally consistent and simple framework for classifying vehicles that includes all vehicle types. ARRB (2013a) identified that the existing heavy vehicle access classification is as follows:

- General access (GA): vehicles that comply with the limits outlined in the regulations have an 'as of right' access to the whole network.
- Exemption notice (N): in general, exemption notices are used for commonly used vehicles that do not comply with the mass or dimension limits outlined in the regulations.
- Access by permit (P): some vehicles require permits to be able to travel on the road network.
- Access by period permit (PP): The main distinction between permits and period permits are that period permits are usually for Class 1 load carrying, special purpose or agricultural vehicles.

- Single trip permits (STP): single permits are issued for once-off travel for vehicles that are considered very high risk and require increased scrutiny.
- Special assessment (SA): special assessments are a term used to describe permits issued for vehicles which do not meet regulations for general access and notices.

The ARRB (2013a) report identified that the existing route assessment criteria consistently ranged across the following criteria nationally:

- road widths (urban, rural)
- overhead clearance
- intersections
- railway crossings
- sight distance
- overtaking provision
- environmental and amenity issues
- bridges (including capacity and width)
- shoulder widths
- horizontal curves, including super-elevation
- truck parking
- roadside infrastructure.

ARRB Group (2013c) defined a vehicle classification framework along with route assessment guidelines and a network classification framework. These are not specifically relevant to this project but are related and hence referred to but not shown in this report.

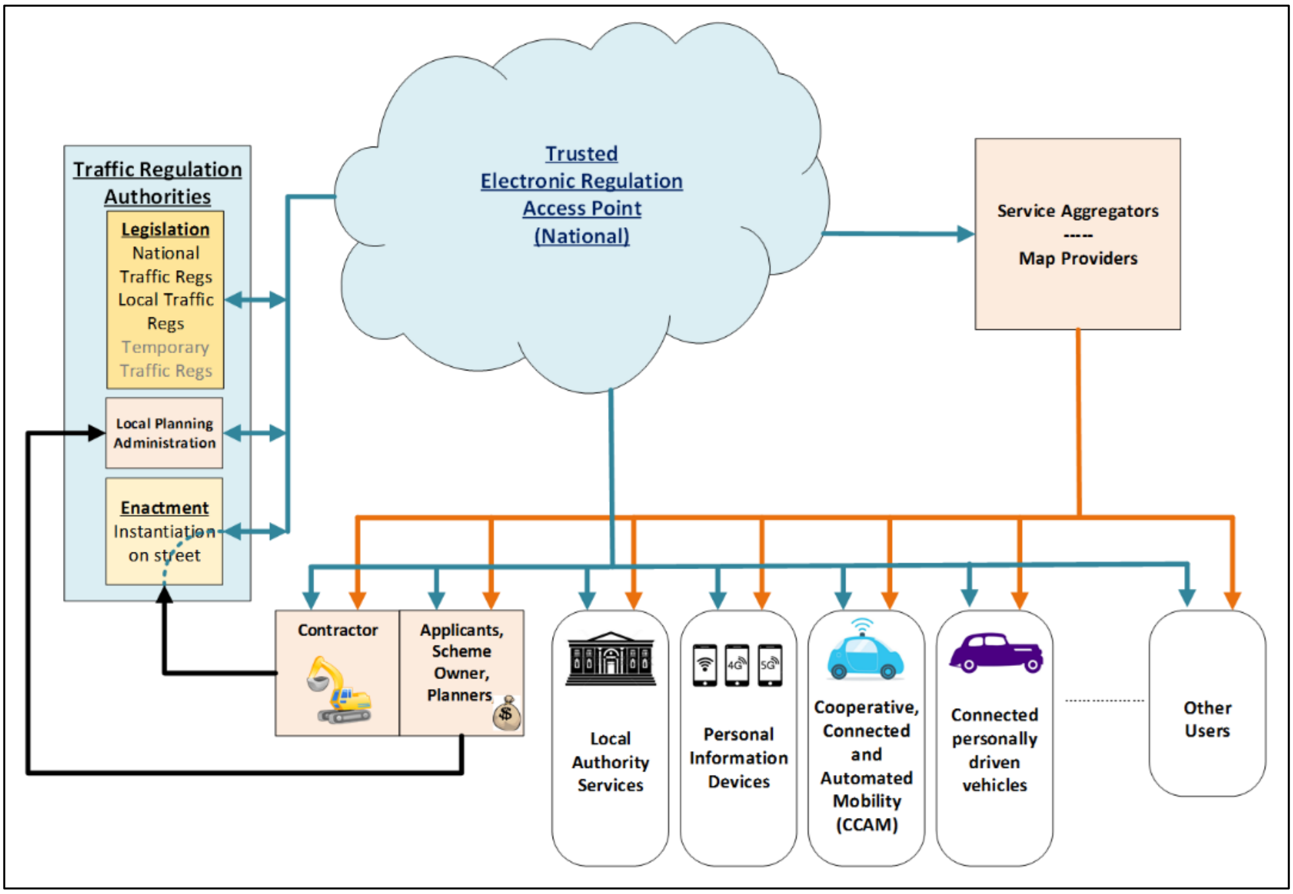
Dan Murray from American Transportation Research Institute (ATRI) (17 November 2017) identified several projects that had been undertaken in America that looked at providing information in-vehicle using telematics. These varied in information supplied to the telematics unit. The projects which were highlighted were the delivery of real-time weather information to trucks, route optimisation and warning of vehicle rollover locations. The common findings of these projects were the quality of data for real-time information was generally very poor and stakeholders which supply information did not take ownership of the data to ensure the quality of the data.

Ross Froat from the American Trucking Association (ATA) (29 November 2017) identified that many of the projects known to be in progress in America relate to providing information in-vehicle through V2I. The information that is pushed into the vehicles includes traffic sign information, signal information, incidents and weather. This also allows for information about the vehicles to be received. It was highlighted that the bigger fleets are taking up technologies such as cooperative ITS (C-ITS) and telematics quicker than the smaller fleets. The Federal Motor Carrier Safety Administration (FMCSA) is undertaking trials with industry, looking at delivering information in-vehicle through cooperative-ITS. The trials have highlighted the need to standardise information to be delivered, with uptake of services being more likely if the required information can be delivered into in-vehicle devices already installed in vehicles. C-ITS is an emerging technology which will enable equipped vehicles to communicate to other equipped vehicles, roadside infrastructure, central infrastructure and vice versa. It is an enhancement of existing in-vehicle telematics and of IAP.

Working Group 17 of CEN TC278 is developing a work area entitled Management for Electronic Traffic Regulation (METR) as outlined in Harrod Booth and Evensen (n.d.). METR aims at building a robust database of road traffic regulations which can be delivered in-vehicle. The primary objective of METR is to ensure automated vehicles follow the road rules. Broadly METR is a way of digitalising existing practices. The METR project will comprise of the following elements:

- METR Architecture: Overview, terminology, organisational framework, roles and interfaces. The envisaged architecture for the METR was outlined by Harrod Booth and Evensen (n.d.) and is shown in Figure 2.2.
- METR Conformance: Quality parameters and testing.
- METR Generation: Definition of interface for the regulatory body permitted to generate an Electronic Traffic Regulation (ETR).
- METR Services: The technical content of the regulation; data definitions and constraints per service. Typically developed as one standard per service. Many of these services are under development or already defined in DATEX II, transport protocol experts group (TPEG) and C-ITS, although under a different service concept than METR, so re-use and integration with these services is strongly suggested.
- METR Operations: Definition of operational constraints for METR cloud service, including storage and access to ETRs.
- METR Public Access: Definition of interface including protocols, access rules, etc. Since METR needs to be pan-European, this interface should be the same as, or co-located with, the ITS National Access Point
- METR Security: This service needs strong security support. Regulations need legal proof from the generating entity all the way to the end user, so that all main security features like confidentiality (privacy), integrity (trust) and availability (denial of service) is present. This includes security services new to the ITS domain such as non-repudiation. To achieve security full public key infrastructure (PKI) is needed, with security based on the C-ITS Platform Trust Model.

Figure 2.2: Architecture for METR



Source: Harrod Booth and Evensen (n.d.).

While the METR project objective is to ensure automated vehicles follow the road rules, it shows examples of where work is being undertaken to migrate traffic regulation from a past form to a digital form for use in-vehicle.

2.4.1 Intelligent Access Program (IAP)

The National Transport Commission (2014a) stated that IAP electronically monitors the location and speed of heavy vehicles assuring road agencies that enrolled vehicles are complying with their road access conditions.

Not only is IAP a means of managing access, it also encourages efficiency gains as identified by the International Energy Agency (2017). The IEA found that various policies to modernise long haul on-road freight. While most policies related to fuel and fuel efficiency of vehicles, the report concluded that the Australian initiated Performance-Based Standards and Intelligent Access Program, which referred to the regulation of the operation of high-capacity vehicles, enable efficiency gains by allowing the use of high-capacity vehicles while avoiding potential infrastructure damage.

Transport operators enrolled in the IAP can gain better access to roads or to meet access conditions set by road agencies. The IAP was developed by Austroads and the program has been in operation since 2009. The NTC had a specific task of developing the laws that underpin the privacy and security of the program. The IAP is the first example of using telematics within the regulatory framework for managing heavy vehicles in Australia.

In discussions with Mark Mitchell and Lindsay Locke of TMR (14 December 2017), it was noted that IAP telematics enable the service provider to turn on and off various information services as required.

TCA certifies and audits IAP service providers, to ensure that all the systems are accurate and reliable. There are currently five service providers certified with the TCA:

1. Transport Compliance Services (MTData)
2. Blackbox Control
3. Pinpoint Communications
4. Navman Wireless Australia
5. C-Track.

The Intelligent Access Conditions application types as outlined in the National Transport Commission (2014a) report include:

- specialised rigid vehicles
  - over dimensional and over mass cranes
  - concrete pump trucks
- mass concession schemes
  - B-double
  - B-triple
  - AB-triple
  - medium articulated vehicle with dog
- Performance-Based Standard
  - PBS-related vehicle route compliance
- higher mass limits
  - increased higher mass limits network
- other
  - non-standard freight vehicles.

Marc Paglia of VicRoads (23 October 2017) said that currently IAP in cranes refers to a map which jurisdictions publish, which can then be accessed by a phone/tablet. In addition, it was noted that IAP can do more than it is currently used for. However due to privacy the information that is obtained is restricted. The only information passed onto the road agencies is non-compliance data. It is noted that IAP data is live but is historical by the time the data is received by TMR.

In discussions with Mark Mitchell and Lindsay Locke of TMR (14 December 2017), it was noted that TMR considers that the required uptake of IAP by cranes has improved compliance with road access conditions by those heavy vehicle types. The uptake of technology is discussed further in Section 2.4.2.

IAP can be combined with On-board Mass (OBM) (OBM is currently separate to IAP) to enforce mass and can be combined with Electronic Work Diaries (EWD) (EWD is currently separate to IAP) to enforce fatigue.

2.4.2 The Take-up of In-vehicle Technology

The take-up of in-vehicle technology to assist heavy vehicle operators comply with conditions is growing. Teletrac Navman (a fleet management technology provider) commissioned a study to gauge current perceptions of electronic work diaries within the Australian road freight industry. The key findings of the research are as follows (Teletrac Navman 2017a):

- Usage of EWDs could triple within the next 12 months, with many fleets able to activate functionality within existing telematics systems.
- EWDs currently have the greatest penetration into larger fleets, with almost a quarter of those with 25+ trucks using EWDs.
- A third of fleets with six or more trucks plan to implement EWDs in the next 12 months.
- Three-quarters of fleets see benefits in EWDs, particularly around monitoring driver performance and compliance.
- Larger fleets are primarily focused on compliance and driver monitoring, while eliminating paper records is the main benefit for smaller fleets.
- Fleets operating interstate (long haul) and intrastate (back to base) routes see greater benefits in EWDs, largely around driver monitoring and compliance.
- Fleets running long distances see monitoring driver performance, compliance and reducing paperwork as the top three benefits of EWDs.
- One in 10 road transport businesses currently use EWDs, mainly those running larger fleets.
- Benefits of EWDs are consistently linked back to performance monitoring and compliance, with larger fleets more likely to recognise the benefits they can offer.

With the take-up of in-vehicle units there is potential to collect data from vehicles equipped with in-vehicle units. This provides various policy insights as presented by the Organisation for Economic Co-operation and Development (OECD) International Transport Forum (2015) as follows:

1. Road safety improvements can be accelerated through the specification and harmonisation of a limited set of safety-related vehicle data elements.
2. Transport agencies will need to audit the data they use to understand what it says (and what it does not say) and how it can best be used.
3. More effective protection of location data will have to be designed upfront into technologies, algorithms and processes.
4. New models of public-private partnerships involving data-sharing may be necessary to leverage all the benefits of Big Data.
5. Data visualisation will play an increasingly important role in policy dialogue.

While this literature review is focussed on the provision of access condition information to drivers and not enforcement, ARRB (2015a) felt that, with respect to heavy vehicle enforcement, in the medium to long term there will be a shift towards telematics/in-vehicle technologies that will enable self-reporting. This could be achieved through the further take-up of technologies such as IAP

In the long term the use of Cooperative ITS, will enable equipped vehicles to communicate to other equipped vehicles, infrastructure and centres. It is an enhancement of existing in-vehicle telematics and of IAP. Although there is currently no off-the-shelf product, C-ITS could potentially provide an avenue for vehicles to self-report. The main issue identified within ARRB (2015a) in terms of the move towards in-vehicle technologies for enforcement is the take-up of technology.

While in-vehicle technologies (in-vehicle telematics, smartphone apps and potentially C-ITS as it emerges) offer the potential to provide information to drivers in the vehicle, the main issue with in-vehicle technology as identified in ARRB (2015b) was ensuring that the technology was in the vehicle and operating.

An example of this was Stamos et al. (2017) who surveyed truck drivers, commercial fleet operators and managers, to investigate their trust in freight transport services and willingness to invest. The project was looking more at the use of in-vehicle technology, with services such as:

- intelligent truck parking and delivery areas management
- priority and speed advice
- CO_2 footprint estimation and monitoring
- cargo transport optimisation.

Stamos et al. (2017) highlighted that although the survey was on-going, the findings show that respondents trust that the service can improve efficiency and reduce costs, however they are not willing to invest in the services. This indicates that although technologies may provide improvements for heavy vehicles and could potentially save fleet operators money, they may not be willing to invest unless they are required to.

Marije de Vreeze of Connekt (10 November 2017) stated that the Netherlands currently has more drivers using mobiles in cabin. As this is not desirable they are aiming at providing information that would be available through their phone into the available telematics devices. Additionally, the Netherlands is part of the InterCor project, which is looking at providing services such as roadworks warnings, collision risk warnings and probe vehicle data using C-ITS into equipped vehicles. This focuses on the delivery of information and ensuring that the system will be able to work throughout Europe.

2.5 Findings

The key findings of this section, which explored road access condition types (Queensland), road access condition information (Queensland), telematics providers and provision of road access conditions in-vehicle in other jurisdictions (locally and internationally) are as follows:

- There is a range of access condition types and information.
- There are many telematics providers.
  — Some are starting to provide truck-related information that they are obtaining themselves.
- Some road agencies are exploring pilots to set up a data portal to provide heavy vehicle access condition data to telematics providers.
- All local, state and territory road agencies access condition data should be made consistent, so that in-vehicle units can be used nationally.
- There is a need for standardised delivery of network access conditions that can be utilised in the telematics devices.
- Jurisdictions need to make access condition data available for use by in-vehicle units.
- There needs to be a clear incentive for users to take up in-vehicle technology, including not using it for direct enforcement.

3 MESSAGING AND INFORMATION TO DRIVERS

This section discusses findings from the literature that relate to:

- Message Dissemination – Traffic and Traveller Information: Section 3.1.
- Avoiding Spoofing and Maintaining Integrity of Messaging: Section 3.2.
- Interoperability and Information Management: Section 3.3.

The literature review identified the following that are related to this project:

- The Department of Infrastructure and Regional Development (2017) has developed a National Infrastructure Data Collection and Dissemination Plan (Data Plan).
- Data is becoming available on the vehicles, which can be used for real-time applications as outlined in the OECD International Transport Forum (2015) report on *Big Data and Transport: Understanding and Assessing Options*.
- HERE (2015) provides an outline on the data elements that can be obtained from a vehicle equipped with a magnitude of sensors and is a good example of the type of big data that is becoming available.
- NACoE (2017) looks at the mobile mapping solutions for heavy vehicles. The aim of the project was to investigate the most appropriate use of GIS, mobile tracking devices and applications to aid in the enforcement and management of heavy vehicle access conditions and restrictions.

3.1 Message Dissemination – Traffic and Traveller Information

While not access conditions, there are lessons to be learnt from the dissemination of traffic and traveller information that could apply to the dissemination of access condition information into vehicles. ARRB Group (2014b) provided an overview on how the traffic and traveller information (TTI) is disseminated, the products that are used and the delivery models. The key features for delivering TTI are to:

1. collect traffic data from multiple sources
2. aggregate, integrate and analyse traffic data
3. disseminate data real-time through multiple sources.

The systems to disseminate the information in Queensland as identified by the ARRB Group (2014b) review include:

- the Queensland traffic website (TMR owned) which has:
  - a map view for location information
  - quick information page suitable for iPads and devices with less bandwidth
  - a mobile phone site
- the Queensland traffic report line, providing text-to-speech information from the website
- local media for broadcast in certain regions through local arrangements
- social media; specifically Twitter
- data feeds for third party access under the open data policy.

ARRB Group (2014b) concluded that TTI will evolve over time, with a mix of work undertaken by agencies and work outsourced. Further, the TTI information will include multi-modal information. In addition, it is noted that road agencies will move towards open data which will enable the private sector to use road agency provided data to provide TTI services.

The International Organisation for Standardisation (2015) is developing performance requirements and test procedures to allow in-vehicle telematics systems to provide curve warnings. IOS (2015) specifies how the curve warning calculations must be undertaken, at what point the driver needs to be warned and the capabilities of the interface.

A feasibility study on sending traveller information to regional travellers was undertaken by ARRB Group (2014a) for Main Roads Western Australia. A summary of the key conclusions of the report which could also apply to TMR are as follows:

- There is no single solution; a range of service delivery platforms are required to meet the road user and road operator's needs. This includes pre-trip and en route distribution.
- Roadside signing options largely require higher-cost investment for whole-of-network coverage than non-signing options, which deliver comparable benefits to road users.
- Non-signing options do not yet present a replacement (or standalone) solution to roadside signing, however they should be invested in as they offer potential. As a minimum, they may reduce requirements for future investment in roadside infrastructure.
- Initial feedback from industry suggests strong support for the use and dissemination of real-time traveller information via telematics services. This provides a cost-effective opportunity to improve the road user experience.
- There is still a case for implementation of new roadside signing options to meet current regional operational requirements. This could be achieved relatively quickly given that most are proven concepts.
- Communications should be considered an enabler not a constraint.

A summary of the key recommendations and next steps from the ARRB Group (2014a) report which could also apply to TMR are as follows:

- Set up a real-time traffic data web portal with appropriate data formats (preferably aligned with national standards) and data release agreements for use by third parties. Undertake proof-of-concept trials with industry and in collaboration with other state road agencies/federal government to promote use of the data, particularly for incorporation in in-vehicle navigation and telematics devices and development of smartphone/tablet applications. In addition, advertise services to encourage take-up.
- Continue to deliver and advertise existing customer phone line, web-based (including social media) and radio services for access by users in regional areas.
- Regions are advised to identify critical locations on their networks for the provision of traveller information, and then assess and select which roadside options are most appropriate for installation at each location. Roadside signing options recommended for consideration include full panel VMS, portable VMS, hybrid VMS, rotating drum VMS, manually operated VMS, satellite-enabled remote internet hotspots for access to Main Roads web services via smartphone/tabled and kiosks for access to Main Roads web services at en route service areas. Detailed guidelines will be prepared to assist regions with this process.
- Undertake further investigation into the development of a satellite SCAD*A (*supervisory control and data acquisition) network.
- Address key operational requirements regarding access by regions to ITS control and consider the appropriate operational control environment for efficient delivery of all traveller information services.

ARRB Group (2014a) provided indicative reference architecture diagrams on how traveller information messages may be delivered to in-vehicle third party telematics devices. The report then went on to present various example reference architecture for delivering messages via third party service providers. This included via the following:

- in-vehicle navigation devices
- third party map displays on the internet
- in-vehicle telematics units/applications
- in-vehicle C-ITS units/applications.

The key for all architecture is the need for a road agency web portal for generating traffic data and information. This is relayed to the public internet for use by providers, where applicable, to value add and provide services. This information can be used by internet clients. This is then sent via mobile broadband to relay the service information to the vehicle.

Marije de Vreeze of Connekt (10 November 2017) felt that from a European standpoint, the information that should be transmitted to the vehicle should include road congestion, whether bridges are open or closed, rush hour lanes, the road network zone which has control over the levels of vehicle emissions, time zones where access is allowed into cities, a combination of logistic information, where loading and unloading of the vehicles can occur and the terminal waiting times at ports.

Jan Pattison of the Queensland Trucking Association (1 November 2017) felt that transport operators have the technology in the truck which can deliver information in-vehicle. If the road agencies can provide this information in a format that can be used in-vehicle, with information such as restrictions and the co-ordinates of the restrictions so that this information can be mapped spatially and used, then this can enable the technology to deliver messages associated with access condition into the vehicle. Avoiding spoofing and maintaining integrity of messaging and interoperability and information management associated with this is discussed further in the following sections.

3.2 Avoiding Spoofing and Maintaining Integrity of Messaging

One of the critical elements for a road agency to consider when making information available for delivery to a vehicle is the need to avoid spoofing and maintaining integrity of messaging.

Marc Paglia of VicRoads (23 October 2017), said that delivering live information to the driver is a good idea, however there is no benefit in providing live information if the integrity of the information is an issue.

Jon Harrod Booth of Harrod Booth Consulting (2 November 2017) advised that Ordnance Survey undertook an experiment in which they tried to collect all the restrictions inside the M25 London Orbital motorway. As it was concluded that there was no reasonable way to maintain the accuracy of the data they stopped part way through the collection.

Peter Girgis of TCA said that (25 October 2017) that it is important that the data provided for route compliance is reliable and accurate. Regulators need to provide accurate data in a format that can be used by commercial products and that can be relied upon by the driver (at present it cannot).

Jose Arredondo of NHVR (24 October 2017) considered integrity of the messaging can be maintained through the following:

- legal conditions (weight, time of travel direction, time based, etc.)
- ad hoc conditions (water over road, heavy traffic, etc.)

James Williams of NTC (25 October 2017) felt that the need for integrity of the information depends on whether the messaging system is certified. In terms of policy, if this is for providing information, government oversight of the integrity is not required. If the in-vehicle messaging is going to be enforceable, then the integrity of the information should go through a certification process.

Like the views of others, Gavin Hill of TCA 30 October 2017) considered hat the integrity of the messaging should depend on the type. If it is advisory messaging, it is used to supplement driver information and is not critical if it goes offline. If the messaging is critical it would require resources, most likely through a pay service, with a helpdesk managing the data. This is to ensure that the data source is accurate, and the data is thoroughly checked, as people are likely to turn off the system if they do not find it to be a good source of information and is not useful.

Jon Harrod Booth of Harrod Booth Consulting (2 November 2017) advised that the need to maintain the integrity of the messaging depends on the intent of the data. It was highlighted that there are two different intents when providing information in-vehicle:

- non-safety critical messaging – the data can be given to telematics providers without any input from the road agencies
- regulatory – the data should be secure to ensure it cannot be tampered with and be traceable so that the source of the data can be checked for authenticity.

Marije de Vreeze of Connekt (10 November 2017) said that maintaining the integrity of the messaging depends of who provides the information, who owns the information and who controls the information.

The OECD International Transport Forum (2017) report identified that further developments in data science might be required as a foundation for implementing new approaches in regulating road freight transport successfully.

3.3 Interoperability and Information Management

Interoperability and information management is another element that is critical for a road agency to consider when making information available for delivery to a vehicle (i.e. it should be in a standardised format).

To ensure that the information is interoperable it should be in a common language, have a common dataset, build on the Intelligent Access Mapping (IAM) and build on a telematics dictionary (Gavin Hill of TCA (30 October 2017)).

Marc Paglia of VicRoads (23 October 2017) advised that to ensure integrity of messaging and interoperability, it is believed that the access conditions should be consistent between jurisdictions. Marc noted that currently there is no consistency, however it is in the process of being harmonised by NHVR. It was also noted that while IAP can be used to control and monitor heavy vehicle access, there is currently no human machine interface that provide an interaction between the driver and the IAP, enabling the relay of access condition information to the driver.

Marc Paglia noted that the information transmitted to the in-vehicle unit for conveying to the driver should be drawn from road managers (i.e. route maps), permitted journeys and discrete pre-approved network maps for different permit types. To enable the in-vehicle unit to obtain access condition information to convey to the driver, real-time position information would need to be sent to a database, which responds to the query with the route in question.

James Williams of NTC raised similar points (25 October 2017), in that to determine that there is interoperability there should only be a single source of data. The interoperability should not be dependent on the unit.

Benjamin Wilson of HERE had a slightly different opinion (26 October 2017) and noted that interoperability is not a requirement if the information is in a single format. It is up to the telematics providers to change the format of the data to ensure that it can be read by their devices.

The OECD International Transport Forum (2017) report on *Data-led Governance of Road Freight Transport: Improving Compliance* identified that there is potential for new technologies, newly available data and the combination of the two to either improve the enforcement of current regulatory frameworks or even replace these by a data-driven approach. However, systems currently are too fragmented, both in terms of geographic implementation, as well as in terms of integration and interoperability. These shortcomings limit the meaningful uptake of many of the new possibilities they offer. Another element that limits the potential for the convergence of data and new technologies to deliver more efficient enforcement actions is the lack of consensus on data requirements – including the object, semantics and structure of data – that could support better enforcement.

Austroads (2016) identified the data standard for road management and investment to provide Australian and New Zealand road agencies and their suppliers with a common approach to specification of operational data. The standard establishes agreed definitions of data to ensure it is collected, used and interpreted appropriately and consistently. Austroads (2016) provides the data standard for access restrictions.

Austroads (2016) identifies that access can be empowered or restricted on the following basis:

- single mode only links or lanes (cycleway, busway or part-time bus lanes)
- motorway (no cycling, no pedestrians, bus or T2 lanes)
- vehicle weight limits (often due to bridge or pavement strength limits)
- vehicle size limits (vehicle width, height, length, say through tunnels or under overbridges)
- heavy goods vehicles in general (residential zones or Central Business Area lanes)
- tolled access (payment is required to travel)
- one-way travel or speed restrictions.

Austroads (2016) also identified that access and restrictions can be permanent or temporary. As Marc Paglia of VicRoads noted (23 October 2017), the type of information that should be transmitted should be the access information in advance of the restriction.

Peter Girgis of Bigmate noted (25 October 2017) that in-vehicle information should include live elements such as urgent changes to access conditions (e.g. dynamic regulatory changes). Traffic conditions, such as accidents and congestion, should not be considered as part of this, as this can already be added to telematics.

Peter Girgis considered that interoperability can be managed by:

- providing standards for the data
- providing business exchange rules (i.e. age of the data, requirements for use of data, time stamp format, datum level).

Jose Arredondo of NHVR advised (24 October 2017) that there is currently no standard to allow for interoperability between systems. Each system has its own requirements for what format the information needs to be in. Austroads (2016) attempted to overcome this by developing a data standard for access condition information.

The data standard would enable access conditions to be transmitted from a portal (developed and maintained by road agencies) to telematics service providers. The data should define the standard format which can be translated easily to a geographical representation of the network. This would enable the distribution of the access conditions by providing data in a format that allowed telematics companies to easily distribute the data to in-vehicle devices. Consultation with telematics providers will help to refine the requirements and allow for a more harmonised set of data, allowing for interoperability between the data and the devices. Austroads (2016) has developed such a data standard for road management and investment.

Jon Harrod Booth of Harrod Booth Consulting has pointed out (2 November 2017) that beyond standardising the data for interoperability there needs to be a measure of quality control in place. The current method depends on manual checking, without the use of algorithms to confirm that the areas where restrictions apply have not missed any streets and are a closed polygon for the areas that they cover.

Gavin Hill of TCA stated (30 October 2017), that drivers are best placed to indicate what information they want. Currently the information based on the road is good, however it will add value to give off-road data, such as information from ports and rest stop areas, to indicate if they are full/delays etc. This type of information could be added and communicated en route to the driver.

3.4 Findings

The key findings of this section, which explored message dissemination (traffic and traveller information), avoiding spoofing and maintaining integrity of messaging, and interoperability and information management are as follows:

- There is a need to set up a data web portal for in-vehicle units to obtain access condition information.
- Delivery of messages to motorists can occur via various third-party service providers such as:
  - in-vehicle navigation devices
  - third party map displays on the internet
  - in-vehicle telematics units/applications
  - in-vehicle C-ITS units/applications.
- Access condition data must be accurate as it will be used for route decision making and indirect enforcement.
- TMR should work with local, state and territory road agencies to ensure that data is consistent. This will help maintain integrity.

4 TECHNOLOGIES

This section discusses findings from the literature that relate to:

- In-vehicle Units: Section 4.1
- Communications: Section 4.2.

4.1 In-vehicle Units

The preference for heavy vehicle operators would be for vehicles to have one unit that could serve multiple tasks such as assist in driver compliance to access conditions including navigational assistance and fleet management and operational monitoring. This project is interested in how information can be provided into the vehicle to assist drivers in complying with the access conditions of the road.

Jose Arredondo (24 October 2017) noted that in-vehicle devices should be set up to allow the user to comply with the law. Further, heavy vehicle operators should be able to get in vehicle units that deliver messages to the driver on access conditions from both OEMs and from aftermarket suppliers. Benjamin Wilson of HERE (26 October 2017) said that aftermarket devices are more likely to be flexible in what they can do.

Benjamin Wilson of HERE (26 October 2017) pointed out that the setup of the in-vehicle unit should be up to the telematics provider. It should allow for drivers to easily find routes and allow for re-routing based on the IAP rules. Currently some in-vehicle devices can access truck routes, but they need to be updated manually based on the specifications of the vehicle. A potential way of undertaking this is through having the truck information on the unit and having a separate centralised system which manages the IAP and truck routing rules and sends routing information to the unit.

4.1.1 Type of In-vehicle Unit

Marc Paglia of VicRoads (23 October 2017) advised that if road agencies were wanting to just give information to drivers in vehicle, the information could be given via phone/tablet. However, if the road agencies were wanting to make the access conditions enforceable, the road agency would need to have the heavy vehicles use IAP or another device which cannot be tampered with. Jose Arredondo had noted (24 October 2017) that the focus should be on telematics rather than IAP for delivering in-vehicle messaging.

James Williams of the NTC (25 October 2017) said that if the in-vehicle unit serves its purpose, it does not matter whether the unit used to deliver in-vehicle information is undertaken by an original equipment manufacturer (OEM) unit or an aftermarket unit. Peter Girgis of Bigmate (25 October 2017) went further to say that what matters is the robustness of the device and it does what it is intended to do.

Gavin Hill of TCA was more specific (30 October 2017) by noting that the in-vehicle unit should be setup by the commercial entities, which build it based on what the drivers want. Gavin Hill went on to stipulate that it does not matter who provides the devices as the market will sort this out. Like phones, the hardware only provides a certain measure of capability, a large part of this is based on the service provider, which depends on what the service provider can give (i.e. it is the service that matters, not the technology).

Peter Girgis of Bigmate (25 October 2017) noted similar comments to Gavin Hill in specifying that in-vehicle devices should be setup to include a central controller with security and privacy. Devices can be audio only, visual only or both. A good deal of flexibility should be allowed due to the different needs of the fleet managers.

Jan Pattison of the Queensland Trucking Association (1 November 2017) noted the following with respect to the in-vehicle unit:

- The in-vehicle unit should have functionality that facilitates an audible sound identifying that a message relating to a change in access conditions has come through or that a condition/restriction is coming up. This information would need to be in real-time, to allow for the truck driver to know information such as when a bridge has been removed from access conditions. This would mean that information would need to have a quick turnaround time, so that information is validated quickly and there is little lag in the information being delivered.
- Setup of in-vehicle devices would ideally be based on the weight of the vehicle and the route that it is able to travel. This could potentially be undertaken through linking the on-board monitoring system to the in-vehicle device, to get information back to the base so they know the axle loads of the vehicle.

4.2 Communications

A study (Transport Certification Australia 2013) undertaken on electronic work diaries (EWD) concluded that the mobile network is suitable for real-time data exchange, even in rural environments. Although there are dead spots, information can be optioned and stored in-vehicle prior to these locations. If the unit cannot get access to the data required, they could be programmed to inform the driver that it cannot access the required data and that they should determine access conditions via traditional means (Peter Girgis of Bigmate (25 October 2017)). Benjamin Wilson of HERE (25 October 2017) reiterated this view in saying that network coverage is not likely a major concern as the units get the information at the start of the journey, so connectivity during the journey does not influence the routing.

James Williams of the NTC (25 October 2017) noted that delivering in-vehicle messaging to drivers is a policy decision. It is up to the road agencies to decide how they wish to do this and whether they wish to invest in roadside infrastructure for scenarios where there is no cellular communications infrastructure.

4.3 Findings

The key findings are that:

- In-vehicle units should be set up by commercial entities. Road agencies (such as TMR) should provide the legislative framework.
  - There should be a process to type approve devices.
- Communication providers are responsible for the communication of messages and in most cases the cellular network is adequate for the delivery of messages on road networks that TMR controls.

5 ROLE OF TMR

The role of TMR in the provision of access condition information in the vehicle as identified by experts through the consultations include:

- The main role of local, state and territory road agencies are to establish and maintain the accuracy of permit conditions. This includes closing out permit conditions that are no longer relevant in a timely manner. This is essential to maintain the integrity of the message. (Noted in discussion with Mark Mitchell, Geoffrey Smith, David Wilson, Mark Jones and Shiven Shah of TMR (1 March 2018)).
- The role of the road agency in distributing access conditions in-vehicle depends on whether the information given is enforceable. If it is enforceable, then jurisdictions should play a role, otherwise leave it up to the heavy vehicle operators to comply with the access conditions (Marc Paglia of VicRoads (23 October 2017)).
- Road agencies must ensure the information delivered to a vehicle is accurate and up-to-date. The market place should be taking care of the in-vehicle devices (Jose Arredondo of NHVR (24 October 2017)). This point was reiterated by Benjamin Wilson (26 October 2017) in that the role of the road agency in enabling in vehicle access condition information is ensuring that the conditions are correct, and the information is robust. It is believed that the route information should be audited to ensure that it is within the framework. Further to this the road agencies do not necessarily have to provide the road access conditions and restrictions to the telematics providers. The role of road agencies is to establish the legislative framework to ensure that the information provided to the heavy vehicle drivers is up-to-date and robust (Jon Harrod Booth of Harrod Booth Consulting (2 November 2017).
- The role of road agencies should be to transmit data such as mass limits which is consistent and well-maintained. Road agencies have a lot of data which was not designed for delivering access conditions and prompting road users but can be converted and implemented to allow for this. The road agencies need to ensure that they undertake the provision of data in a consistent approach (i.e. the format and type of data is the same between jurisdictions). The data needs to be maintained, this does not just mean maintaining it for its current purpose, it should be maintained for transmission into the vehicle (Gavin Hill of TCA (30 October 2017)).
- Road agencies need to have a level of oversight into the delivering of information. Commercial telematics devices vary in capability and quality and do not always align with regulatory objectives. To ensure they can be relied upon, road agencies should provide the standards for minimum level of compliance for the device to be used in the vehicle. The devices should be tested and validated by an independent organisation, to ensure they comply. Additionally, the road agencies need to ensure that all the providers are using accurate information, not just from when it was certified, but day to day (Peter Girgis of Bigmate (25 October 2017)).
    - Road agencies could provide incentives for telematics providers to use data correctly by not providing data to those providers who misuse it (Mark Mitchell, Geoffrey Smith, David Wilson, Mark Jones and Shiven Shah of TMR (1 March 2018)).
- Road agencies should provide as much information as possible in a format that can be used by telematics providers. Information provided should include different configurations of trucks and their available routes based on configuration (Jan Pattison of the Queensland Trucking Association (1 November 2017)).

5.1 Findings

The key findings are:

- Road agencies need to establish and maintain the accuracy of permit conditions. This include closing out permit conditions in a timely manner that are no longer relevant.
- Road agencies should set up the standards for minimum level of compliance for telematics devices.
  - This is to ensure users can rely on the devices.
  - The standards should allow for flexibility in the delivery of information.
- Road agencies need to ensure that telematics providers are using accurate information, not just from when it was certified, but day to day.
  - Road agencies could provide incentives for telematics providers to use data correctly by not providing data to those providers who misuse it.

6 OPPORTUNITIES

Telematics is built on the success of its data, information and delivery components. If the key issues in these areas can be addressed, they can then lead to opportunities. In the process of the consultations the stakeholders were asked what they perceive the opportunities of delivering access conditions and restrictions in-vehicle to be. The responses that were given are in line with the findings of the literature review as outlined in earlier sections of this report. The opportunities that were identified include:

- Having the access conditions given to drivers in-vehicle is expected to provide safety and productivity outcomes (Marc Paglia of VicRoads (23 October 2017), Jose Arredondo of NHVR (24 October 2017), Gavin Hill of TCA (30 October 2017), Peter Girgis of Bigmate (25 October 2017), Benjamin Wilson of HERE (26 October 2017 and Dan Murray of ATRI (17 November 2017).
  - The safety benefits do not include any potential for the in-vehicle telematics device to result in driver distraction or result in the human interacting with it in a non-desirable manner. This would need to be managed and addressed by the telematics provider through the operation of their telematics devices in the vehicle. Use of the telematics devices while driving is also governed through road rules.
- Cost savings due to reduced overhead for administrators, quicker determination of access routes and provision of more data which can be used to assess compliance and understand the use of the fleet (Peter Girgis of Bigmate (25 October 2017).
- Improved compliance to IAP access conditions and all the benefits achieved from IAP compliance (James Williams of NTC (25 October 2017), Benjamin Wilson of HERE (26 October 2017) and Jan Pattison of the Queensland Trucking (1 November 2017)).
- The delivery of information en route will also help satisfy ongoing requests and demands by the trucking organisations in relation to access and operating conditions. As drivers are not usually familiar with the urban areas this will help to reduce risks, manage compliance, manage chain of authority and ensure over-height vehicles do not go where they are not supposed to (Gavin Hill of TCA (30 October 2017)).
  - An example of this was identified by Jan Pattison of the Queensland Trucking Association (1 November 2017). Jan outlined that industry has been seeking in-vehicle information on access conditions and restrictions for a while. Currently information such as bridges can be removed from a permit, which means that oversize/overmass vehicles which have had a permit can get fined for not following their permit even though it changed while they were en route or shortly before they left. Any information such as access conditions and restrictions in-vehicle would be good.
- Currently the NHVR is assessing how to provide for digital access permits which can be encoded into telematics devices. There may be opportunities for road agencies such as TMR to leverage off this work to deliver access condition information into the vehicle (Jose Arredondo of NHVR (24 October 2017)).
- Any system implemented should be scalable. When commencing to deliver in-vehicle messaging it should start by giving static access conditions but have the framework to allow for change in the future, such as the inclusion of live elements (James Williams of NTC (25 October 2017)).
- An opportunity in the short term is the increased compliance of heavy vehicles; in the long term this may include the removal of truck-related signage (Jon Harrod Booth of Harrod Booth Consulting (2 November 2017)).

- Reliable information, optimised driving, improved comfort, safety and sustainability if they have green waves for the vehicles themselves. For the road operators this can include improved safety, sustainability and liveability (Marije de Vreeze of Connekt (10 November 2017).
- Improved compliance of heavy vehicles, better harmonisation between traffic and heavy vehicles and reduced impact on other vehicles (Don Geering of Transport for New South Wales (21 November 2017)).
- Improved safety, efficiency and productivity will be achievable from delivering access conditions and restrictions in vehicle (Ross Froat of ATA (29 November 2017)).

6.1 Findings

The key findings are:

- Opportunities for TMR due to making access condition data available in-vehicle include:
  - improved safety (excluding any potential for the in-vehicle telematics devices to result in driver distraction or result in the human interacting with it in a non-desirable manner)
  - improved productivity
  - quicker determination of access routes
  - improved compliance to access conditions.
- Any data portal set up by TMR should be scalable.

7 KEY ISSUES

The key issues found in the literature and the stakeholder consultation have been broken up into three sections, data, information and delivery, as highlighted in Figure 7.1. To ensure that the telematics is successful the combination of each of these components is required to be successfully delivered.

Figure 7.1: Components required to ensure telematics functions successfully

The key issues identified with respect to these three components are discussed below.

- Data – Section 7.1
- Information – Section 7.2
- Delivery – Section 7.3.

7.1 Data

In the context of this project successful data is the access conditions and restrictions on the road networks, and the specifications around what is needed. The key issues highlighted are as follows:

- The source of the data, whether it is a primary or secondary source, is important when deciding whether to transmit the information (Marc Paglia of VicRoads (23 October 2017)). This emphasises the need to ensure the information can be relied upon.
- The quality of the data is also an issue (Don Geering of TfNSW (21 November 2017), Mark Mitchell and Lindsay Locke of TMR (14 December 2017)).
- Integrity of the data is important where decisions based on that information are enforceable. If not enforceable, then integrity is not so important, although it may not be used by drivers if viewed as having low integrity. This needs to be worked out between the jurisdictions prior to implementing into the system (i.e. if it is enforceable in one state and not in another state, the operators may choose not to use it).
- While there may not be barriers in terms of technology, key issues associated with the delivery of access condition information into the vehicle are (Peter Girgis of Bigmate (25 October 2017):
  - There need to be standards around how and when the data is used.
  - There needs to be a standardised access to the data, which is in a central location.
- The format of the data needs to be in a standardised format. Ideally this should happen at a national level to better enable use of devices across jurisdictions.
- The access conditions vary by jurisdiction (ARRB 2013a and ARRB 2013b).
- Transport agencies will need to audit the data they have to understand what it says (and what is does not say) and how it can be used (OECD International Transport Forum 2015).

7.2 Information

In the context of this project successful information is how the information is delivered. The key issues highlighted are as follows:

- The commitment and resourcing of the road agencies to deliver static and live information while maintaining the integrity of the information is considered a key issue in the implementation of a process to enable access conditions to be delivered into the vehicle (Gavin Hill of TCA (30 October 2017)).
  - In discussions with Mark Mitchell and Lindsay Locke of TMR (14 December 2017), it was noted that TMR needs the resources to be able to maintain the information to ensure that it is current and valid.
- There are different heavy vehicle access arrangements, which include single trip permits issued for once-off trips (ARRB 2013a). These would need to be mapped out and transmitted specifically for a truck as opposed to being provided a general route. This would also mean that if it deviates from the route it may not necessarily re-route the trip and would potentially be out of its permit route.
- The benefits of telematics depend on what applications are used, how the operators use the information to change systems, behaviours and culture (National Transport Commission 2014b).
- Further developments in data science might be required as a foundation for implementing new approaches to regulating freight successfully (OECD International Transport Forum 2017).
- Systems are currently too fragmented in terms of geographic implementation, integration and interoperability (OECD International Transport Forum 2017).
- Currently, legislation, depending on the state, does not allow for access documents to be carried in the form of pdf instead of a hardcopy (Peter Girgis of Bigmate (25 October 2017)).

7.3 Delivery

In the context of this project successful delivery depends on use of the in-vehicle units, which includes how the information that is to be delivered is maintained and whether it is up-to-date. The key issues highlighted are as follows:

- There is a need for interoperability in the delivery mechanisms to ensure that information can be delivered to drivers via a variety of the in-vehicle units (Jose Arredondo of NHVR (24 October 2017)).
- With respect to IAP, road agencies only have access to breaches in access conditions for enforcement purposes. The IAP information could be further used for delivery of access conditions if there was not the issue of confidentiality (i.e. the data de-identified) (Marc Paglia of VicRoads (23 October 2017)).
- A key issue associated with delivering access conditions is the age of the data. The age of the data should be assessed frequently to ensure that it is up-to-date (Benjamin Wilson of HERE (26 October 2017)).
- Road transport businesses which have larger fleets use electronic work diaries, which are a form of telematics (Teletrac Navman 2017a). ARRB (2015a) reiterates that the main issue with in-vehicle technology is ensuring that it is in-vehicle and operating.
- The uptake of services is more likely to occur if the information can be delivered into already installed in-vehicle devices.

- Although technologies may provide improvements and potentially save fleet operators money, they may not be willing to invest unless they are required to (Stamos et al. 2017).
- Cellular coverage is needed to deliver information to drivers. In discussions with Mark Mitchell and Lindsay Locke of TMR (14 December 2017), the view was that TMR considers the cellular coverage on the road network that TMR controls to be good.

7.4 Findings

The key findings are:

- For access condition data to be delivered in-vehicle requires that the following be implemented successfully:
  - data
  - information
  - delivery.
- The primary domain area of interest for TMR is the provision of data.
- Telematics providers can then access the data and develop systems to turn the data into meaningful information for example, route guidance.
- Telecommunication providers enable the data to be delivered.

8 CONCLUSIONS AND RECOMMENDATIONS

The investigation involved a literature review of 32 documents. In addition, consultations were undertaken with twenty professionals across 14 organisations. The organisations ranged across local and international road agencies, national agencies, industry, standards bodies and research agencies.

The key recommendations are outlined below.

1. TMR should develop a policy on making their road access condition data for heavy vehicles available for use in-vehicle via telematics providers. The policy should not specify the technology to be used and remain technology agnostic. The policy should also refer to the need for local government to provide road access condition data applicable to their network.
2. TMR should standardise their access condition information.
3. TMR should develop a concept of operations to outline how TMR road access condition data is to be made available. The concept of operations could incorporate the elements identified in Figure 8.1.

Figure 8.1: Possible concept of operations elements

1. Set up web data portal.

   To enable data to be accessed by telecommunication providers requires data web portals with appropriate standards (preferably aligned with national standards). TMR should look to work with other road agencies and select a common language in which to make the data available. This is so the telematics providers can develop systems that can access the data for all jurisdictions, rather than separate systems for separate jurisdictions. If all jurisdictions do not agree TMR would need to develop a system for use within TMR only.

   Once the data web portal is set up, messages may be delivered to motorists via various third-party service providers such as in-vehicle navigation devices, third party map displays on the internet, in-vehicle telematics units/applications and in-vehicle C-ITS units/applications as discussed in Section 3.1 (including reference architecture diagrams).

2. The web data portal should not only include the access conditions, but all terms and conditions associated with the access condition.

   The terms and conditions associated with the access permit condition is just as important as the access permit condition itself. It should be available in the web data portal along with the access permit condition, for use by the telematics providers.

3. The system set up to provide access condition information for heavy vehicles should be scalable.

   While the focus is on road access condition for heavy vehicles the system should be scalable so that it may relay other information as deemed appropriate in the future. This not only includes other information to heavy vehicles but also information to other vehicle types such as light vehicles (e.g. traffic and traveller information).

4. Ensure data contained in the web portal is accurate.

   Drivers need to respect the information derived from the data portal (refer to element 2) for drivers to use the data in their decision making. While the technology may not be used for direct enforcement (refer to element 7), the information will be used for decision making that will result in the driver either complying or not complying with access restrictions. Therefore, it is important that the data is of high quality and has high integrity and does not result in advising the driver of the non-current and incorrect access conditions. If non-current and incorrect access condition information is provided drivers may eventually choose to ignore it and TMR will not achieve the opportunities associated with the provision of the data.

5. Set up standards for minimum level of compliance for telematics devices.

   Commercial telematics devices vary in capability and quality and do not always align with the regulatory objectives. To ensure they can be relied upon, TMR should establish the standards for a minimum level of compliance for such devices.

   The standards should allow for flexibility in the delivery of information by telematics providers.

   Additionally, the road agencies need to ensure that all the providers are using accurate information, not just from when it was certified, but day-to-day.

   This is to demonstrate that the telematics device complies with the standards and provides reassurance to the heavy vehicle driver and operator that they have a telematics device that can provide accurate information based on TMR provided access condition data.

6. Create incentives for drivers to take up the technology.

   For drivers to access the information in-vehicle, drivers need to adopt in-vehicle technology. The take-up of technology can be an issue. There needs to be sufficient incentives for drivers to take up the technology, plus the drivers need to be made aware of these benefits.

   Incentives for drivers to adopt the technology can be obtained by making the data available for telematics providers for use in their products and for them to develop products that achieve multiple objectives for the transport operators.

   To make drivers aware of the technology and to promote the use of the data, TMR should undertake proof-of-concept trials with industry and advertise the positive outcomes of these proof-of-concept trials.

7. Limit the use of technology to relaying information only and avoid using technology for direct enforcement or driver monitoring.

   Avoiding anything perceived to be negative with the technology will also aid in the take-up of technology. This includes avoiding any functions associated with the collection of data from the heavy vehicle which may be passed to the road agency. This includes not using the technology for direct enforcement and maintaining privacy.

8. Maintain existing systems (e.g. on road signage and websites).

   While the data gets taken up by industry and used in-vehicle for the communication of access conditions TMR should aim to maintain existing systems which communicate the access conditions.

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APPENDIX A CONSULTATIONS

A range of consultations were undertaken across company type (e.g. road agency, regulatory agencies and industry) and locally and internationally). The consultations undertaken are outlined in Table A 1.

Table A 1: Consultations

Region	Type	Company	Officer	Date
Local	Road agencies	TMR (1)	Mark Mitchell Geoffrey Smith David Wilson Lindsay Locke Kelvin Marrett Paul Langton Mark Jones Manu Hingorani	25 August 2017
		TMR (2)	Mark Mitchell Lindsay Locke	13 December 2017
		VicRoads	Marc Paglia	23 October 2017
		Transport for New South Wales (TfNSW)	Don Geering	21 November 2017
	National agencies	National Heavy Vehicle Regulator (NHVR)	Jose Arredondo	24 October 2017
		National Transport Commission (NTC)	James Williams	25 October 2017
		Transport Certification Australia (TCA)	Gavin Hill	30 October 2017
	Industry	Bigmate	Peter Girgis	25 October 2017
		HERE	Benjamin Wilson	26 October 2017
		Queensland Trucking Association	Jan Pattison	1 November 2017
International (UK/EU)	Standards	Harrod Booth Consulting Limited	Jon Harrod Booth	2 November 2017
	Industry	Connekt	Marije de Vreeze	10 November 2017
International (USA)	Research	American Transport Research Institute (ATRI)	Dan Murray	17 November 2017
	Industry	American Trucking Association (ATA)	Ross Froat	29 November 2017
	National agency	Federal Motor Carrier Safety Administration (FMCSA)	Brian Routhier	30 November 2017