SMART ON-BOARD MASS IN AUSTRALIA – LEARNINGS AND INSIGHTS

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Abstract

Since the release of the On-Board Mass System Functional and Technical Specification in 2017 and the first policy deployments of digitally connected, or 'Smart' On-Board Mass ('Smart OBM') systems in Australia in 2020, Australia has seen significant growth in the number of vehicles fitted with Smart OBM systems and transmitting mass measurement data to Transport Certification Australia (TCA).

In addition to the rapid adoption of this technology by the transport industry, there has been a rapid adaptation by authorities in utilising this data to improve decision-making. Examples that have been identified include the use of mass data to monitor and adjust bridge mass limits according to real usage data, informing the prioritisation of existing investment funding to best target high-priority bridges and pavements, utilising mass and journey data to improve applications for new funding for road enhancements, and supporting more dynamic access decisions to maximise the efficient and safe use of roads – particularly in managing higher axle group masses.

Smart OBM has become a key element in access and road investment decisions by Australia's road and transport agencies. As low and zero emission heavy vehicles (LZEHVs) become more prominent in Australia's road transport fleet, the use of Smart OBM systems is anticipated to become more widespread over time.

Keywords: Smart On-Board Mass, OBM, digital technology and data, data, intelligent access.

1. Introduction

Digital technology and data are now central to the operation of transport, as well as future productivity and safety reforms. No longer considered an adjunct to the role of transport technology, data should be viewed as a centrepiece of transport operations, road safety, road infrastructure planning and regulation.

The concepts of Intelligent Access have been widely discussed over recent years. These concepts have been deployed in various ways across the world, with deployments across Australia and Europe in particular (Walker and Moulis et al, 2021).

Achieving the core concept of maximising public road productivity by ensuring "*the right truck is on the right road, in the right configuration and mass*" requires the efficient and effective coordination of a framework of actors, with clear responsibilities and interfaces (Walker and Moulis et al 2021, and Hill and Gordon 2019).

The benefits of data collection for the heavy vehicle industry have been well documented in previous papers on Intelligent Access and On-Board Mass (OBM) systems.

Smart On-Board-Mass (Smart OBM) was introduced as a new function of Australia's Intelligent Access arrangements in 2020. Smart OBM is mass monitoring functionality designed as an optional feature of a telematics application of the National Telematics Framework. It utilises an OBM system approved by TCA to Category B or C (see 3.1 below for further details). Since 2020, the coordinated process of digital capture, transmission, processing, storage and analysis has gone from a concept to a reality. At the time of writing, over 1,300 vehicles are actively participating in this functionality, providing data for public purpose analysis – supporting improved road management, maintenance, planning and investment.

2. Current frameworks for managing government access to data through technology

Many of the concepts which underpin this work are included in legislative and regulatory frameworks related to the use of Intelligent Access in Australia. They also leverage the digital infrastructure and governance arrangements administered by Transport Certification Australia (TCA), as outlined in previously published papers (Hill and Greenow 2021, Hill and Gordon 2019, TCA 2016). Australia's National Telematics Framework combines legislative, contractual, operational and technical requirements to enliven the policy objectives of governments in Australia by providing an open marketplace of telematics and related intelligent technology providers.

2.1. Government interest in heavy vehicle transport data

In the rapidly evolving landscape of transportation, digital technology and data have emerged as pivotal components. This shift extends beyond mere support. Technology and data now have the potential to significantly improve the core of transport operations, safety reforms, road infrastructure planning, delivery and operations. The critical enabler to collecting, retaining, utilising, and securing data from heavy vehicles is the establishment of trust between actors which give effect to Intelligent Access. It could be argued that the question of how to establish and maintain trust to underpin data-sharing arrangements has not received the attention it deserves from academia, policymakers, practitioners, and technology providers. The unprecedented volume of data generated by heavy vehicle technologies presents, therefore, both opportunities and risks.

A paper to the World Congress on Intelligent Transport Systems identified a range of potential benefits for road managers and the community by the adoption of Smart OBM (Hill and Gordon 2019). Since then, Smart OBM has become operational and is providing highly valuable data analytics which are meeting a range of these forecast uses. Road managers and regulators have begun using this data analysis to support grant applications between governments, prioritise funding requests, improve heavy vehicle access policy decisions, better plan road maintenance and enhance investment decisions.

For example, at least four states in Australia have begun using Smart OBM to monitor critical infrastructure, allowing them to assess potential risks of utilisation by monitored vehicles and compliance with any temporary reductions in access to key structures (TCA 2023a, b, c, d).

3. The road to Smart On-Board Mass

Upon the request of Australian governments and industry, TCA developed an OBM program within the National Telematics Framework (TCA 2017). This initiative began in 2008-09 with a performance-based assessment of OBM systems (TCA, 2009). It evolved into the development of a performance-based functional and technical specification for OBM systems as discussed below. Commercial OBM systems were introduced in 2013 as part of the Interim OBM Program administered by the Department of Transport and Main Roads Queensland, where it operates. In October 2016, an operational learnings report was issued and made accessible to Australia's road and transport agencies (Koniditsiotis and Hill, 2018).

In 2017, TCA released the On-Board Mass System Functional and Technical Specification (the OBM System Specification), coupled with an assurance mechanism which provided independent assessment and type-approval of OBM systems against the requirements of the specification. A growing selection of OBM system providers have been type-approved through this specification, leading to the growth of a marketplace of service providers, and rapid uptake by road transport operators. This has led to significant insights and opportunities in system efficiency, safety, and road asset optimisation, as anticipated in TCA's 2019 publication (Koniditsiotis, 2019). The enhanced functionality provided by Smart OBM systems is supporting the efficient generation, capture, and secure digital transmission of mass and location data from participating vehicles.

3.1. Key requirements of the OBM System Specification

TCA has been responsible for the development, maintenance, and administration of the OBM System Specification (and associated specifications, consent agreements, and other documents that support the operation of Smart OBM). These activities have sought to balance the:

- policy needs of government;
- feasibility of technical delivery of expectations; and
- delivery of Smart OBM to end users at a cost that does not outweigh the value of the requirement for access monitoring, or additional productivity.

A key feature of the OBM System Specification is a distinction between the three categories of OBM system types:

- Category A systems – which satisfy accuracy and integrity requirements but do not generate or transfer digital data records
- Category B systems – which build on Category A systems by generating and transferring digital data records which can be shared with certified Application Service Providers (ASP)
- Category C systems – which build on Category B systems by using a common interoperability mechanism between Smart OBM systems, telematics devices and certified ASPs, allowing for 'plug and play' functionality between trailers and prime movers.

Category B and C OBM systems are referred to as 'Smart OBM systems' since they generate and transfer digital data records, which can be combined with other forms of Intelligent Access data within the National Telematics Framework. Key functional and technical requirements of Smart OBM systems (as described in the OBM System Specification) include:

- 98% accuracy of mass readings from each mass sensor unit (MSU), for 95% of recordings
- installation of MSUs on each axle group of the prime mover, and each trailer unit connected to it
- the ability to combine data to determine the vehicle 'configuration' and a total combination mass, as well as transmitting the axle group masses
- data storage and transmissions
- interconnectivity (pairing) with ASPs and telematics devices
- data security and protection.

4. Evolution of Intelligent Access and Smart OBM

Intelligent Access has progressively evolved over the past twenty years and has been well documented at previous HVTT events (Walker and Moulis et al 2021, Koniditsiotis and Sjögren 2012, Wandel, Sternberg and Hill 2014, Wandel and Asp 2018, Walker 2018, 2016) and the ITS World Congress (Hill and Gordon 2019).

The original deployment of Intelligent Access was in the Intelligent Access Program (IAP). The IAP was introduced as a high-integrity telematics monitoring application to manage heavy vehicle road access arrangements. Enrolled vehicles have their movements, as well as their speed, time of travel, vehicle weight and route travelled monitored on a 24/7 basis. Compliance with the parameters of operating conditions is assessed. (TCA 2016).

In May 2018, Australian Transport Ministers tasked TCA with exploring ways to enhance Intelligent Access, expanding its applicability to a broader spectrum of vehicle types and purposes (Walker and Moulis et al 2021). The results of this effort, which received approval from the relevant ministers in November 2018, gave rise to new Intelligent Access applications at lower levels of assurance, namely:

- Road Infrastructure Management (RIM) and

- Telematics Monitoring Application (TMA).

These applications have been widely adopted by road authorities to specify access conditions for a more diverse range of vehicle types and data usages. Because they operate at lower levels of assurance to the IAP application, they allow TCA to certify telematics systems already employed by transport operators for use in the IAP. The TMA application also supports the use of Smart OBM and other optional data streams and devices, as discussed in Section 4.1.

Further details on these developments in Intelligent Access are explored in depth in the HVTT16 paper "*Applying a Risk-Based Approach to Road Access Using Telematics*" (Hill and Greenow 2021), and in the paper presented at HVTT17, "*Two Decades of Intelligent Access in its Birthplace of Australia – Where We've Been and Where We're Going*", (Hill and Koniditsiotis 2023). Smart OBM is often an additional condition of access associated with these access and productivity concessions.

During the 2022-23 financial year, there was a 35% increase in the total number of vehicles enrolled in Intelligent Access applications. The majority of this growth has occurred in the TMA application, including schemes which require vehicles to be fitted with Smart OBM systems.

4.1. Introduction of Smart OBM

The OBM System Specification was approved and published in 2017. In the same year, the Australian Standard for Bridge Assessment (AS 5100.7:2017) was released, incorporating reduced traffic load factors for vehicles monitored with Smart OBM through Intelligent Access.

The first OBM systems were type-approved against the OBM System Specification in August 2018, with the first Smart OBM system approved in February 2020.

The first government policy to realise Smart OBM through conditions of road access was in the Australian jurisdiction of Tasmania, which included Smart OBM as the preferred method for the capture of mass data for Performance Based Standards (PBS) vehicles operating under conditions of access (TCA 2023a).

Tasmania was followed in 2021 by the Australian jurisdiction of Victoria (TCA 2023b), which introduced Smart OBM as a condition of access for High Productivity Freight Vehicles (HPFVs) under the '*Moving More with Less*' policy (DoT 2021). This was followed by the implementation of similar policies in the jurisdictions of New South Wales (TCA 2023c) and Queensland (TCA 2023d) which included the use of Smart OBM for other specific heavy vehicle configurations. In 2023, Smart OBM has been made a condition for schemes relating to low and zero emission heavy vehicles (LZEHV), which feature steer and drive axle masses that exceed regulated limits. Additionally, there are several schemes which allow for Smart OBM as a preferred optional method of declaring mass.

The growth of these schemes over the last few years is illustrated in Table 1.

Table 1 – Adoption rates and scheme expansion using Smart On-Board Mass

	January 2022	July 2022	January 2023	July 2023	October 2023
Number of schemes associated with Smart OBM	2	3	6	6	14
Number of vehicles transmitting Smart OBM data	0	10	149	790	1301

Table 1 indicates the uptake of these schemes by the transport industry. Smart OBM allows the industry to gain additional access certainty and often increased access, increased mass and productivity, as well as participation in the sharing of data for improved road planning and management.

5. Managing Smart OBM through the National Telematics Framework

The National Telematics Framework is managed by TCA as an open marketplace of certified and registered ASPs (Walker and Moulis et al 2021, TCA 2018). The National Telematics Framework is a digital business platform with infrastructure and rules that aims to ensure an open marketplace of telematics and related intelligent technology providers (TCA 2018). The effective management of the National Telematics Framework in Australia is heavily reliant on the coordinated interaction and interface between various actors within this framework, as highlighted by Walker and Moulis (2021).

These interactions are particularly important for Smart OBM to operate effectively, as they depend on standardised business processes between Smart OBM system providers, certified ASPs. Each Smart OBM system 'type' and certified ASP needs to have a pairing relationship for Smart OBM to operate within an Intelligent Access monitoring application such as TMA. A pairing is an agreed approach established between each party for matters relating to data sharing, connectivity, and business processes for installation, maintenance, and calibration of Smart OBM systems (TCA 2017).

TCA actively manages this marketplace of actors through formal means, such as type-approval processes and certification agreements, complemented by structured engagement processes. Transparency of communication has been established as a key requirement of the success of the National Telematics Framework (Walker and Moulis et al 2021).

5.1. The market of Smart OBM systems

The first Smart OBM system was type-approved by TCA in 2020, three years after the release of the OBM System Specification in 2017. Now, six years after the introduction of the OBM System Specification, there is a marketplace of providers with seven commercial Smart OBM providers (providing nine different models of devices), as well as one Smart OBM system which has been approved for use within a single transport operator's business.

During this time, Smart OBM systems have introduced innovative approaches to the assessment of functional and technical requirements described in the OBM System Specification, including the use of Bluetooth connectivity between prime movers and trailers, and the use of Electronic Braking Systems. TCA anticipates further technical and business innovation and performance-based assessment methods as this marketplace evolves and expands further.

5.2. Roles and responsibilities of different actors

It is the responsibility of ASPs to integrate their telematics devices to Category B OBM systems using agreed interfaces (which form part of the certification process). The ASP must thereafter report the OBM system data captured by the telematics device to TCA as Smart OBM data records formatted in accordance with the relevant data transfer specifications, as illustrated in Image 1.

6. Policy learnings from implementation

The introduction of Smart OBM as an optional functionality that may be used within established Intelligent Access applications has led to significant insights and learnings. Foremost amongst these are the complexities which arise from having multiple actors (namely certified ASPs and Smart OBM system providers) being responsible for different aspects of Smart OBM functionality which take place through pairing arrangements. Notably, key learnings from implementation have less to do with technology, and more to do with market readiness and the capacity of certified ASPs and Smart OBM system providers to meet the demand created by policy makers. Learnings include:

- Allowing technology providers sufficient time to adapt to policy changes and introduce the necessary technology
- Providing early and solid market signals about the introduction of new policies for monitoring, to allow adaptation in the marketplace
- Once timeframes and deadlines for the adoption of these monitoring technologies have been introduced, manage the market deployment and consider carefully any need for exemptions where the marketplace has been slow to meet expectations
- A robust audit program and data validation is required to ensure the early identification of issues between actors
- The need for a central body to coordinate the marketplace and coordinate interface issues between technology providers, service providers, the transport industry and policy makers.

7. Data analytics and improvements

Smart OBM data is being utilised for a wide variety of purposes, to improve the utilisation and management of public roads. Ensuring the data is sufficiently reliable to underpin these decisions is critical. During the initial deployment of Smart OBM, TCA has identified a range of issues which have become apparent, each having the potential to affect the data and analytics received by policy makers. These issues are summarised below.

- Axle group masses being reported as combined values (particularly steer and drive axles)
- Implausible steer axle group mass values (including where data values for errors are being coded into mass fields)
- Incorrect or null mass sensor unit (MSU) ID/mass values

- Inconsistent MSU counts or missing MSU ID for periods of vehicle activity (dropping devices, sometimes due to environmental conditions or interrupted Bluetooth connectivity)
- Inconsistent mass record timing intervals.

Resolution of these issues can be complex and requires cooperation between TCA, Smart OBM system providers, ASPs and policy makers. Data analysis and validation is being routinely undertaken to identify issues – either isolated or systemic in nature.

7.1. Insights from Smart OBM lead to improved decision-making

Smart OBM data and analytics is being used for a range of purposes by road managers in Australia, including:

- monitoring the utilisation of vulnerable bridges and other structures, including identifying potential over-mass events
- monitoring newer low and zero emission heavy vehicles with steer and drive axle masses over the regulated limits
- monitoring other vehicles with greater-than-regulated axle masses
- reporting on productivity and economic utilisation of structures for prioritisation of maintenance and investment funding
- supporting access and road management decisions by examining travel trends and journey optimisation (for example, by analysing actual road utilisation and comparing travel times on alternative routes)
- providing assurance to road managers (particularly local governments) on the utilisation of public roads
- compliance management by identifying potential non-compliances for future risk assessment and investigation
- using data for improved management such as auditing of ASPs and Smart OBM system providers.

Some examples of the analytics generated by Smart OBM include statistical reports, allowing analysis of road utilisation by location, vehicle type, combination (number of axle groups), year, month and date/time. An example is provided in Figure 1.

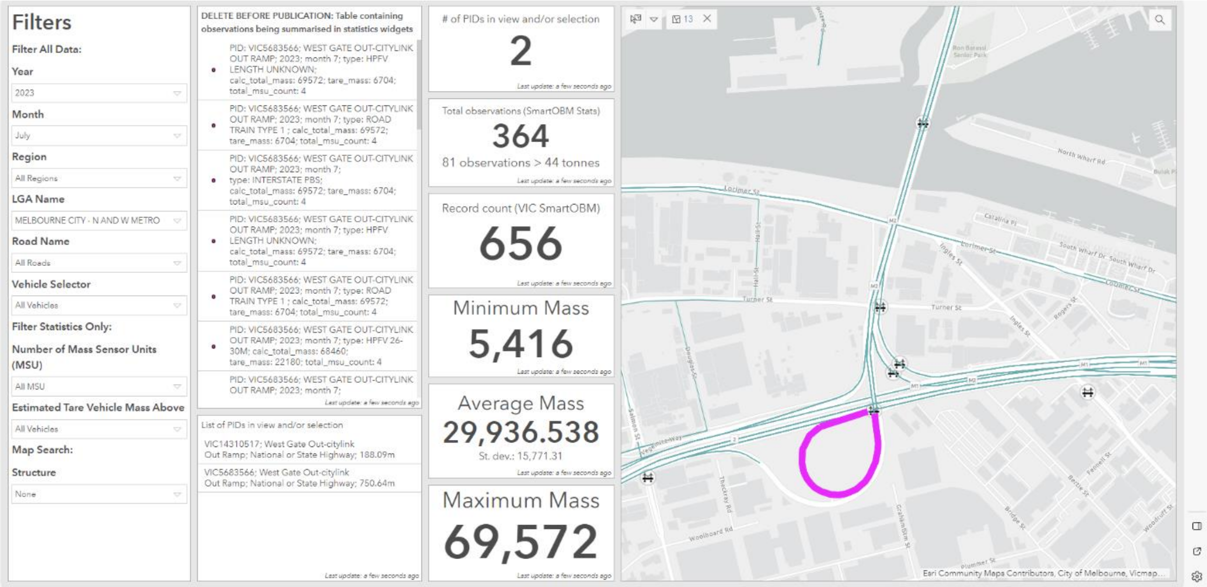

Figure 1 – Smart OBM statistical analysis for a vulnerable structure

Figure 1 illustrates a draft analytical dashboard currently being developed in collaboration with road authorities, which focuses on an on-ramp to a major bridge operated by a state road authority. This on-ramp was recently identified as being under strain, which led to the relevant authority having to reduce the permissible load on the bridge. The authority requested an analysis of mass records on this structure.

The analysis provides a detailed breakdown of the number of specific road segments included (2), the number of 'observations' (364 mass records), number of records above the structure's allowable mass limit (81 records over 44 tonnes), total record count over the structure for the month of July (656 records), and the minimum (5.4 tonnes), maximum (69.6 tonnes) and average tonnes (29.9) on the structure for the selected parameters on the left.

Figure 2 below illustrates a 'hotspot' report that was generated for another major bridge structure, illustrating that vehicles covered by this report were all travelling under the legal mass limit of 86.5 tonnes per vehicle combination. Additionally, the use of data was able to reassure bridge engineers that many vehicles were utilising this bridge for low-mass trips, or unladen trips. More trips were occurring in a southbound direction, indicating vehicles taking an alternative route for the return journey.

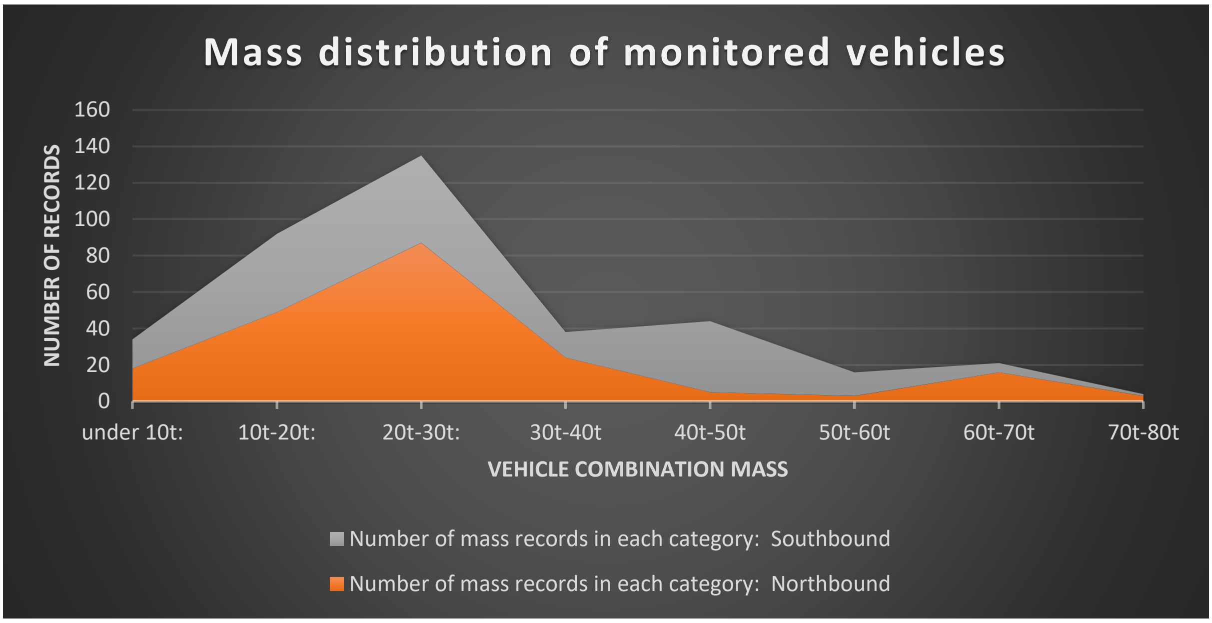

Figure 2 – Smart OBM 'hotspot' reporting on a major bridge

8. Future developments

It is anticipated that Smart OBM will be increasingly used in Australia to:

- monitor low and zero emission heavy vehicles with steer axle masses over 7 tonnes, or with drive axle group masses over the regulated limits, as part of transport emission reduction strategies;
- informing investment decisions, utilising mass data for roads and alternate routes, to determine optimal investment locations and target levels of service;
- integration of Smart OBM and telematics location data with automated vehicle access assessment systems to monitor vehicle compliance in a more automated manner, and identify critical, high and lower-risk events to address systemic risk to infrastructure and other road users; and
- utilising Smart OBM data to complement dynamic or tailored mass and route access decisions, compared with static permissible mass and access decision-making.

9. Conclusion

The introduction of Smart OBM in Australia as an optional functionality that may be used within established Intelligent Access applications represents a significant advancement in the management of heavy vehicles to enhance their productivity and safety.

The learnings and insights from Australia's experience are transferrable to other regions and policy environments. Key success factors that were identified through this implementation process include:

- a national telematics framework for trusted data sharing between the transport industry and government;

- a clear role and mandate for a coordinating body to ensure the smooth operation of the framework;
- clear policy decisions and market awareness of the introduction of vehicle monitoring
- sufficient time for the technology sector and freight transport industry to adapt, install, and implement Smart OBM; and
- a robust data validation, audit and feedback process.

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