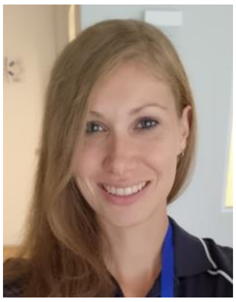
USING ELECTRONIC BRAKING SYSTEM (EBS) FOR SMART OBM



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Abstract

During 2022 first Smart OBM system which used Electronic Braking Systems (EBS) technologies was introduced into the Australian market, after having obtained TCA type-approval.

This EBS-enabled Smart OBM system responded to regulatory changes in Australia in the form of Australian Design Rule (ADR) 38/05, which required the fitment of Trailer EBS modules to all new trailers. It also required prime movers, regardless of age, to be correctly equipped to power the Trailer EBS modules effective from November 1, 2019.

This paper highlights how Knorr-Bremse developed a system using components which, when used in combination, was able to satisfy the functional and technical requirements necessary for a Smart OBM system.

The paper also explores the European approach to On-Board Weighing and its relevance to Smart OBM developments in Australia.

Keywords: Heavy Vehicles, High Productivity Freight Vehicles, On-Board Mass, Stakeholders, Transport Monitoring Application, Smart OBM, Transport Certification Australia, Telematics Analytics Platform, Trailer Electronic Braking Systems

1. Background

Type-approved Smart On-Board Mass (OBM) systems were first mandated in the Australian jurisdiction in Victoria for High Productivity Freight Vehicles (HPFVs) on November 1, 2021.

A Type-approved Smart OBM system generates mass data to record the weight of axle groups in a standardised format, which is then combined with other data collected by Application Service Provider (ASPs) operating in the National Telematics Framework (NTF). ASPs are more conventionally known in the marketplace as ‘telematics providers.’

Smart OBM systems must register with TCA and proceed through a type-approval process to ensure that they meet all functional and technical requirements. The requirements for Smart

OBM systems are set out in the 'On Board Mass System Functional and Technical Specification'.

Smart OBM is used with the Telematics Monitoring Application (TMA), which is a form of intelligent access within the NTF. Transport operators of HPFVs need to engage a certified ASP which has satisfied applicable requirements of the 'Telematics Monitoring Application Functional and Technical Specification'. As such, there is a relationship and assigned roles between OBM suppliers, ASP providers, TCA, and operators. This is represented in Figure 1.

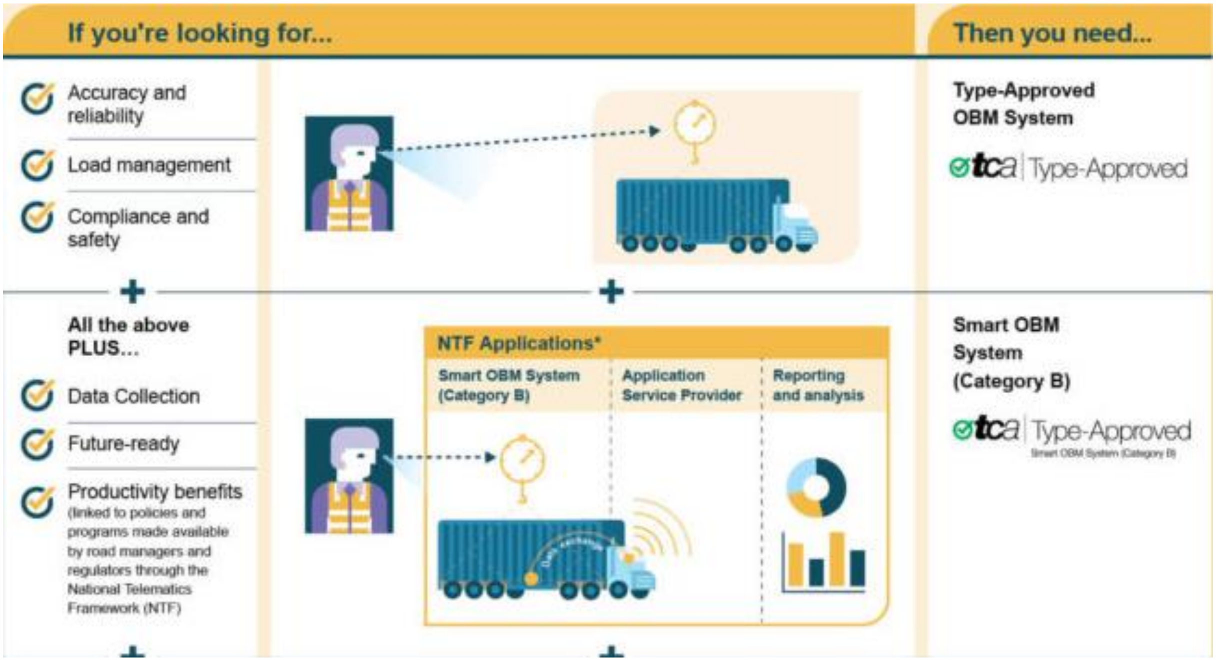

Figure 1. Type Approved Smart OBM Info Graphic produced by TCA

Since November 1, 2021 other Australian jurisdictions have also set dates for the implementation for TMA and Smart OBM across varying heavy vehicle classes. This includes New South Wales, Queensland, and Tasmania. It is expected that access arrangements which require Smart OBM will continue to expand in the coming years.

Smart OBM is used to optimise productivity, road network access and safety of heavy vehicles. Smart OBM gives road managers better data on how the road network is being utilised by HPFVs. Additionally, bridges and structures doing the most work can be identified and targeted to improve future investment decisions about the road network.

2. Smart OBM

There have been significant changes in the past twenty years in the fields of telematics and technology. Electric vehicles, autonomous vehicles, growing concerns around carbon emissions and climate change, emergence of new variants of intelligent access (such as TMA) and buy-in from stakeholders have all gained momentum and opened the field of players and possibilities.

As one example, with ambitious global targets for the reduction of carbon emissions, the move to electric vehicles has gone from a possibility to a certainty as all cars in Germany were mandated to be electric by 2030. The flow on effect of this is the rapid adoption of batter electric heavy vehicles.

Due to heavy battery banks in place of traditional fuel tanks, E-Vehicles currently require local exemptions to run 7.5t steer axles and are hence obvious candidates for requiring Smart OBM monitoring. It is becoming clear that the need for data is increasing and the requirement for vehicles to fit Smart OBM is following the same trend in the marketplace.

There have been many new Smart OBM suppliers enter the Australian market in the last three years, with 8 suppliers having had systems type-approved by TCA, and 5 certified ASPs having been paired with Smart OBM systems. Having a variety of providers has proven to drive innovation, price reductions, simplified solutions, experimentation, and value add options to meet the needs of the market.

3. EBS based Smart OBM Systems

In early 2018 Knorr-Bremse Australia first began exploring the feasibility of using the mass output from Knorr-Bremse Trailer EBS. At this time, Australian Design Rule (ADR) 38/05 had just been released which required mandatory fitment of Anti-lock Braking Systems (ABS) and RSP Roll Stability Program (RSP) to trailers which essentially required the fitment of Trailer EBS modules to all new trailers. It also required prime movers, regardless of age, to be correctly equipped to power the Trailer EBS modules effective from November 1, 2019.

A project team within Knorr-Bremse Australia was assembled to review the possibilities of developing a Knorr-Bremse Smart OBM offering to meet the TCA’s functional and technical requirements for a Smart OBM system. Consideration was given to the emerging use of Smart OBM by Australia’s road agencies and introduction of new forms of intelligent access such as TMA.

A core focus of the work performed by Knorr-Bremse Australia was the combined use of technologies to satisfy Smart OBM functional and technical requirements, including:

- Pressure sensors
- Electronic Levelling Control (ELC)
- Deflection sensors
- Trailer EBS (EBS) Unit
- Driver Interface Unit.

Key components of what became known as the iMass® Smart OBM system are detailed in Figure 2.

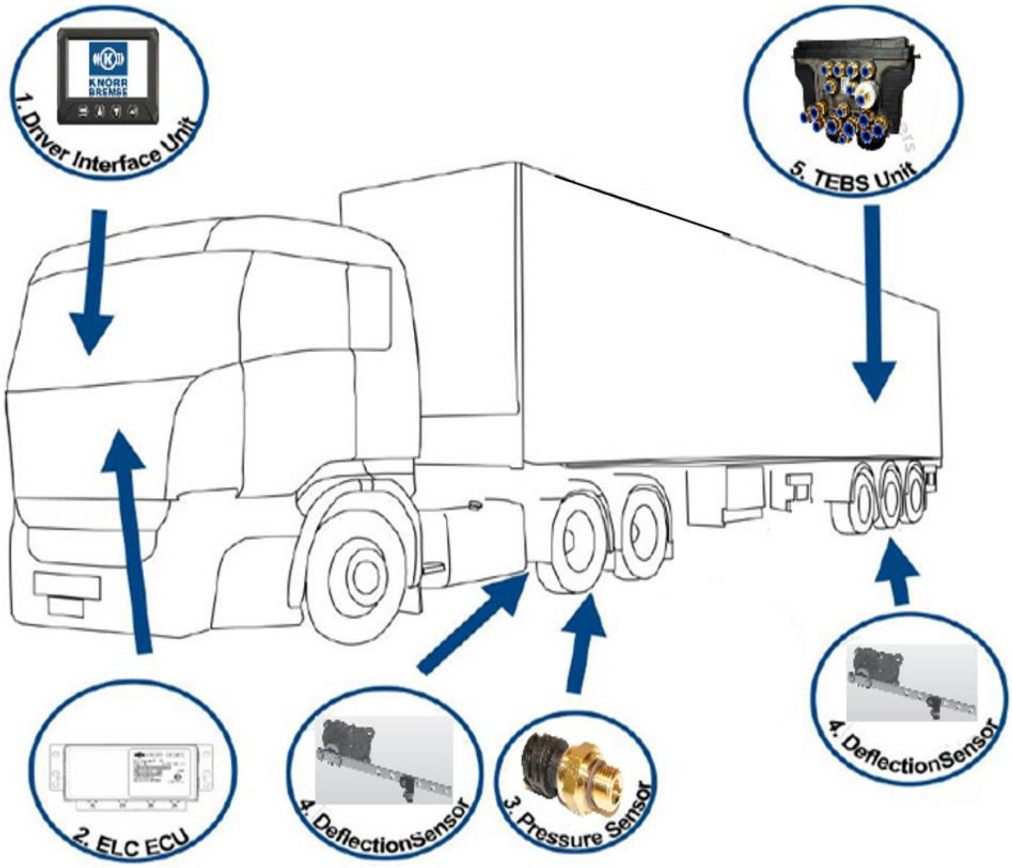

Figure 2. Key components of the Knorr-Bremse iMass Smart OBM type-approved EBS based system

In August 2022 Knorr-Bremse Australia released iMass® to the Australian market after having obtained type-approval from TCA. iMass is the first EBS based type-approved Smart OBM system - and currently remains the only EBS based approved offering in the market. A key feature of the iMass® Smart OBM system is that it automatically identifies the Vehicle Identification Number (VIN) of each trailer. This also allows for the seamless interchangeability between prime mover and trailers fitted with the iMass® Smart OBM system.

This is represented in Figure 2 using the Driver Interface Unit.

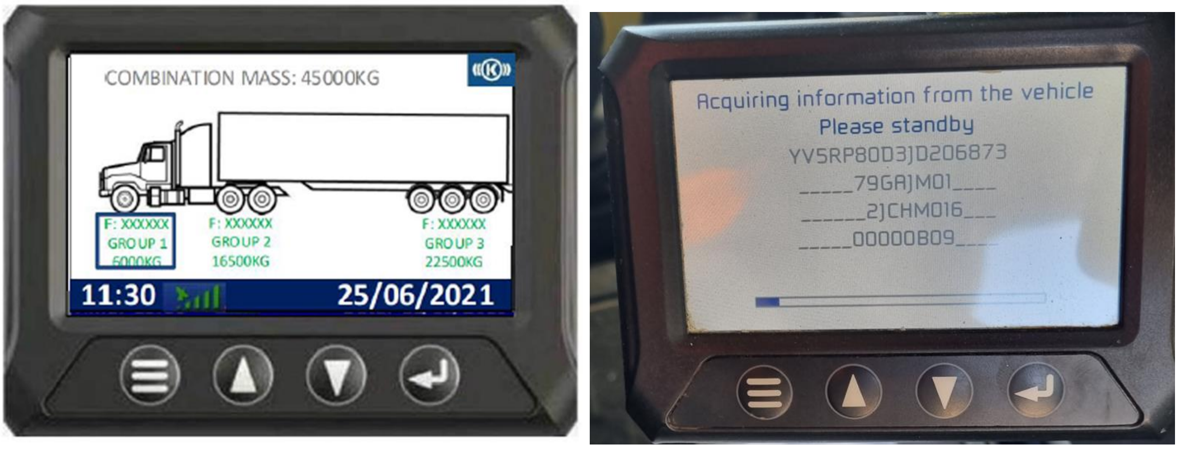

Figure 2. iMass Driver Interface Unit Views. Mass display screen (left); Automatic VIN recognition at start up (right)

The current iMass® Smart OBM system is considered by Knorr-Bremse as a first-generation system. There are opportunities to further leverage EBS and other sensors to further enhance future generations of the iMass® system; and contribute to improved road transport outcomes.

4. On-Board Weighing (OBW) in Europe

A proposal for On Board Weighing (OBW) were developed in consultation with industry between 2017 – 2019. The proposal was put forth to the European Union in 2019 but was not passed into legislation.

Prior to submission of this legislation, there were concerns by some stakeholders over the industry’s ability to meet the accuracy requirements. Initially OBW was to meet ‘+/-10% or better when the vehicle is loaded at greater than 90 % of its maximum authorised weight.’ This was then revised down to ‘+/-5%’ which increased the difficulty of the requirement significantly.

There was a consensus that with more testing and development, an accuracy of +/-5% could be achieved, but each unique vehicle would need to be considered and calibrated – which may bear a significant cost to industry. Notably, this measurement was to meet this accuracy requirement whilst the vehicle was both moving and stationary.

The European OBW approach contrasts with the Australian Smart OBM approach to accuracy for accuracy found in section A.15.4 of the OBM System Functional and Technical Specification, which states the data:

‘Shall not deviate from the absolute Axle Group Mass by more than 2% of the Maximum Permissible Mass of the axle group for 98% of observations, when:

a. the vehicle is stationary and on level ground.
b. the MSU is calibrated; and
c. the OBM System is operating in accordance with this Specification.’

Testing revealed that the iMass® system could deliver accuracy to within 2% of a certified weighbridge (a requirement of TCA for type-approval of a Smart OBM system).

As a notable difference to the Australian requirement, the EU approach required the ability of an intelligent system to accurately calculate 'moving mass'. Due to this, an additional model of mass calculation known as 'mass estimation' was investigated by the European OBW system suppliers on vehicles and combinations which is currently utilised for vehicle stability control (different to airbag-based mass measurement on Trailer EBS).

Mass estimation function uses a combination of vehicle data and inputs to provide an accurate mass value to the braking ECU which feeds into the vehicle stability algorithm. On an EBS vehicle, the Mass Estimation module estimates the complete vehicle mass (including trailer or semi-trailer) from engine information, wheel speeds and longitudinal acceleration using Newton's Law. That is m=f/a. (mass =force/acceleration).

Typically, the systems run at an assumed +/- 10% accuracy without any tuning, this is the equivalent to +/-4t for a 40t combination. The systems have a high capability to determine the combination mass based on the engine torque required to pull a given combination minus any known losses such as from the driveline. It should be noted that because electric vehicles have less losses through the driveline, it is possible for greater levels of accuracy to be derived.

Mass estimation can require several minutes of driving to assess the engine torque and braking effort of the vehicle and hence determine the load the vehicle is pulling. An example of a data trace is shown below. The top line is the estimated mass in kg and the bottom line shows the vehicle speed. This is taken over a period of approximately 5 minutes. In this plot, the system generates a consistent mass calculation after 75 seconds of driving. See Figure 3.

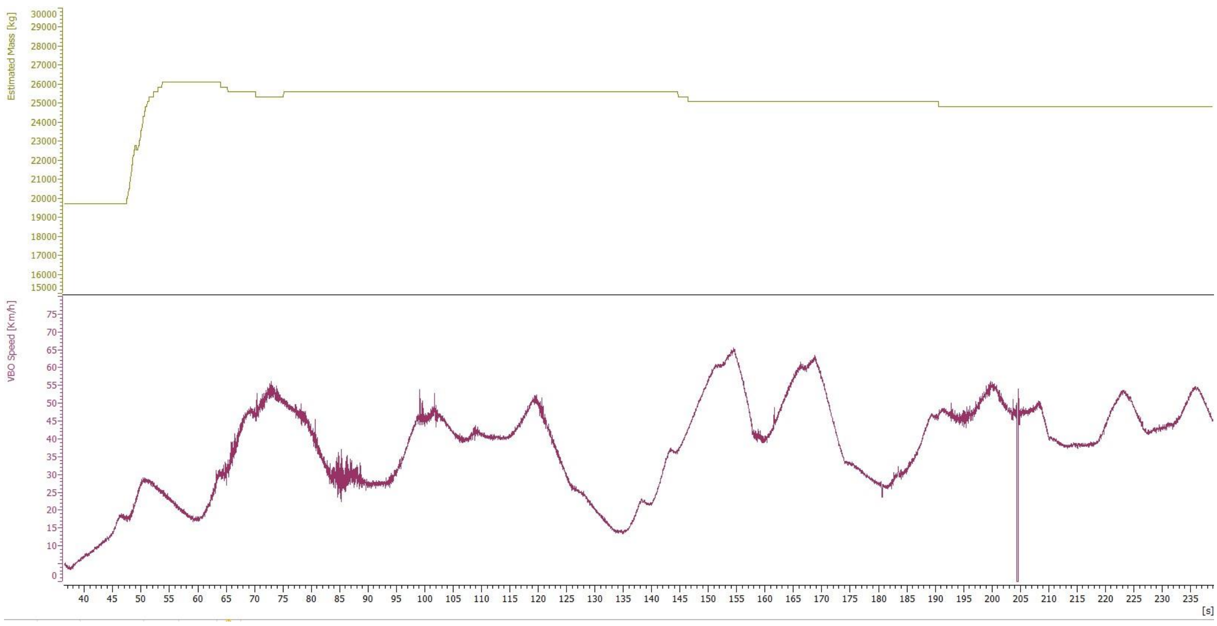

Figure 3. Sample Vehicle EBS stability control system mass estimation calculation

If moving mass were to be considered in Australia, another challenge, particularly with multi-trailer combinations which are prominent in Australia, is determining which proportion of the mass may belong to the vehicle and which to each trailer. Whilst the current EBS based trailers systems are quite accurate, if the trailers were to be deducted from a system (which represents +/-4t in laden accuracy), this would increase the percentage inaccuracy of the prime mover alone. It would also be difficult to ensure the proportion of mass loading allocated to the front and rear groups of the prime mover with the mass estimation function in its current state.

Where these systems may be quite useful is on rigid vehicles or specialty combinations (i.e. trailers with rows of 8 and mechanically suspended vehicles). In these situations, if the total combination mass (within 10%) and the make-up of a combination is known, an arbitrary mass allocation could be given to each axle group based on maximum legal permissible loading. Depending on the access arrangement and the risks being managed, a lower level of accuracy may be acceptable by road managers and regulators as a trade-off for a lower cost system.

5. Pathway to interoperability between prime movers and trailers

In an environment where trailers are used across different prime movers, and/or different transport operations, owners or contracted parties, issues of interoperability between different Smart OBM systems can be highlighted.

To address this, TCA developed what is known as 'Category C' Smart OBM. Category C Smart OBM is intended to provide 'plug and play' compatibility between different ASPs and Smart OBM systems. Category C depends on the use of the Interconnectivity of Telematics Device with Other Systems Functional and Technical Specification. Figure 7 graphically depicts the outcomes enabled through Category C Smart OBM systems.

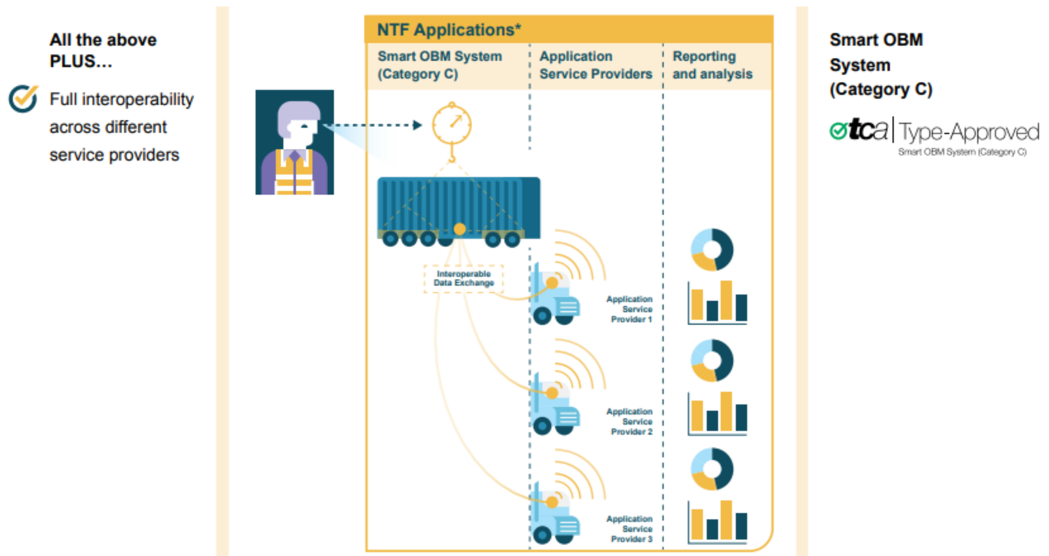

Figure 5. TCA graphic depicting interopability enabled through Category C Smart OBM

The need for Category C Smart OBM responds to the different ways in which different Smart OBM systems transfer data to the telematics devices in the prime mover. In Australia, Smart OBM systems are connected to telematics devices (used for intelligent access) using physical or wireless connections and may use proprietary data transfer formats through these connections.

Although the TCA Interconnectivity of Telematics Device with Other Systems Functional and Technical Specification provides a method of achieving interoperability between the telematics device and an OBM system, it does not accommodate the use of different types of Smart OBM systems on different trailers. There are several options which could be explored to enable this.

One option is to extend the Interconnectivity of Telematics Device with Other Systems Functional and Technical Specification to accommodate the use of Trailer EBS mass data sent via the ISO7638 trailer connection. Another option, which appears to have been contemplated as part of the European OBW framework, is to allow individual OBM suppliers to establish wireless connections between trailers and prime movers – as shown below in Figure 6.

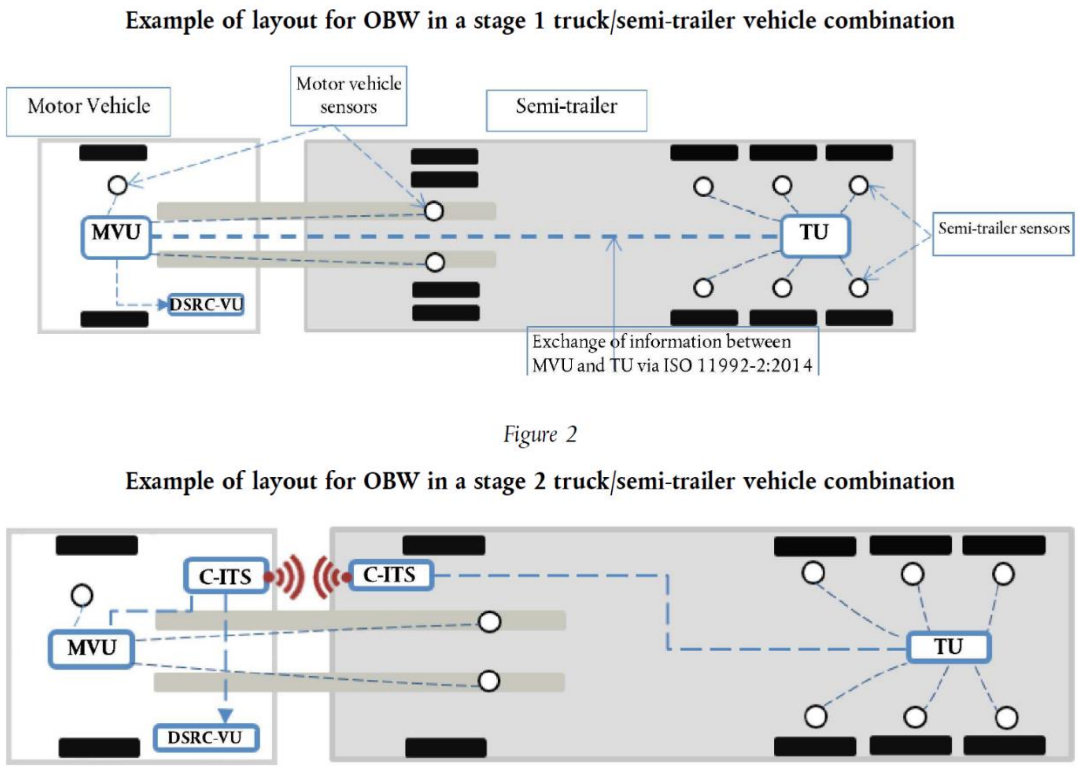

Figure 6. OBW Implementation options from 2019 non-legislative framework from the EU

What is notable is that issues of interoperability between on-board mass systems fitted to trailers and telematics devices fitted to prime movers are being dealt with Europe and Australia – albeit with subtly different approaches.

Compared with the Australian approach, the European approach prescribes the use of wired or unwired transmission methods, which are directly associated with two stages of implementation. The implication is that although Stages 1 and 2 could co-exist, individual parties would need to decide the method of connection and data transmissions between prime movers and trailers.

At the time of writing, there are no Category C Smart OBM systems which have been approved by TCA available in the market. This signals that the demand from transport operators for Smart OBM interoperability between prime movers and trailers is not yet a sufficient level to justify the investments necessary for Smart OBM suppliers to deliver Category C systems.

It may also reflect that the initial deployments of Smart OBM systems are associated with specific kinds of PBS combinations, which are subject to lower levels of changes of individual prime mover and trailer assets within those combinations. It should be anticipated, however, that breadth of multi-combination vehicle types will not likely be limited to PBS combination in the future. With this shift, it is likely that the demand for Category C Smart OBM systems will increase in Australia.

The opportunity for the Australian marketplace to move in tandem with OBW developments in Europe should therefore not be overlooked.

6. Conclusion

Australia has led the world with the deployment of Smart OBM systems.

This paper has highlighted that EBS can be successfully used to satisfy the functional and technical requirements of a Smart OBM system. The Australian experience with Smart OBM and intelligent access arrangements can be used to inform regulatory frameworks in other regions.

There are opportunities to further develop interoperability arrangements between telematics devices and Smart OBM systems, by leveraging and harmonising developments between Australia and Europe.

Despite the early outcomes realised in Australia, there are opportunities to further evolve the use of Smart OBM to further advance road productivity and safety outcomes together.

7. References

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