RE-ENGINEERING ROAD NETWORKS THROUGH ON-BOARD MASS (OBM) SYSTEMS

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Abstract

In Australia, On-Board Mass (OBM) systems are being used to record the mass and configuration of heavy vehicle combinations. This paper presents an overview of the functional and technical requirements which are being applied to OBM Systems, and how different approaches are encouraged to achieve an outcome – fostering innovation and best practice, and the promotion of competition and choice – while catering to government and industry demands for greater reliability, accuracy, integrity and security in the measurement of heavy vehicle mass. The paper also provides an update on the implementation of a certified OBM program, which will provide the strongest assurances that OBM data can be relied upon by infrastructure managers to introduce productivity enhancing access arrangements – without being forced to invest in upgrades to road and bridge infrastructure.

Keywords: On-Board Mass (OBM), in-vehicle monitoring, telematics, productivity, higher productivity vehicles, standards and regulations, high productivity vehicles, pavement and bridge loading, lifecycle management, compliance and enforcement.

1. Introduction

On-Board Mass (OBM) Systems are technologies that are able to measure the the mass of axle groups and calculate the gross vehicle mass of a vehicle.

Often referred to as weigh scales or mass measurement systems, the transport industry has adopted the use of OBM Systems to better manage commercial obligations and conformance with regulatory loading and mass regulations.

OBM Systems also offer the opportunity to change the way road assets are utilised, which can enable changes to access arrangements, and ultimately, lead to significant productivity and safety reforms.

It is through the availability of reliable and accurate vehicle location, mass and configuration from OBM Systems which can unlock improved productivity outcomes. More specifically, the use of OBM Systems have the potential to support higher productivity heavy vehicle access arrangements, which would not otherwise be possible.

2. Using OBM Systems to optimise road asset utilisation

The availability of reliable and accurate vehicle location, mass and configuration information can enable improved productivity outcomes to be achieved.

OBM Systems, when used with vehicle telematics, can link these critical information components together.

Although heavy vehicles are widely recognised as contributing to the 'consumption' of road assets at a greater level than other vehicle types, there has not been a consistently reliable method of gaining insights into the utilisation and loading of heavy vehicles operating on the road network.

Where data are available for heavy vehicle road use and loading, conventional methods of collecting data typically only provide 'point-based' data samples (i.e. road-based systems which count vehicle passes, axle groups and or loads). Compared with other economic utilities (such as electricity, water or communications infrastructure), there is a comparative shortfall in data collected from road assets to inform the level of asset utilisation and consumption.

Shortfalls in the level of data granularity sought by policy makers can lead to assumptions being made which over-compensate for risks (particularly with respect to bridge loadings). This can lead to sub-optimal outcomes for heavy vehicle access policies, and limit the potential for innovative, higher productivity vehicles to be introduced on the road network.

With the forecast growth in road freight transport over the coming decades, coupled with fiscal constraints which impact on road asset maintenance and capital investment programs, alternative approaches need to be included to complement conventional options considered by policy makers and road asset managers.

The challenge for infrastructure managers and regulators is not having access to the right tools to meet these emerging challenges.

The next wave of heavy vehicle productivity and safety reforms will depend on having better mass loading information from vehicles, derived from OBM Systems.

3. Work to Date

Transport Certification Australia (TCA), together with Australia's road and transport agencies, first started assessing the performance of OBM systems in 2008-09. TCA produced an 'On-Board Mass Monitoring Test Report' in 2009[1].

This report provided a detailed assessment of available technologies, development paths, and accuracy and reliability of equipment. The report's conclusion suggested various areas for further investigation or development of standardised requirements.

Based on this work, TCA developed a draft On-Board Mass Unit (OBM) Functional and Technical Specification. This established a set of functional and technical requirements needed for an OBM System. Core components of the draft Specification were deployed operationally from 2011.

In September 2013, TCA commenced the national administration of commercially available OBM Systems, linked to the Intelligent Access Program (IAP) – an access and compliance management application of the National Telematics Framework.

During 2014, these arrangements were extended to further geographic region in Australia, supporting different vehicle combinations and access entitlements.

In October 2015, an operational learnings report was published, and made available to Australia's road and transport agencies. The operational learnings revealed the need for:

- Greater definition and clarity of the roles and responsibilities between IAP Service Providers and OBM system suppliers
- Improved management of access to data
- The identification of malfunctions and tamper events
- The need for more frequent periodic calibration to ensure accuracy of OBM systems.

In May 2017, TCA released the OBM Functional and Technical Specification[2]. This followed significant engagement with a range of stakeholders, including:

- OBM suppliers
- Telematics providers
- Road infrastructure managers
- Regulators
- Heavy vehicle operators.

The OBM Functional and Technical Specification provides the foundations for a certified OBM monitoring service currently being implemented (see section 8 – Moving Forward).

4. Managing the mass of vehicles – comparisons with other approaches

The need to manage heavy vehicle loading is well established in regions across the world.

Heavy vehicles are widely recognised as contributing to the 'consumption' of road assets at a greater level than other vehicle types. There are a diverse range of approaches which have been adopted by infrastructure managers regulators, and the industry to manage vehicle loading, and compliance with regulatory requirements.

These approaches can be broadly grouped into three categories:

1. Information and advisory systems – involve the use of Weigh-in-Motion (WIM) systems, and other in-road systems which, when used with camera-based systems, can identify and select vehicles which are overloaded (for possible follow-up action or direct enforcement).

2. Direct enforcement – which involves direct intervention approaches, including road-side inspections and mass measurements – using certified weighing systems and/or portable weigh scales (to measure individual axle groups) – as well as high speed WIM systems in some European regions.

3. Self-management/accreditation – adopts an alternative approach, which places greater emphasis on the role of transport companies to manage their conformance with mass loading regulations. Examples include the Road Transport Management System (RTMS) in South Africa and the National Heavy Vehicle Accreditation Scheme (NHVAS) in Australia.

Direct enforcement approaches are generally limited in scope, can be expensive and often subject to avoidance, abuse and manipulation by truck operators[3]. For example, road side monitoring of compliance can be undertaken by enforcement staff, however, this is often selective, intermittent and resource intensive.

Self-management/accreditation relies on trucking firms self-monitoring and self-reporting their compliance, and while cost effective for regulatory agencies, is susceptible to mishandling and falsification unless there is some form of external monitoring and periodic checking to validate the accuracy of firm records[4].

The ongoing development and widespread application of Intelligent Transport Systems (ITS), which involves the remote monitoring of vehicle compliance, can complement on-road and self-regulatory compliance and assurance systems[5].

In other words, while each of these approaches have relative benefits, they need not be seen as mutually exclusive.

An efficient, cost-effective risk-based approach to the management of heavy vehicle access, compliance and safety management can be achieved through a combination of these approaches.

5. Establishing performance-based requirements and outcomes for OBM Systems

In Australia, TCA has developed a performance based, Functional and Technical Specification (Specification) for OBM Systems, which forms part of the National Telematics Framework (ISO 15638 **–** Framework for collaborative **T**elematics **A**pplications for **R**egulated commercial freight **V**ehicles (**TARV**)[6].

The Specification has been developed following extensive consultation with:

- Road and infrastructure managers
- Regulators
- OBM System suppliers and providers
- Telematics providers
- Heavy vehicle operators.

The philosophy which guided the creation of the Specification has been the focus on required outcomes; that is, it is performance-based without being overly prescriptive as to a solution.

OBM Suppliers are encouraged to meet the various requirements of the Specification in innovative and novel ways.

In conceptual terms, an OBM System consists of two key components:

- An Electronic Control Unit (ECU)
- Mass Sensor Units (MSUs) on each axle group.

By definition, an OBM System must consist of an ECU, and at least one MSU. However, an OBM System may have multiple number of MSUs connected to the ECU, to reflect the natural variation in vehicle configurations.

There are three broad vehicle and configuration types in which an OBM System (consisting of an ECU and MSUs) may be utilised. This includes:

- Rigid vehicle (Figure 1);
- Prime mover vehicle (Figure 2)
- One or more trailers connected to a prime mover or rigid vehicle (Figure 3).

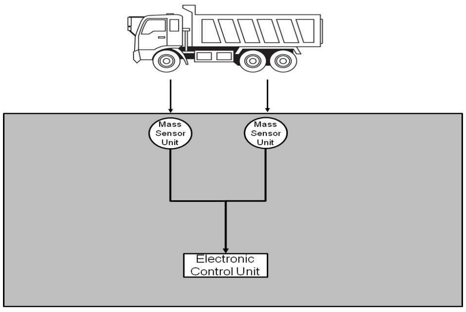

Figure 1: Rigid Vehicle with OBM System

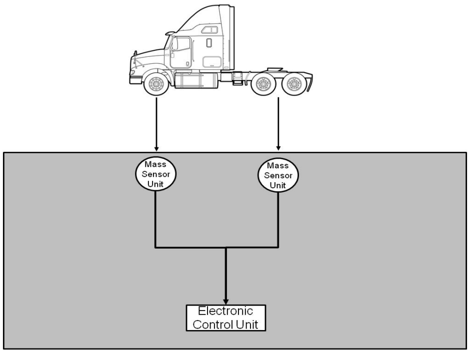

Figure 2: Prime mover with OBM System

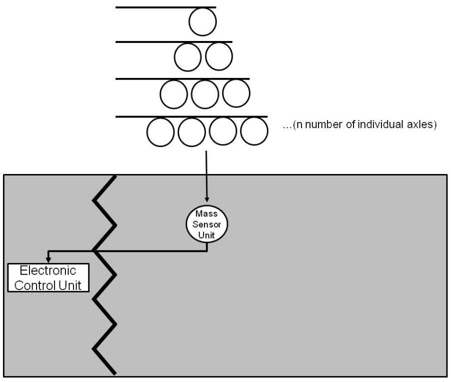

Figure 3: OBM System in a Typical One-or-More Trailer or Dolly Axle-Group Environment Connected to a Rigid Vehicle or Prime Mover

Prime movers or rigid vehicles with one or more trailers provide specific operational challenges for OBM Systems.

Specifically, there is not necessarily an exclusive and ongoing association between a particular ECU and particular MSUs. This is because trailers and dollies may be used across numerous prime movers (Figure 3).

OBM Systems must therefore be able to support the dynamic connection of MSUs to an ECU. Further, a mechanism is required to detect where a trailer or dolly is physically connected to the vehicle but there are no connected MSUs installed on the trailer or dolly.

6. Key performance requirements for OBM Systems

The OBM System Functional and Technical Specification provides a number of performance requirements that provide assurance in the use of OBM Systems, and the measurement of mass through those systems.

With a focus on performance outcomes, the Specification encourages innovative approaches to meet the requirements. For example, OBM Systems may be provided as original componentry by a vehicle and/or trailer manufacturer, or installed as an after-market product to existing vehicles and/or trailers.

Similarly, because the measurement mass can be performed in any number of ways, the Specification does not prescribe what methods or technologies should be used within an OBM System.

Some of the key performance requirements contained in the Specification include:

- The minimum accuracy requirements for each axle group mass readings should not deviate from the absolute axle group mass by more than 2% for 98% of observations, subject to:
  - The vehicle is stationary and on level ground
  - The MSU is calibrated
  - The OBM System is operating correctly.
- The OBM System must have a resolution of 10 kilograms or better for each axle group
- The OBM Systems needs to have mechanisms to detect tampering and malfunctions
- The OBM Systems must collection date and time with a resolution of 1 second, and operate independently of the primary power supply

Consistent with the focus on outcomes (rather than technical prescription), the onus is on each OBM System provider to:

- Define what combination of technologies, components and systems will be used to deliver an OBM System
- Demonstrate how their OBM System meet performance requirements
- Explain how OBM System calibration, operation and maintenance will be managed in service.

One of the most prominent differentiators between OBM Systems is the way mass information is presented and recorded – from the provision of electronic displays, through to mass information collection, and interconnectivity with telematics devices.

Three broad categories of OBM Systems are recognised within the OBM System Functional and Technical Specification, as summarised in Table 1.

Table 1 – Categories of OBM Systems

Category	Description
Category A	OBM Systems in this category electronically display mass information to drivers and/or loaders
Category B	OBM Systems in this category also collect and transmit mass information
Category C	OBM Systems in this category collect and transmit mass information in a standardised way to telematics devices (in accordance with TCA's Interconnectivity Specification) permitting the ability to 'plug and play'

Each of these OBM Systems meet different consumer needs, but have common requirements relating to the accuracy, integrity and reliability of mass measurements.

7. Type-approval of OBM Systems

In May 2017 TCA commenced receiving type-approval applications from OBM providers.

Type-approval allows OBM Suppliers to have their means their product offerings recognised and approved by 'type' across a diverse range of policy areas, regulators and industry sectors. TCA Type-approval of OBM Systems consists of two activities:

1. A Probity and Financial assessment of OBM System suppliers

This assessment establishes the legitimacy and financial standing of suppliers seeking type-approval of an OBM System. The outcomes of the probity and financial assessment are critical indicators of OBM System suppliers' ability to deliver the level of business continuity and support expected by stakeholders.

2. A Functional and Technical Assessment of OBM Systems

This assessment establishes that an OBM System is able to satisfy each of the functional and technical requirements contained in the *On-Board Mass (OBM) System Functional and Technical Specification*.

8. Re-engineering the use of road networks with OBM Systems in Australia

Australia has a large geographic land area, coupled with a small, dispersed population. Australia also has a highly distributed road network with variable levels of quality.

A large land area, coupled small, dispersed population, means that Australia's economic output is highly influenced by the performance of freight transport.

The performance of road freight transport is of importance, with over 75% of non-bulk domestic freight being carried on roads[6]. However, governments face challenges gaining community acceptance of larger heavy vehicles and funding road infrastructure improvements.

In the absence of further heavy vehicle productivity enhancing regulatory reform, fleet-wide heavy vehicle average loads are likely to increase by less than 5 per cent between 2010 and 2030 (which contrasts sharply with the 40 per cent growth in average loads over the past two decades)[7]. Productivity growth has been historically recognised as the primary driver of economic growth. Improvements in freight productivity and efficiency reduce the cost of moving freight, adding directly to national economic output – and economic growth.

With the forecast growth in road freight transport over the coming decades, coupled with fiscal constraints which impact on road asset maintenance and capital investment programs, alternative approaches need to be included to complement conventional options considered by policy makers and road asset managers.

In 2016 Infrastructure Australia recognised that "(l)ow-cost in-vehicle transponders and satellite tracking are increasingly being used to open up parts of Australia's road network to suitably-specified trucks. Productivity improvements of up to 100 per cent are being realised, and associated reductions in fuel use are cutting emissions"[7].

Infrastructure also recognised that "technology is now being used to remotely monitor truck mass, thereby providing assurance to road owners that overloaded vehicles are not damaging their assets. In addition, the technology allows road managers to accredit heavy vehicles to be used on roads that, previously, they would not have been able to use"[8].

During 2017 updates were made to the Australian Standard for bridge assessment (AS 5100.7:2017)[9]. The updated standard incorporates *reduced* traffic load factors for vehicles monitored through the IAP and OBM for the Ultimate Limit State (ULS).

AS 5100.7:2017 is the national standard for assessing bridge infrastructure, and forms part of the national Bridge Design series. AS 5100.7:2017 highlights how the availability of reliable and accurate vehicle location, mass and configuration information – provided through the IAP and OBM – can enable improved productivity outcomes.

This allows road managers to make access decisions which can increase mass loadings of heavy vehicle combinations. The updated standard also notes that load factors can be further reduced, provided a vehicle speed limit is specified. This recognises how heavy vehicle speed can be monitored through telematics, which allows road agencies to impose low-speed speed restrictions (as needed) on bridges, and to receive reports (based on the GPS measurement of speed).

The following sections provide examples of how OBM Systems have facilitated a reengineering of road networks in Australia.

8.1 A-Doubles transporting export produce - Queensland

Introduced in 2011, A-Double combination were introduced by the Queensland Government to improve the efficient and productive transport of export grain produce from rural locations to a major port.

A-Double combinations have been approved to operate on a 160km route between Toowoomba and the Port of Brisbane are:

- Performance Based Standards (PBS) approved, and able to operate up to 85 tonne Gross Vehicle Mass (GVM)
- Monitored through the IAP for route and speed compliance (maximum of 100km/h)
- Fitted with OBM Systems.

The use of OBM Systems has enabled a reduction in bridge load factors on bridges along the 160km route. Without these reductions in load factors, these vehicles would not have been able to operate.

The use of A-Double combinations has halved the number of vehicles movements that would otherwise be required to support the export market of grain produce.

8.2 Higher Productivity Freight Vehicles (HPFVs) – Victoria

Introduced in 2013, HPFVs were introduced under the Victorian Government's 'Moving More With Less' policy.

HPFVs are longer than standard B-Double combinations and are:

- Performance Based Standards (PBS) approved (73t Quad-Tri and 77.5t Quad-Quad B-Doubles)
- Up to 30m in length
- Monitored through the IAP for route and speed compliance (maximum of 90km/h)
- Fitted with OBM Systems.

These vehicle combinations are able to operate on parts of the road network that were not previously available.

The 'Moving More With Less' policy has put downward pressure on the number of trucks operating on Victorian roads by facilitating the use of ore efficient vehicle combinations on approved roads.

8.3 Safety, Productivity and Environment and Construction Transport Scheme (SPECTS) – New South Wales

Introduced in 2016, SPECTS allows for 'general' (unrestricted) access to vehicles operating at Higher Mass Limits (HML) axle loads, which would otherwise be subject to restricted access (with over 140 bridge restrictions in the Sydney region).

Transport operators are eligible to participate in SPECTS if vehicles are:

- Approved as a Performance Based Standards (PBS)
- Monitored through the IAP for route compliance
- Fitted with OBM Systems.

140 bridge restrictions in Sydney have been removed (only 1 bridge restriction remains) – based on the assurance available to road agencies by known the location and mass of vehicles.

SPECTS was introduced with the aim of reducing the number of vehicle movements across Sydney, which is being increased as a function of a major increase in infrastructure investment and construction.

9. Moving forward

As demonstrated from the examples provided, OBM Systems have the potential to provide data which can be linked with other key pieces of data, including the configuration of the vehicle, its location and time of collection, and, when required, its speed. This means that mass data can be contextually aligned with other key pieces of information to provide new ways of regulating the operation of heavy vehicles, and their use of the road network.

Furthermore, the ability to obtain assurance through the accuracy and integrity of mass measurements presents new opportunities for all stakeholders. There are two broad areas being progressed to achieve this objective:

1. Develop linkages between WIM and OBM Systems to:
   - Establish mechanisms to cross reference data collected from WIM and OBM System to improve their collective accuracies and reliabilities
   - Explore the opportunities to use real-time connectivity between WIM and OBM systems, so that faults and malfunctions can be identified and rectified quickly
   - Develop a standardised approach to the collection of vehicle mass and configuration data, by building upon established practices
2. Implement a certified, high assurance level OBM application which:
   - Builds upon the use of type-approved OBM Systems
   - Enables road access and loading conditions to be electronically monitored, and reports generated when an overloading occurs
   - Allows for the automatic detection of malfunction, miscalibration or potential tampering.

Implementation of the certified OBM application is being led by TCA in conjunction with road infrastructure managers, regulators, telematics providers and OBM System providers.

The certified OBM application has been earmarked as an enabling instrument that will underpin future productivity reforms in Australia, where the highest level of assurance is required including:

- Improved linkages between utilisation (consumption) or road assets, and investments to maintain and develop road assets
- The next wave of productivity reforms (by removing barriers to higher productivity vehicles and access arrangements, which may introduce greater infrastructure management and road safety risks)
- Road pricing reforms (which are based on having high integrity location and mass inputs to derive road pricing calculations based on distance travelled and mass carried).

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