NACOE
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FINAL REPORT

Project Title: Mobile Mapping Solutions for Heavy Vehicles

Project No: PRJ16078

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arrb Queensland Government

SUMMARY

The Australian Road Research Board (ARRB) was commissioned by TMR under the NACOE work program to conduct a scoping study with a focus on mobile mapping technologies. The aim of this project was to investigate the most appropriate use of GIS, mobile tracking devices and applications (apps) to aid in the enforcement and management of the specific access conditions and restrictions for heavy vehicles. The findings from this project will be used to inform the future NACOE work program.

This report presents the results of the scoping study which included the following tasks:

1. A review of current processes and requirements for managing heavy vehicles and a case study using heavy vehicle compliance data supplied by TMR.
2. A review of data sources and technology based solutions, including telematics, mapping systems and development of a mobile application.
3. Consultation with telematics service providers and mobile application developers.

ARRB recommends as a first step that a detailed review of data gathered as part of compliance and enforcement processes within TMR be conducted. The review should identify datasets that can be combined to offer greater information and value by understanding the format and content, including the key attributes such as length, width, height, axle mass, GCM, and axle spacing. Following this review, the use of alternative data sources can be explored to address any gaps and where is a lack of detailed information.

This report outlines the benefits and limitations of three options for obtaining new data sources: (1) truck telematics, (2) Probe data, and (3) mobile application. A summary of the options for obtaining new data were reviewed and the findings is now presented.

Truck telematics was found to be the most suitable source of data for gaining an improved understanding of road freight movements. Telematics data contains a vehicle ID and provides sufficiently accurate information for speed and location and mass. TMR must establish agreements with individual data owners to access this data or with an organisation that has existing agreements to access the data. Provided that issues regarding privacy and data ownership are resolved sufficiently, efforts should focus on building a consolidated data platform that will aid in the decision making process when it comes to managing heavy vehicle access. Enforcement directly from data should not be the immediate or even long term focus of a future work program.

Probe data has low fleet penetration but, nonetheless, is a proven method to perform network operation analyses. Probe data is not expected to include the key vehicle attributes such as vehicle type, length and mass; however, the number of vehicles and level of detail for this dataset is expected to increase.

TMR should be aware of the limitations of developing a mobile application. The uptake of a mobile app is an important consideration. It is unlikely that the heavy vehicle operators have a need for a mobile application as their routing and fleet management needs are currently met by telematics service providers. A mobile application more likely to be suited to drivers of smaller freight vehicles (less than 4.5 tonne), but relies on the driver to have a mobile phone app on during a trip. If TMR wish to investigate the possibility of developing an application the costs, limitations and benefits can be better understood after participation in a pre-development workshop.

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1 INTRODUCTION

There is a vast amount of information available to road managers to assist with providing insight and ultimately innovative solutions to existing network problems. As the state of technology continues to steadily improve, opportunities to harness new tools and sources of data arise. One particular family of technologies that has grown in maturity over the past decade is Geographical Information Systems (GIS) and the associated location datasets available for use and integration into mobile phone applications. Queensland Department of Transport and Main Roads (TMR) has recognised that these technologies have potential applications to planning and policy development, proactive traffic management, network access and compliance and enforcement.

The Australian Road Research Board (ARRB) was commissioned by TMR under the NACOE work program to conduct a scoping study with a focus on mobile mapping technologies. Due to the vastness of the technology, the data available and the ways in which they can be applied, the scope of this project was limited to an investigation of the possible uses of mobile mapping technologies to aid in the enforcement and management of access conditions and restrictions for heavy vehicles on the TMR road network.

1.1 Project Scope

This project was a scoping study to investigate the most appropriate use of GIS, mobile tracking devices and applications (apps) to aid in the enforcement and management of the specific access conditions and restrictions for heavy vehicles. The findings from this project will be used to inform the future NACOE work program in the emerging area of GIS and accompanying mobile technologies.

1.2 Method

The project method comprised the following clearly-defined tasks:

1. Review of non-compliance reports recorded for major road restrictions and problematic areas[1].
2. Review of the following the three technology-based solutions as enforcement options:
   (a) telematics
   (b) mobile application
   (c) mapping systems.
3. Consultation with service providers to determine:
   - existing data and the feasibility of implementing a solution
   - additional data requirements
   - practical issues and limitations
   - market penetration and processes for roll out
   - cost estimates for mobile application development.

1.3 Report Layout

The report commences with a discussion of the need for access restrictions, as well as the current state of non-compliance across TMR's network with a focus on particular case study locations. Several specific technologies that have the capability of managing heavy vehicle access and movements are then explored, including vehicle telematics systems and GPS probe (or floating

[1] This was varied in agreement with the TMR project manager due to a lack of suitable compliance data.

car) datasets. Management solutions utilising this data are also discussed, including the use of geo-fencing in conjunction with mobile applications or in-vehicle devices and consolidated data platforms for use by road agencies. Finally, recommendations are made regarding the next steps that will likely be the most effective in terms of implementing a mobile mapping solution for managing heavy vehicle access.

The report comprises 13 sections which can be grouped into the following three topics:

1. current processes and requirements for managing heavy vehicles
2. online sources of freight and road data
3. mobile vehicle tracking technologies including mobile applications.

The following sections of the report introduce the basic concept of heavy vehicle access, current processes and requirements for managing heavy vehicles:

- Section 2: Heavy vehicle network access – explains motivation and requirements for managing restricted access vehicles on the road network.
- Section 3: Understanding the road freight task – an overview of vehicle registrations and traditional data sources.
- Section 4: Vehicle classification – an explanation of the vehicle class as defined in the Heavy Vehicle National Law (HVNL) as well as alternative classification approaches.
- Section 5 : Heavy vehicle attributes – the attributes of a heavy vehicle that not only define it as unique but are critical of managing its access.
- Section 6: Heavy vehicle compliance data – a case study of heavy vehicle compliance data (WIM records) provided by TMR.
- Section 7: Vehicle data sources – a review of currently-available data sources including vehicle and road data. This section highlights the emerging public online spatial data portals that can assist with understanding the use of the road network.

The final topic presented in this report is a review of emerging mobile mapping technologies based on industry consultation (Section 8). The aim of the review was to identify the requirements of a mobile application to aid in the enforcement and management of the specific access conditions and restrictions for heavy vehicles. The findings are presented in the following sections:

- Section 8.1: Open location platforms
- Section 8.2: Telematics service providers
- Section 8.3: Mobile application developers.

A summary of the key findings is provided in Section 9 and recommendations regarding the next steps to be undertaken in a future work program are provided in Section 10.

2 HEAVY VEHICLE NETWORK ACCESS

In order to meet the demanding freight task, Australia has adopted the use of high productivity vehicles (HPV) including B-doubles, road trains and innovative multi-combination vehicles. As a result there is a diverse range of specialised heavy vehicles operating on the road network, which often have unique requirements and access conditions to ensure the safe, efficient and most amenable transportation of goods to their destinations.

Heavy vehicle access conditions exist for many reasons, including maintaining the highest levels of safety and reducing the impacts on roads and structures that were not designed for these new-generation heavy vehicles. Currently, these access conditions are applied by road agencies and enforced by the Police and/or roadside transport inspectors. Traditional enforcement methods include visual inspections and roadside weighing (either using portable scales or a weighbridge). However, new technologies are now being used, including automatic number plater recognition (ANPR), vehicle length scanning and weigh-in-motion (WIM). Whilst vehicle-based technology is more commonly utilised by transport operators to better manage their vehicle fleet and drivers, these technologies also offer benefits to road managers, particularly to assist with identifying where problematic areas exist on the network. It is possible that currently-available GIS datasets can provide data which will enable the movements of heavy vehicle along the network to be monitored with a greater level of accuracy.

2.1 Heavy Vehicle Access

2.1.1 Motivation

The motivation for heavy vehicle access restrictions can be distilled into three main pillars:

Safety

The size of heavy vehicles can become a safety hazard when they travel along routes not designed with the appropriate tolerances. A simple example of this is high vehicles travelling on roads with low-lying overhead structures such as bridges. Impacts with these structures can damage the vehicle, cause traffic disruptions and, in the worst case, damage the structure. Route restrictions can also be put in place on roads where particularly long vehicles will struggle to manoeuvre. The swept path of a turning truck can dwarf that of a typical car; it is often the case that certain roads, such as in mountainous or suburban locations, are simply not designed with heavy vehicles in mind.

Amenity

Access restrictions are used to preserve location amenity, most commonly by keeping longer and heavier restricted-access vehicles out of suburban areas. Factors that affect amenity include their overall length and mass and their effects on traffic flow as well as the noise generated from these vehicles. The use of engine brakes, especially at night, is often used to typify the negative impact heavy vehicles have on a locality.

Infrastructure preservation

Pavements deteriorate deterministically depending on the volume and mass of the vehicles traversing them. The rate of deterioration can increase exponentially with load. As a result, and depending on the design traffic, an over-presence of heavy vehicles can shorten the life of the pavement many times faster than originally intended. Heavy vehicle access restrictions can be used to prevent this from occurring, by protecting vulnerable roads from loads for which they may not have been designed. This has the overall positive effect of increasing the life of the road network and reducing the need for premature renewal and reconstruction works.

Safety, amenity and infrastructure preservation are all equally important reasons to have a robust set of heavy vehicle access restrictions in place. This makes it all the more important to ensure that such restrictions have good compliance. While the Police can work to enforce these restrictions at key locations, a full understanding of vehicle patterns and non-compliance rates would improve the ability of road agencies to manage heavy vehicle access across their networks.

2.2 Heavy Vehicle Access Conditions

The HVNL defines access conditions in three categories: vehicle, road and travel. The vehicle conditions are primarily the responsibility of the National Heavy Vehicle Regulator (NHVR) whilst the travel and road conditions are primarily the responsibility of the road manager. This is based on the responsibilities of each organisation. 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 particular mass or dimension
- installation and use of certain components (including safety features or other equipment)
- limiting the vehicle to a particular speed.

The NHVR Guidelines for Granting Access (NHVR 2014) lists considerations for the NHVR and the road manager to minimise risk; these are listed in Table 2.1.

Table 2.1: Considerations for managing risks

NHVR (vehicle considerations)	Road manager (travel and road considerations)
Size and mass of the vehicle	Vehicle's ability to interact with surrounding traffic
Security of couplings	Vehicle's ability to interact with the infrastructure and road
Distribution of mass	Suitability of the dimensions (length and width) of the road
Dynamic stability and tracking characteristics	Location of infrastructure on or near the road
Acceleration and braking characteristics	Traffic conditions
Manoeuvrability	Use of properties near the road
Visibility to other road user	Sight distance for other road users
Suitability of the vehicle to the task	Clearance zones for the road
Load restraint	Results of road safety audits
Rollover risk	Suitability of the road for transport of dangerous goods

The list of considerations is broad and requires extensive knowledge of heavy vehicles, roads and infrastructure. Road conditions are intended to minimise risks associated with road infrastructure, the community and public safety. The NHVR Guidelines (NHVR 2014) list the following examples of road conditions:

- do not use particular bridges or sections of the otherwise-approved route
- only carry particular loads
- be limited to a particular 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
- require the operator to participate in an intelligent access program.

Travel conditions may require that the movement of exempt heavy vehicles is undertaken at stated times or in a stated direction. *Draft Version 1.0 (March 2016) Standard Road and Travel Conditions* is a being developed by the NHVR. The aim of this document is to list standard conditions that can be applied by road managers.

2.2.1 Summary of Heavy Vehicle Network Access

The key points regarding heavy vehicle access are:

- Road managers have the right to apply conditions when granting access to restricted access vehicles.
- The NHVR is working with road managers to develop a list of standard conditions.
- Three types of conditions are applied: vehicle, road and travel.
- Road and travel conditions are primarily the responsibility of the road managers. Access conditions (including road and travel) are ultimately based on the vehicle attributes.

3 UNDERSTANDING THE ROAD FREIGHT TASK

This section of the report discusses the traditional data sources currently used to define the freight task. These traditional data sources include:

- The Australian Bureau of Statistics (ABS) Motor Vehicle Census (MVC)
- The ABS Road Freight Movements Survey (RFMS)
- The National Exchange of Vehicle and Driver Information System (NEVDIS).

Other data sources referenced in this section include:

- The Australian Road Transport Suppliers Association (ARTSA) trailer statistics
- The NHVR Performance Based Standards (PBS) application statistics.

The ABS data includes the following vehicle groups:

- passenger vehicles
- campervans (excluded from this report)
- light commercial vehicles – *motor vehicles less than 3.5 tonnes gross vehicle mass (GVM) constructed for the carriage of goods*
- light rigid trucks – *motor vehicles greater than 3.5 tonnes and less than 4.5 tonnes GVM with a load carrying area*
- heavy rigid trucks – *motor vehicles exceeding 4.5 tonnes GVM with a load-carrying area*
- articulated trucks – *a prime mover with a turntable device for towing a semi-trailer*
- non-freight carrying trucks
- buses
- motorcycles.

Under this classification, rigid trucks include trucks towing trailers via a tow bar, draw bar or other non-articulated coupling. Articulated trucks include single-trailer and multi-trailer articulated truck combinations, such as B-doubles and road trains. A heavy vehicle is defined as any motor vehicle with a GVM of 4.5 tonnes or more, including both trucks and buses.

The ABS MVC provides information on the total number for vehicles registered in Australia each year. The data includes all registered vehicles; however, the vehicle categories are broad and provide limited scope for integration of an individual vehicle or unique configuration types.

3.1 Proportion of Vehicle Fleet

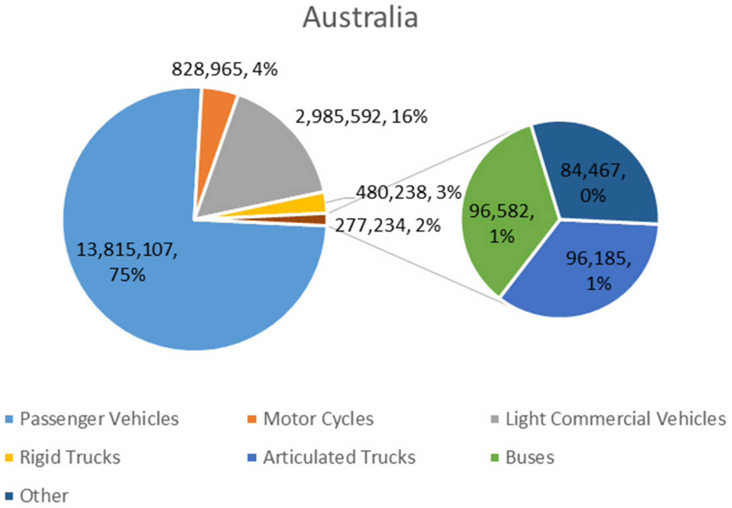
An understanding of the road freight task, and the vehicles performing this task, is vital if any value is to be extracted from any mobile mapping or monitoring solution. Due to the vastness of the road freight industry and the range of specialised heavy vehicle types it is necessary to understand the sectors of the industry and the different vehicle types. This section of the report commences by providing a broad perspective of the number of vehicles performing Australia's road freight task. Section 4 expands on this by summarising the vehicle classes, types and vehicle attributes that can be used to identify vehicles.

Based on the 2016 census the total number of registered vehicles in Australia was made up of:

- 13 815 107 passenger vehicles (75%)
- 3 743 067 comprised of freight vehicles, buses and non-freight carrying trucks (21%)
- 828 965 motorcycles (4%).

Figure 3.1 shows the number registered vehicles in Australia adapted from MVC 2016.

Figure 3.1: Number of registered vehicles in Australia



Source: Adapted from ABS MVC (2016).

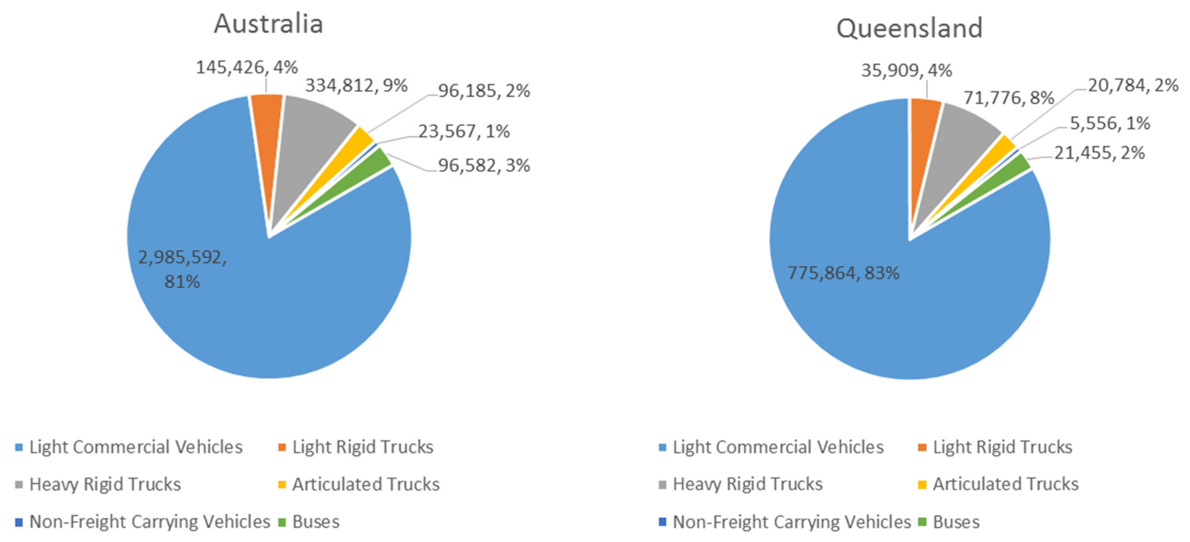
Of the registered heavy vehicles in Australia 81% (2 985 592) were light commercial vehicles, 13% (480 238) were either light or heavy rigid trucks and 3% (96 185) were articulated trucks. The remaining vehicles were non-freight-carrying vehicles and buses. In Queensland the percentage of vehicles was similar to the Australia-wide trend. The number of registered heavy vehicles by type for Australia and Queensland is shown in Figure 3.2.

The data available from ABS MVC provides information on the total registrations for each vehicle category only. The National Exchange of Vehicle and Driver Information System (NEVDIS) is a national system that exchanges information about vehicles including each vehicle's Vehicle Identification Number (VIN). NEVDIS was established in 1998 and is owned by Austroads on behalf of the eight states and territory jurisdictions who contribute registration information. The NEVDIS database contains more detailed information that can be processed and analysed to provide more resolution within each vehicle category. For example NEVDIS data could include the information shown in Table 3.1.

Table 3.1: NEVDIS database example

Make	Model	Aggregate Trailer Mass (t)	Approval No.	VIN
Drake	Quad axle low loader	85.0	11325	6T9T25ABJX0AKG001

Figure 3.2: Registered heavy vehicles in Australia and Queensland



Source: Adapted from ABS MVC (2016).

This data can be interpreted to provide further insight into the vehicle's potential use, for example:

- vehicle GCM: *110 tonne*
- suspension type: *hydraulic*
- freight task: *oversize over-mass*
- manufacturer location: *Queensland*.

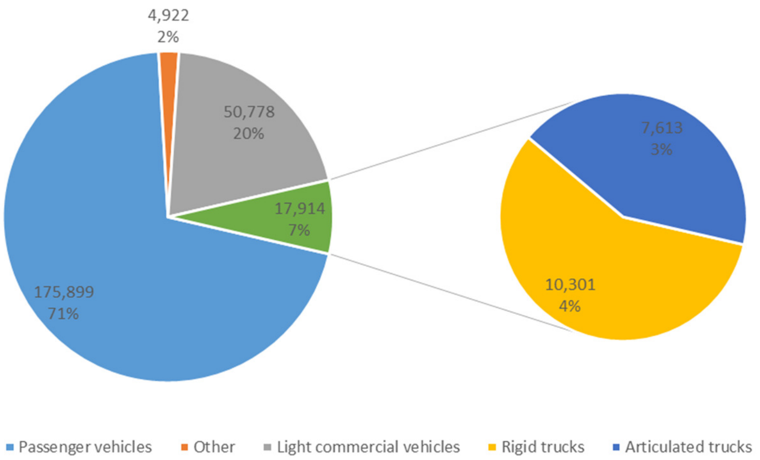
The Australian Road Transport Suppliers Association (ARTSA) provides a service which adds value to the NEVDIS data; it prepares quarterly and yearly data summaries available for purchase (ARTSA Truck and Trailer Reports). The reports provide graphical analyses of the heavy prime mover and trailer sector and the medium and heavy duty rigid truck sector for prime movers, trailers and rigid trucks. An example of the data provided by ARTSA is shown in Figure 3.3.

Figure 3.3: Example of the data provided by ARTSA: new prime mover registrations

Source: ARTSA (2016).

Greater understanding of the freight task can be achieved by considering the distance travelled by each vehicle type. Analysis of the ABS MVC data indicates that freight vehicles in Australia travelled an estimated 204 575 million tonne-km (MVC 2016). The number of kilometres travelled by heavy vehicle type in Australia, adapted from MVC 2016, is shown in Figure 3.4.

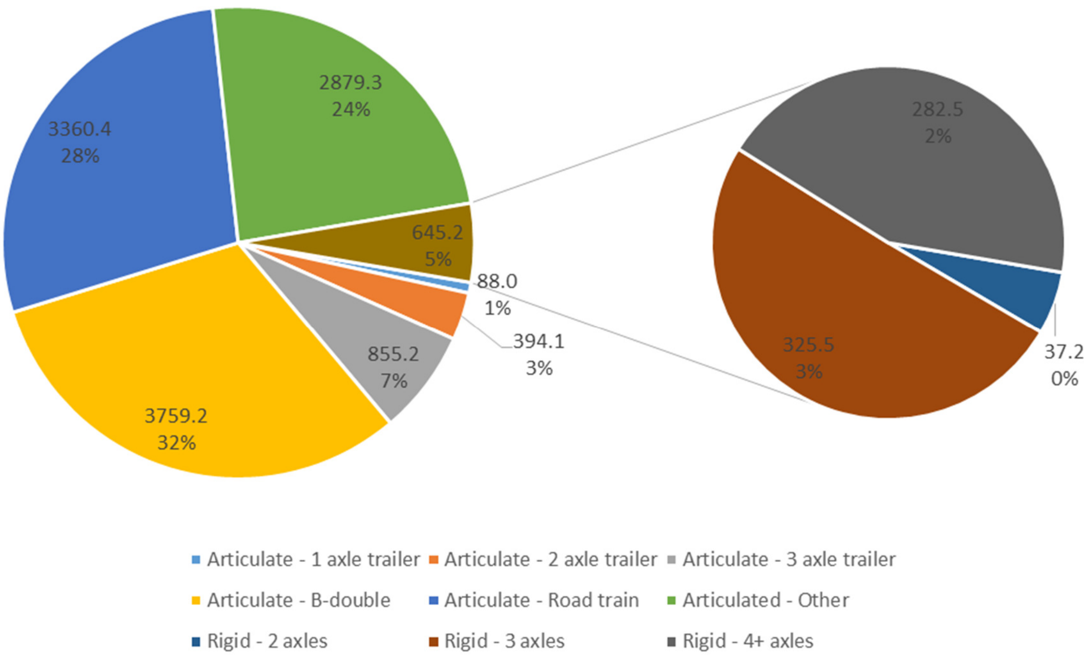
Figure 3.4: Total km travelled by heavy vehicles in Australia



Source: Adapted from ABS MVC (2016).

The tonne-km travelled by articulated heavy vehicles types and rigid trucks in Australia is shown in Figure 3.5.

Figure 3.5: Total tonne-km ('000s) travelled by heavy vehicles in Australia

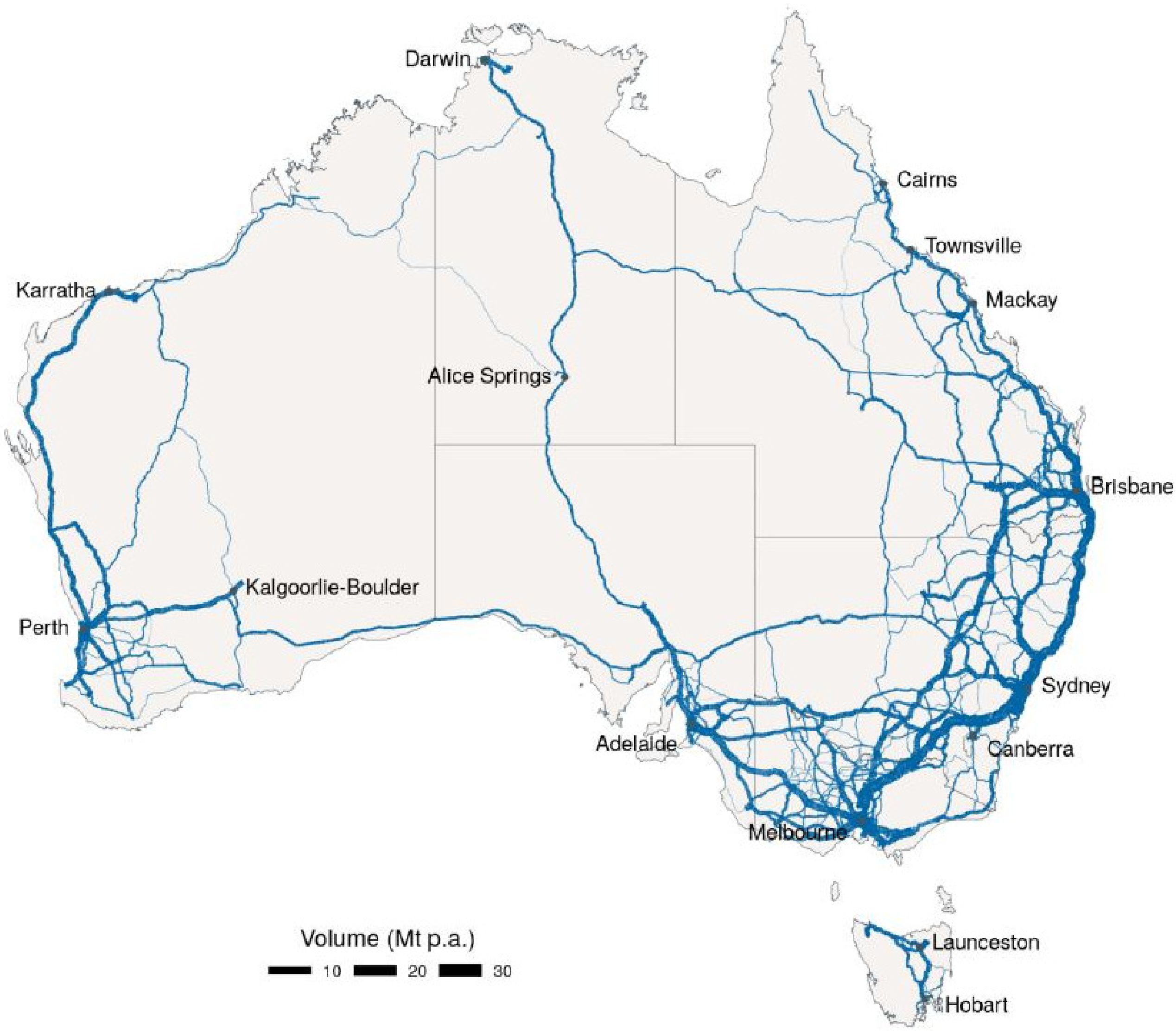


Source: Adapted from ABS MVC (2016).

The total number of tonne-km travelled provides information regarding the amount of work being done by heavy vehicles. This information is useful for understanding general productivity trends. In order to understand localised road freight movements this data must include a spatial element. This can be achieved by including origin and destination data and the assumption that vehicles are using the key freight routes. If specific restricted access vehicle configurations can be identified it is possible and reasonable to assume that these vehicles are using the approved network between the origin and destination.

Figure 3.6 show a spatial visualisation of road freight movements, by origin and destination, for the 12 months ended 31 October 2014. This example was sourced from the ABS Road Freight Movements Survey and adapted from material produced by David Mitchell (BITRE) for the ARTSA Data forum held in September 2016.

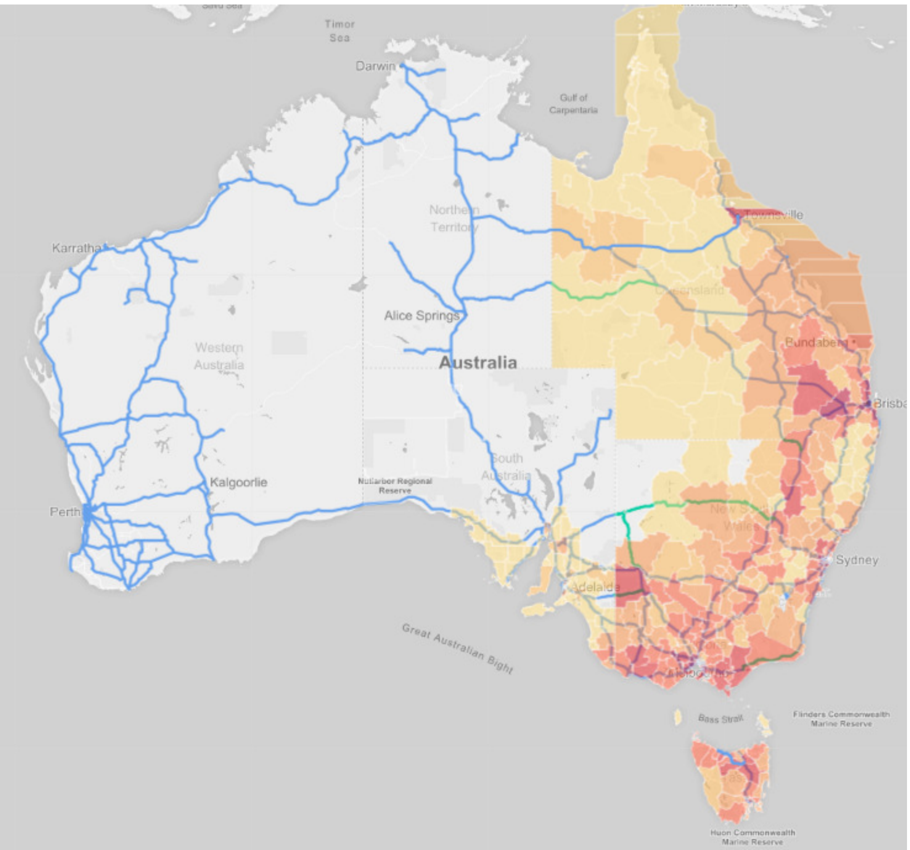
Figure 3.6: Example of road freight movements



Source: ABS Road Freight Movements Survey and adapted from material produced by David Mitchell (BITRE) for the ARTSA Data forum held in September 2016.

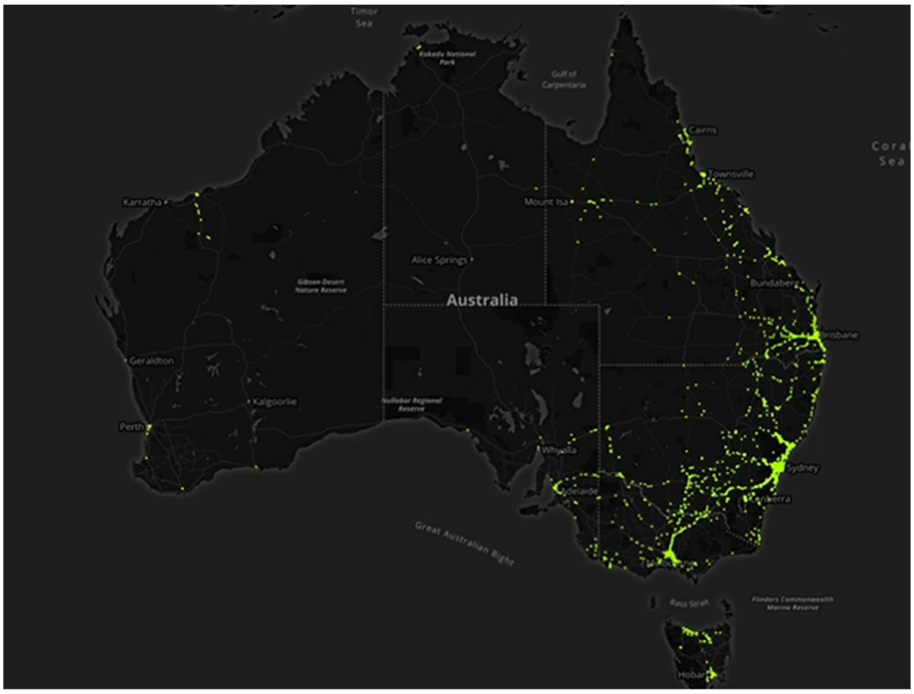
Similarities exist between the data shown in Figure 3.6, the key freight routes shown in Figure 3.7 and vehicle movements (based on Transport Certification Australia (TCA) data) shown in Figure 3.8.

Figure 3.7: Key freight routes



Source: Adapted from material produced for the NHVR Portal Awareness Information Session held in June 2017.

Figure 3.8: Vehicle movement visualisation based on TCA data



Source: Adapted from material produced by Paul Corkill, General Manager Operations, TCA.

3.2 Summary of Understanding the Freight Task

The key points for understanding the freight task are as follows:

- The Australian Bureau of Statistics (ABS) Motor Vehicle Census (MVC) provides information on the total number for vehicles registered in Australia each year. Although the data is thorough and includes records for all vehicles, the vehicle categories are broad and provide limited scope for integration of an individual vehicle or unique configuration types.
- Of the registered heavy vehicles in Australia 81% were light commercial vehicles, 13% were either light or heavy rigid trucks and 3% were articulated trucks.
- The ABS Road Freight Movements Survey (RFMS) provides a detailed survey of freight movements in Australia for the periods in which the survey is conducted.
- The National Exchange of Vehicle and Driver Information System (NEVDIS) provides details of vehicles based on registration data, including each vehicle's Vehicle Identification Number (VIN).
- The Australian Road Transport Suppliers Association (ARTSA) provides a service which adds value to the NEVDIS data and prepares quarterly and yearly data summaries available for purchase as ARTSA Truck and Trailer reports.
- Spatial data included in the RFMS contains detailed information that provides insight into the volumes carried on the key freight routes. However, a detailed survey such as this is costly and is not conducted on a regular basis. Therefore, the need for a cost-effective means of gathering similar spatial data remains.

4 HEAVY VEHICLE CLASSIFICATION

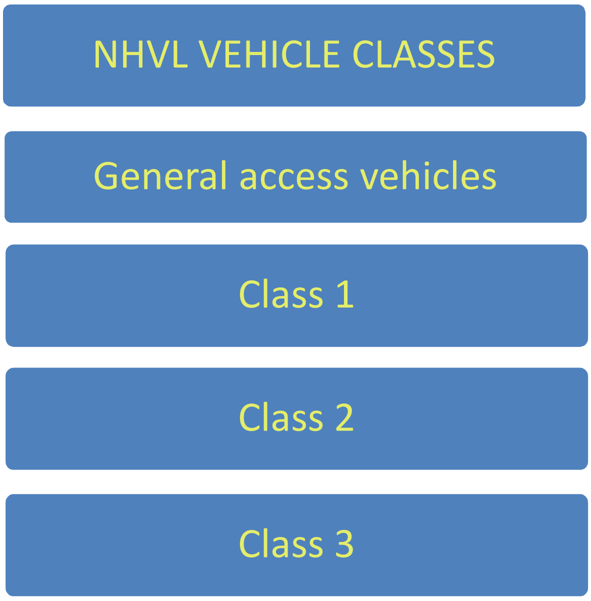
This section of the report describes the vehicle classes used in heavy vehicle regulation and the vehicle attributes that are important to consider when determining access rights for restricted access vehicles.

4.1 National Heavy Vehicle Classes

A heavy vehicle is defined in legislation as a vehicle with a GVM exceeding 4.5 tonnes and includes trailers. The NHVR is Australia's independent regulator for all vehicles over 4.5 tonnes GVM. It also administers the HVNL. The national law applies in Queensland as well as the Australian Capital Territory, New South Wales, Queensland, South Australia, Tasmania and Victoria.

The vehicle class system employed in the HVNL provides a basis for national vehicle classes; namely Class 1, Class 2 and Class 3 (Figure 4.1).

Figure 4.1: Heavy vehicle classes



These heavy vehicle classes cover all the heavy vehicles in operation on the network. Whilst the vehicle classes provide a means for applying the HVNL, it is more common to describe vehicle by their category or type.

The following vehicle categories can be used to describe the vehicles that exist within each category.

- general access vehicles
- special purpose vehicles
- agricultural vehicles
- oversize-overmass vehicles
- restricted access freight vehicles
- controlled access buses
- tow trucks
- other vehicles, that do not fit into the previously-listed categories.

4.1.1 Class 1 Vehicle

A Class 1 vehicle is defined in the HVNL (Chapter 4, Part 4.5, Division 1, Section 116) as follows:

A heavy vehicle is a Class 1 heavy vehicle if it, together with its load, does not comply with a prescribed mass requirement or prescribed dimension requirement applying to it, and

(a) It is a special purpose vehicle; or

(b) It is an agricultural vehicle other than an agricultural trailer; or

note: See subsection (2) for agricultural trailers

(c) It

(i) is a heavy vehicle carrying, or designed for the purpose of carrying a large indivisible item, including, for example, a combination including a low loader; but

(ii) is not a road train or B-double, or carrying a freight container designed for multi-modal transport.

4.1.2 Class 2 Vehicle

A class 2 vehicle is defined in the HVNL (Chapter 4, Part 4.6, Division 1, Section 136) as follows:

A heavy vehicle is a class 2 heavy vehicle if:

(a) It

(i) complies with the mass requirements and prescribed dimension requirements applying to it; and is:

A. a B-double; or

B. a road train; or

C. a bus, other than an articulated bus, that is longer than 12.5 m; or

D. a combination designed and built to carry vehicles on more than 1 deck that, together with its load is longer than 19 m or higher than 4.3 m; or

E. A motor vehicle, or a combination, that is higher than 4.3 m and is built to carry cattle, sheep, pigs or horses; or

(b) It is a PBS vehicle.

4.1.3 Class 3 Vehicle

A class 3 vehicle is defined in the HVNL (Chapter 4, Part 4.5, Division 1, Section 116) as follows:

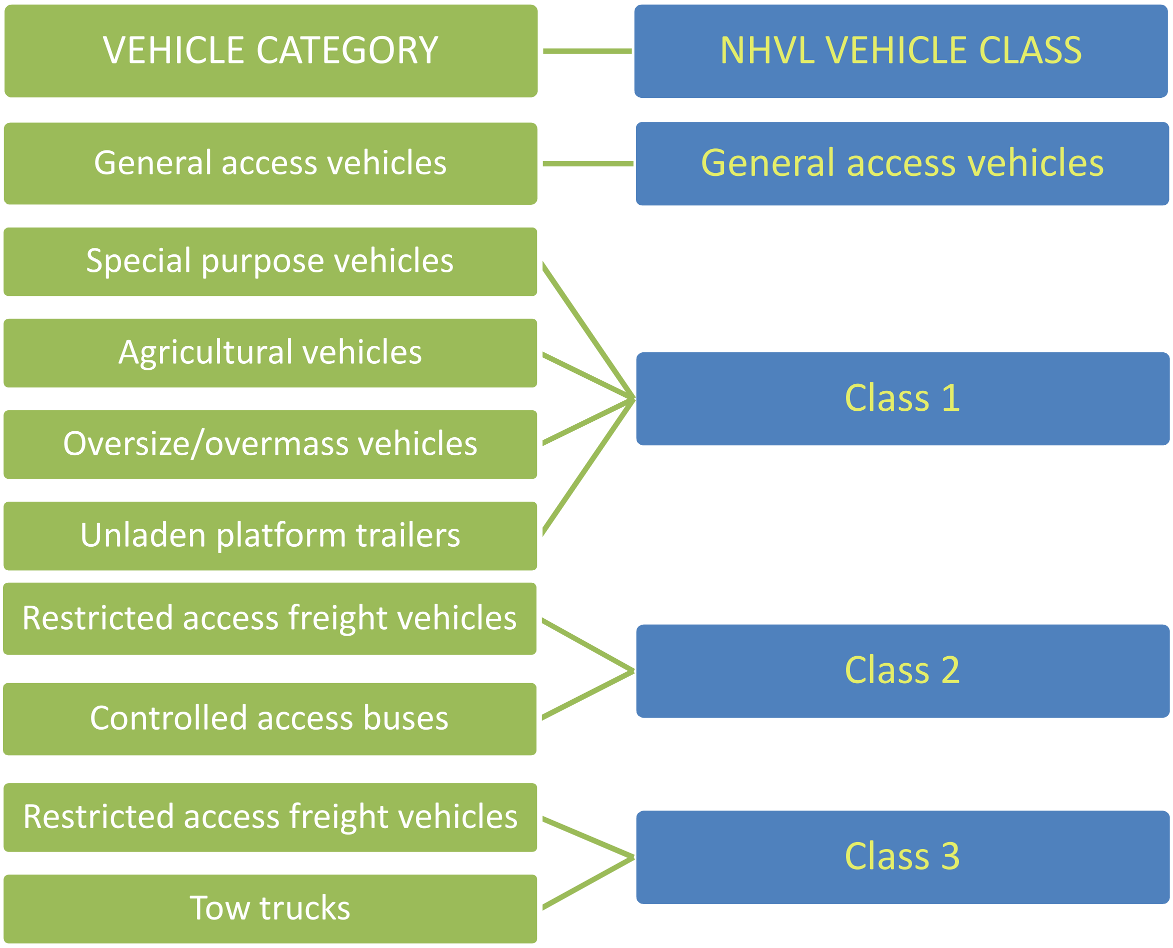
A heavy vehicle is a Class 3 heavy vehicle if:

(a) it, together with its load, does not comply with a prescribed mass requirement or prescribed dimension requirement applying to it; and

(b) it is not a Class 1 heavy vehicle.

The three HVNL classes and their categories have been grouped accordingly as shown Figure 4.2.

Figure 4.2: HVNL classes and their categories



Within each category there are a number of different vehicle types or configurations. For example, the restricted access freight-carrying vehicles can include the following vehicle configurations.

- B-doubles, A-doubles
- B-triples, A-triples, AB-triples, BA-triples
- ABB-quads, BAB-quads, AAB-quads, BAA-quads.

The NHVR has produced a list of common heavy freight vehicle configurations. It is not a comprehensive representation of the entire Australian heavy vehicle fleet; its purpose is to assist industry and road managers by providing common terminology.

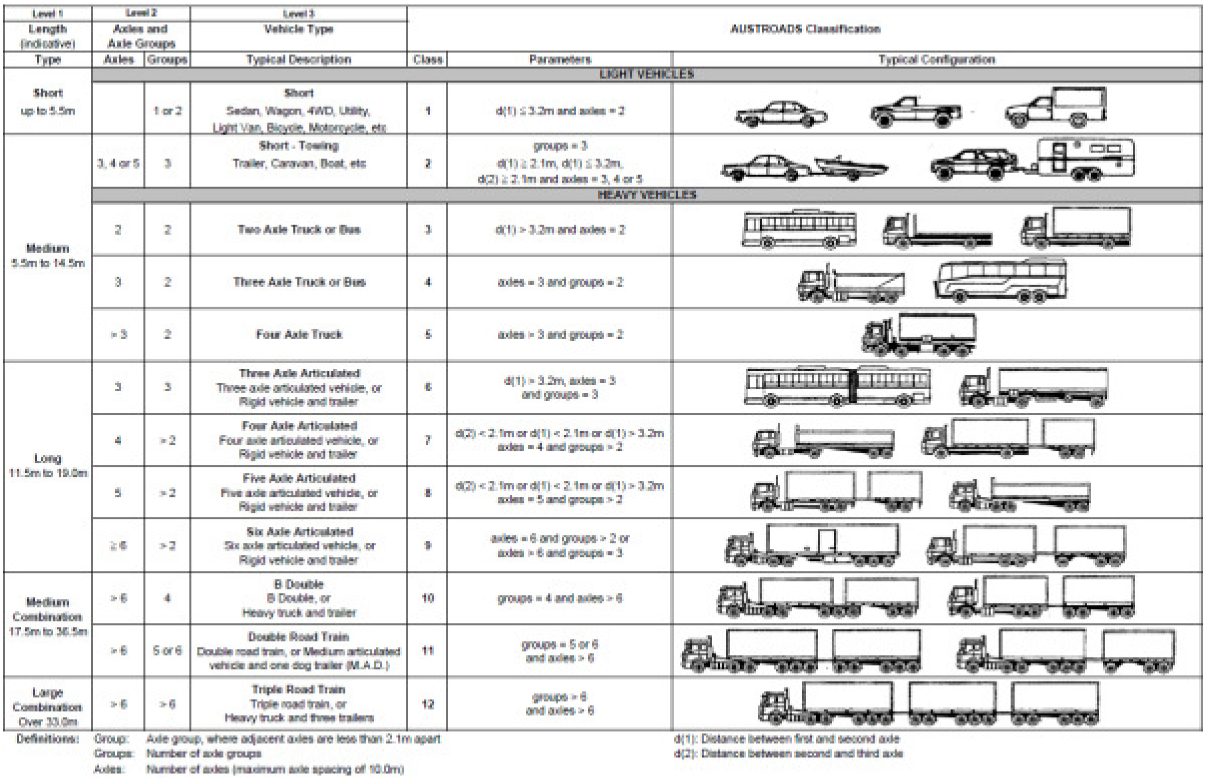
4.2 Austroads Vehicle Classes

The Austroads vehicle classification system, shown in Table 4.1, is based on the number of axles, axle groups and length of the vehicle. The features of the Austroads vehicle classes are:

- 12 classes
- progressively increases from two-axle buses and rigid trucks to triple road trains
- classes are based on vehicle length, number of axles and number of axle groups.

The Austroads vehicle classes include the metrics: axles and axle groups. This suggests this vehicle classification is based on the impact on pavements and bridges.

Table 4.1: Austroads classification table for vehicles



Level 1 Length (indicative) Type	Level 2 Axles and Axle Groups: Axles	Groups	Level 3 Vehicle Type: Typical Description	AUSTROADS Classification: Class	Parameters	Typical Configuration
	LIGHT VEHICLES					
Short up to 5.5m		1 or 2	**Short** Sedan, Wagon, 4WD, Utility, Light Van, Bicycle, Motorcycle, etc	1	d(1) ≤ 3.2m and axles = 2	
Medium 5.5m to 14.5m	3, 4 or 5	3	**Short - Towing** Trailer, Caravan, Boat, etc	2	groups = 3 d(1) ≥ 2.1m, d(1) ≤ 3.2m, d(2) ≥ 2.1m and axles = 3, 4 or 5	
	HEAVY VEHICLES					
	2	2	**Two Axle Truck or Bus**	3	d(1) > 3.2m and axles = 2	
	3	2	**Three Axle Truck or Bus**	4	axles = 3 and groups = 2	
	> 3	2	**Four Axle Truck**	5	axles > 3 and groups = 2	
Long 11.5m to 19.0m	3	3	**Three Axle Articulated** Three axle articulated vehicle, or Rigid vehicle and trailer	6	d(1) > 3.2m, axles = 3 and groups = 3	
	4	> 2	**Four Axle Articulated** Four axle articulated vehicle, or Rigid vehicle and trailer	7	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 4 and groups > 2	
	5	> 2	**Five Axle Articulated** Five axle articulated vehicle, or Rigid vehicle and trailer	8	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 5 and groups > 2	
	≥ 6	> 2	**Six Axle Articulated** Six axle articulated vehicle, or Rigid vehicle and trailer	9	axles = 6 and groups > 2 or axles > 6 and groups = 3	
Medium Combination 17.5m to 36.5m	> 6	4	**B Double** B Double, or Heavy truck and trailer	10	groups = 4 and axles > 6	
	> 6	5 or 6	**Double Road Train** Double road train, or Medium articulated vehicle and one dog trailer (M.A.D.)	11	groups = 5 or 6 and axles > 6	
Large Combination Over 33.0m	> 6	> 6	**Triple Road Train** Triple road train, or Heavy truck and three trailers	12	groups > 6 and axles > 6	

Definitions: Group: Axle group, where adjacent axles are less than 2.1m apart
Groups: Number of axle groups
Axles: Number of axles (maximum axle spacing of 10.0m)

d(1): Distance between first and second axle
d(2): Distance between second and third axle

Source: Austroads (2013).

4.3 Performance Based Standards (PBS) Vehicle Levels

The PBS scheme is an alternative heavy vehicle access scheme which is performance based' It provides an alternative to the current requirement to meet the prescriptive mass and dimension limits as outlined in regulations or notices. The PBS scheme is based on the premise that access is granted on the basis of how a vehicle performs. For example, this allows vehicles that do not comply with the prescriptive regulations to access a portion of the road network that is deemed suitable. Under PBS, the vehicle in question must undergo assessment and certification to determine whether it satisfies the safety and performance criteria. The performance of the vehicle is matched to an appropriate level of access, as summarised in Table 4.2.

Table 4.2: Vehicle levels according to the PBS scheme

Vehicle performance	PBS road access level		Example	PBS vehicle length limit A	PBS vehicle length limit B
Level 1	1		Semi-trailer, truck and trailer, short B-double	20 m	
Level 2	2A	2B	Long B-double, short A-double, short B-triple	26 m	30 m
Level 3	3A	3B	AB-triple, long A-double	36.5 m	42 m
Level 4	4A	4B	A-triple, quad road train	53.5 m	60 m

The levels of access have been defined using the PBS network classification guidelines (NTC 2008). The majority of road managers have embraced the PBS scheme and have either classified or are in the process of classifying parts of their road network as PBS networks. Despite the benefits of PBS, the vast majority of vehicles operating on the Australian road network do so under prescriptive regulations, with less than 0.1% of the fleet being PBS vehicles (Arredondo 2012) but the expectation is that this will grow over the next decade. PBS vehicles currently operate under permit, and in order to receive a permit a number of steps must be completed which includes a vehicle assessment. This process requires more time, effort and expense to the applicant which inhibits the take-up of PBS. Nonetheless, the performance standards - the foundation on which PBS stands - are based on proven research and are well accepted.

4.4 Other Vehicle Classes

This section of the report describes three alternative vehicles vehicle classifications used by Main Road Western Australia (MRWA), the National Transport Commission (NTC) and the Australian Transport Assessment and Planning (ATAP) Guidelines.

4.4.1 Vehicle Classification: Main Roads Western Australia

MRWA has developed a comprehensive ‘Restricted Access Vehicles’ (RAV) classification system for its prime mover and rigid truck combinations. The system segregates heavy vehicles into 10 categories. The categories are based upon vehicle (combination) type, with each having its own prescribed maximum length, mass, number of axles and axle groups. The main features of the MRWA RAV classification system are:

- every freight vehicle has a category
- there is a direct link to access (e.g. Category 1 vehicles operate on Network 1 routes)
- it is simple and well understood by operators
- it does not include special-purpose vehicles (SPVs), over-size/over-mass (OSOM), tow trucks or agricultural vehicles, although MRWA has a similar system for low loaders and platform trailers.

In addition, MRWA also has classifications for prime movers hauling low loaders and platform trailers under period permit arrangements. This approach has been shown to be very effective in Western Australia, although compatibility issues exist with other road managers, especially relating to length limits.

4.4.2 Vehicle Classification: National Transport Commission

When determining heavy vehicle road user charges, the NTC classified heavy vehicles into over 25 separate classes. The main features of the NTC vehicle classification are as follows:

- most major vehicle groups are captured
- it progressively increases from 4.5 tonne rigid trucks to triple road trains and SPVs
- classes are based on the number of vehicle units, trailer units, mass and axle configuration
- heavy vehicles are differentiated according to vehicle type, axle configuration, number of trailers and GVM
- it is not used elsewhere.

4.4.3 Australian Transport Assessment and Planning Guidelines

The ATAP Guidelines provides parameter (unit) values for use by economic evaluation practitioners in Australian jurisdictions, as well as models to estimate vehicle operating costs (VOC) and, in turn, calculate road user costs (RUC) for the purposes of cost-benefit analysis

(CBA). In order to address these issues, the ATAP developed a 20 vehicle classification system appropriate to Australia. This was undertaken as it is broadly consistent with the vehicle classifications contained in Austroads (2013). It provides a sufficiently broad range of vehicle types from which practitioners can select the vehicles most appropriate to their local vehicle fleets. The ATAP 20-vehicle classification provide further dissection of the 12 Austroads vehicles classes, but still neither include the necessary resolution to represent the complex range of vehicle types in Australia. The 20 vehicle types are listed in Table 4.3.

Table 4.3: Vehicle classifications – ATAP guidelines (2016)

Vehicle types	Vehicle types
01. Small Car	11. Artic 5 Axle
02. Medium Car	12. Artic 6 Axle
03. Large Car	13. Rigid + 5 Axle Dog
04. Courier Van-Utility	14. B-Double
05. 4WD Mid-Size Petrol	15. Twin steer + 5 Axle Dog
06. Light Rigid	16. A-Double
07. Medium Rigid	17. B Triple
08. Heavy Rigid	18. A B Combination
09. Heavy Bus	19. A-Triple
10. Artic 4 Axle	20. Double B-Double

4.5 Summary of Vehicle Classification

The key points regarding the vehicle classifications are as follows:

- A heavy vehicle is a vehicle with a GVM exceeding 4.5 tonnes and includes trailers.
- The vehicle class system employed in the HVNL) provides a basis for national vehicle classes: namely Class 1, Class 2 and Class 3.
- There are three vehicle classifications that are specific to quantifying the costs and benefits of vehicles (NTC, ATAP and Austroads). These classifications are not useful for managing heavy vehicle access.
- The national approach (excluding the NT and WA) is to adopt the PBS vehicle classification for managing heavy vehicles access.
- The NHVR has defined the heavy vehicle configurations that are permitted access the Australian road network. These definitions are required to identify which conditions are applicable to certain vehicles access permits.
- The vehicle class, PBS level, and vehicle configuration are required in order to understand which conditions are applicable to certain vehicles access permits.
- Although vehicle classification is important for the application and enforcement of conditions, it is not critical if vehicle movements are being monitored to understand network utilisation.

5 HEAVY VEHICLE ATTRIBUTES

Heavy vehicle attributes such as wheelbase, rear overhang, axle group masses are diverse and varied, especially when compared to passenger cars. Table 5.1 lists heavy vehicle attributes that are listed in mass and dimensions regulations, notices or gazettes and considered when making heavy vehicles access decisions. Many restricted access vehicles gain access to the road network via the PBS scheme, which is based on the premise that prescriptive dimensions do not matter if the vehicle is proven to perform satisfactorily. However, despite the PBS scheme offering flexibility for many vehicles attributes, access is granted conditional to limits on mass, length, width, height and axle spacing being adhered to. Furthermore, the proven performance of a PBS vehicle is intrinsically linked to that vehicle only, therefore every attribute that defines the vehicle is critical to its performance and consequently its access.

Table 5.1: Heavy vehicle attributes commonly linked to access

Attributes	Description
Dimensions	
Overall length	▪ Overall longitudinal dimension of a vehicle or combination of vehicles including load
Wheelbase (prime mover/rigid truck)	▪ Longitudinal distance from the centre of the steering axle to the geometric centre of the drive axle unit of a tractor
Wheelbase (trailer)	▪ The longitudinal distance from the centre of the kingpin of a semi-trailer, or the turntable of a full trailer, or the hitching device on a trailer to the centre of the rearmost axle group of the trailer
Rear overhang	▪ Of prime mover/rigid truck: longitudinal distance from the centre of the last axle group of the vehicle unit to the rearmost point of the vehicle or cargo, whichever is greater ▪ Of semi-trailer: longitudinal distance from the rearmost axle group of the vehicle unit to the rearmost point of the unit or cargo, whichever is greater
Forward projection	▪ Of prime mover/rigid truck: longitudinal distance from the centre of the steer axle to the foremost point of the vehicle or cargo, whichever is greater ▪ Of trailer: longitudinal distance from the fifth wheel connection to the foremost point of the unit body or cargo, whichever is greater
Height	▪ Maximum overall vertical distance from the highest point on the vehicle or load to the ground
Width	▪ Maximum lateral distance of a vehicle or combination of vehicles including load; does not include mirrors, signalling devices and side-mounted lamps
Axle spacing	▪ Longitudinal dimension between the centres of adjacent axles
Ground contact width	▪ The distance between the outer edge of the contact patch of the outside tyres on an axle
Ground Clearance	▪ The minimum distance to the ground from the underside of a vehicle excluding its tyres, wheels, wheel hubs, brake backing plates and flexible mudguards or mudflaps
Tyre width	▪ The width of the contact patch of each tyre
Axle mass limits	
Mass limits related to tyre width	▪ Mass limits defined in relation to the tyre contact width
No of tyres per axle	–
Ground contact width	▪ The distance between the outer edge of the contact patch of the outside tyres on an axle
Mass limits of axle (single axles or axle groups)	▪ The maximum limit of the sum of all wheel loads on an axle of a vehicle
Other mass limits	
Gross combination mass	▪ The maximum laden mass of a motor vehicle combination as specified by the manufacturer. ▪ The maximum of the sum of the gross vehicle mass of the hauling unit plus the sum of the axle mass of any vehicle capable of being drawn as a trailer
Gross vehicle mass	▪ Tare weight (unladen weight) of the motor vehicle plus its maximum carrying capacity

All the vehicle attributes listed in Table 5.1 can be critical to heavy vehicle access and must be measurable and enforceable.

Table 5.2 lists the attributes and the vehicle categories that are applied when determining network access.

Table 5.2: Vehicle attributes linked to access conditions by vehicle type

Attribute	Special purpose	Agricultural	Oversize/ over-mass	Unladen platform trailers	Restricted access freight vehicles	Controlled access buses	Tow trucks
Length	✓	✓	✓	✓	✓	✓	✓
Width	✓	✓	✓	✓	✓	✓	✓
Height	✓	✓	✓	✓	✓	✓	✓
GCM	✓		✓	✓			
Axle mass		✓	✓		✓	✓	✓
Rear overhang	✓	✓	✓				✓
Front overhang	✓						
Ground contact		✓	✓				
Tyre width			✓				
Axle spacing			✓		✓		

Heavy vehicle data and mobile solutions are applicable to all vehicle types and classes. The focus of this scoping study focuses on how data and mobile solutions are applicable to restricted access freight vehicles only. The decision to narrow the focus was necessary to provide maximum value, restricted access freight vehicles were selected as they perform the majority of the freight task.

5.1 ummary of Vehicle Attributes

The key points regarding vehicle attributes are as follows:

- Heavy vehicle attributes are diverse and varying in importance depending on the vehicle type and use.
- Some attributes are important for certain vehicle types only; it is therefore important to identify the vehicle configuration.
- PBS vehicles are not exempt from prescriptive mass and dimension limits.
- For PBS vehicles, every attribute that defines the vehicles is critical to its performance and consequently its access.
- The essential vehicle attributes for managing network access are listed in Table 5.3.

Table 5.3: Basic vehicle attributes for managing heavy vehicle access

Attribute	Restricted access freight vehicles
Length	✓
Width	✓
Height	✓
Axle mass	✓
GCM	✓
Axle spacing	✓

These attributes will be explored through the vehicle data sources in Section 8.2.

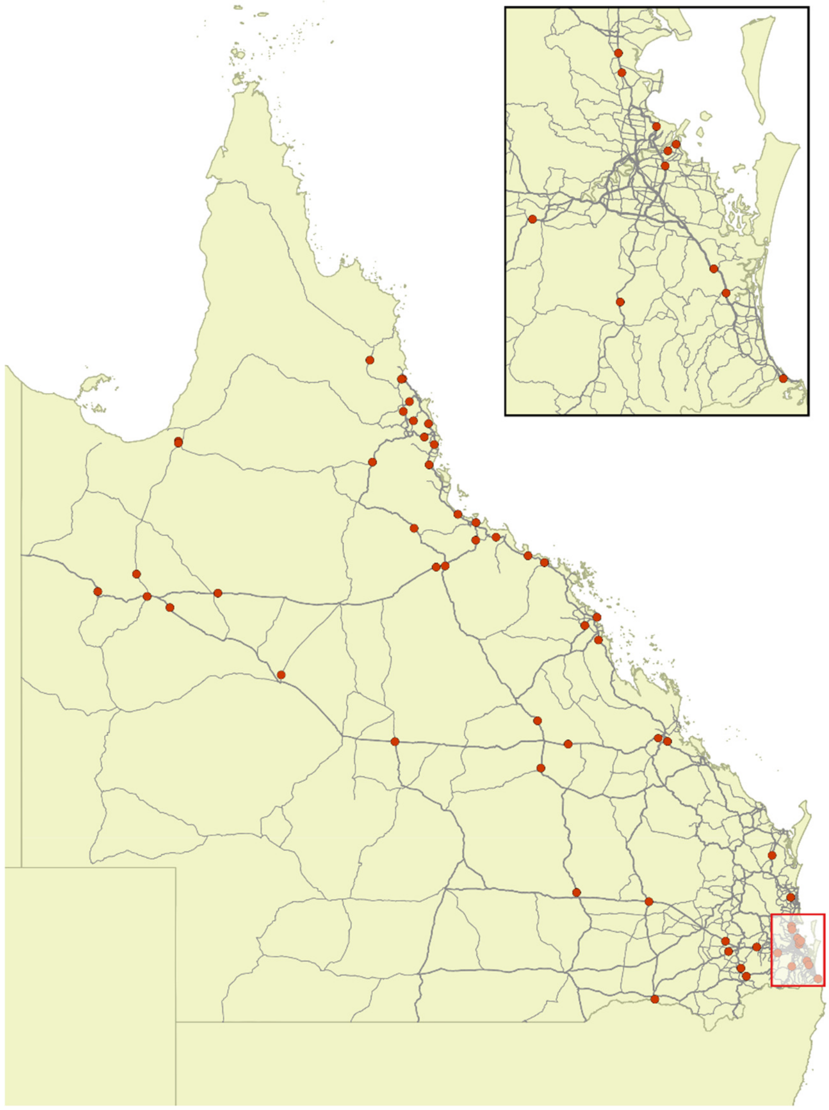
6 HEAVY VEHICLE COMPLIANCE DATA

This section of the report presents an example of weigh-in-motion (WIM) compliance data supplied by TMR.

6.1 Case Study: WIM Data

Figure 6.1 shows the locations of WIM sites in Queensland.

Figure 6.1: WIM locations in Queensland



Source: Adapted from TMR data.

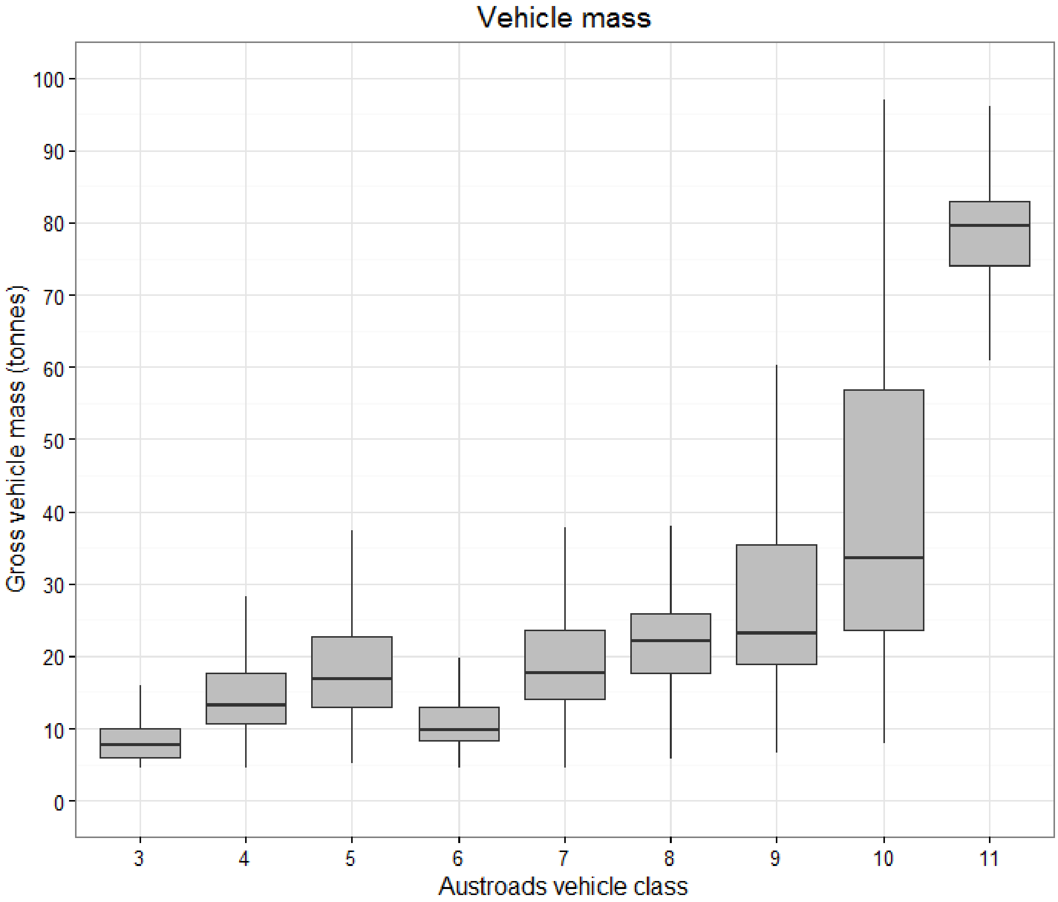
The following information is provided by WIM devices:

- axle group mass
- number of axles
- number of axle groups.

This basic information can be used to determine the vehicle type, class and GVM or GCM. This data is useful for compliance and enforcement purposes.

Figure 6.2 shows an example of the data collected at the Belmont WIM site.

Figure 6.2: Example of WIM data GVM by Austroads vehicle class

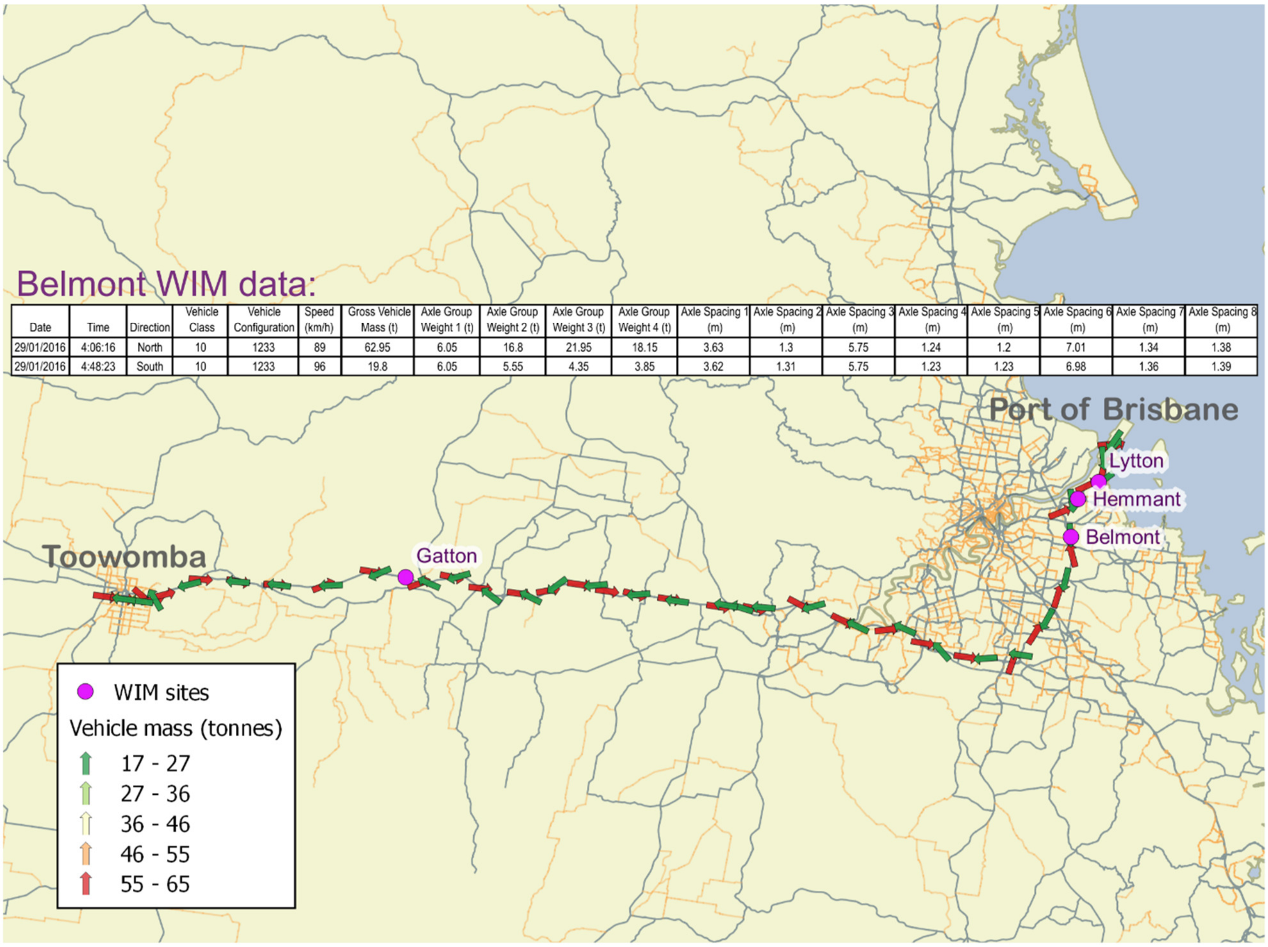


Source: Adapted from TMR data.

WIM data provides greater value when combined with other data sources. Vehicles participating in the Intelligent Access Program (IAP) generate non-compliance reports (described in Section 7.2.1) which are provided to TMR were not reviewed as part of this study but as these reports

An example of combining WIM data with truck telematics data (supplied by industry) is shown in Figure 6.3. In this example, the telematics device provides information on the vehicle's location and its approximate total mass via on-board scales. Through basic interpretation of the data it can be assumed that the vehicle began its journey in Toowoomba (unladen) and travelled to the Port of Brisbane where it was loaded before returning to Toowoomba (laden). During this journey, the vehicle passed through the WIM station at Belmont. The WIM data provides more information including the axle group masses, axle spacings and vehicle configuration. This information allows for a better understanding of the impact this vehicle will have on the pavement and bridges on its return journey. The WIM data can now be coupled to this vehicle as it continues its journey to its destination.

Figure 6.3: WIM and truck telematics example



Date	Time	Direction	Vehicle Class	Vehicle Configuration	Speed (km/h)	Gross Vehicle Mass (t)	Axle Group Weight 1 (t)	Axle Group Weight 2 (t)	Axle Group Weight 3 (t)	Axle Group Weight 4 (t)	Axle Spacing 1 (m)	Axle Spacing 2 (m)	Axle Spacing 3 (m)	Axle Spacing 4 (m)	Axle Spacing 5 (m)	Axle Spacing 6 (m)	Axle Spacing 7 (m)	Axle Spacing 8 (m)
29/01/2016	4:06:16	North	10	1233	89	62.95	6.05	16.8	21.95	18.15	3.63	1.3	5.75	1.24	1.2	7.01	1.34	1.38
29/01/2016	4:48:23	South	10	1233	96	19.8	6.05	5.55	4.35	3.85	3.62	1.31	5.75	1.23	1.23	6.98	1.36	1.39

Source: Adapted from TMR WIM data and industry telematics.

6.2 Summary of Compliance Data

The key points regarding compliance data sources are as follows:

- The devices and systems (including the IAP) used to gather vehicle data for compliance and enforcement purposes are becoming more advanced and can provide more information about the vehicle.
- When combined with truck telematics data, WIM data allows for a better understanding of the impact a vehicle will have on the pavement and bridges during its journey.
- WIM data can be enhanced when combined with other heavy vehicle enforcement technologies such as ANPR, height detection and The Infra-Red Traffic Logger (TIRTL) counters allow for the vehicle to be identified and more vehicle attributes to be gathered.

7 VEHICLE DATA SOURCES

This section of the report presents a list of available data sources that could be integrated to provide an improved understanding of road freight movements.

A number of technologies and data sources exist to potentially fill the information gap for managing network access for restricted access vehicles. This study provides a summary of the current status of road side compliance and enforcement technology and explores the potential of vehicle telematics and GPS probe data. These data sources include: online databases, vehicle telematics, probe data and vehicle counters.

7.1 Online Databases

Table 7.1 provides a summary of the national vehicle publicly available databases that provide information relevant to understanding road freight movements.

Table 7.1: Summary of national vehicle datasets

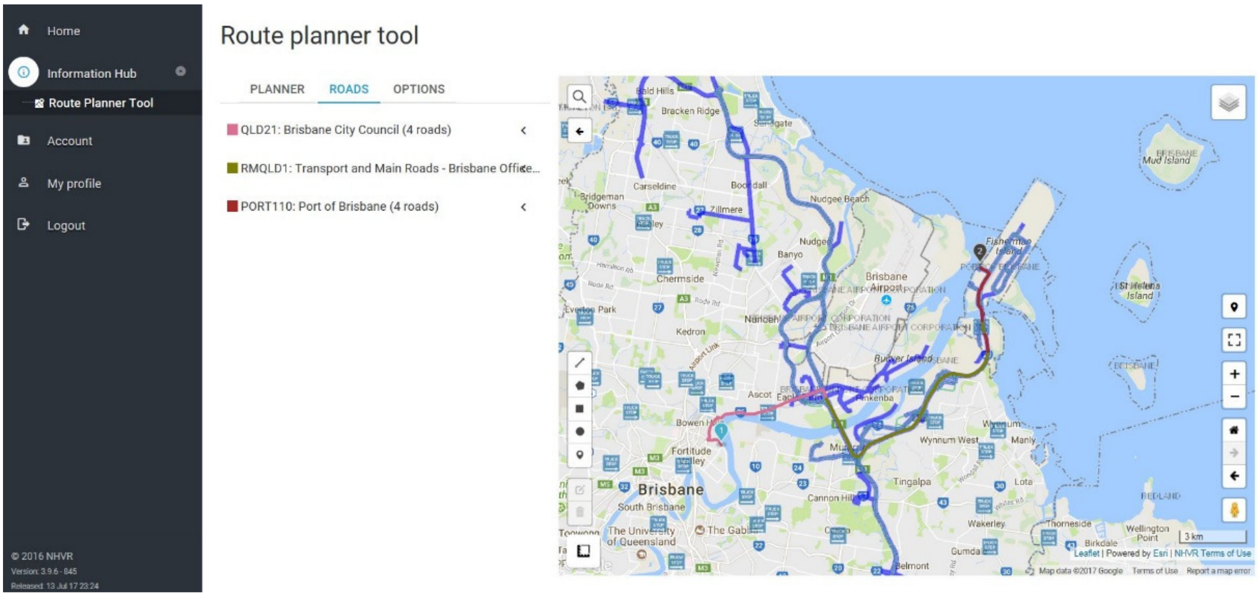
Source	Description and data
data.gov.au	Data.gov.au is a national hub to access public data from around Australia. It contains about 50 000 datasets, many of which link to other government data sites (e.g. qld.data.gov.au), from 521 different organisations. Some organisations that have data listed include: • ABS • Road agencies • Local government • CSIRO • Bureau of Infrastructure, Transport and Regional Economics • Bureau of Meteorology • Geoscience Australia • Department of Infrastructure and Regional Development The site can provide API access and digital downloads depending on the data source and spatial data can be viewed with National Map.
National Map (Figure 7.2) nationalmap.gov.au	National Map is a website for map-based access to publicly available spatial data from Australian government agencies and is closely linked with data.gov.au. The site provides links back to the source of any data available for the map which in many cases can be downloaded.
Aperture (Figure 7.3) arrbaperture.com	Aperture is a web-based mapping system that provides access to vast amounts of transport-related data. Much of the data is from publicly available sources; however, it also includes internally developed datasets. The Aperture Toolbox is linked to Aperture and has provision to keep data and/or web tools in a secure environment requiring a login. The site is currently publicly available however it is still in beta form with many planned improvements.
Australian Bureau of Statistics stat.data.abs.gov.au	While ABS data are included in data.gov.au there is a lot on the ABS web site (and in stat.data.abs.gov.au) that is not included. The most notable thing missing from the other sources is spatial data. The most relevant data to the transport industry is likely to be the survey of motor vehicle usage.
Geoscience Australia ga.gov.au/data-pubs	Geoscience Australia has data linked to other providers however it is possible to directly access topographic maps, web map services and online spatial data tools directly via their website.
BOM bom.gov.au	Contains national climate and weather observation data details historic observations are not publicly available.

A summary of the Queensland specific vehicle databases is provided in Table 7.2.

Table 7.2: Summary of Queensland specific vehicle datasets

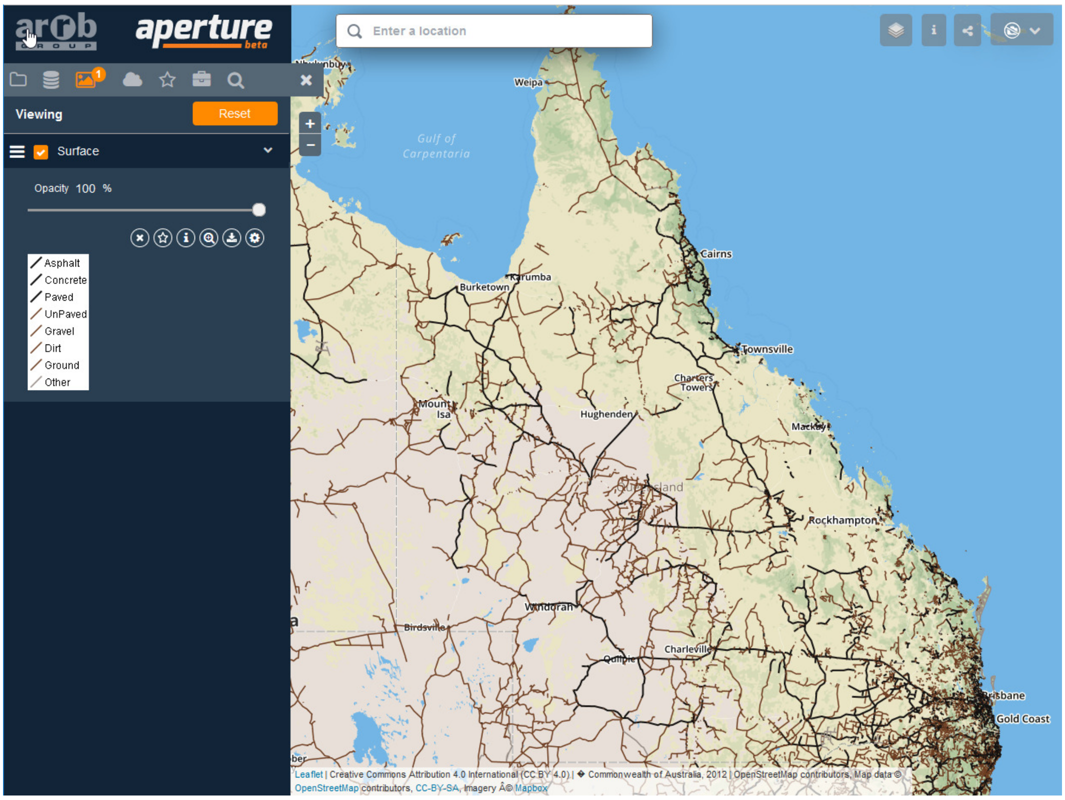
Source	Description and data
Queensland Government data data.qld.gov.au	The Queensland Government data web site contains information from many agencies including Transport and Main Roads Queensland. Available transport data includes: • road centreline (state roads and all roads) • bridge data (state roads) • Bluetooth travel limes (key links) • road traffic cameras • traffic census • Qld traffic Geo-JSON application program interface (API) • crash data • climate data. The site can provide API access and digital downloads depending on the data source.
Brisbane City Council Open Data data.brisbane.qld.gov.au	The Brisbane City Council Open Data web site contains datasets municipality that the Council has made publicly available. Available transport data includes: • corridor travel times • real time intersection traffic volume • road centreline • freight routes. The site can provide API access and digital downloads depending on the data source.
NHVR portal (Figure 7.1) service.nhvr.gov.au	The NHVR portal is an online service offering NHVR customers to submit online applications for heavy vehicles access. The site includes the following features: (1) the route planner allows customers to select an origin and destination and provides routing functionality with consideration to restricted access roads, (2) the mapping tool offers overlays of road categories and other relevant information such as the location of truck stop.
Other local government	Other local government organisations also make open datasets available via data.gov.au, these currently include: • Gold Coast City Council • Logan City Council • Morton Bay City Council

Figure 7.1: Route planner tool provided by the NHVR customer service portal



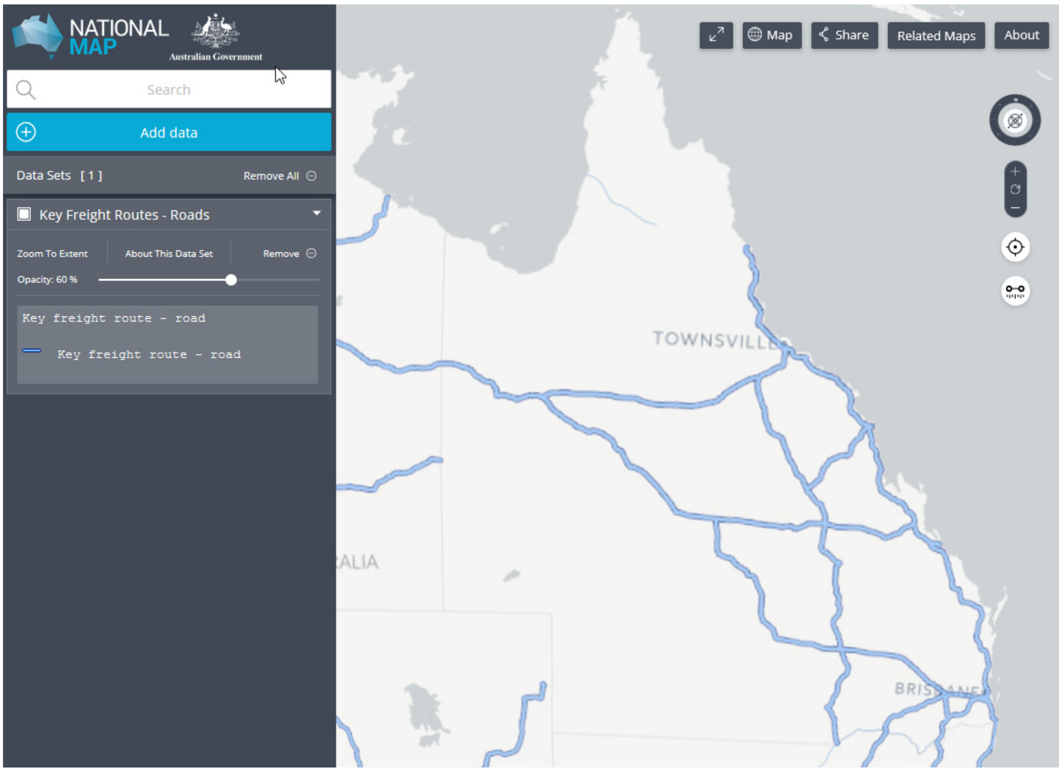
Source: NHVR, Customer service portal.

Figure 7.2: Online spatial data portal Aperture under development by ARRB



Source: Aperture, ARRB.

Figure 7.3: Online spatial data portal National Map provided by the federal government



Source: National map, Data61.

7.2 Vehicle Telematics

Telematics refers to a broad set of technologies that are generally used to keep track of the status of a vehicle while it is on the road. Pervasive across the heavy vehicle industry, telematics devices are used primarily for fleet management. Installed individually in each vehicle, these systems can allow the location, speed and mass to be monitored at any time from a central location.

When consolidated in raw form, telematics can typically provide the following data points about a vehicle fitted with the appropriate system at 30 second intervals or shorter:

- vehicle make and model
- GPS coordinates and heading
- vehicle speed
- vehicle mass.

The use cases for such a rich dataset are essentially endless. Many transport operators use telematics to enforce speed limits within their organisation. Another common benefit of such a system is that it can facilitate the external fatigue monitoring of drivers, helping ensure that the correct breaks are being taken to decrease driver risk from tiredness.

This type of data is ideal for the assessment and management of heavy vehicle access restriction compliance. The combination of vehicle location and attributes such as gross combination mass mean that truck movements can be cross-checked against the restricted access network – instantly yielding cases where operators have not been following the rules. With a large enough sample of telematics data, problematic areas could be unambiguously identified paving the way for the development of appropriate treatments. Hypothetically, if the telematics data-gathering apparatus on each vehicle were certified to be accurate enough – the data itself could be used directly in enforcement, with heavy vehicles being booked automatically should they use a restricted access road they are not certified for.

The Intelligent Access Program (IAP) has been in existence since 2008 offering the first national regulatory telematics applications in Australia. Heavy vehicle operators utilise telematics to provide assistance to drivers, as well as tracking vehicles and their loads. IAP provides the platform for road managers to realise the potential of extending these commercial telematics services into the regulatory context. TCA administers and implements the IAP nationally. The IAP provides road managers with a source of telematics data but traditionally only for operators under the Higher Mass Limits (HML). The benefits and limitations of the IAP are described in more detail in Section 7.2.1 and Section 7.2.2.

Vehicle telematics data has some key limitations in relation to this use case. The first, and arguably least significant, of these is that not all heavy vehicles are necessarily fitted with such a system. The insights gleaned from telematics will likely be slightly biased towards representing the movement of large operators who have the resources to fit each of their vehicles with the technology. Given that most heavy vehicles subject to restricted access conditions would be under the umbrella of a large operator, this is not a concern. However, cases always exist and problematic areas frequented by non-compliant trucks without telematics devices could be missed. It remains to be seen how this bias would ultimately affect a large-scale analysis of access restriction compliance, and these shortcomings should be acknowledged but not prohibit further investigation of the potential use of telematics data.

A second shortcoming of telematics data lies in its source. There are many different commercial telematics providers active in Australia, each providing their own unique fleet management products to operators. No universal telematics dataset exists for Australian vehicles. It is likely that each provider maintains uniquely formatted records that have their own access procedures and policies. Until a standard exists for the consolidation of different telematics data sources, it will remain a difficult task to produce a representative sample of heavy vehicle traffic on a road network that can be used satisfactorily for analysis (with the exception of the IAP). If data from only one telematics data supplier is used for example, it would be quite possible to only receive vehicle data from a small number of operators that only operate on certain routes. This would not be very useful for investigating restricted access compliance across a whole network – the key is obtaining a representative sample of the heavy vehicle population.

As an extension of the previous limitation, the major concern regarding the use of telematics data is privacy. Currently, vehicle telematics data is kept in entirely closed systems, often only privy to the operators using the data currently. The reason for this is simple – the location data of vehicles is valuable. With this information, you would be able to discern all of an organisation's routes, trip timings and travel patterns. With the accompanying speed, mass and other attributes, you would also be able to see if an organisation is abiding by road rules and regulations, or even what types of vehicles constitute their fleet. This is sensitive information, and it is unlikely that any operator or telematics provider would provide it in unedited form to an external third party.

Effective anonymisation will remain the key to using telematics data in an open and transparent fashion. It is simple to remove identifying information from vehicle entries, masking ID as well as make and model. However, location data can still reveal the locations of distribution centres and delivery points – this would still mean that vehicles and operators could be identified with contextual information and a moderate amount of effort. As a result, a robust set of policies needs to be developed surrounding the anonymisation of telematics data that can remove a sufficient number of identifying features before it can be plausibly used for analysing restricted access conditions. This would have to include masking of direct identifying features as mentioned, as well as indirect ones such as the start and end of vehicle trips for example. Further work needs to be completed in this area to investigate which techniques would be most effective at achieving this goal. Such an endeavour will become more difficult in time as inference techniques improve. Research has already shown that simply being in possession of speed and time data for a trip can be enough to estimate a trip destination in certain instances, without using GPS coordinate data.

Vehicle telematics represents arguably the best source of data for analysing access restriction compliance. The rich combination of location and vehicle attribute data points are well suited to this role. However, a number of shortcomings must be worked through before it can be used in this fashion. The most significant hurdle will be the creation of a universal data format that different telematics providers can use, that can also facilitate standardised anonymisation policies to protect sensitive information about their client operators. This is not a trivial task, but would be feasible with the right approach and cooperation from industry.

7.2.1 Benefits of IAP

TCA certifies and audits IAP-SPs, to endure that all systems are accurate and reliable. There are currently five IAP-SPs certified with the TCA:

- Transport Compliance Services (MTData)
- Blackbox Control
- Pinpoint Communications
- Navman Wireless Australia
- C-Track.

The existence of only five IAP-accredited service providers appears low in comparison with the total number of service providers in the market. The costs to accreditation appear to be high; these certification costs may be a barrier to some service providers wishing to gain TCA certification and enter the IAP market. However, the five current service providers are participating in an active market and the number of operators and vehicles operating under IAP is growing. This suggests that there is a sufficient number of options for operators wishing to join the IAP. Telematics providers offer a suite of products and for those suitably accredited, IAP is another product and is priced comparably.

During consultation with an IAP-SP, it was suggested that a small number of operators, when first entering IAP, were concerned about road managers acting in response to minor breaches (such as speeding on downhill grades). This is no longer a concern for these operators or new participants, according to this IAP-SP.

In general, the IAP provides a platform for better managing the network. This can result in even greater productivity gains than just those offered by HML.

The NTC conducted a thorough review (NTC 2014) of the IAP. The key findings from that review are as follows:

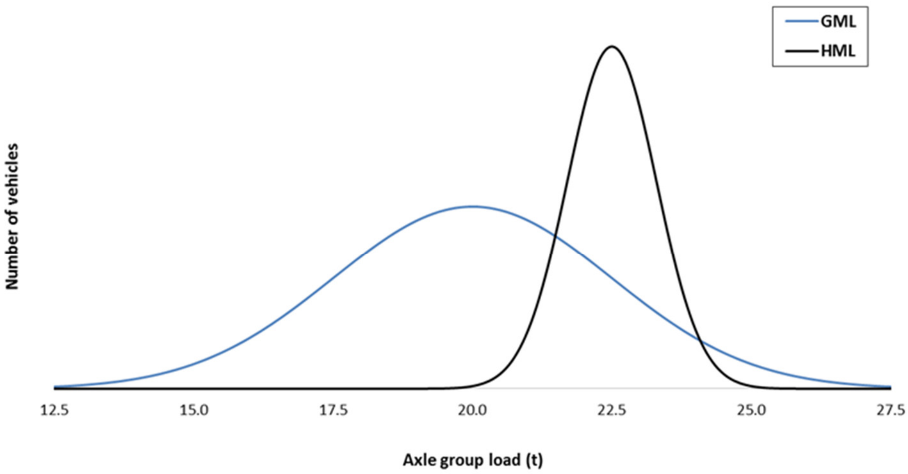
- The IAP is currently operational and available in six states: New South Wales, Queensland, South Australia, Tasmania, Victoria and Western Australia.
- In July 2013 there were 2 483 vehicles enrolled in the IAP compared with an estimated take-up number of 8 383.
- Factors that may have contributed to the lower than expected vehicle take-up numbers are: road authorities have made fewer than the anticipated IAP applications available; the introduction of concessional mass limits; enrolment costs; the demand for HML may have been overestimated; and heavy vehicle access issues on local roads.
- The estimated costs of the IAP to governments were around $203 million compared to the actual costs of around $68 million. The key factor for these lower costs is that not all states and territories have implemented the program and not all IAP applications have been used.
- The estimated benefits of the program to governments were about $107 million. The NTC was unable to calculate the actual benefits to governments due to a lack of data.
- The estimated program costs to industry were around $62 million over its first five years. The actual costs to industry range from $18.8 million to $24.3 million, based on 2 483 vehicles across four operational years.
- The benefits of the program to transport operators were estimated to be around $280 million. The NTC was unable to calculate actual benefits to operators. Case studies from individual companies show benefits including greater payloads and fewer trips.
- It appears that the objective of the IAP is being achieved.

7.2.2 Benefits of IAP with on-board mass monitoring (IAPm)

Participation in the IAP has been technically feasible for all HML operators since 2007. Greater benefits can be realised through the IAP including improved visibility and understanding of network utilisation.

IAP-equipped vehicles provide a platform for on-board mass (OBM) monitoring which is expected to provide a major benefit to HML operation by reducing overloading. This theory is illustrated in Figure 7.4, which was produced by ARRB to show the effect that can result from increased mass limits coupled with increased monitoring. The result can be a narrowly distributed concentration of loads at the increased mass limit, compared with a wide distribution centred around the lower mass limit. As shown in the figure the HML example this can mean fewer loads well in excess (i.e. greater than 10%) of the legal limit.

Figure 7.4: Theoretical effect of increased limits coupled with increased monitoring



Source: ARRB.

OBM provides another source of data on the critical vehicle attributes of axle group mass and gross combination mass. OBM may also provide an option for monitoring the health of the suspension to ensure it remains road friendly with potential to be incorporated as part of a compliance solution.

A summary of the findings of the industry consultation with Transtech an IAP-SP is provided in Section 8.2.

7.3 Probe Data

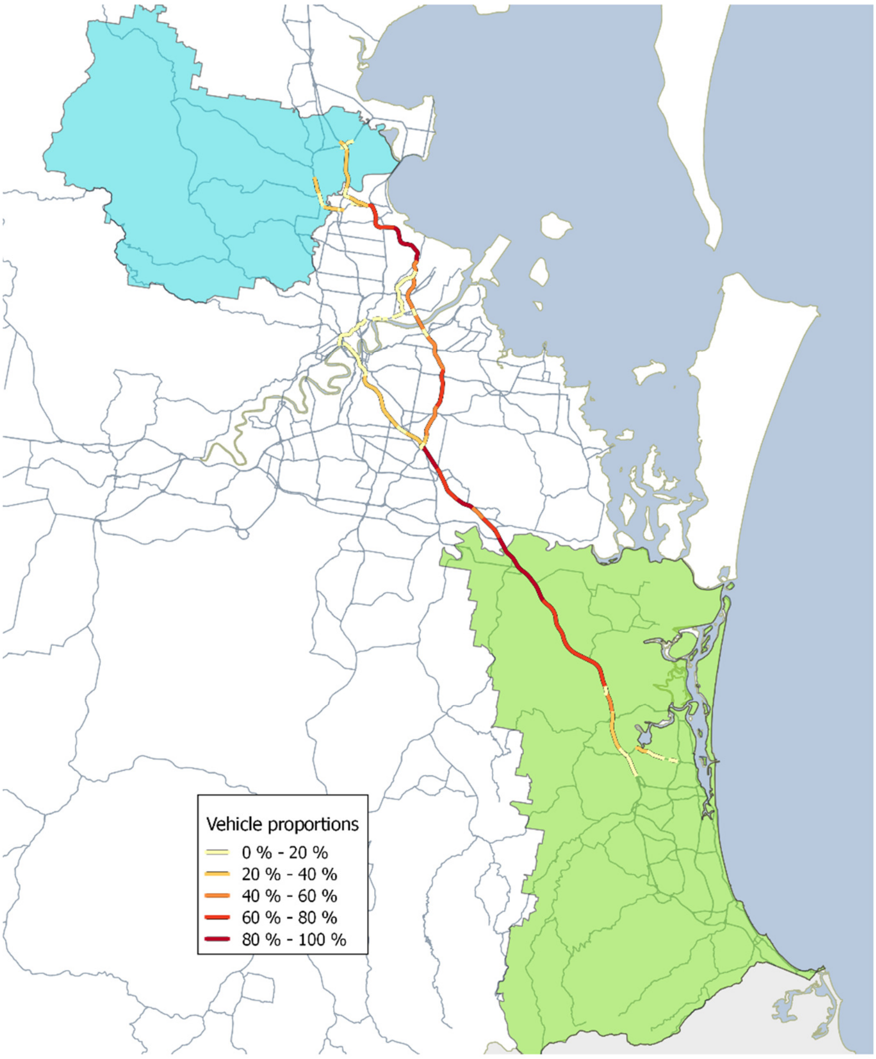
The term 'probe data' refers to a broad family of GPS datasets detailing vehicle locations – usually collected from applications or devices present inside vehicles. For example, a provider of GPS navigation devices could assemble the locations of all vehicles using its technology at certain time intervals. This would represent a probe dataset.

When paired with the appropriate vehicle attributes such as type and configuration, probe datasets are a strong candidate for analysing heavy vehicle movements. Probe data is, in essence, a decentralised form of telematics using information inferred from systems within a vehicle. Platforms have been built around the collection and analysis of this data, one of which is the HERE Traffic Analytics product. HERE collects and combines many sources of GPS location data provided through services such as its mobile navigation smartphone app and connected cars to provide a real-time picture of traffic conditions. A summary of the findings of the industry consultation with HERE is provided in Section 8.1.1.

An exploratory investigation was undertaken using "HERE: trip data" to develop and interactive origin-destination map for regions around Brisbane. While the sample provided a limited number of records it was possible to map the travel times, travel time delays and proportion of vehicles travelling (from a given origin to destination) on TMC links in the region. Figure 7.5 shows the proportion of vehicles travelling (from a given origin to destination) on TMC links between the origin and destination.

This type of map can give insight into the location of choke points on the network and be used to determine if there is a need for road upgrades. It can also has the potential to be combined with on-site traffic counters to extrapolate detailed traffic information at a point across the network using appropriate sampling.

Figure 7.5: Origin destination visualisation used HERE trip data



Source: ARRB.

As with vehicle telematics, probe data is also beset by its own unique limitations. Not every vehicle is equipped to provide probe data. For example, if a vehicle is not connected to a HERE device in any way, apart from being detected by an external road sensor, the vehicle does not exist in the probe dataset. It is estimated that less than 5% of all traffic movements are captured by a probe data provider like HERE. While the penetration rate of this data is not an issue for assessing metrics such as the travel speed and time along certain roads to a satisfactory degree of accuracy, it does have implications on its use in the context of observing heavy vehicle movements with the aim to manage non-compliance. Trucks commonly constitute less than 10% of the overall traffic flow, which means that the amount of probe data related specifically to these vehicles can become prohibitively small. With small sample sizes, any statistics discerned from this data can be heavily affected by random chance – making any insights ultimately unreliable.

More significantly, the use of probe data in this context requires the accurate identification of vehicle type at the very least. Depending on how the probe data is provided, this information may not be available. It is common for data of this type to be disseminated in an already aggregated form, for example in the form of average speeds along certain links of the network. If this is the case, information about individual vehicles will be unattainable – making this form of data unusable for assessing heavy vehicle access restriction compliance. Further investigation into the quality and granularity of different probe data sources is warranted to determine its usefulness in this context.

7.4 Vehicle Counters

The proliferation of devices that count vehicles provides an opportunity to gather information covering a larger part of the road network. Traditionally WIM devices have been used to determine heavy vehicle compliance at a single or a small subset of key sites.

STREAMS loop counter data, can be used to perform analysis along sections of the road network and ARRB has done so successfully for a portion of the Bruce Highway for TMR.

TIRTL traffic counters provide some unique opportunities for gathering rich data, particularly as more sites are installed and when paired with devices like Automatic Number Plate Recognition (ANPR) and WIM sites.

TIRTL traffic counters (in addition to vehicle counts) provide precision measurement of:

- speed
- volume
- lane of travel (on a multi-lane road)
- axle spacing.

The unique aspect of these counters is the precision with which they can measure axle spacing, to the extent that heavy vehicles can be uniquely identified by their axle spacing. While identifying vehicles is not helpful in isolation, a network of counters can be used to trace vehicle routes or as 'gates' for origin destination surveys.

In addition to this TIRTL sites are increasingly being used in association with WIM sites, ANPR and over height or length detection technology. TIRTL sites are used to improve vehicle classification at WIM sites and trigger ANPR and other sensors at monitoring and enforcement sites.

With sufficient TIRTL sites paired with additional detection technology and appropriate extrapolation (potentially in conjunction with probe data) it will be possible to produce a detailed picture of the vehicles and vehicle axle masses travelling on major roads. While exploration of this data extrapolation is relatively new, it is likely to be available in the next 12 months. A challenge to overcome, which may slow progress in this area, is to have sufficient sites installed to provide network coverage. There are currently no TIRTL counters installed on the TMR road network.

7.5 Summary of Vehicle Data Sources

The key points regarding vehicle data sources are as follows:

- There are several online databases that contain a broad range of topics relating to roads and freight.
- Online portals/tools exist with functionality that allows these data sources to imported, filtered, analysed and presented in way that adds value. An example of such a system is the Aperture Toolbox under development by ARRB.
- Publicly-available spatial data and TMR's knowledge of its assets can be utilised to provide improved understanding of truck movements when combined with other data sources particularly telematics data.
- Truck telematics data is a reliable source of data for vehicle ID, speed and location. Mass data can be gathered from vehicles fitted with on-board scales however this is not to an evidentiary standard.

- Truck telematics data is owned by the service providers and transport operators. TMR would not have access to this privately-owned data unless an agreement to share data is in place. Road managers have access to non-compliance reports via the IAP; however, this will only include data for vehicle participating in the program.
- Probe data has low fleet penetration but nonetheless is a proven method to perform network operation analyses, including travel time peaks, speeds, volumes and O-D studies.
- Traditional road management and compliance and enforcement technologies are becoming more advanced and can gather more data.
- TIRTL traffic counters provide precision measurement of speed, volume, lane of travel (on a multi-lane road) and axle spacing.
- In addition to this TIRTL sites are increasingly being used in association with WIM sites, ANPR and over height or length detection technology.
- With sufficient TIRTL sites paired with additional detection technology and appropriate extrapolation (potentially in conjunction with probe data) it will be possible to produce a detailed picture of the vehicles and vehicle axle masses travelling on major roads.

8 INDUSTRY CONSULTATION

ARRB consulted with technology providers to better understand the requirements specifically related to developing a mobile application to aid in the enforcement and management of heavy vehicle access conditions and restrictions. Through the consultation ARRB met with map providers (open location platform), telematics service providers and mobile application developers.

The findings are presented in the following sections:

- Section 8.1 – Open location platforms
- Section 8.2 – Telematics service providers
- Section 8.3 – Mobile application developers.

8.1 Open location platforms

This section discusses mobile mapping solutions, referred to as open location platforms, which could be incorporated in a mobile (phone) application. Four mobile mapping methods were identified as suitable for managing heavy vehicle access and in particular reducing possible access infringements on the TMR network:

- geo-fencing
- map software development kits
- Bluetooth beacons
- Personal portable navigation devices.

All proposed solutions require mobile phone apps to be developed or in-vehicle device to operate. Geo-fencing and map software development kits require only a mobile app on a smartphone or navigation device; Bluetooth beacons require roadside installations on site.

Geo-fencing

The concept of a geo-fence is to create a virtual barrier on a map for a real-world geographic area. A virtual 'fence' can be constructed around a location and a mobile device, which crosses the fence can be configured to send a notification or warning.

During industry consultation, geo-fencing has been proposed by both app developers and the implementation process is discussed in Section 8.3.1 and Section 8.3.2.

Map Software Development Kits (SDK)

A map SDK provides a set of programming interfaces to allow developers to build mobile apps using detailed maps from map providers. During industry consultation only HERE Maps (HERE) were identified to collect and display heavy vehicle attributes (discussed in Section 5); the HERE Maps SDK allows mobile app developers to utilise this map information in their products.

Bluetooth Beacons

Bluetooth low energy devices, such as Apple's iBeacon, broadcast a Bluetooth signal to nearby mobile devices and can be used to display a message or prompt on mobile phones. There are currently Bluetooth beacons available that target Apple devices, Android or both platforms.

Bluetooth beacons may be installed roadside as a single unit or at multiple locations on the roadside, preferably where the vehicle is travelling at low speed, such as roundabouts, bends and turns. The beacon will interact with the driver's mobile device and send a message or push notification. To do this, an app must be installed on the mobile device prior. Once installed, the app may stay dormant and will require minimal computational power from the mobile device.

The beacon technology will send a message or notification to the mobile device through the following process:

1. Wake app: the dormant app on the mobile device receives a Bluetooth signal from the beacon and is activated.
2. Read code: the beacon obtains details of traveller and vehicle.
3. Contact server: the beacon compares the traveller information with the access restrictions and determines if the vehicle is compliant or not.
4. Make decision: if the vehicle is non-compliant, a warning message or signal will be sent to the mobile device to warn the driver against proceeding.

The following limitations and obstacles in applying this method have been identified:

- drivers must have the app installed on their device prior to beginning their journey
- Bluetooth must be enabled on the mobile device
- push notifications and/or app messaging must be enabled
- drivers must have a smartphone device compatible with the beacon
- vehicle details must be entered for each vehicle.

Use cases of Bluetooth beacons have only been identified for sending content to mobile phones while people are walking, such as sending the schedule of game times to people when they walk through the entrance of a sporting arena, or a pop-up promotion of a new product or meal when walking past a fast food restaurant.

No use cases have been found for Bluetooth beacons engaging mobile phones in moving vehicles. There is a possibility that beacons will not be able to establish a connection and transfer data while the moving vehicle would be within range of the beacon.

Personal Portable Navigation Devices

Portable navigation devices (PND) such as those provided by Navman, TomTom and Garmin, use global positioning systems (GPS) to calculate routes and provide navigation functions to drivers. These devices may be installed in vehicles during manufacturing or clip to the windscreen.

Navman and Garmin offer heavy vehicle specific products built over HERE's maps. In these heavy vehicle specific products, the user (driver) is to enter their vehicle characteristics (such as height, length, weight) and the navigation system will calculate a safe route for the vehicle, considering any road restrictions and access conditions, applicable based on the entered information.

TomTom has a trucking model of navigation system available in Europe. Currently TomTom does not offer a product specific to trucks, with heavy vehicle attributes, in Australia.

8.1.1 HERE Technologies

ARRB met with Rohan Fernando, Sunny Wijewardana and Nick Preston from HERE Technologies (HERE). Formerly known as NAVTEQ, the new unified HERE brand was established in 2012, with primary investors AUDI AG, BMW Group and Daimler AG. HERE create high definition maps for navigation system providers; HERE maps are prevalent throughout in-car navigation systems in BMW, Garmin, Toyota, Yahoo and many more.

HERE's heavy vehicle information has road access conditions already loaded onto the map, which can be used to reroute heavy vehicles based on road restrictions through a heavy vehicle navigation app.

Map attributes

HERE has included heavy vehicle specific attributes in their maps based on road restrictions and verified by roadside signage information collected during road surveys. The attributes recognise restrictions placed on height, length, weight and any other posted restrictions. App developers and telematics providers, such as Transtech, can utilise HERE's heavy vehicle attributes to create route compliance tools.

A road on the HERE map network is comprised of links; a link is mapped along the centreline of the road and may vary from less than 100 m in length to 1.5 km. Each link has attributes assigned to it that may include dimensional restrictions and B-double restricted access.

HERE create high definition 3D maps by collecting 'true data' on road surveys. 3D maps can be used in simulations to detect the drivability of the road with consideration to attributes, which are not apparent on a 2D map, such as height, surface undulation and road gradient.

Product Viability

Commercially available devices from Navman and Garmin use HERE maps in their navigations. Both Navman and Garmin sell truck navigation devices (Garmin's trucking option is called Dezl) which utilise HERE's heavy vehicle attributes. These are off-the-shelf products available now.

8.1.2 Intelematics

ARRB met with Fred Curtis and Brian Smith from Intelematics.

Intelematics provides telematics programs and content services focused on motoring mobility and has been operating programs in Australia since 1999. Intelematics' flagship service is SUNA Traffic Channel, which is Australia's leading digital traffic information and can be found in many in car navigation systems.

Map attributes

There are currently no map attributes specific to heavy vehicles offered by Suna. Suna maps are developed to an international standard by overseas offices, usually based in Europe. It is very difficult to edit the map for individual cases. The process for entering a new feature into the map is as follows:

1. Collect the data.
2. Enter the data into the base map; data must be entered as a heavy vehicle attribute.
3. Business to business interaction between the map provider and the navigation system developers to find a way to utilise the new data.
4. Implement warning system and update navigation software.

Intelematics believed the greatest hurdle in this process as step 3: finding a way to utilise the map information. This step requires a third-party navigation service provider to create a platform which either displays non-compliance warnings to drivers or automatically re-routes the journey.

A fundamental issue with the Intelematics framework is that a warning message will affect all drivers in the area, including those that are not impacted by the particular restriction. Targeting only heavy vehicles through the navigation system may require input from the driver, perhaps to enter their vehicle length.

There are many other locations and scenarios resulting in high incident rate for specific vehicle types, which could be flagged in navigation systems, e.g. pinpointing underpasses, and tunnels for over-height vehicles. The recurrent issue for map developers is how to display this information and target the vehicles that may be of risk without affecting other road users.

Product Viability

Intelematics advised that the introduction of a new app to warn drivers of the Gorge might cause more problems than it is able to solve. The major problem is targeting a small number of drivers who may be driving a non-compliant vehicle into a particular geo-fenced area without confusing other (compliant) drivers.

Another obstacle identified by Intelematics was the cost of developing a new app. Developing a simple app for common mobile operating systems may be relatively inexpensive, however further investment will be required to develop the app for multiple platforms and phone models. The app would only be effective if majority of the driver population was using it; therefore, a flexible, adaptable app available on most platforms and phones would be required.

8.1.3 Summary of Open Location Platforms

The following conclusions have been made for utilising open location platforms:

- Geo-fencing is a proven method for identifying location based non-compliance and is used by mobile applications and telematics devices.
- Truck specific PNDs are not common, with the majority of heavy vehicles being fitted with telematics in vehicle units. Telematics devices offer more scope than PNDs.
- Bluetooth beacons are used to engage with personal Bluetooth devices (mobile phones). No heavy vehicle specific use cases were identified. Bluetooth devices do not offer cost effective means for identifying vehicles and their attributes when compared to telematics devices.
- A map SDK provides a set of programming interfaces to allow developers to build mobile apps using detailed maps from map providers. During industry consultation only HERE Maps (HERE) were identified to collect and display heavy vehicle attributes.
- The HERE open location platform offers scope for managing heavy vehicle access.
- HERE Maps offer usable heavy vehicle data that is available right now, and has been available since 2009, for routing of heavy vehicles. The heavy vehicle attributes are installed in off-the-shelf Navman and Garmin devices or can be utilised by app developers using the HERE Maps SDK.
- In order to utilise the existing HERE maps with heavy vehicle attributes, a navigation service provider must offer a device or app that accesses the map information and relays it to the driver in a timely and useful manner.

ARRB consulted with a telematics service provider, Transtech, and two app developers, Outware Mobile and Spark Digital to understand the use of HERE maps in their products and services.

8.2 Telematics Service Providers

ARRB met with Anthony Laras and Val Kennedy from Transtech. Transtech have been acquired by Navman Wireless, but provide the same products under the Transtech brand.

8.2.1 Transtech

Transtech develops integrated mobile and compliance solutions for the transport and logistics industry, providing the following services:

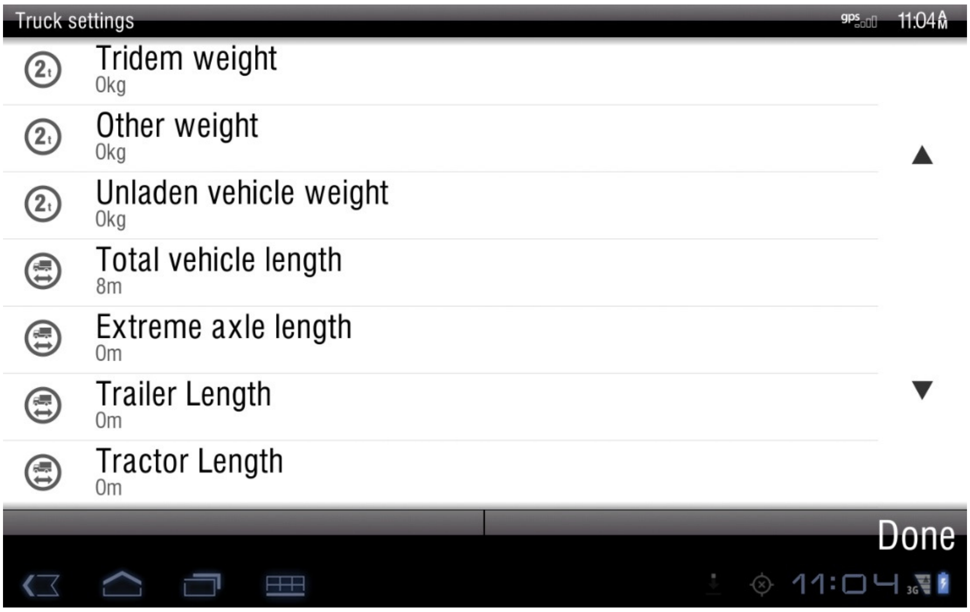
- in-vehicle units
- vehicle navigation and tracking
- vehicle speed monitoring
- driver fatigue management
- on-board real-time load/mass monitoring
- mass management & pre-trip checklist solution to help meet NHVAS requirements.
- IAP services

SmartNav is a navigation app developed by Transtech for heavy vehicles. It calculates safe and compliant routes for the vehicle's characteristics entered into the navigation device by the driver. SmartNav uses the HERE map, launches a routing app developed by Sygic and integrates this with heavy vehicle attributes such as length, speed and weight.

Vehicle Attributes

The Transtech devices and apps allow the driver to enter multiple characteristics of their vehicle, including dimensions and weight. A sample of the truck settings is included in Figure 8.1.

Figure 8.1: Truck characteristics: Transtech



Transtech provide route compliance from both a driver's perspective and a 'back-end' perspective for fleet manager, whereby transport operators can save locations through backend software and create alerts. A transport operator may define map attributes such as a geo-fence to restrict access of an area for their fleet; the geo-fence service is managed through a web interface that transport operator is able to log on to and administer themselves.

Product Viability

A Transtech navigation device calculates a route based on the vehicle characteristics, with consideration to any restrictions places on roads. A geo-fenced area can be recognised as a restricted access area on Transtech devices; the SmartNav app already has all of the functionalities required to deter restricted access vehicles from entering the area. Therefore, trucks fitted with Transtech devices will not be navigated through a restricted geo-fenced area.

8.2.2 Summary of Telematics Providers

Following industry consultation with telematics providers, ARRB has made the following conclusions:

- telematics offer business to business solutions that can be catered to individual vehicles and customers.
- heavy vehicles fitted with Transtech navigation products are routed to roads they are approved to use only
- the Transtech product allows for the critical vehicle attributes to be entered for individual vehicles
- Vehicle IDs and attributes are recorded and available for further analysis via a web interface.

8.3 Mobile Application Builders

ARRB consulted with Outware Mobile and Spark Digital on the possible solution to heavy vehicle navigation and management through a mobile app. Both companies discussed mobile applications that creates a geo-fence around areas of interest and sends warnings to the mobile phone when the geo-fence is crossed.

The use of HERE's map SDK was also discussed; however, neither app developer had experience with this product.

8.3.1 Outware Mobile

Outware is Australia's leading mobile software design and app development company. Outware have designed apps for clients such as the NSW Government, Google, ANZ, Coles and the AFL. ARRB met with Jarrod Pepper and Alex Burton from Outware.

Previous apps developed by Outware for the NSW Government include ORPA, which is used by the Department of Transport (DoT) NSW. It allows DoT officers to scan Opal card with their phone to check the ticket validity of commuters. ORPA was awarded the Gold Winner in the 2015 App Design Awards. Details of this app have been further discussed in Appendix A, together with an app developed for the NSW Environment Protection Agency.

Development Process

The app development process that Outware follows is comprised of two phases: pre-development and development.

Pre-Development

Pre-development is also termed the scope and design phase. During this phase, Outware establishes the objectives of the client and essentially create the app's blueprint. The ideation, wireframe and user experience for the app are defined. The process for the pre-development stage is as follows:

1. Planning and research – working with the customer to understand the problem statement, collate information including: user experience, analytics, API documentation, digital strategy. Including three days to gather insight on user behaviour, goals, attitudes.
2. Workshop – three days to define the scope, discuss and prioritise, develop designs.
3. Prototyping and testing – create an interactive prototype, run test scripts, usability testing, analysis and re-prototyping.
4. Finalisation and cost estimation – an estimate to build and next steps for a business case.

Outware provided a proposal that outlines the process and costs of the pre-development phase which is included in Appendix B, the cost of which is $33 900+GST. The components of the cost estimate for the pre-development process (not including the build costs) are shown in Table 8.1.

Table 8.1: Basic vehicle attributes for managing heavy vehicle access

Service	Costs (ex GST)
Preparation (Research and Analysis)	$8400
3-day Sprint Workshop	$8400
Prototyping and Testing	$12 300
Finalisation	$4800
Total	**$33 900**

At the end of the pre-development stage, the customer is provided with all of the plans and specifications created during this process. The customer is free to take this proprietary work to another company, but the majority continue with Outware to the development stage.

Development

During this stage, the app is coded and built from the plans during the development phase. The prototype app is tested to identify and resolve bugs. On completion, Outware provides the customer with the full code for the developed app to allow for customisation and additions to be made by the customer.

Product Viability

Outware recommend building an app that automatically calls the mobile phone of a driver approaching the geo-fenced areas.

This app has potential to be used for the enforcement of over-height vehicles approaching bridges, weight restrictions for suburban roads and preventing the use of engine brakes in designated areas.

A valuable function that can be included in the app is backend analytics; allowing TMR to collect data from the vehicles/drivers who are using the app – including areas which drivers have accessed and the warning messages which have been received.

Similar to other solutions using mobile technologies previously discussed, a significant hurdle faced in implementing this app is promoting people to download the app. The app can be marketed or be combined with other services required by the transport industry to increase downloads. It is recognised that an effective trucking app will spread organically through the heavy vehicle community through word of mouth.

8.3.2 Spark Digital

Spark creates mobile apps and websites for the local Australian market. The Spark team has over 16 years of web design and online marketing experience. Refer to Appendix B for further details of Spark. ARRB met with Spark Digital (Spark). Also present at the meeting were Nick Davies and Cate Murray.

Development Process

Spark follows a six-step process to design and develop an app:

1. Planning and strategy: define the objectives of RMS; explore ways to solve the problem with current technologies.
2. Content planning: wireframe and core functions of the app are planned.
3. User experience: design the skin, look, feel and the key screens.
4. Build, test and launch: test on different platforms and devices, test functionality of the app on site at Galston Gorge.
5. Digital marketing: define the marketing strategy.
6. Measurement and refinement: gather data on effectiveness of the app.

Spark partners with a local marketing company, Bastion Brands, to market products online.

Backend software is available for RMS to monitor the ongoing take-up and use of the app after its release.

Product Viability

Spark offer a viable solution to heavy vehicle enforcement based on geo-fenced locations and pre-entered vehicle attributes. Indicative pricing for app development has been estimated at $30 000 to $50 000 (refer to Appendix C). Spark strongly recommends marketing offline to promote local awareness for this project.

8.3.3 Summary of Mobile Apps

The following conclusions can be made in terms of implementing a mobile app as a management/enforcement solution:

- A mobile app can provide a means of notifying drivers of the redirection and upcoming hazards.
- A mobile app is limited by the requirement for the driver to download the app and enter vehicle information.
- The uptake of a mobile app is an important consideration and relies on a strong marketing strategy and to have a high number of installations, or more importantly, installed by the target users.
- The cost of the app development varies greatly, $30 000 to potentially over $300 000
- The development cost can be better understood after a pre-development planning stage. The pre-development three-day workshop provides a cost effective means for engaging with a mobile application developer to scope the project and fully understand the requirements, limitations and benefits.

9 SUMMARY OF KEY FINDINGS

The key points regarding heavy vehicle access, classification and attributes are as follows:

- Road managers apply conditions when granting access to restricted access vehicles based on the vehicle attributes. Vehicle classification is not critical to monitoring vehicle movements and understanding network utilisation.
- Heavy vehicle attributes are diverse and varying in importance depending on the vehicle type and its use. It is important to identify the vehicle configuration. The NHVR has produced a list of common heavy freight vehicle configurations to assist industry and road managers by providing common terminology.

The key points regarding understanding the freight task, compliance data and alternative data sources are as follows:

- Traditional heavy vehicle statistics such as MVC is thorough but the vehicle categories are too broad. The NEVDIS database contains detailed information including each vehicle's Vehicle Identification Number (VIN) which could utilised in a mobile mapping solution.
- Non-compliance reports provided to TMR for vehicles participating in the IAP and the devices and systems used by TMR to gather vehicle data for compliance and enforcement purposes are becoming more advanced and can provide more information about the vehicle. TIRTL traffic counters provide precision measurement of speed, volume, lane of travel (on a multi-lane road) and axle spacing. In addition to this TIRTL sites are increasingly being used in association with WIM sites, ANPR and over height or length detection technology.
- Publicly-available spatial data and TMR's knowledge of its assets can be utilised to provide improved understanding of truck movements when combined with other data sources particularly telematics data.
- The case study showed that WIM data, when combined with truck telematics data, provides a better understanding of the vehicle's movement and impact on the network.
- There are a number of online databases, portals and tool that contain a broad range of data relating to roads and freight and offer functionality to analyse and present in way that adds further value.
- Truck telematics data is a reliable source of data for vehicle ID, speed and location and potentially mass. This data is owned by the service providers and transport operators. TMR would not have access to this privately-owned data unless an agreement to share data is in place.
- Probe data has low fleet penetration but nonetheless is a proven method to perform network operation analyses, including travel time peaks, speeds, volumes and O-D studies.

The following conclusions have been made for utilising open location platforms in portable devices and mobile applications:

- Geo-fencing is a proven method for identifying location based non-compliance and is used by mobile applications and telematics devices.
- Truck specific PNDs are not common, with the majority of heavy vehicles being fitted with telematics in vehicle units. Telematics devices offer more scope than PNDs.
- Bluetooth beacons are used to engage with personal Bluetooth devices (mobile phones). No heavy vehicle specific use cases were identified. Bluetooth devices do not offer cost effective means for identifying vehicles and their attributes when compared to telematics devices.

- The HERE open location platform offers scope for managing heavy vehicle access. In order to utilise the existing HERE maps with heavy vehicle attributes, a navigation service provider must offer a device or app that accesses the map information and relays it to the driver in a timely and useful manner.
- A mobile app can provide a means of notifying drivers of the redirection and upcoming hazards but is limited by the requirement for the driver to download the app and enter vehicle information.
- The uptake of a mobile app is an important consideration and relies on a strong marketing strategy and to have a high number of installations, or more importantly, installed by the target users.
- The cost of the app development varies greatly from $30 000 to potentially over $300 000.
- The development cost can be better understood after a pre-development planning stage. The pre-three-day workshop provides a cost effective means for engaging with a mobile application developer to scope the project and fully understand the requirements, limitations and benefits.

10 FUTURE WORK PROGRAM

ARRB recommends that the following next steps are taken to better utilise emerging mobile mapping technologies. The two approaches are to (1) make better use of existing data sources, and (2) identify and develop new sources of heavy vehicle data. The existing data sources identified include:

- the current devices and systems used to gather vehicle data for compliance and enforcement purposes including data from IAP non-compliance reports
- the NEVDIS database which contains the VIN for each registered vehicle
- online databases (listed in Section 7.1).

ARRB recommends, as a first step, that a detailed review of data gathered as part of compliance and enforcement processes within TMR be undertaken. The review should identify datasets that can be combined to offer greater information and value by understanding the format and content including the key attributes such as length, width, height, axle mass, GCM, and axle spacing. Following this review, the use of alternative data sources can be explored to address any gaps and where is a lack of detailed information.

The options for obtaining new data were reviewed and the findings are as follows.

10.1 Truck Telematics

Truck telematics was found to be the most suitable source of data for gaining an improved understanding of road freight movements. Telematics data contains a vehicle ID and provides sufficiently accurate information for speed and location and mass. This data is owned by the service providers and transport operators. Therefore, TMR must establish agreements with individual data owners to access this data or with an organisation that has existing agreements to access the data. Provided that issues regarding privacy and data ownership are resolved sufficiently, efforts should focus on building a consolidated data platform that will aid in the decision making process when it comes to managing heavy vehicle access. Enforcement directly from data should not be the immediate or even long term focus of a future work program.

10.2 Probe Data

Probe data has low fleet penetration but nonetheless is a proven method to perform network operation analyses, including travel time peaks, speeds, volumes and O-D studies. Probe data is better suited to providing an overview of freight movements and is not expected to provide sufficient resolution nor include the key vehicle attributes such as vehicle type, length and mass. It is expected that the probe data will continue to develop and the number of vehicles and level of detail for these vehicles will increase. For the next year’s work program the use of probe data should be pursued as a second priority to truck telematics and used to supplement the truck telematics dataset.

10.3 Mobile Application

TMR should be aware of the limitations of developing a mobile application for the purpose of obtaining detailed heavy vehicle movement data. The uptake of a mobile app is an important consideration. It is unlikely that the heavy vehicle operators have a need for a mobile application as their routing and fleet management needs are currently met by telematics service providers. A mobile application more likely to be suited to drivers of smaller freight vehicles (less than 4.5 t), but relies on the driver to have a mobile phone app on during a trip. The cost of the app development varies greatly from $30 000 to over $300 000. If TMR wish to investigate the possibility of developing an application the costs, limitations and benefits can be better understood after participation in a pre-development workshop offered by Outware.

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APPENDIX A OUTWARE COMPANY PROFILE

A.1 ORPA – Transport for NSW

Outware have developed the Opal Revenue Protection App (ORPA) for the Department of Transport NSW, which allows Transport Officers to scan Opal cards with their phone to check the eligibility and fare compliance of public transport users.

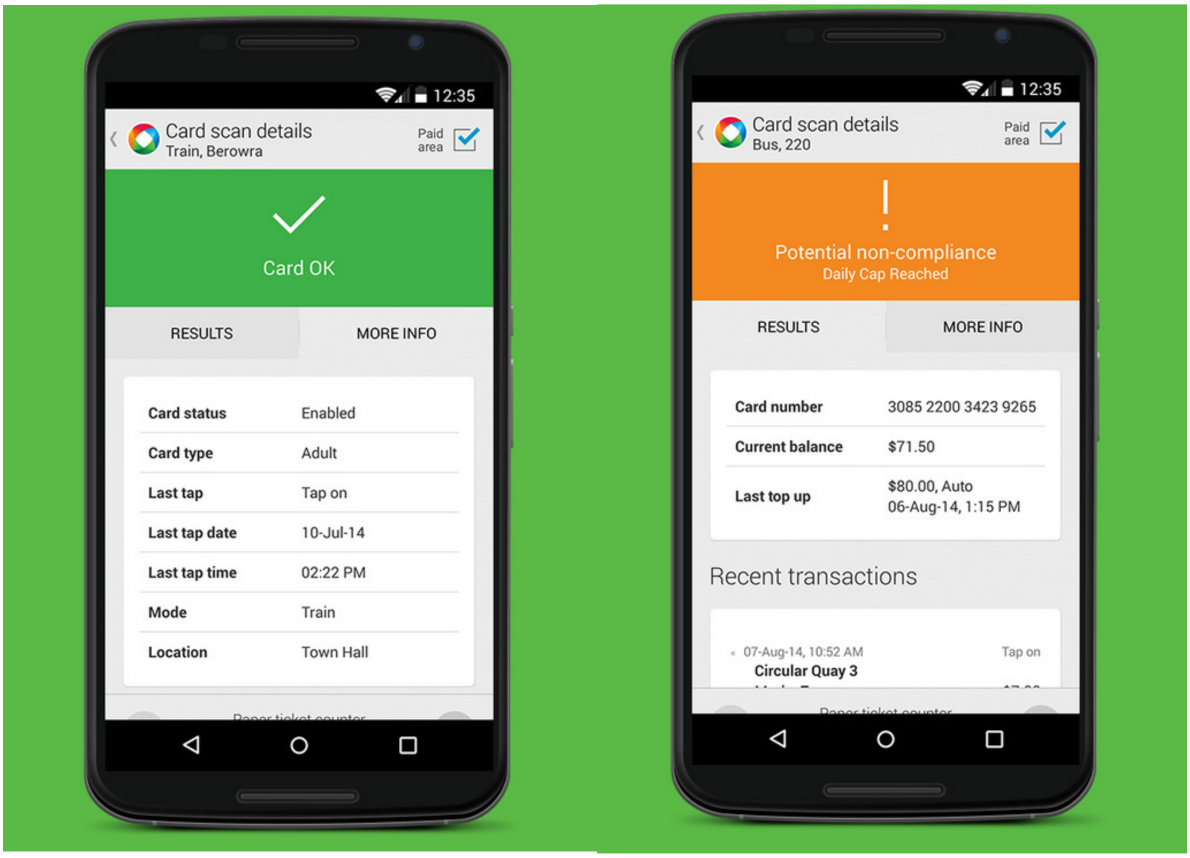
The Opal card provides access to all public transport modes throughout the broader Sydney area; including trains, buses, light rail and ferries. Commuters are able to load a monetary balance onto their card or pay for time-based transport passes.

When using a public transport service, commuters will tap their Opal at a card reader at the start and end of their journey. The appropriate fare will be calculated and deducted from the commuter's balance by the electronic ticketing system.

The Opal and card readers use near field communication (NFC) to transfer data; this same technology is used by ORPA in Android smartphones to read data from the Opal card. The introduction of an effective app has nullify the need for specific card reading devices to be carried by Transport Officers.

The objective of ORPA is to provide an app which was simple and quick to use. Figure A 1 displays the possible results that the Transport Operator will see on their screen after scanning a commuter's Opal card. The accepted screen is easily identifiable with a green header and tick, the potential non-compliant card is identified by the orange header and exclamation mark; indicating that the Transport Operator will have to ask more questions of the commuter.

Figure A 1: OPRA card accepted screen and potential non-compliance screen



Source: Outware (2015a).

A.2 Report to EPA

The role of the NSW Environment Protection Authority (EPA) is to improve environmental performance of manmade equipment and facilities. The EPA control waste management and monitor the following pollutants:

- smoky vehicles
- dust from coal mining
- illegal waste dumping.

The EPA is the primary environmental authority in NSW.

Outware was commissioned by the EPA to develop an app to enable community members to help improve the environment by reporting pollutants such as smoky vehicles, litter from vehicles and noisy exhaust.

The app features a simple, intuitive home screen, as seen in Figure A 2. The app allows the user to report a pollutant to the EPA and enter their contact details.

Figure A 2: Report to EPA home screen

APPENDIX B OUTWARE PROPOSAL

Outware

Australian Road Research Board

Pre-Development Sprint Proposal

July 2017

Alex Burton
Senior Business Development Manager

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+61 408 502 982

Introduction

We are passionate believers that mobile, when carefully planned and beautifully executed, can be truly transformative.

We are excited to be at the start of a collaborative and innovative journey with ARRB.

What is a sprint?

A tried and tested process, inspired by Google Ventures, that helps in answering critical business questions through design, prototyping, and testing ideas with users.

What problem does it solve?

By clearly defining ARRB's problem statement , we ideate and plan to address this problem in creative and insightful ways, **reducing risk before** you commit to building a full product.

Who's involved?

A dedicated Sprint Facilitator, a Business Analyst and a Product Owner from ARRB. We will then call on Subject Matter Experts at appropriate points to guide the solution.

What are the outputs?

A customer validated prototype. A high-level estimate to build. A sprint pack with next steps, including any tech-spikes or proof-of-concepts required.

Costs & Timescales

$33,900, ~4 weeks

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About Outware

Who are we?

Founded in 2009, Outware is **Australia's leading mobile app development company**. Our mission is to turn good ideas into great mobile experiences that are intuitive, effective, and engaging. Undertaking development with Outware means working with Australia's leading Mobile App Development Agency, with a proven track record of delivering best of breed mobile experiences for their clients. We work collaboratively with our clients and partners to help them achieve their business goals through mobile, from strategy, front end design and development right through to backend infrastructure and integration. We know that great customer experience is a key differentiator for our clients, so we focus on compelling user experience design and technical excellence in all our projects.

Outware has developed over 100 native apps for iOS and Android. We successfully partner with many of Australia's most well known businesses to deliver, maintain and improve high-profile mobile apps, including projects for Telstra, AFL, ANZ Bank, NAB, Coles, nib, Qantas, Transport for NSW, Google, Officeworks, and both the NSW and Victorian State Governments.

Outware Mobile is proud to be a member of the Melbourne IT Group. Melbourne IT is an Australian owned and operated company listed on the Australian Stock Exchange (ASX:MLB) with over 400 employees.

The Outware *Promise*

Our experience, based on delivering over 100 enterprise level mobile applications, has taught us that successful mobile software development requires strong levels of collaboration between all stakeholders, be they business owners, delivery teams, other vendors, or end users. It is for this reason that we choose to work in a partnership model with many of Australia's leading brands, business and organisations.

We care about the quality and success of your products as much as you do. Our objective is to help make all of our apps market leaders, and our advice, recommendations and processes will always be angled toward achieving this objective. By partnering with Outware Mobile, we promise open and honest channels of communication and beautiful & intuitive software design, to ensure your project is successful.

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Awards

We're extremely proud that Outware has been recognised nationally and internationally with the following awards:

Australian Mobile Awards Best Studio
2016, 2015, 2014, 2013

Australian Mobile Awards Winner
2016, 2015, 2014, 2013, 2012, 2011

AIMIA Award Winner
2015, 2014, 2013

W3 Award Winner
2015, 2014, 2013, 2012

Melbourne Design Awards
2015, 2014

Sydney Design Awards
2015

Apple iTunes Best Apps
2014, 2013, 2012, 2011, 2010

BRW Fast 100
2016, 2015, 2014

Deloitte Technology Fast 50
2015, 2014, 2013, 2012

Our clients

Outware are proud to have partnered with the following companies, helping to create industry leading mobile experiences.

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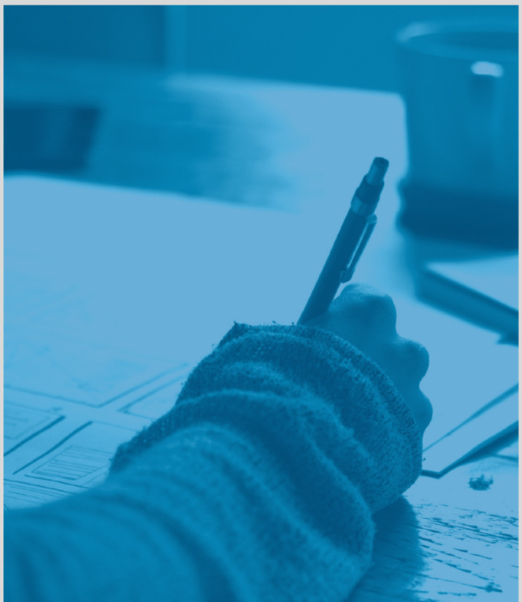

The brief

Our understanding of the brief

ARRB is dedicated to supporting and delivering high quality applied research for Australian and New Zealand state road agencies and for the community. ARRB would like to design and develop a mobile application for the Department of Transport and Main Roads in Queensland.

Before finalising the feature set of the initial release of a mobile app for Department of Transport and Main Roads QLD, there are a number of key focus areas that require strategy, ideation, UX and design support.

Outware would love the opportunity to contribute to ARRB's evolving digital & mobile strategy and product roadmap. We recommend that ARRB engage Outware for facilitation of ideation, prototyping and user testing services prior to finalising the scope for it's mobile application.

Outware's Pre-Development Sprint engagement will explore a number of the exciting ideas that ARRB have for it's mobile application and ensure that they are either validated or fail fast, **before** the business embarks on an extensive design and development project. In order to best explore these ideas and to drive overall digital strategy, the sprint process can also involve Strategy resources that play a key role in Sprint Planning, Gathering Inputs and Research activities prior to the first workshop. Further, we can include technical specialists that will help to define technical constraints, integration approach and considerations as well as to inform overall solution architecture.

The key outputs of the Pre Development Sprint are high fidelity prototypes, a summary report with findings, high level cost estimates and defined next steps. These artefacts will help ARRB to define the scope of the specific mobile product as well as provide several critical inputs to any business case for the design and development project.

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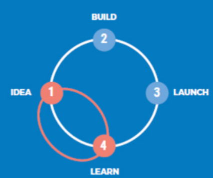
The Outware Pre-Development Sprint

A Google Ventures inspired process for answering critical business questions through design, prototyping, and testing ideas with customers.

Introduction

The Outware Pre-development Sprint is an ideation, design, and planning engagement that provides a shortcut to learning without having to build and launch a full product. It consists of a number of design activities and workshops to define & understand the problem we are solving, create compelling ways to solve it, and prepare for next steps.

A shortcut to product learning



Working together in a sprint, we will shortcut the endless-debate cycle and compress months of time into a super-lean process. The sprint will give you true product insight: you can fast-forward into the future to see your finished product and customer reactions, before making any further commitments.

Benefits of this approach

There are a multitude of benefits to undertaking a sprint.

- The process is user-centred. We gather actual customer insight and test against candidates that match your personas, thus increasing the likelihood of a good product fit when launched.
- We follow tried & tested design techniques such as Lean UX, effectively balancing business needs and user needs.
- It is a hugely collaborative process, and provides an exciting opportunity to look at business challenges from multiple different viewpoints.

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The process

Shown below is an indicative process for an end-to-end Pre-Development Sprint.

**The research phase may vary depending on the inputs provided by ARRB.*

Activity	Detail	Client Involvement
Sprint Planning	Working with ARRB to gain a thorough understanding of the problem statement. Preparing for the sprint.	Required
Gathering inputs	Gathering critical information available. To make the most effective use of time and to achieve the goals of this engagement, it is essential that the team begin subsequent phases of the sprint prepared. As such, ARRB will collate and share with the team all information pertinent to the project, including (but not limited to): • Any existing Customer / User Experience documentation (e.g. User personas, CX surveys, CX Forrester Scores, NPS Data) • Key analytics insights • API Documentation • Digital/Mobile Strategy • Any existing competitor analysis	Required
*Research	3 days of quantitative/qualitative research undertaken by the UX & BA resources to gather insight on user behaviour, goals, pain points, attitudes towards mobile etc.	Optional
Workshop 1 - Unpack	On the first day of the workshop, the team will "unpack" everything we know. Expertise and knowledge on most teams is asymmetrical so it will be a chance for everyone to vocalise their expertise in the problem with the entire team. We'll use this to create a customer journey map.	Required

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The process cont.

Activity	Detail	Client Involvement
Workshop 2 - MVP Planning	Idea generation, discussion and prioritisation are all covered in workshop 2. We will base all of these on the information from the previous day, helping us to identify scope for an MVP product. Follow-up tech spikes and proof-of-concepts will also be identified during this session.	Required
Workshop 3 - Ideation	Workshop 3 will consist of a number of design studios, interactive exercises intended to generate as many design ideas/concepts as possible across the whole team in a short space of time.	Required
Prototyping	UX & VD collaborate on a high-fidelity interactive prototype.	Not required
Creation of test scripts	UX will work with ARRB to identify and author scripts to test with target end users.	Optional
Usability Testing	5 x 1:1 facilitated usability testing sessions using the prototype created. Over 80% of usability issues are identified with just 5 end users.	Optional
Analysis of results	Review of key customer insights from testing. These will be prioritised with ARRB.	Optional
Re-Prototyping	Update of prototype to address user insights.	Optional
Creation of Output Pack	Creation of pack covering all activities undertaken.	Not required
Estimation	Creation of a high-level estimate to build.	Not required
Planning for next steps	Plan for progressing a ARRB business case.	Required

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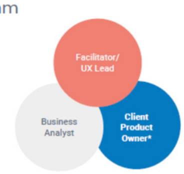
Our solution can
ever be as good as
our understanding of
the problem.
A sprint makes sure
you're designing the
right thing, before
designing the thing
right.

Who's involved?

The Pre-Development Sprint team is made up of a cross functional group that will be involved throughout the majority of sprint activities, as well as a number of subject matter experts who will be called upon to provide relevant input. This variety of expertise provides a number of different viewpoints on how we might capture requirements, create ideas and ultimately best meet the needs of ARRB internal stakeholders.

Core Sprint team



**A dedicated product owner from your team, someone capable of making product decisions, is critical to the success of a sprint.*

Subject Matter Experts

As part of the planning activities for the Sprint, we will work in conjunction with ARRB to identify the right Subject Matter Experts (SMEs) to involve. At various stages throughout the sprint (and the workshops) we will then call on these SMEs to provide key insight that will have implications on the direction of the product idea.

Dependending on the scope of the sprint, we will potentially call upon the following **Outware roles**: Strategy Lead, Visual Designer, iOS Developer, Android Developer, Integration Services Developer, Solution Architect.

We will also request specific involvement from the following **roles within your team** (if available): Client Marketing/Brand Manager, Client Solution Architect. If you can make an actual customer of yours available for the Sprint as well, even better!

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The outputs

The purpose of the Pre-Development Sprint is to challenge assumptions, ideate, mitigate downstream risk and understand the feasibility (business, customer experience, technical) of a project. In the process of achieving these outcomes the below artefacts will be created:

1 A user-tested prototype

An interactive prototype, available on-device that can be shared with ARRB stakeholders. This will have been validated with actual customer feedback.

2 A Sprint Summary Report

Pre-development Sprint report containing;

- Research findings
- User flows, personas and other UX artefacts produced in workshops
- Epics and high level features
- Identified technology spikes (if required)
- Design concepts
- User testing results

3 A high-level estimate

A high-level breakdown of the effort and associated costs required to deliver the idea created. Any assumptions made to arrive at this estimate will also be presented.

4 Defined next steps

A plan for how and when to best approach tech spikes identified, and how Outware can support ARRB in the creation of a business case.

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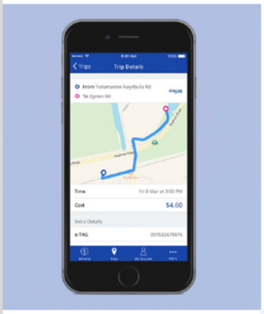
Outware's Work

Outware has worked on some incredibly exciting projects that have impacted millions of Australians. Below are some sample projects Outware has designed and developed.



CityLink App
iOS

Transurban commissioned Outware Mobile to develop a customer app for iOS that would provide users with greater visibility and control of their accounts, and provide an additional customer service channel to improve customer experience and lower cost-to-serve.

The CityLink app revolutionises the way customers engage with the Transurban, enabling users to manage their accounts on-the-go, make manual payments, set up automatic payments, purchase e-Tags, and update their personal and vehicle information.

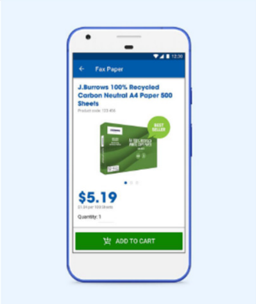
The CityLink app was awarded the Gold (Home & Living) and Silver (Transport Technology) Awards at the 2016 World Design Awards.

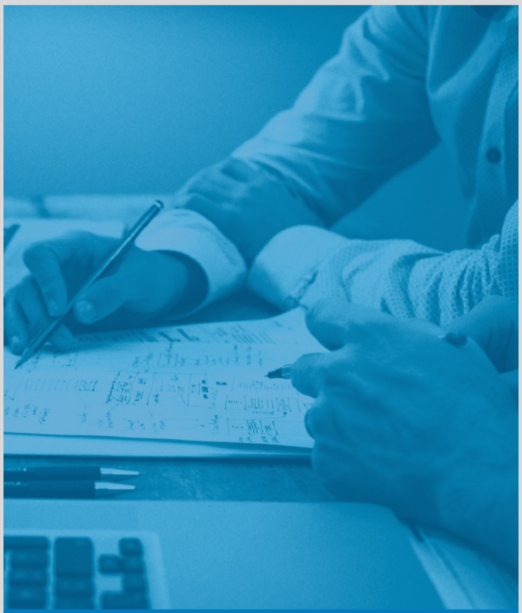
Officeworks App
iOS, Android

Officeworks engaged Outware Mobile to develop an app that would function as 'a team member in your pocket'.

The app allows users to shop from the entire Officeworks online catalogue, create shopping lists, view stock availability in different stores, locate their nearest store, and scan barcodes in-store to view product information.

Outware worked closely with Officeworks to develop a native mobile experience that compliments the existing Officeworks website, and improves the in-store user experience through additional functionalities such as barcode scanning.





Commercials

Sprint Plan

Costs

Service	Cost (ex GST)
Preparation (Research and Analysis)	$8,400
3 Day Sprint Workshop	$8,400
Prototyping & Usability Testing	$12,300
Finalisation and Handover*	$4,800
Total	**$33,900**

*Should the Pre-Development Sprint team collectively agree that follow up activities (such as tech spikes or proof-of-concepts) are required to finalise any component or output item of the Sprint, these will be estimated separately and presented to ARRB for approval.

High-Level Plan

Milestone	Date
Contract Sign-off	31/07/2017
ARRB Documentation Handover	04/08/2017
Sprint Preparation	07/08/2017 - 11/08/2017
Sprint Kick-off	15/08/2017
Sprint Final Day	17/08/2017
Artefact Handover	**01/09/2017**

The above plan is indicative and is subject to ARRB's project sign-off.

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Sprint assumptions

Assumption	Details
Artefacts are subject to change	The Artefacts specified as outputs should be seen as a guide. Should the Pre-Development Sprint follow a different direction during the course of the process, particular elements may be omitted with the approval of the team. Artefacts created during the Pre-Development Sprint are preliminary and should not be seen as complete solution design documentation.
Resource allocation	3 members of the Outware team will participate in the Pre-Development Sprint. The Outware UX/BA will facilitate the sprint process. The Outware Project Manager will oversee the overall project and will orchestrate the high level MVP estimation.
ARRB Participation	A ARRB Product Owner will be required to participate in the full three (3) days of workshops. Any other team members pertinent to the process should also be included, up to a maximum of five (5) individuals.
ARRB dependencies	Delivery dates assume ARRB dependencies have been met. Dependencies include the handover of all background information and attendance at workshops as per the dates specified. Failure to do so may result in milestones being missed and/or Change Requests.
Deliverable Sign-off	Outware assume that artefacts generated as part of the Pre-Development Sprints are signed-off at its closure.
Additional output iterations	Any additional amendments to delivered artefacts beyond the closure of the Pre-Development Sprint will require a separate agreement.
Estimates	Estimates provided will be high-level only. Further detailed design work will be required to provide a detailed estimate.
Location	The engagement will be run from the Outware Head Office.

Contact

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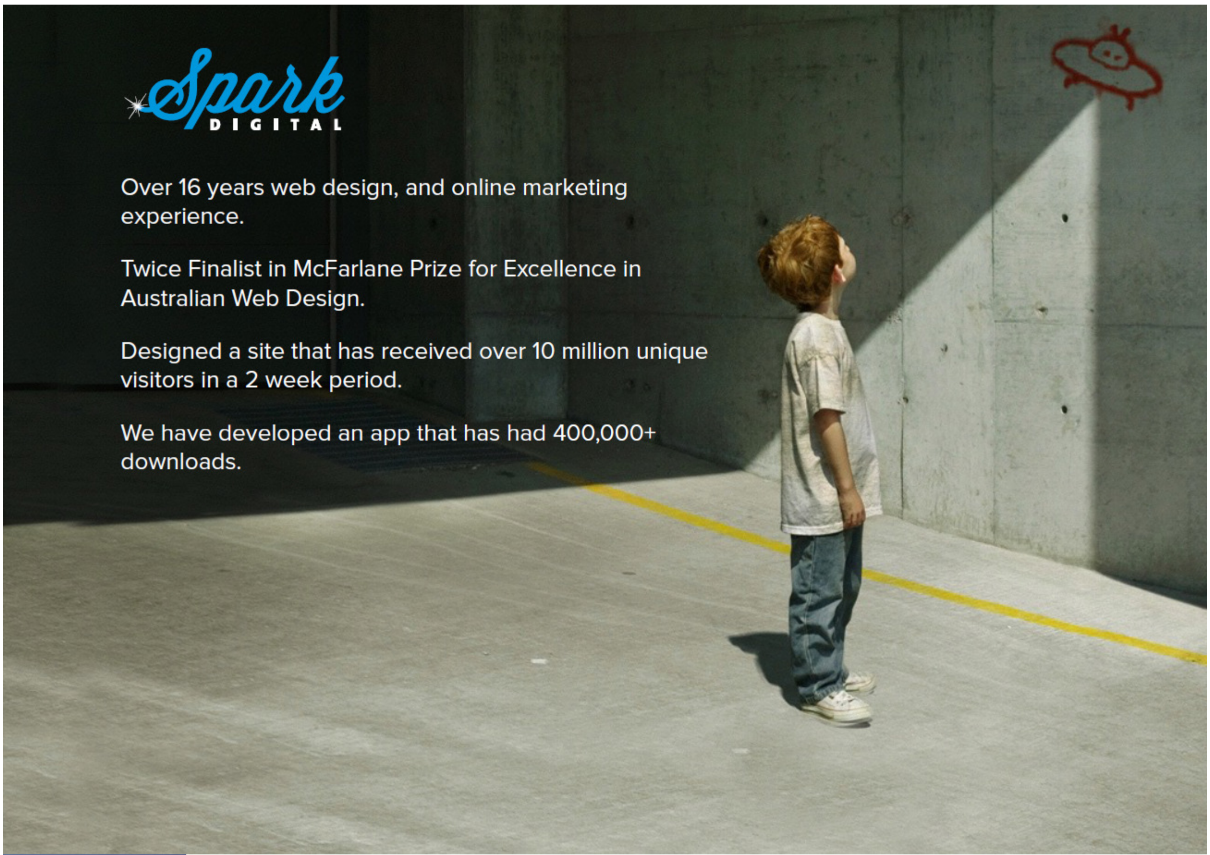
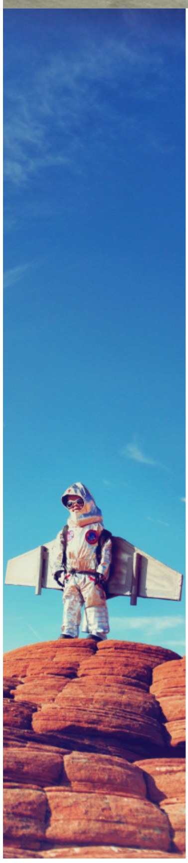
APPENDIX C SPARK DIGITAL

CLIENTS WE WORK WITH

Companies including BMW and Medibank trust us with their websites, apps and online marketing





INVESTMENT

iOS iPhone and Android App

ALLOW
$30,000
to $50,000
+ GST

Planning & Strategy
In the planning & strategy stage we start by having a series of planning workshops with the client team to confirm functionality and requirements. We create realistic goals and KPI's for the app to measure success. We review current best practices and competitor apps to see where we can draw influence from. We create wireframe mock ups of each unique app screen. These will be refined in 2 rounds of client amendments. We dig deeper into the target audiences for your website mapping out user-flow paths and scenarios.

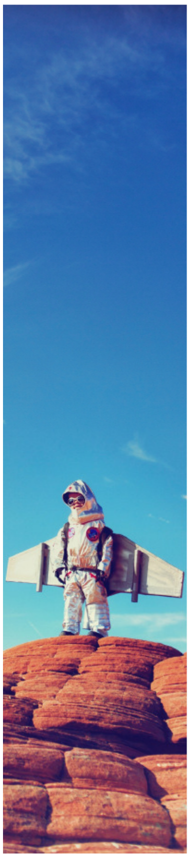
Content Strategy
We'll work with the client team to map out content to be included on the app. We will plan out integration with a back-end web server with a Content Management System (CMS) that will be set up that allows updating of content on the apps.

User Experience Design
We start with a discovery phase, combining design influences from your team and our user experience design experts. We put together full scale design mock ups, which will also be refined in 2 rounds of client approvals.

Build, Test & Deploy
We then turn our planning into a working app. We'll connect the app up to a WordPress CMS installation, where the client can edit content. Once the build is complete for iOS and Android, we will commence our 4 point testing across iPhone and Android devices. This testing phase will also include client testing. Once the app has been approved, it will be submitted to the iTunes and Google Play stores for approval. A round of CMS training will also be provided to the client.

We invoice 50% on initiation, 25% on design approval and 25% on training on how the app content can be updated via the web-based server. Our terms are 14 days.

Spark DIGITAL



INVESTMENT ONGOING

Server Hosting

The app backend will be hosted on the cloud using Amazon's Web Services (AWS). Cloud hosting allows your site to scale up as traffic increases. Amazon has a guarantee of 99.95% uptime.

$25 + GST
per month

Support, monitoring, backups and software costs

We will monitor the app backend server 24/7 and are sent text messages within minutes if there are any outages. We are available for phone and email support between 8.30am and 5.30pm AEST Monday through till Friday. Additional support availability can be arranged if required. The monthly cost also includes our costs for the Bitnami and Pingdom services that we run on your server. The server is automatically backed up each day to the cloud on AWS.

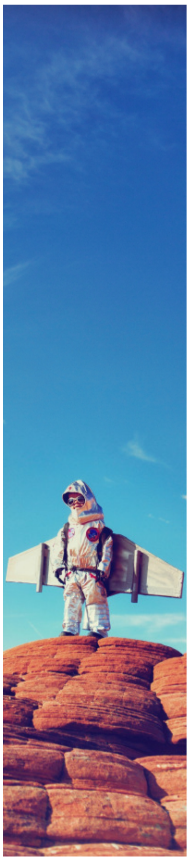
$75 + GST
per month

Warranty

As part of our warranty period, Spark honours to fix any bugs within the website (that fall outside of new functionality) for the following 90 days post launch.

Ongoing Terms

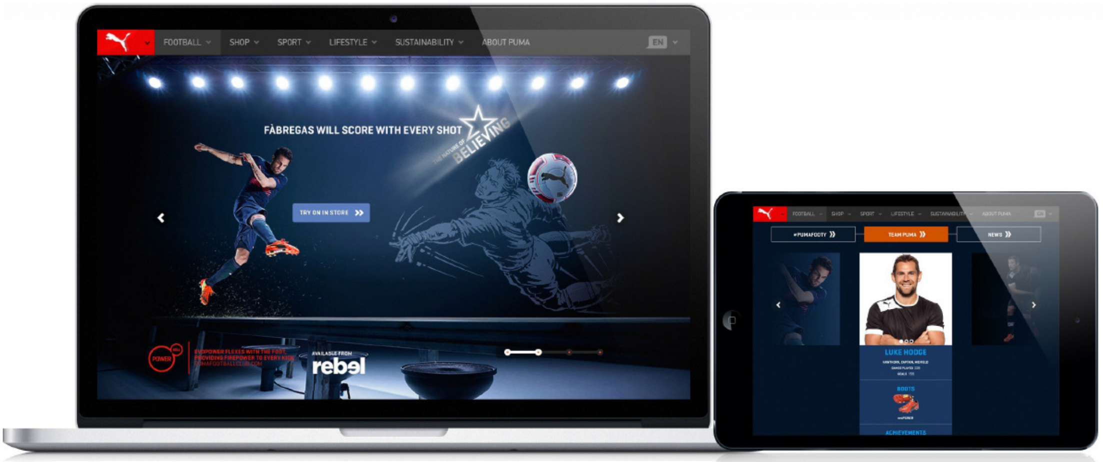
We invoice quarterly in advance for hosting, support, monitoring, backups and software costs. Our terms are 14 days.



TIMINGS

Proposed Timeline	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12 onwards
Planning & Strategy												
Content Planning												
User Experience Design												
Build												
Testing												
Launch												
Marketing												

PUMA - AUSTRALIAN FOOTBALL WEBSITE

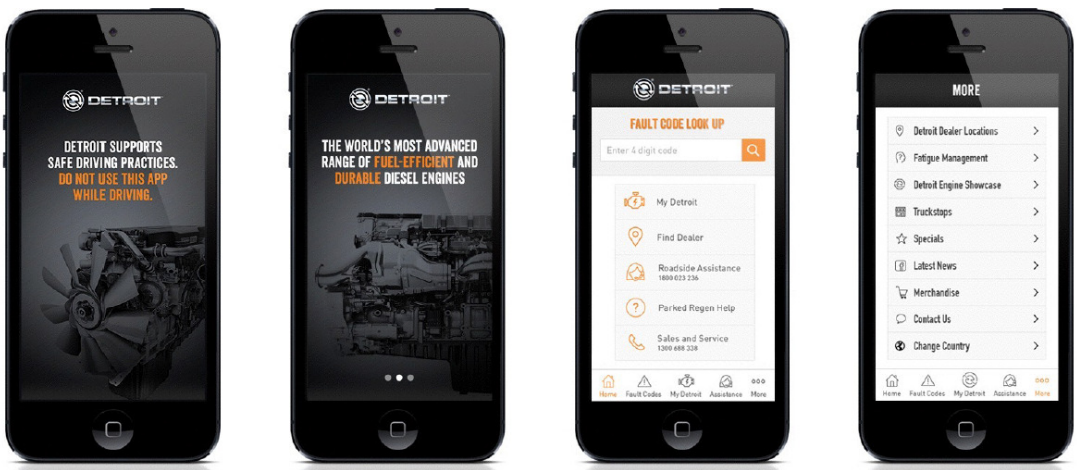


BACKGROUND
With support of football in Australia segmented between four major codes, an Australian football website was planned by PUMA. The website would promote PUMA's sponsored athletes and teams across AFL, NRL and A-League. PUMA Australia engaged Spark Digital to help them create a new online home for PUMA Australian Football.

STRATEGY
Leveraging puma.com, Spark created a microsite to sit in the football vertical, which included social media integration (#PUMAFooty), monthly competitions for fans to enter, insights on local and international PUMA sponsored athletes and teams, promoted news and product information.

RESULTS
The site was built on the WordPress CMS, allowing PUMA staff to update content easily and quickly. Launched in February 2014, via leveraging social media word-of-mouth, the site traffic doubled from 5,000 to 10,000 unique views in its second month, tripling competition entries and exceeding KPIs on target locations, reaching 'football crazy kids' from as far as the Northern Territory.

PENSKE - DETROIT IOS AND ANDROID APP



BACKGROUND
Detroit is a world leader in building and servicing truck engine platforms, owned by Penske Power Systems, the Detroit brand engenders extreme brand loyalty in the trucking community. Detroit approached Spark Digital to build an app for their core market, the truck driver on the road in both Australia and New Zealand.

STRATEGY
One of the key objectives is to reduce the telephone calls to the Detroit service centre by drivers enquiring about a sequence of appearing alert dashboard lights. By using the app to reference and interpret the sequence of flashes the drivers is easily able to establish the problem and take appropriate action..

DELIVERABLES
An iOS and Android app was planned, designed, built and tested by Spark Digital. The app included a fault code search, information about their Detroit engine and helpful information for regenerating the truck engine. The app also includes other valuable information including location services for drivers to search on nearby service centres and roadside stops