

On-Board Mass Monitoring for Commercial and Regulatory Purposes in Australia: Operational Learnings from the Interim OBM Solution



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Abstract

In Australia, On-Board Mass (OBM) systems are applied to measure and record the mass of heavy vehicles and are implemented in conjunction with the Intelligent Access Program (IAP), using a combination of telematics technologies and mass sensor units (MSUs) fitted to the vehicles' axles. With both the mass and location of enrolled vehicles monitored for compliance with access arrangements, Road Managers obtain stronger assurances that the conditions of access are being met. For Transport Operators, better access in exchange for monitoring offers productivity, efficiency and environmental outcomes – greater loads, fewer trips and greenhouse gas emissions, and more direct routes. This paper presents an overview of the OBM program currently operating in Australia, its broader context within the heavy vehicle landscape, and some of the key insights and operational learnings that are progressing the program to its next stage.

Keywords: On-Board Mass (OBM) monitoring, In-vehicle technology, Regulatory telematics

1. Introduction

The availability of vehicle telematics technology provides the opportunity for higher levels of compliance with road transport laws, hence higher levels of safety and road use efficiency with lower enforcement costs. Using a combination of advanced in-vehicle telematics technologies, and operating within a complex policy, regulatory and commercial environment, Road Managers and Transport Operators can better match individual vehicles to the differing capabilities of the road network. Transport Operators can realize significant productivity gains, and Road Managers can grant improved access to selected parts of the road network, confident that the conditions of this access will be adhered to.

This paper focuses on two operational programs in Australia: the Intelligent Access Program (IAP), and the On-Board Mass (OBM) monitoring program.

The OBM program monitors the mass of heavy vehicles, using a combination of telematics technologies and mass sensor units (MSU) fitted to the vehicles' axles. By enrolling in the OBM program, vehicles can carry additional mass, or use uncommon vehicle combinations. These vehicles can then be granted access to parts of the road network that would otherwise be restricted, due to, among other concerns, asset protection and managing the wear and tear that these heavy vehicles carrying higher than usual loads might pose to road infrastructure. The access conditions of heavy vehicles are determined in a permit, issued by a Road Manager to a Transport Operator.

The mass and location of enrolled vehicles are monitored for instances of non-compliance with the permit, providing Road Managers with assurance that the conditions of the permit are being met. For Transport Operators, better access in exchange for monitoring offers productivity, efficiency and environmental outcomes – greater loads, fewer trips and gas emissions, and more direct routes.

To participate in the OBM monitoring program, vehicles must be enrolled in the Intelligent Access Program (IAP), the first land-based voluntary, regulatory telematics program in Australia, which began operations in 2009. The IAP uses the Global Navigation Satellite System (GNSS) to monitor heavy vehicles' road use. There are three parameters which are currently monitored in the IAP: position, time and speed. The current use of OBM monitoring with the IAP is transitional in nature, intended to bridge the gap between the IAP and a more advanced program that integrates mass as a parameter of the IAP.¹ It caters for a limited number of vehicles (approximately 200) and is designed to monitor specific vehicle combinations travelling on selected parts of the road network. The program has been operational since 2011, and Road Managers are looking to expand their use of mass monitoring and progress to a more comprehensive monitoring program where the data collected can be used for regulatory and evidentiary purposes.

¹ Mass compliance, via OBM monitoring was considered as a first-day parameter of the IAP during the development phase, but was identified as in need of further trialing (Austroads 2003).

2. Background to the IAP

To participate in the OBM monitoring program, vehicles must be enrolled in the Intelligent Access Program (IAP), the first land-based voluntary, regulatory telematics program in Australia, which began operations in 2009. The IAP uses the Global Navigation Satellite System (GNSS) to monitor heavy vehicles' road use. There are three parameters which are currently monitored in the IAP: position, time and speed.

The IAP enables Transport Operators to obtain access, or improved access, for heavy vehicles to operate on the road network. In return, heavy vehicles enrolled in the IAP are fitted with an In-Vehicle-Unit (IVU) and monitored for compliance against a set of conditions. The IAP also uses driver declared information to monitor heavy vehicles against mass and vehicle type restrictions. The IAP reports only instances of non-compliance with an Intelligent Access Condition (IAC) (and of possible malfunctioning and tampering with systems), ensuring that only the required information is provided to Road Managers. In the IAP, there are four distinct entities, each with their own responsibilities, as described below and illustrated in Figure 1.

- Road Manager: Road Managers are the Australian state and territory road transport authorities. Road Managers may establish applications, schemes or permits to improve road access for heavy vehicles and use the IAP as a compliance monitoring tool. The Road Manager examines both the proposed vehicle and the requested access to determine what effect, if any, the proposal may have on safety, infrastructure and the environment.
- Transport Operator: A Transport Operator (e.g. trucking company) enrolls in a particular IAP Application offered by a Road Manager, or may approach a Road Manager for a unique IAP Application which better suits its particular needs.
- IAP Service Provider (IAP-SP): An IAP-SP is a commercial, third party telematics company certified by TCA to provide IAP services. A Transport Operator engages an IAP-SP to install and maintain the in-vehicle technology used in the IAP, and to monitor its heavy vehicle from a back office system. The IAP-SP reports instances of non-compliance in the form of a Non-Compliance Report (NCR) to the Road Manager.
- Transport Certification Australia (TCA): TCA acts as an independent government organisation which administers the IAP, certifies and audits IAP-SPs, and type-approves IVUs.

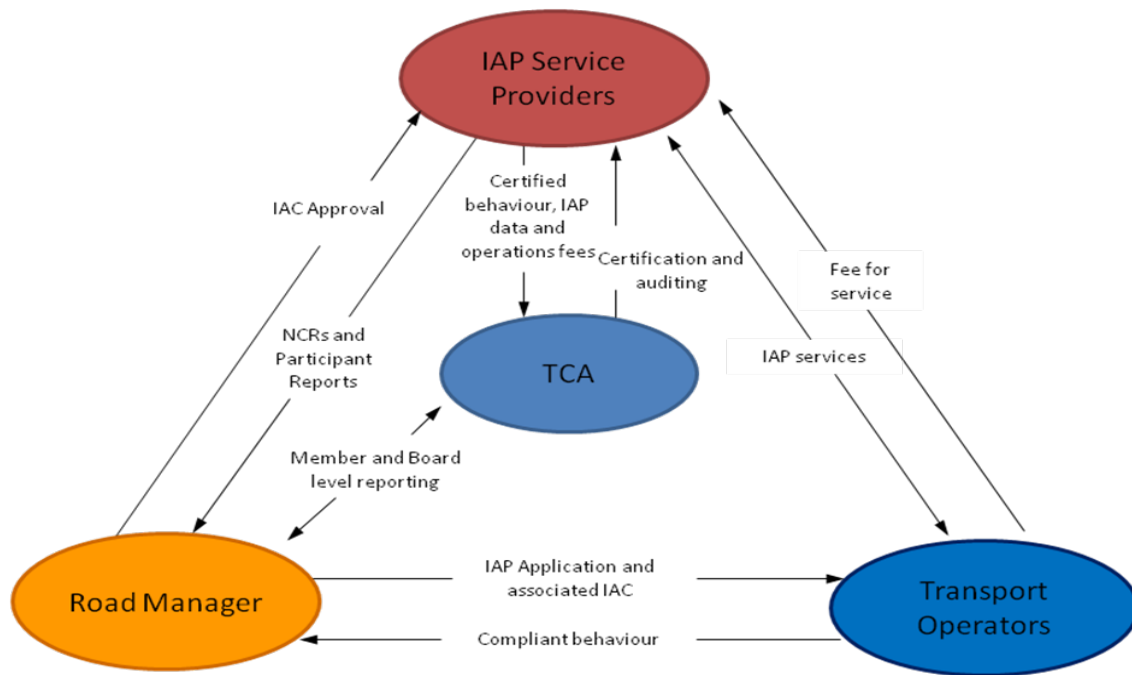


Figure 1: Overview of the IAP operating model

3. How OBM Monitoring linked to the IAP Works

The IAP and OBM monitoring – as applications of Australia’s *National Telematics Framework* – represent strategic means of utilising existing and new technologies in dealing with Australia’s growing freight task, meeting industry demands for greater productivity and more efficient use of infrastructure, and realising public-purpose outcomes through targeted government policies.

The Framework is premised on the concept of a core, nationally agreed environment which transcends traditional policy areas of government, industry sectors and end-users.

The Framework provides a critical intersection between public and private interests by:

- Providing a central point of reference for the deployment of telematics and related intelligent technologies in Australia
- Enabling the market to develop and deliver optimal technical, commercial and operational outcomes
- Ensuring public purpose outcomes are delivered through the use of telematics and related intelligent technologies by aligning policy and end-user intent.

The Framework has been recognised by the International Standards Organisation (ISO 15638 – *Framework for Cooperative Telematics Applications for Regulated commercial freight Vehicles* (TARV)), with TCA’s work in deploying operational applications through the Framework considered a world’s best practice approach to facilitate the sustainable use of telematics and related intelligent technologies.

Effectively, this means that mass is a fourth parameter (in addition to position, time and speed) of the IAP, although the two programs are not yet fully integrated, and run in parallel. The use of OBM monitoring involves another additional entity into the IAP – an OBM Supplier that is engaged by the IAP-SP to supply, install, maintain and calibrate the OBM system.

This is illustrated in Figure 2. In addition to the type-approved IVU fitted to the prime mover – which is a pre-requisite for enrolment in the IAP – the IAP-SP operates a back office for the collection, processing, storage and communication of OBM data.

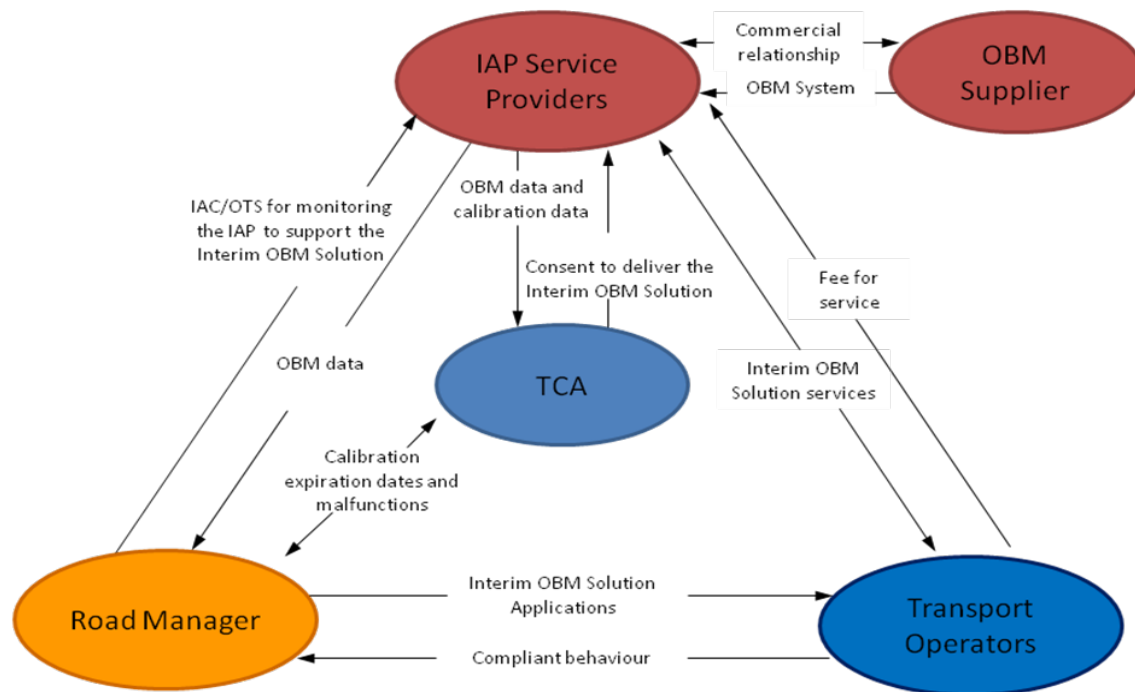


Figure 2: Overview of how OBM monitoring works within the IAP operating model

4. OBM Systems

An OBM system determines both the Axle Group Mass (AGM) and Gross Combination Mass (GCM) of a heavy vehicle, and includes the following key components:

- Electronic Control Unit (ECU) – installed in the rigid vehicle or prime mover, responsible for generating OBM data from the mass data collected from the Mass Sensor Units.
- User Interface (UI) – the screen and touchpad/keypad used by drivers to access and enter information
- One or more Mass Sensor Unit (MSU) – the load sensor and associated cables and connectors that measure the mass of an axle group.

Three types of MSUs are typically used with OBM systems: load cell sensors, air pressure sensors and strain gauge sensors.

5. OBM and Calibration Data

There are two types of data: OBM data and Calibration data. OBM data is generated automatically by the OBM system every 30 seconds (dynamic data) when the vehicle ignition is on. OBM data is also triggered when the driver requests it of the OBM system, when the vehicle is stationary (static data). OBM data can assist with the identification of malfunctions and/or indicate possible tampering (with the OBM system or the load of the vehicle).

OBM data is generated by the OBM system and transmitted to the IVU, which in turn transmits the data to the IAP-SP. OBM data is then prepared by the IAP-SP, and transmitted to the Road Manager and TCA.

OBM data includes the following information:

- IVU ID – the specific IVU that captures and transmits data generated by the OBM system
- Date and Time – when the data was captured
- Record Type – whether the data was generated automatically or self-declared
- Gross Combination Mass (GCM) – the combined mass of the laden or unladen trailer(s) and the prime mover/rigid truck
- Axle group ID – the specific axle or group of axles supporting a single section of the vehicle
- Axle Group Mass (AGM) by axle group ID – the mass measured by load sensors, taken from a specific axle or group of axles supporting a single section of the vehicle.

To ensure accuracy of these readings, OBM systems are calibrated at weighbridges, where a calibration certificate is completed. The calibration certificate captures the OBM system's pre-calibration readings of individual AGM as recorded by the MSU and the corresponding readings recorded by the weighbridge. To complete the calibration, the OBM system is adjusted to match the MSU readings with those of the weighbridge as much as possible.

The calibration procedure is performed under the following conditions:

- Calibration is performed for each required axle group
- A vehicle must be calibrated at unladen and laden conditions
- The unladen and laden conditions are measured by the same weighbridge
- The vehicle component(s) being calibrated must be on flat ground
- The entire vehicle combination is stationary
- The fuel tank(s) are at least 75% full
- The vehicle brakes are off
- Relevant wheels are not chocked
- The vehicle engine is running
- The ride height valves are in the correct positions
- Steer axle tyres are straight and parallel to the weighbridge
- Calibration at laden load condition must reflect at least 75% of the maximum specified load per axle group
- Calibration at laden load condition must not exceed the maximum specified load per axle group.

6. Interim OBM Solution

The use of OBM monitoring with the IAP is the basis for the current Interim OBM Solution, which is transitional in nature and intended to bridge the gap between the IAP and a more advanced program that integrates mass directly with the IAP. The Interim OBM Solution supports a limited number of vehicles (currently approximately 200) and is designed to monitor specific vehicle combinations travelling on selected parts of the road network.

In the next stage of OBM monitoring, OBM systems will undergo type-approval and associated testing to ensure their suitability for regulatory purposes. In the Interim program, the mass data is transmitted to an IVU that has been type-approved for the IAP. Mass data is transferred from the IVU to a back office operated by the IAP-SP but separate to IAP. IAP-SPs format and send the mass data to jurisdictions and TCA in a text format, using secure email as the method of delivery. Jurisdictions must then import, process and link the mass data to spatial non-conformance reports for analysis. Figure 3 shows the generic architecture of an Interim OBM Solution.

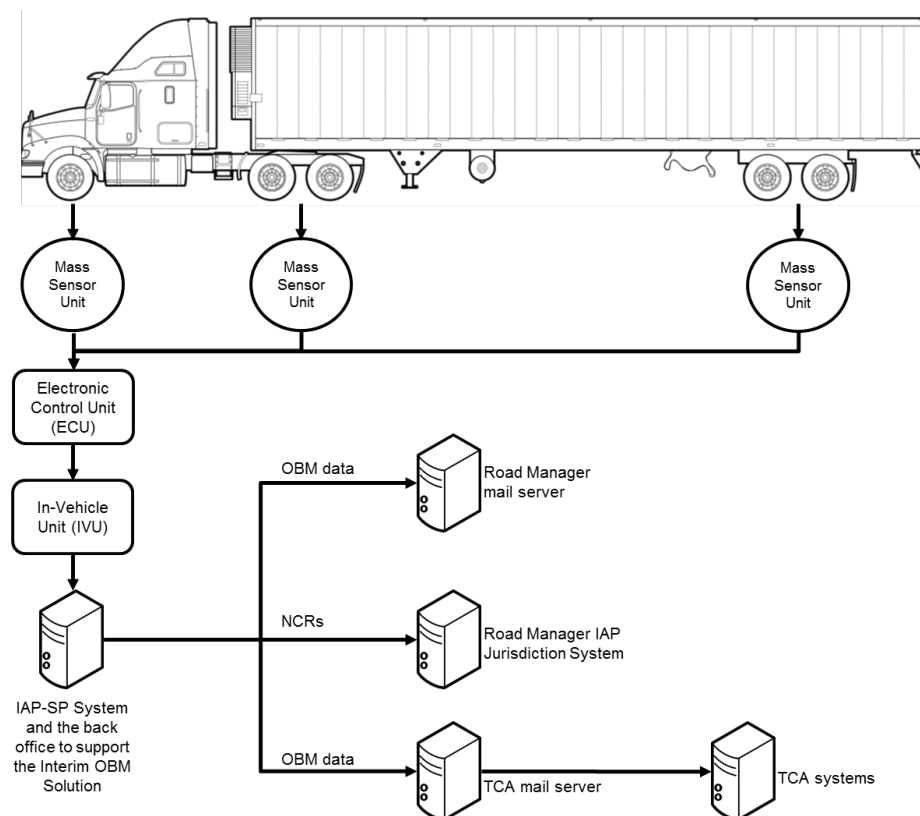


Figure 3: Generic Architecture of the Interim OBM Solution

The Interim OBM Solution has been operational since 2011, and following the delivery of operational learnings – including those related to accuracy of MSUs – Road Managers are looking to expand the use of OBM monitoring.

6.1 Example Applications of OBM Monitoring

Types of Vehicle Combinations Enabled by OBM Monitoring

As a transitional, first stage application, OBM monitoring has been deployed to accommodate a maximum of 200 operational vehicles, where a specific vehicle is granted a permit to complete a specific task, with permits granted on a case-by-case basis. The assurance provided by OBM monitoring linked to the IAP has allowed Transport Operators to use previously unavailable vehicle combinations, most notably types of PBS vehicles,² A-Doubles and Road Trains.³ At the time of writing, the majority of participating vehicles enrolled in the Interim OBM Solution are:

- PBS-2B vehicles – these vehicles meet rigorous safety standards, and are a maximum of 30 metres in length
- Super B-doubles – these vehicles are capable of carrying for 20ft containers or two 40ft containers.⁴

Improved Use of Infrastructure through OBM Monitoring: Bridge Load Factors

In addition to enabling the use of new heavy vehicle combinations, OBM data gives bridge and structural engineers increased visibility to heavy vehicle use of bridges, allowing them to confidently revise and establish new mass limits and access arrangements. Bridges are usually designed with a load factor of 2, meaning that twice the predicted maximum load of the bridge can be supported. Because OBM monitoring provides accurate and transparent data relating to AGM, TCM and load distribution, load factors have been able to be reduced from 2 to 1.8, increasing the maximum allowable load for certain bridges (Austroads 2014: 63).

Using OBM Monitoring to Provide Assurance of Empty Payload

Accurate and real-time OBM monitoring addresses the lost revenue and inefficiency of conservatively underloading. However, OBM monitoring need not be used exclusively to maximise load capacity. Transport Operators can gain access to roads and infrastructure on the condition that their vehicles are unladen. OBM monitoring allows operators to check in real-time that vehicles travelling on certain parts of the road, or travelling across certain bridges, are complying with access conditions related to reduced, or indeed no payload, rather than additional mass.

² Performance Based Standards (PBS) vehicles are assessed, accredited and allowed to operate based not on conventional mass and length requirements, but on how well they perform on the road (e.g. acceleration capacity, ability to maintain motion on a specific grade, tyre contact area). The scheme is intended to progress productivity through innovative and optimised vehicle design in tandem with safety and infrastructure protection standards (NTC 2008). Within the scheme there are four levels (1-4) and two classes (A and B) e.g. PBS 2B vehicle.

³ A Road Train (or A-Double) consists of a motor vehicle towing two or more trailers (excluding converter dollies supporting a trailer) (NHVR 2014).

⁴ A B-double consists of a prime mover towing two semitrailers, with the first semitrailer being attached directly to the prime mover, and the second semitrailer mounted on the rear of the first semitrailer (NHVR 2014).

A combination of using OBM monitoring to maximise payload and access on an outgoing trip, and gaining more direct access on an unladen return trip has yielded distinctive productivity gains in one case study. With a combination of OBM monitoring and enrolment in the IAP, under this arrangement, a Transport Operator has been able to load an additional 2.5 tonnes per outbound trip – saving 12, 500 trips per year – and cut the return trip by 8km on an alternative route, by demonstrating that all vehicles are returning empty (Transtech, n.d.).

6.2 Key operational learnings from the Interim OBM Solution

There are two types of mass data collected in the Interim program: static data, and dynamic data. Static data, which is captured when the vehicle is stationary, is currently the most reliable OBM data. Static data readings provided by OBM systems are required to provide an accuracy of 2% within 95% of readings.⁵

Dynamic data, which the OBM system generates every 30 seconds, can assist with the identification of malfunctions and/or possible tampering with OBM systems. This data can provide insights into instances when a driver changes their load or vehicle configuration, and fails to make a self declaration.

The key operational learnings from the Interim OBM Solution include the following:

The need for greater definition and clarity of the roles and responsibilities between IAP-SPs and OBM system suppliers

The importance of having greater definition and clarity of the roles and responsibilities of IAP-SPs and OBM system suppliers has been identified as a key learning. Further defining these roles and responsibilities will improve operational performance, efficiency and administration. Enhancing the commercial and contractual arrangements with IAP-SPs and OBM system suppliers will ensure roles and responsibilities are clearly managed in accordance with expectations.

Management of access to data

The management of access to data is critical to maintain the integrity of the IAP, and the privacy protections which are an integral, foundational aspect of the program. The management of data, and the protections of participant's privacy in the early application of the Interim OBM Solution, was commensurate with risk. However, as Road Managers expand their use of the Interim OBM Solution, the applications being identified have a greater risk profile associated with their use. Offering a higher degree of integrity in the management of mass monitoring and reporting will ensure emerging applications are managed appropriately.

Monitoring of data integrity, tampering and malfunctions

The ability to monitor the integrity of the Interim OBM Solution, together with the identification of tampering and malfunctions, while suitable for a limited number of participating vehicles, will need enhancement with the projected growth in participating vehicles. This includes the need for automated reporting of possible malfunctions and tampering of OBM systems.

⁵ Testing of OBM systems against a weighbridge at full load showed accuracies within approximately $\pm 500\text{kg}$ s or $\pm 2\%$ of weighbridge for AGM (TCA 2009). Further testing is being conducted by TCA as the program progresses towards integration with the IAP.

The need for more frequent periodic calibration to ensure accuracy of OBM systems

Finally, TCA has identified – through its administration of the Interim OBM Solution – the need for increased periodic assessment of calibration of OBM systems, to maintain and assure the accuracy of the mass data they provide.

Analysis performed by TCA reveals that the current six-month calibration frequency required in the Interim OBM Solution is insufficient to ensure that the accuracy of mass data generated by MSUs, within a tolerance that is acceptable to Road Managers. Furthermore, TCA's analysis indicates there are other factors that may be influencing the accuracy of an OBM system that may be unrelated to their calibration, such as malfunctions and tampering.

As a result of this analysis, TCA has identified a three-month calibration frequency be introduced until there is sufficient operational data available for further analysis.

7. OBM Next Steps

In a number of States, recent Ministerial announcements in regard to high productivity freight vehicles have included the requirement for TCA type-approved OBM Systems to be fitted to nominated heavy vehicles as a condition for access to the road network. It is apparent that continuation of the Interim OBM Solution is not sustainable and would not meet Members' needs for type-approval of OBM Systems and the subsequent levels of assurance and operational oversight.

As such, TCA has developed a staged approach to implement 'next steps' for OBM, beyond the current Interim OBM Solution. The goal is to progress to a more comprehensive monitoring program where OBM data collected can be used for regulatory and evidentiary purposes.

The 'next steps' plan responds to projected growth in the number of access entitlements that will utilise OBM systems linked to the IAP, as indicated by TCA's Members. TCA is working with the OBM industry, TCA Members and IAP Service Providers to complete a performance-based Functional and Technical Specification (Specification) for TCA type-approval of OBM systems. Type-approval provides assurance of a systems reliability, accuracy, integrity and security.

The key benefits of moving to type-approved OBM systems are:

- Ability to support the growth of vehicles enrolled in the OBM in the medium term
- Improved security of data
- Greater monitoring of data integrity, and reporting of tampering and malfunctions
- More frequent periodic calibration to ensure accuracy of OBM systems.

TCA is planning to finalise the Specification for type-approval of OBM systems by the end of 2016. Type-approval would commence shortly thereafter, subject to the receipt of applications from OBM suppliers.

8. Conclusion

The IAP and OBM monitoring – as applications of Australia’s *National Telematics Framework* – represent strategic means of utilising existing and new technologies in dealing with Australia’s growing freight task, meeting industry demands for greater productivity and more efficient use of infrastructure, and realising public-purpose outcomes through targeted government policies. Used together, and progressing towards a fully integrated program, the IAP and OBM serve as a nexus between the needs of the road transport industry – improved access, reduced trip times, higher permitted loads – and the requirement of road authorities and government to protect their infrastructure assets, and the industry compliance needed to achieve this.

Significantly, OBM monitoring has enabled a number of unprecedented outcomes – especially in the use of new vehicle combinations. These combinations have both immediate uses for specific tasks, and are being considered for wider adoption, based on the productivity gains they are able to achieve. The OBM program, and the data rich, IAP environment, to which it contributes, has also been earmarked for a number of future innovative technology, commercial and policy outcomes.

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