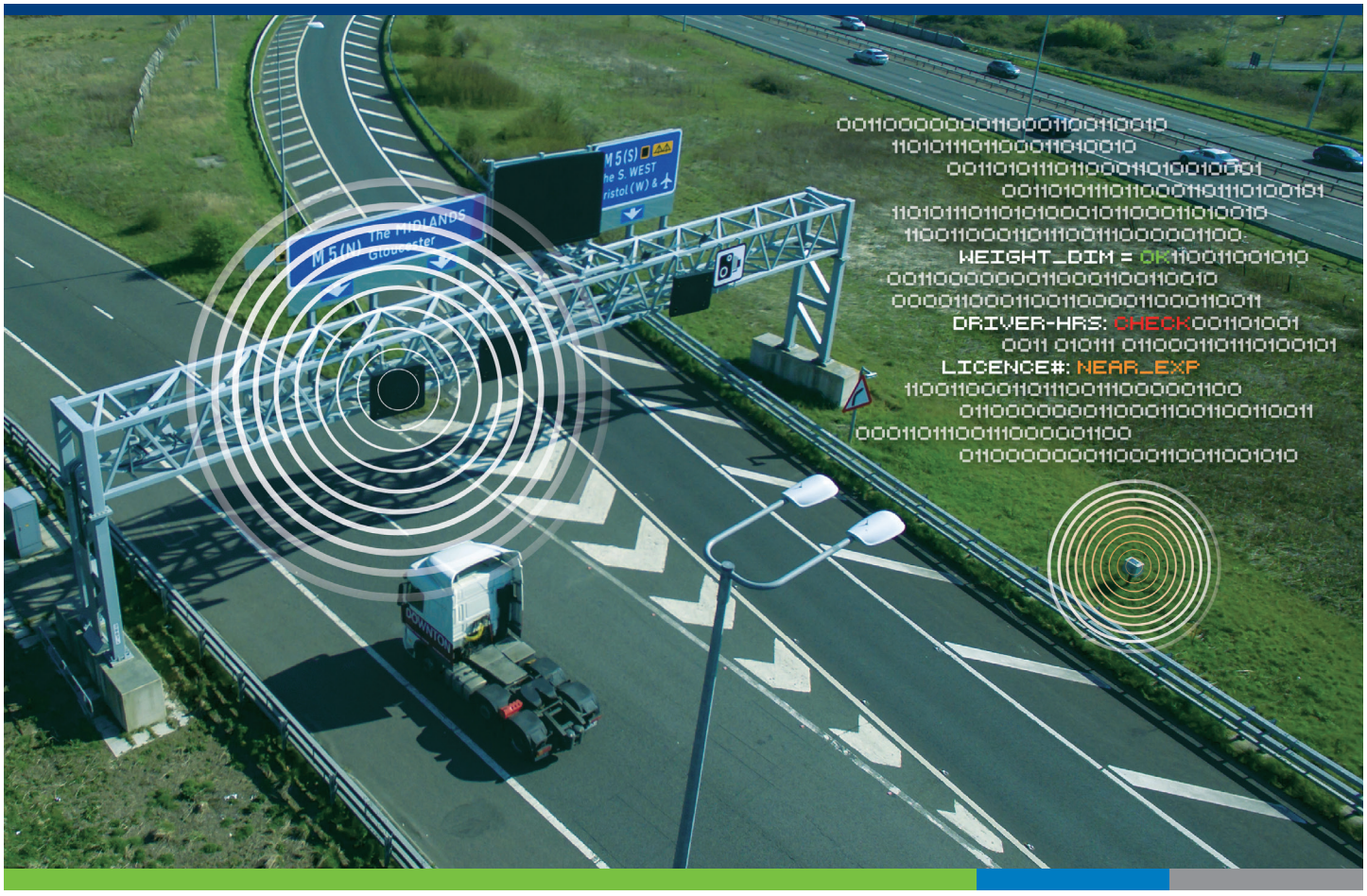
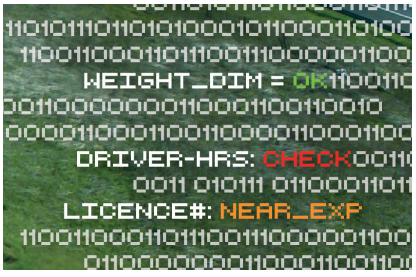
International Transport Forum

CPB
Corporate Partnership Board



Data-led Governance of Road Freight Transport

Improving compliance

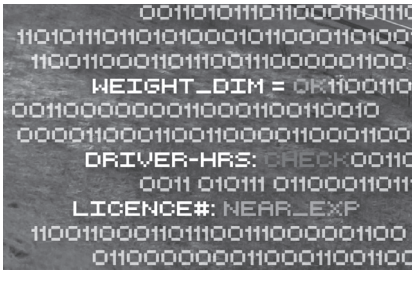


Corporate Partnership Board Report

OECD

Data-led Governance of Road Freight Transport

Improving compliance



Corporate Partnership Board Report

About the International Transport Forum

The International Transport Forum at the OECD is an intergovernmental organisation with 57 member countries. It acts as a think tank for transport policy and organises the Annual Summit of transport ministers. ITF is the only global body that covers all transport modes. It is administratively integrated with the OECD, yet politically autonomous.

ITF works for transport policies that improve peoples' lives. Our mission is to foster a deeper understanding of the role of transport in economic growth, environmental sustainability and social inclusion and to raise the public profile of transport policy.

ITF organises global dialogue for better transport. We act as a platform for discussion and pre-negotiation of policy issues across all transport modes. We analyse trends, share knowledge and promote exchange among transport decision makers and civil society. ITF's Annual Summit is the world's largest gathering of transport ministers and the leading global platform for dialogue on transport policy.

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Foreword

The work for this report was carried out in the context of a project initiated and funded by the International Transport Forum's Corporate Partnership Board (CPB). CPB projects are designed to enrich policy discussion with a business perspective. They are launched in areas where CPB member companies identify an emerging issue in transport policy or an innovation challenge to the transport system. Led by the ITF, work is carried out in a collaborative fashion in working groups consisting of CPB member companies, external experts and ITF staff.

Many thanks to the members of the Corporate Partnership Board companies involved in this work: Kapsch, PTV Group and Venice Port Authority.

The report draws conclusions from ITF CPB Workshop "Data-led Enforcement of Road Haulage" held on 19-20 December 2016 at Kapsch premises in Vienna. Participants of the workshop included:

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Executive summary

What we did

In road freight transport, an increasing gap exists between regulatory frameworks and their underlying policy objectives. The effects of this range from unforeseen and undesired outcomes to specific enforcement challenges. The emergence of big data in transport creates an opportunity for more data-driven policy making. It holds the promise of bridging this gap with more targeted and more flexible regulatory frameworks as well as more efficient enforcement mechanisms.

A review of the current legislative environment and enforcement practices in road freight allowed to identify emerging regulatory opportunities related to the availability of data and single out key issues in this space, which were discussed at a workshop with 18 international experts in Vienna in December 2016. The background research, outcomes from the workshop and additional consultation with other key stakeholders provide the basis for this report.

What we found

Clear potential for data-driven approaches to regulating and enforcing road freight transport can be identified, however, a number of specific challenges still need to be overcome for wide-spread implementation of data-driven regulation and enforcement. Internationally, the uniform level of readiness for implementation of technologies, policy approaches and economic development does not currently exist. This will require a two-tier system that would provide minimum functionalities or even a specific separate system for those less technologically advanced. Here, the growing disparity between an accelerating pace of technological innovation and regulatory responses also should be taken into account. Some issues for data-led regulation and enforcement will arise from changed roles and responsibilities of the stakeholders involved. This includes the outsourcing of some tasks traditionally performed by public authorities, to the private sector, and encouraging all data owners to share data under such a scheme.

What we recommend

Use currently available data within existing frameworks

As a first step for moving towards data-led policy-making in road freight transport, an improved enforcement regime based on existing but underutilised data sources could be implemented. This could counteract shortcomings of current approaches and radically improve compliance and could already be implemented for current rules and regulations using existing data.

Consider a completely new data-driven regulatory approach

There is considerable potential for a completely new regulatory framework based on data-driven governance. Current rules and regulations in road freight transport could be replaced by quantifiable policy indicators complemented by the use of data from multiple sources allowing the analysis of stakeholders' alignment with policy objectives and compliance with regulations in near-real time.

Develop cross-sectoral approaches to data handling and processing

Many other horizontal issues across a range of related sectors will need to be addressed in order to implement a data-driven regulatory framework for road freight transport, including safeguarding commercial and private data and protection against cyber-crime; here guidelines and approaches should follow ongoing developments, rather than attempting to recreate them.

Investigate the best uses of new technologies, systems, and data science

Further developments in data science itself might be required as a foundation for implementing completely new approaches in regulating road freight transport successfully; the blockchain approach can be seen here as a key technology emerging in its application to the transport sector, promising a solution to many of the current concerns in this space, particularly regarding safety and security of data handling by the diverse actors.

Investigate applicability of wider and less structured big data sets

Given the use of data sets accessed or mined specifically for regulatory purposes in road freight transport, and the legal implications, a high level of trust, reliability, consistency and continuity is essential; therefore the use of much of the contents of wider big data sets available might be problematic at this stage, but this could change as this space develops over time.

Consider impacts of automation of road freight vehicles

A key related development in this context is the envisaged automation of road vehicles, including those for freight transport. This will affect how these vehicles and the wider logistics industry needs to be regulated, as well as the necessary data-rich environment with high levels of data connectivity providing an enabling setting for highly sophisticated data-driven policy approaches.

1. Introduction

Legislative environment

Legislators around the world have created a legislative environment for regulating the road freight transport industry. It ranges from legislation that concerns entrepreneurship in general, and that applies to companies of any industry, to one that concerns specific aspects of road transport operations. Rules and regulations that apply specifically to road transport define the required condition of the vehicles, specific social rules for professional drivers, goods safety, access to profession and the market, and other issues.

The development of the legislative environment and specific rules within it is always guided by specific policy objectives that the legislator has in mind. For example, to achieve a certain level of professional competency and ensure quality of service, most countries have put in place a licencing system for road freight operators. It defines the level of professional competency, requires good repute and availability of financial resources to access the market and perform goods transport operations. Establishing good repute and financial stability is important because operators are entrusted with valuable goods, which remain under their sole responsibility until they are delivered to the recipient.

In an ideal world the motivations of policy makers should be guided by improving social benefits in the country, thus producing legislation that is clear and simple. In practice the desires of different groups in society are not uniform, and legislators must take these into account. Often this leads to policies that are guided by conflicting interests within the society and the concerned industry itself. A clear case is that of the conflict between the general public interest in road safety and in support of good quality infrastructure, and private hauliers' interest in minimising operating costs which could lead to higher speeds and loadings of the trucks. Although public opinion seems to be clearly in favour of the former set of objectives, there are still frequent stories about operators stepping over the limits in search of profit maximisation. The strong evidence associated with cases having led to fatal crashes has led to stricter enforcement of those rules.

Often the motivations behind regulations are presented using such terms as "safety", "security", "environment protection" or "preventing social dumping". The conflicting interests that legislators take into account lead to the creation of legislative environments with complex, sometimes ambiguous, rules and numerous exceptions to those rules. This complicates the work of transport undertakings and enforcement bodies.

Due to the international nature of road transport in parts of the world with smaller countries and relatively open international road freight markets, the most important rules and regulations in the field are supranational. National regulations are more important in larger countries with significant domestic freight markets and low levels of openness for foreign operators. Rules and regulations, both national and supranational, must be enforced to deter offenders from repeated infringements and to promote responsible behaviour of drivers and road freight operators. In road freight transport rules can be classified in one of the following three groups: market-based rules, driver-based rules and vehicle condition rules.

Market-based rules

Market-based rules are those that apply to road haulage operators and regulate their access to the road transport market or its specific segments. They could be rather general and specify what provisions the haulier has to fulfil to obtain a licence and be able to operate in the market, or specific, e.g. defining what are the requirements for transporting dangerous cargo in a specific location of the road network.

Examples of supranational market-based rules are the European Regulation (EC) No 1072/2009, which sets common rules for accessing the international and cabotage markets in the European Union, and the

introduction of ECMT Quality Charter for international road haulage operations approved in 2015 (and to be applied from 2018), harmonising market access conditions in the pan-European road freight transport market with the Multilateral Quota system established in 1974 by the European Conference of Ministers of Transport (ECMT).

Driver-based rules

Driver-based rules are those that apply to accessing the profession and the driver's actions when working, resting or in the state of availability to perform their duties. They include social aspects, but also relate to actions that the driver might take when driving, including those regulated by the traffic code.

A good example is the regulation of driving time. In the European Union the maximum daily and fortnightly driving times and minimum rest periods for road freight drivers and drivers of passenger transport vehicles are set out in regulation (EC) No 561/2006. In the 19 European countries outside the EU, which are signatories to the AETR (European Agreement concerning the Work of Crews of Vehicles engaged in International Road Transport, 1970), the AETR rules apply. (These countries include Albania, Andorra, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Kazakhstan, Liechtenstein, Macedonia, Monaco, Montenegro, Moldova, Russia, San Marino, Serbia, Turkey, Turkmenistan, Ukraine and Uzbekistan.) The AETR rules apply to the whole journey, including parts of the journey occurring in any EU country, therefore the AETR agreement has been amended to recognise the digital tachograph, in line with European Union regulation (EC) No 561/2006. The enforcement of the driving time regulation in the EU and AETR countries is based on the records of tachographs fitted to every goods vehicle with total weight more than 3.5 tonnes. In the US the Hours of Service regulations and in Canada the Commercial Vehicle Drivers Hours of Service Regulations SOR/2005-313 set similar requirements for the drivers. In Mexico it is the labour law that limits the drivers daily hours of service.

To help drivers from one country to drive in another, the efforts to harmonise traffic codes of different countries include the 1968 Vienna Convention on Road Traffic (amended in 2011) and the 1968 Vienna Convention on Road Signs and Signals.

Vehicle condition rules

Vehicle condition rules relate to the technical conditions that the vehicle must meet to be able to perform freight transport operations in the market.

In some parts of the world homologation of the vehicles is harmonised across countries, e.g. between the United States (US) and Canada and within the EU. In the US the Federal Motor Vehicle Safety Standards (FMVSS) regulates technical characteristics of road vehicles. And Canada works closely with US to align its Motor Vehicle Safety Standards to those of the US. Neither of these countries recognises the standards of the 1958 United Nations Economic Commission for Europe (UNECE) Agreement on Uniform Technical Prescriptions for Wheeled Vehicles. In the EU technical harmonisation of vehicles is based on the Whole Vehicle Type-Approval System (Directive 2007/46/EC), under which a manufacturer can obtain certification for a vehicle type in one EU country and market it EU-wide without further tests.

Although most of the countries perform technical inspection of vehicles every 6-24 months, vehicles should meet the vehicle condition rules throughout the period between those inspections. Vehicle condition rules are, of course, not limited to the technical condition, but also include other important aspects that relate to vehicle condition, like vehicle loading.

Enforcement practices

The cost-efficient enforcement of road haulage rules and regulations among different countries or regulatory regimes is complicated due to the lack of harmonisation of interpretations and of application. New enforcement practices taking advantage of newly available data could be part of the solution to this problem. Understanding current enforcement targets and practices can help map out where technology-enabled and data-supported enforcement opportunities may emerge in the future.

The enforcement of road haulage rules for regulating road-based freight transport is carried out via on-the-spot roadside checks (with or without stopping vehicles) or via checks on company premises.

On-the-spot roadside checks

On-the-spot roadside checks are carried out either at the roadside or near it at dedicated sites where authorities check vehicle condition rules (e.g. authorised load weights, roadworthiness), market-based rules (e.g. making sure the company is licenced for freight transport operations of that type and in that geographical space) and driver-based rules (e.g. tachograph records). In order to carry out these controls, countries must assign a competent authority and enable that authority to legally carry out enforcement actions. In many cases the police are assigned this role but due to the complexity of some rules and requirements for special equipment, it could also be another dedicated entity.

Foreign vehicles carrying international freight on national territory are checked for the same rules as local vehicles, but additional attention is paid to the documents allowing them access to the international road transport market in the country (e.g. international operator's licence, EU Community licence, bilateral road haulage permits, ECMT licence).

One of the principal advantages of roadside checks is the possibility to immediately sanction non-compliant operators or vehicles, thus preventing potentially dangerous situations from arising. On-the-spot enforcement also allows authorities to impound non-compliant vehicles thus removing them as a threat to other road users until the vehicles are in compliance with national and international rules. Roadside checks can lead to robust enforcement but they are relatively low-tech, slow and expensive on a per-vehicle basis. Because of this, only a few vehicles are checked potentially allowing a number of non-compliant vehicles to go undetected. Moreover, there is a risk that enforcement officials make subjective judgements on when to control a vehicle or make mistakes when doing so. This would be prejudicial to the outcome. Controlling officers may also abuse their power and request bribes to nullify or falsify enforcement actions.

Some rules, like speed limits, vehicle dimensions, or requirements to post evidence of mandatory vehicle insurance, can be enforced with automated roadside devices like cameras and telemetry equipment. Vehicle weights and loading can also be checked via roadside drive-through weigh stations. This kind of automation lowers the cost per checked vehicle and allows increasing the sample size of processed vehicles and the fairness of the procedure.

Checks on the premises of undertakings

Checks on company premises allow enforcement of specific legislation, e.g. the company registration or some of the driver-based social rules. In on-premise checks, control officers visit the company and physically check the records and documents that the company is required to hold either in paper or digital form. Such checks, like the roadside ones, are slow and quite expensive and cannot be performed on a regular basis in every company – especially since in many countries and regions, the road haulage industry is comprised of hundreds to thousands of small, sometimes single-vehicle fleets. On-premise checks are similarly vulnerable to the same human error and abuse of power risks as for road-side checks.

Intelligent Transport Systems and big data opportunities

Various applications of new technologies can contribute to a more efficient as well as a more flexible regulatory framework for road-based freight transport. These technologies include various in-vehicle systems (e.g. on-board diagnostic modules, vehicle condition monitors, in-cabin sensors, vehicle navigation and tracking, advanced driver assistance systems) and road-side/infrastructure systems (e.g. weigh-in-motion, RFID/Bluetooth transponder/receivers, automatic license plate readers, cloud-based computing platforms, variable/dynamic message signs). These and other technologies produce data that opens new possibilities for lighter but more comprehensive and widespread enforcement actions. This previously unavailable data also may make real-time enforcement a possibility and lead to an overhaul of regulatory regimes towards more data-driven approaches.

The combination of conventional and novel data sources, the innovative use of data sets and data sources beyond its originally intended purpose, advanced (both real-time and historical) data analytics, and new business models enable new tailored services to enter the road-freight and logistics market. In addition, recent developments, including vastly improved digital connectivity and ubiquitous use of mobile devices with mobile internet access, have helped speed up these processes.

A shift to data-driven policy and regulation, enabled by these developments, holds the promise of offering policy makers and regulators a superior tool for detecting non-compliance to rules and ensuring that transport services contribute to fulfilling pre-defined policy objectives. In addition, the same systems and technologies may also revolutionise the road freight industry, enabling more efficient transport solutions based on platforms matching supply and demand, creating more flexible conditions for drivers through vastly reduced driving tasks, or even full automation of vehicles.

Other related technologies and systems, which are relevant in this context include road user charging schemes, infrastructure monitoring and maintenance, the use of larger and heavier vehicles in the places and at the times in which they are compatible with the infrastructure and traffic conditions and vehicle automation/platooning. Distance-based road user charging systems for freight vehicles are in use in a growing number of countries in Europe; these systems already allow the tracking of vehicles, giving valuable insights for regulators. Infrastructure monitoring for road maintenance already collects a wealth of data; integration with systems for regulation of vehicles could therefore lead to better outcomes – including in the area of enforcement.

The use of larger and heavier vehicles for road freight transport holds the promise of large capacity gains, but the political discourse on this issue is often contentious. Approaches such as the Intelligent Access Programme (IAP) (Box 1) using performance-based standards (PBS) (Box 2) can help improve acceptability by ensuring that these vehicles are restricted to suitable parts of the network. A wider application of this technology in the road freight sector, beyond just larger and heavier vehicles could be a first step for a more intelligent regulatory approach.

Truck automation and its application in platooning are potentially transformative developments, which are currently high on the political agenda in many countries. Live tests have already taken place in Nevada and Texas and many expect to see platooning available commercially (at least in the US to begin with) in the very near future. April 2016 saw several operators including Volvo, MAN Truck and Bus, and Daimler participate in the European Truck Platooning Challenge, driving across national borders within Europe. Vastly reduced driver workload or even replacing the driver by an operator in a remote control centre (handling more than one vehicle) could also have large improvements for road safety performance, one of the key policy objectives in this context.

High levels of truck automation may obviate the need for certain types of enforcement actions. Rules relating to driver work hours may evolve in a scenario where much of the driving task – or all of it for long periods – is shifted from the driver to the vehicle. How these rules evolve in partial automation scenarios

will depend on the cognitive loading imposed by monitoring, rather than operating, the vehicle. In full automation scenarios, enforcing speed rules and monitoring dangerous manoeuvres presumably become moot since legal requirements are fully integrated into the driving algorithms.

Box 1. **Intelligent Access Programme**

The Intelligent Access Program (IAP) is a national program developed by the Australian National Government in partnership with all Australian States' and Territories' road agencies. It uses satellite tracking and wireless communication technology to remotely monitor where, when, and how heavy vehicles are being operated on the road network. It provides an opportunity for transport operators to achieve productivity gains, better turnaround times and increased profits by allowing more access or increasing allowable mass in exchange for compliance.

Under the Heavy Vehicle National Law (HVNL), IAP can be imposed as a condition of a permit or notice by a road manager. The way in which IAP is applied, or the sort of IAP applications that are made available to transport operators, may differ between states and territories. State and territory road transport authorities deliver all IAP services under the delegation of the NHVR, i.e. operators enrol in the IAP through the state they are travelling in.

Enrolment in the IAP is a road condition for higher mass limits (HML) vehicles operating in New South Wales and Queensland. In South Australia the IAP is voluntary for those operating at HML. However, if HML operators in South Australia are not enrolled in IAP, they must complete, sign and carry a HML Route Compliance Certificate.

IAP can be applied as a condition for a number of different vehicle types, for example IAP is a condition for certain cranes and special purpose vehicles operating in Queensland, New South Wales and Victoria. Operators should check with the relevant state or territory road transport authority to find out whether IAP may be a condition for their desired operations.

Where the IAP is specified as a condition of access, transport operators enrol vehicles into the IAP, and engage an IAP service provider to monitor access and compliance against agreed conditions of access. The IAP operates through the legislated interaction of four different parties, each with defined roles and responsibilities:

- **Transport operators** gain access entitlements to the road network through the IAP as a condition of that access.
- **Road agencies/road managers** specify access entitlements and conditions through the IAP.
- **IAP service providers** provide IAP services to transport operators.
- **Transport Certification Australia** ensures IAP service providers are certified/audited, and administers the IAP on behalf of its member organisations, including supporting development and implementation of the IAP.

Source: Queensland Department of Transport and Main Roads (2017).

There is potential for new technologies, newly available data and the combination of the two to either improve the enforcement of current regulatory frameworks or even replace these by a data-driven approach. But systems currently are too fragmented, both in terms of geographic implementation, as well as in terms of integration and interoperability. These shortcomings limit the meaningful uptake of many of the new possibilities they offer. Another element that limits the potential for the convergence of data and new technologies to deliver more efficient enforcement actions is the lack of consensus on data requirements – including the object, semantics and structure of data – that could support better enforcement.

Box 2. **Performance-based standards**

The performance-based standards (PBS) scheme offers the Australian heavy vehicle industry the potential to achieve higher productivity and safety through innovative and optimised vehicle design. PBS vehicles are designed to perform their tasks as productively, safely and sustainably as possible, and to operate on networks that are appropriate for their level of performance. The basic principle of PBS is matching the right vehicles to the right tasks. PBS vehicles are tested against stringent safety infrastructure standards to ensure they fit the existing road network and are safe. The scheme has been in operation since October 2007.

Vehicle certification rules

Vehicles must be certified as meeting the specifications for which their design approval was granted. The certification sets out how the certification process is to be carried out. It also sets out the qualifications certifiers need and the accreditation process for certifiers. Certifiers are required to carry at least AUD 10 million public liability insurance and AUD 5 million professional liability insurance.

Network Classification Guidelines

Network Classification Guidelines have been developed for four levels of road network. The basic principle is that PBS vehicles seeking wider access to the road network must meet tougher safety standards. By classifying roads in a consistent manner, the "weak" links can be identified and systematic roadwork priorities set. A uniform, national road classification system also improves connectivity of freight routes within and across state/territory borders.

Operating conditions

In granting final approval for a vehicle, the NHVR may impose national operating conditions on the operation of the vehicle under the PBS Scheme. The conditions may comprise either or both:

- operating requirements, being requirements in relation to the way a vehicle is managed, used or maintained to ensure that it continues to comply with PBS once it begins operating
- compliance assurance mechanisms, being requirements intended to ensure that there is continued compliance with particular operating requirements.

Source: Queensland Department of Transport and Main Roads (2016).

Examples of envisioned approaches

There are a number of potential new enforcement actions and areas for new control strategies to ensure better outcomes from road freight. This section describes the vast range of opportunities that become available with the use of ITS and big data in transport. The following examples are not exhaustive but give an idea of the diversity of new possibilities.

New approaches for enforcement of **weights and dimensions** could be developed. They could include:

- **Total laden weight protection**, where depending on current infrastructure conditions and limitations, these limitations could be enforced automatically, and, as a preventive measure, better routing could be suggested by the navigation system of the vehicle so that limitations are not breached. Infrastructure-embedded stress and deflection sensors could serve a double purpose in this context; better support for road and infrastructure maintenance programmes and potentially vehicle-specific over-weight alarm messages to control authorities to help target enforcement.
- **Axle load protection** could be designed in a way that on-board axle sensors dynamically monitor loading and provide the driver, the driving system (in the case of automated vehicles) and/or authorities with information on potentially dangerous axle loading. This data could also be used to ensure that total vehicle weight is monitored in real-time, transmitted and used in determining road and infrastructure access permissions or damage-based road charging fees.

- **Tailored dimension restrictions for specific infrastructure**, e.g. tunnels or bridges, could be provided in standardised open formats so that on-board systems or fleet dispatching can suggest adapted route guidance. Infrastructure-embedded receivers or monitors could track non-compliance and initiate enforcement actions.

The availability of vehicle or context-specific data could support in-vehicle displays of **customised variable messages**. These could communicate customised traffic rules based on individual vehicle characteristics (e.g. load, dimensions) and the cargo carried (e.g. hazardous materials). These messages could also display custom information relating to road conditions, weather, and safer – or required – routing information based on traffic or other conditions (e.g. slow speed operation during poor air quality alerts).

Countries could issue (and exchange) **electronic market access instruments**: bilateral permits and national and international licences. Pending the existence of the corresponding legal support, these instruments could be designed to:

- limit the number of heavy goods vehicles in a specific country, territory or on a specific road at any given time
- limit the number of trucks of a specific type, from a specific country in the market at any given time
- introduce geographical limitations for specific market access instruments (e.g. licences)
- solve movement pattern enforcement issues, i.e. not more than a certain number of trips in cabotage or bilaterally between two countries (with the same licence or the same vehicle).

Some countries are already taking the steps in this direction. For example, the Netherlands is working on a project for issuing and allocating market access documents electronically. The user will have to digitally provide information that a truck is using a specific document. The checks could then be done based on available data in the database held by the authority.

Considerations for data requirements

In order for any data-driven policy elements to be implemented, a number of specific data-related requirements need to be determined at an early stage, including (amongst others) the object, semantics and structure of the data to be used, the communication channels for data exchange, and defining what data needs to be stored, where, and how.

Data characteristics and usage should strongly influence the collection approach. Vehicle safety-related data or other data related to the operation of the vehicle may require high-frequency collection. Other data could be monitored with lower frequency on the order of daily, trip-related, monthly or yearly reports. For example, data on vehicle performance (speed, acceleration, deceleration), condition (brake fluid pressure, particulate emissions), driver drowsiness, weather and traffic data require higher collection frequency. On the other hand, data relating to vehicle routing, technical characteristics and cargo information (type, weight, origin, destination, Convention on the Contract for the International Carriage of Goods by Road waybill [CMR] information, etc.) could be collected with a low frequency. This should be considered when designing communication channels for data exchange between the collection points and storage infrastructure, both nationally and internationally.

The temporary or permanent storage needs on different types of equipment should also be identified. Data could alternatively be stored on-board the vehicle and follow the vehicle, attached to a driver-specific device (driver licence, electronic file, etc.), housed on company premises (data relating to all drivers and vehicles while they are assigned to that specific company), or embedded in national databases.

2. Data-led opportunities for enforcing existing rules

This chapter presents data-led opportunities for enforcement of the three types of rules (the market-based, driver-based and vehicle condition rules), followed by an outline of the data processes (data sources, transfer of data and data storage and deletion) that this enforcement would entail. Enforcement of existing rules in road transport will differ depending on the type of rules that need to be enforced. In some cases it may even depend on the interest authorities have at any particular moment in prioritising the enforcement of certain categories of rules.

Market-based rules

As described previously, market-based rules are those that regulate access of operators to the road transport market or to its specific segments. The access to the market is given as a result of a procedure that is performed by the competent authority in any given country. Usually the operator would apply for market access, provide the required documentation, and after a decision is taken by the authority, is granted access to the market. The operator would usually be issued a document that certifies that it has been given the access to the market under specified conditions, for a set duration, and, if applicable, for a set number of trips. The information about the decision to issue access to the market is recorded in the databases of the authority.

For freight transport operations an example of this could be the procedure of issuing an operating license based on professional competency, financial standing and good repute. This is the case in Europe for operators seeking to obtain a bilateral transport permit for a specific trip or an ECMT licence for unlimited number of trips throughout the year.

Current enforcement actions for market access rules are comprised of authorities checking that operators have relevant market access documents and these are valid. In cases where market access is restricted to specific companies or for a certain number of laden trips, operators may try to forge or modify market access documents. Authorities seek to ensure the veracity of market access permission by controlling the document – e.g. by checking the security features of the documents.

Introduction of data-led enforcement solutions could allow avoiding risks that come from the combination of restricted market access and easily forgeable documents. Using readily available data on issued market access instruments on government servers, various data-led enforcement approaches could be developed. The simplest approach could be securing the documents using machine readable codes (e.g. QR code), which would allow the controlling officer to ensure that the document presented by the operator has actually been issued and that the information on it has not been changed since the time of issuing. The next step could be the transition to paperless documents, where the validity of the document could be checked in a government database. For some types of documentary checks, this could take place without stopping the vehicle based on the vehicle licence plate that the document is assigned to.

Drive-by enforcement strategies should ensure that data gathered in the enforcement action is incontrovertibly tied to a specific vehicle. The most simple and cost-effective way of doing this leverages optical character recognition-based number plate identification. This allows the enforcing authority to link license plates, registration information and other types of data including the type of market access granted for that vehicle. Other applicable approaches could include different short range communication methods, but these may require fitting vehicles with specific devices, or the use of existing devices like road charging boxes. Ensuring universal coverage, making sure that technical installation and operation of the devices meets standards and implementing data transfer protocols may complicate wide-spread uptake and have an incidence on costs.

Exactly how control of market access rules will be implemented in the future (and indeed, whether the rules themselves may evolve in light of new technology or availability of data) is still unclear. At present, though, some developments are taking place – for example, some countries have started printing barcodes on their market access documents for easier processing. At the time of writing, however, we are not aware of any completed implementation cases where market access instruments are implemented with the possibility of their checking and enforcement using a data-led approach.

Driver-based rules

Driver-based rules relate to the actions that an employee of a road haulage company performs as a driver. Usually the actions of drivers are determined either visually by the control officer, or based on records on paper or by technical equipment. For example, for rules that relate to driving and rest periods, data related to drivers' actions is recorded by on-board data logging and recording devices called tachographs.

The enforcement of driver-based rules is currently done either during on-the-spot roadside checks or at the premises of undertakings. In the future more efficient enforcement of driver-based rules may become possible by creating additional data recording/transfer devices and by using existing data from the vehicle. As an example, to control driving hours, automatic regular data transmission from the vehicle to a site controlled by the authority informing about its location and travelling speed could soon be possible at low cost for very adequate frequencies (e.g. every few minutes).

The use of data-driven approaches for enforcement of some parts of the traffic code (e.g. the priority-to-the-right rule), is less applicable for technical or economic reasons, as the sufficient information on a network-wide level might not yet be available or collected. But on specific parts of the network, e.g. on high-demand corridors equipped with road-side sensor and communication infrastructure or larger signalised intersections, video systems (e.g. red light cameras at junctions, speed-over-distance systems, automated number plate recognition systems, or cameras as part of existing road user charging systems) are likely to be in place with the capability to precisely monitor vehicle movements, thus potentially providing the data sets required for enforcement.

Vehicle condition rules

Vehicle condition rules define the technical conditions vehicles must meet at all times during their operation. These rules are typically checked at on-the-spot roadside checks. The increasing penetration of information technology in the vehicles could allow automated enforcement of existing rules based on the information provided in real time by the on-board computers of heavy goods vehicles. Monitoring this data could be facilitated through infrastructure-embedded receivers.

Traditional roadside checks could benefit from the availability of advance information from the on-board computers and infrastructure, since this might guide the targeting of vehicles susceptible to more robust inspection. This could lead to increased cost efficiency for control procedures, because only those vehicles that are likely to infringe upon the rules would be checked.

Using data-led approaches, certain existing vehicle condition rules could be better enforced. For example, the existing information from the on-board systems on emission performance of the vehicle could be used for enforcement of emission limits required by vehicle condition rules. Another example, could be the regular transmission of total vehicle weight that could be used to automatically enforce rules related to weight limitations on specific parts of the infrastructure, e.g. bridges. Also, it would be possible to counter the use of electronic cheating devices that allow hauliers to avoid using diesel exhaust fluid (e.g. AdBlue, which reduces harmful emissions from diesel engines).

Some vehicle condition rules are more difficult to enforce using data-led approaches and some rules may require a certain element of human inspection. For example, tire wear, condition of suspension and the trailer kingpin may realistically still need to be inspected by a qualified officer. But in the medium-term future it would theoretically be possible to monitor tire condition by controlling for the exact number of kilometres each tire has rolled. The suspension is another area where stress loading sensors could monitor vehicle suspension struts in real time; this might enable a move away from human intervention to an automated systems also in this area. There will, however, be a further list of vehicle condition rules, which are well suited for automated approaches to cost-efficient checking. Also, the efficiency of traditional roadside checks can be improved with preliminary analysis of information and selection of specific vehicles for inspection, like it is done in the United Kingdom (UK), where the Operator Compliance Risk Score (OCRS) system is used to calculate the risk of an operator not following the rules and based on that decide which vehicles should be inspected (see Box 3).

Box 3. **Operator Compliance Risk Score**

In the UK the Driver and Vehicle Standards Agency (DVSA) uses Operator Compliance Risk Score (OCRS) system to decide which vehicles should be inspected. OCRS is used to calculate the risk of an operator not following the rules on roadworthiness (the condition of its vehicles) and traffic, e.g. drivers' hours, weighing checks.

The OCRS system is based on data collected by DVSA over a three-year rolling period. Data is taken from annual tests, roadside inspections and inspections at operators' premises. An operator gets points when a test or inspection finds a defect or infringement of the rules. The more serious the defect or infringement, the more points. Vehicles of an operator with high OCRS are more likely to be inspected.

DVSA also has a non-GB OCRS system for operators based outside the UK. It's based only on data captured at the roadside, because there is no annual test or prosecution data available.

Source: DVSA (2017).

Data processes

Sources for market-based rules

The primary data sources for data-led enforcement of market-based rules will be the government databases of the competent authority controlling market access and the flow of data generated by vehicles and their operation:

- For licencing and access to special market segments: data sources are the relevant authorities that do the licencing or manage the transport of specific cargo (e.g. overweight, oversize, hazardous).
- For bilateral international road transport permits: data sources are the relevant authorities that issue the permits in the country of registration of the haulier.
- For multilateral international freight transport licences: data sources are the issuing authorities in the countries of registration of the hauliers, but the information could potentially come together in one central location, as is the case for ITF for the ECMT multilateral quota system.

Sources for driver-based rules

The data sources for enforcement of the driver-based rules will be those that contain information on the actions of the driver.

For enforcement of one part of the driver-based rules, the on-board and remote recording equipment will be the main data source. For other rules data from infrastructure, e.g. license plate recognition information, might be needed. Also, for these rules the information of new or existing vehicle on-board systems like

cameras, GPS and other on-board sensor data could contribute significantly if this information was made accessible for enforcement purposes. It is conceivable that some parts of this data could be automatically transmitted to the authorities at regular (frequent) intervals.

Part of the collected data might be considered of a sensitive nature from a personal privacy perspective. This is because the data relates to a physical person – the driver – who in complying with rules may encode data that could be used to discover or intuit personal information. This implies that the data collection, transfer and storage procedures should comply with rules on protection of this data.

Sources for vehicle condition rules

Two main data sources can be used to check that the vehicle condition is in compliance with the rules: data from the vehicle and data from the infrastructure. Data from the vehicle are the data that exists on-board and that could be recorded and/or automatically transferred to the competent authority for enforcement purposes.

Data from infrastructure could provide information on various physical characteristics of the passing vehicle. The collected information could include information like axle loads, total weight, length, height and other measurable parameters.

Both vehicle-generated and infrastructure-collected data can be either explicitly or implicitly linked to a specific commercial enterprise. When this data records locations, times of passage and routes there is a possibility that commercially sensitive data could be revealed – especially when combining this data with other sources of data. For instance, the number of vehicles of a specific company passing a gantry near a supplier could reveal information regarding the volume and nature of trade taking place. This risk is especially acute in countries where data held by public agencies is discoverable via freedom of information-type requests.

Transfer

In order to perform enforcement procedures using data-driven approaches, certain technical and IT infrastructure are required. This infrastructure should link data sources to the enforcement activities of the competent authority. In particular, this infrastructure should be able to link data from the following sources:

- driver data storage (e.g. driver tachograph card or equivalent)
- vehicle systems (e.g. vehicle sensor data from on-board systems)
- road infrastructure.

The enforcement authority can check compliance with rules by directly accessing relevant data from driver, vehicle or infrastructure systems during on-site control procedures. Alternatively, this data may be automatically uploaded from these systems to remote, authority-controlled servers. In this case, roadside checks for checking data may become obsolete though they may remain relevant to enforce detected cases of non-compliance with rules. The automatic checking of data would also free up time and resources for enforcement actions thus strengthening the deterrent nature of these.

One of two approaches could be adopted in order to reconcile data collected from operators in the field with that stored in central databases. The choice of the applicable approach will depend on the specific context of the roadside check and the checking procedure in question:

- Real-time checking, which is most suitable for locations with good data connections and for complete paperless applications.
- Cached checking, where either the data collected from operators or vehicles is remotely cached and matched afterwards to data in a central government database. This approach is more suitable for

locations where no immediate access to the central database is possible, or the quality of access cannot be guaranteed.

Transfer of data from infrastructure for checks could be done using stationary wired or fibre optic data connections, via wireless mobile phone data links, or via ad-hoc networks leveraging vehicle-to-vehicle and vehicle-to-infrastructure communication.

Storage and deletion

A digital and data-rich enforcement paradigm would generate and transmit considerable data on checked vehicles and detected infringements of the rules. Storage and deletion procedures for this data should be devised carefully so that they are in line with other existing legislation.

Privacy legislation in different countries usually requires that only data that is needed for performing specific duties, in this case enforcement, should be collected and stored. In this case the data on infringement by specific drivers, vehicles of companies at specific times and specific locations could be collected and stored for enforcement purposes. Data relating to the location/movements of other vehicles, which comply with rules, however, should not be stored. Aggregated data collection techniques that are robust to re-identification attacks should be authorised as these pose minimal privacy concerns.

Clear procedures for data deletion should be established as well. Data should be deleted for those checks which detected no infringement, but in cases where infringements were detected, a different data deletion algorithm could be established to allow enforcement procedures to occur and be completed, including the time for assessment of claims. The procedures should ensure the protection of sensitive commercial data of the companies, ensuring that only data that is needed for enforcement is collected and stored.

The driver data storage and deletion algorithms require particular attention. They should ensure that data transfer, storage and deletion procedures comply with the rules on protection of personal data. Often the drivers will change jobs or work for different transport companies over the same time period. In those cases, data storage and deletion procedures should properly allocate the drivers' infringements to the correct company that they are working for at the time of the infringement.

The AETR/EU tachograph data management serves as an example of good data handling protocols in the context of enforcement actions – especially as concerns data transfer, storage and deletion algorithms. The tachograph stores different types of data for different durations, e.g. speed information is kept at least 24 hours whereas other driving information is kept at least 365 days. The company has an obligation to regularly download the data from the tachographs on-board its trucks and store it for at least two years, but it only has access to data from the data file that the company has opened itself, which means only for the time it has owned the vehicle. All information is accessible to the control authorities.

For driver and vehicle data, a similar approach for storage with different access permissions and deletion schedules could be devised. In cases of the automation of checking procedures, data could be transferred to server infrastructure, where it could be treated in a similar manner.

It may be worth considering setting up uniform algorithms for data storage and deletion when dealing with enforcement of any type of rules in road transport, be it market-based, driver-based, or vehicle condition rules. This would increase the transparency of enforcement procedures and ensure the data protection legislation is uniformly followed.

3. New approaches for regulating road freight

This chapter describes the way forward for data-led approaches for regulating freight: the requirements, key issues and challenges for implementation, as well as the financial implications. Many related developments are under way, which will have further implications and potential for improving enforcement regimes. These include distance-based road user charging systems for freight vehicles, which are in use in a growing number of countries in Europe. These systems already allow the tracking of vehicles, giving valuable insights for regulators. Infrastructure monitoring for road maintenance already collects a wealth of data; integration with systems for regulation of vehicles would thus be mutually beneficial. Of particular importance in this context are the enforcement implications that arise with the use of larger and heavier vehicles, vehicle automation and platooning, and platform-based systems for freight matching.

The use of larger and heavier vehicles

Although a politically contentious issue, some countries are moving towards relaxing the rules concerning weights and dimensions of road freight vehicles, thus allowing larger and/or heavier vehicles on parts of the road network, in order to allow increased capacity and efficiency of the supply chain in a controlled environment. By ensuring that these vehicles are restricted to suitable parts of the network (possibly also with some time limitations, either at fixed intervals or dynamically defined as a function of traffic) can help improve acceptability (see Box 1). A wider application of this technology in the road freight sector, beyond just larger and heavier vehicles could be a first step for a more intelligent regulatory approach.

Vehicle automation and platooning

These are potentially transformative technologies, which are currently high on the political and business agenda, for example the recent European Truck Platooning Challenge and multiple traditional and start-up companies launching their pilot projects for driverless operations. Vastly reduced driver workload or even replacing the driver by an operator in a remote control centre (handling more than one vehicle) can have large improvements for road safety performance, one of the key policy objectives in this context.

Platform-based freight matching system

Systems where supply and demand are more effectively aligned have the potential to minimise empty running of vehicles and overall vastly improve the efficiency of the supply chain. But a larger move to this approach, particularly if based on platforms introduced by new players into the market, can also have disruptive effects. Whilst not directly related to regulation, the vast data sets both used and generated by such a scheme could provide a wealth of information that could be used to improve regulatory outcomes for road-based freight transport.

Overview of new approaches

The emergence of big data and its application to the transport sector has enabled various innovative solutions and business models, but uptake in the area of road freight transport has been somewhat slower compared to other domains. This new context of a richer and more timely availability of data should make possible the development of smarter, evidence-based policies and more flexible data-driven legislation and regulations, and with it the potential to deeply change how the road freight sector operates and is regulated. This should bring large scale improvements to both supply chain efficiency and transparency, and responsibility of the sector.

Systems for vehicle tracking and network access

Much of the underlying information required for regulating the various aspects of road-based freight transport relates to the geo-location of vehicles over time, e.g. knowing movements of vehicles, hours of operation and position/paths taken within the network. Different techniques have traditionally been used to gain the necessary insights to see at least parts of the overall picture, thus supplying sufficient information for regulators to monitor adherence to regulations put in place.

A more straightforward approach, seeing the whole picture through one stand-alone system and disposing of the individual fragmented systems currently used, would be tracking all freight vehicles in the network, ideally in connection with a driver ID. Recent progress in mapping, sensor, and IT technology has enabled these approaches. An example for the implementation of this would be the Australian Intelligent Access Programme (IAP), which has been put in place to ensure acceptable use of larger and heavier vehicles by tracking these vehicles and managing access to the network.

Implementing a similar system, but extending it to all freight vehicles, could be a solution to provide much of the necessary data for enforcement purposes, using a tried and tested technology but deploying it on a larger scale and for wider policy purposes. But to enable cross-border operation of such a system streamlining of national regulatory approaches as well as technology interoperability (including communications) would have to be ensured. In the context of vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication the underlying communication channels and technologies to be deployed need to be carefully considered.

Traditionally this data exchange in the automotive sector, e.g. for many road tolling systems, relies on dedicated short-range communications (DSRC) using one-way or two-way short-range to medium-range wireless communication channels specifically designed and a corresponding set of protocols and standards. Globally these lack appropriate harmonisation as significant variations occur relating to things like frequency, baud rates and protocols. Due to lack of available frequencies opening up a specific frequency dedicated to road freight operation could be beneficial, but this would then need to be available across borders. In the context of vehicle automation, there is increasing consensus that 5G mobile communication is required in view of the increase in volume of data exchange necessary; this could then also be used in the context of road freight governance once it becomes available.

But it should be noted that reliance on 5G mobile communication in a road safety context, such as for vehicle automation, will require a near 100% coverage, thus requiring not just a technology upgrade but also additional base stations. Therefore, for either communication technology option, DSRC or 5G, additional communication infrastructure will be necessary, leading to the question: Who will bear the cost: industry or the public sector? The answer will likely depend on business models and the quantification of the effect on public good (e.g. improvements in road safety). Decreasing public sector budgets will put a strain on this, nevertheless the European Commission's Cooperative ITS (C-ITS) programme and similar initiatives in the US for example are trialling this on a corridor basis.

Combining geo-fencing and slot management into "geo-timing"

Building on the point above about rolling out a system similar to IAP to cover all freight vehicles, additional elements could be added to such an approach. One example could be to apply the approach of slot management, as used in the aviation sector, to road freight.

This together with dynamic geo-fencing of certain vulnerable parts of the network at certain times could lead to a geo-timing approach. This would then widen the approach to a vastly improved logistics operation with routing/tracking vehicles through appropriate parts of the overall network at appropriate times and with pre-booked access to parking areas, loading/unloading areas in logistics centres, and border crossings.

Emerging innovative business models and services

Many of these new technologies produce a significant amount of data, which is potentially useful for other areas, allowing innovative services and business models, based on leveraging this data, such as for parking and border crossing. These services could use or provide information from digital infrastructure, data from sensors and mobile phone networks.

In addition, these services can also alleviate pressure on regulatory frameworks, as many of them will directly address the policy objectives these frameworks were put in place for. As they are more likely to emerge based on private sector innovation, mandating use could be problematic, but an approach could be envisaged where proof of voluntary use of certain socially beneficial systems can lower the reporting obligations of logistics companies.

Realising the potential of big transport data

In addition to the increasing amount of data collected from traditional and novel data sources, data mining, and the innovative use of data and data analytics, there are also relevant new technological developments in the field of data science itself.

One particularly interesting development is the potential application of the blockchain technology in the transport sector. Blockchain technology combines advances in data science, cryptography and novel governance principles. Specifically, it enables frictionless transactions regarding payment and access to distributed services, data and rights without the need for a third party to establish trust between transacting parties. Functionally, it builds on a distributed and inviolable log of events setting access rights and encoding transactions – each modification to the log is checked against the shared distributed "clones" thus ensuring conformity and preventing modifications that are not vetted by the parties involved in the transaction. Blockchain opens up new possibilities to seamlessly manage distributed and fractional capacity (both for vehicles and infrastructure) and offers the possibility of customised, dynamic and sized-for-purpose transport to parties. It also allows operators to manage access rights, data and payments across a broad network of unrelated and competing service providers and platforms.

Requirements for implementation

Certain case-specific requirements for successful implementation of the new data-led approaches will likely exist. Some of these are described below and relate to geographical context of the implementation, the way that the transition from traditional approaches is ensured, political acceptability of the enforcement practices and the achieved enforcement service quality.

Geographic context should not hinder implementation

The geographic context where the data-led enforcement is implemented should be taken into account so that it does not hinder implementation. In geographic contexts dominated by multiple border crossings and jurisdictional rules, e.g. in Europe, international harmonisation of rules and technology solutions (including data exchange) across actors and sectors is necessary to enable interoperability.

In other situations, where road freight transport is predominantly focussed on national markets, data-led control initiatives may initially forgo such international harmonisation in return for fast implementation and uptake.

Ensure transition to a higher coverage

The implementation of data-driven approaches in enforcement should allow transitioning from current sampled enforcement to 100% coverage in enforcement of certain rules. In the initial stages of

implementation such a level of checks would be constrained by the share of adequately equipped fleet and the technical capacity of control authorities. A higher level of coverage can be ensured as the existing fleet would gradually be replaced by a newer fleet that meets the new technical enforcement requirements.

Full coverage does not mean that *all* trucks would be checked *all* the time, but rather that the data would be available to easily check *any* truck *any* time or even *all* the time. A higher or lower sampling rate, possibly accompanied by some screening based on earlier compliance of the operator, could be decided by the authority based on its priorities and available resources.

Given the social benefits of full compliance, (mostly) non-financial incentives can be conceived to stimulate hauliers to a quicker transition to a new fleet or retrofitting of their current fleet with the new IT capabilities.

The selection of rules for an increased or universal level of checks requires sound justification by policy makers, particularly about the data that is to be transmitted to them by the operators. That set of data and the enforcement practice should be justified in the context of the policy goals that the particular rules are designed to achieve.

Characteristics of enforcement practices should be politically acceptable

The effectiveness of data-led control relies on trusted, robust, immediate but fair enforcement practices following a detected infringement. Road transport operators must be aligned with the policy makers on acceptable enforcement practices. Positive incentives like whitelisting for consistent compliance with the regulations are something that the industry is likely to embrace easier than blacklists leading to increased checks. That will ensure that hauliers see compliance as a competitive advantage and will comply with regulations seeing it also as a way of reaching the specific policy objectives that the legislation was developed for.

Part of building the trust of the industry will require adequate stakeholder engagement in the conception and development phases of the new approach and readiness to challenge enforcement actions that are seen as unwarranted. In both cases additional resources can be necessary, but investment in the earlier phases should lead to lower friction and costs later on.

Service levels need to be ensured

A certain level of data storage environment centralisation or access to operators' data is required in order to ensure pre-defined service levels of the system and to allow timely enforcement actions. These service levels should be ensured even in situations where data is stored at different locations nationally or internationally.

Key issues

In addition to the general requirements for implementation of the new data-led approaches for regulating road freight transport, as described above, specific issues relating to the underlying data itself and its use need to be addressed, including the following.

Views on trustworthiness and reliability of big transport data

Whilst big data has a large potential for providing solutions for more efficient logistics and supply chains and the corresponding road freight movements, the specific underlying data sources, data characteristics, and their implications need to be studied in more detail.

In this context many service providers have emerged, who have access to data sets and offer business models based on this data access coupled with innovative use of data sources originally intended for other

uses, data fusion with conventional data sources and uses, and data analytics. While this is a positive development, the issue of vendor/service provider lock-in might arise, which certainly would have to be addressed, if the public sector would enter into any contractual set-ups.

In addition to this specific aspect of big data, there is also the increasing availability of open data. This data can of course also prove to be useful here, but concerns over the reliability, trustworthiness, consistency, etc., might at this stage prevent this from being used for regulatory purposes.

Access to on-board vehicle data

A key hurdle to utilising specific sources of very useful data is that these data sets are seen as commercially sensitive by its owners. This is particularly the case with vehicle performance data collected by vehicle manufacturers. This would be a highly relevant and very reliable source of data and a potential key component of the kind of approaches discussed here. In such a situation, either a mandate from the legislator will be needed to access the data stored by the on-board recording equipment, or if this is not practical, then a system could be put in place where benefits will be given for access to data, i.e. preferential treatment and access to a less burdensome regulatory framework.

In either case the reliability and trustworthiness of the collected data made accessible needs to be ensured, through means like certification procedures for sensors involved, guidelines for data storage, management and analytics. But given the commercially sensitive characteristics of these data sets, there also needs to be an obligation for the regulating authorities to prove that they stay within their specific mandate and that procedures are in place safeguarding privacy, confidentiality and cyber security.

Data issues: Ownership, architecture, privacy, cyber security

The move towards data-led regulatory approaches, particularly in the case of a wider and more comprehensive implementation of such systems, will require guidelines and technology solutions to address some key data-related issues, including the question of data ownership, a specific data (and trust) architecture, and privacy and cyber security protection measures.

Two emerging systems for road freight transport take different approaches in data sharing. In the e-CMR system (see Box 4) the checks are done without provision of detailed information to the controlling body, while e-TIR system (see Box 5) provides advance real-time cargo information to speed up the procedures. Both systems are shown here as an example of these different approaches on data-sharing, but it should be highlighted that they both focus on a different aspect (the cargo) from those that have been discussed in this report.

Box 4. **e-CMR consignment note**

CMR consignment note, covered by the United Nations Convention on the Contract for the International Carriage of Goods by Road, is an instrument that harmonises contractual conditions for goods transported by road and helps facilitate the goods transport.

To remove the paperwork and lower the handling costs, in February 2008, a protocol was added to the CMR Convention, which allowed CMR to be managed electronically, via "e-CMR". This protocol entered into force on 5 June 2011, and so far, 11 countries have ratified this new electronic system. These include Bulgaria, Czech Republic, Denmark, Estonia, Latvia, Lithuania, France, the Netherlands, Slovakia, Spain and Switzerland, with additional countries showing strong interest.

e-CMR officially launched in January 2017 with the first ever border crossing to use electronic consignment notes between Spain and France, proving that the system works and is simple to implement and use.

Source: IRU (2016).

Box 5. **eTIR international system**

TIR Convention provides an internationally recognised procedure to facilitate the cross-border transportation of goods in transit through use of a standard, internationally recognised Customs document, the TIR Carnet, which serves as proof of existence of an internationally valid guarantee.

In 2003 the contracting parties launched "eTIR Project", aimed at providing an exchange platform for all actors (customs authorities, holders, guarantee chains) involved in the TIR system. The eTIR international system will ensure secure exchange of data between national customs systems related to the international transit of goods, vehicles or containers according to the provisions of the TIR Convention and will allow Customs to manage the data on guarantees issued by guarantee chains to holders authorised to use the TIR system.

Two eTIR pilot projects have been started to advance the establishment of fully fledged eTIR system: (1) the UNECE-IRU eTIR pilot between the Islamic Republic of Iran and Turkey and (2) the eTIR pilot project between Georgia and Turkey.

Source: UNECE (2017).

The need for legislation on data-led enforcement approaches

As a way forward, the currently missing legislation for data-led enforcement systems and infrastructure should be developed in order to alleviate regulatory burden. This would, at the same time, offer a more flexible system as easing the monitoring of adherence to more easily enforceable quantifiable pre-defined policy objectives. A further advantage of such a system would be that the use of data-driven approaches in enforcement could allow developing different, simpler-to-follow rules, which in turn could lead to a lesser need for enforcement. These preparatory works should be launched with engagement of the wide set of stakeholders involved in road freight transport in order to ensure adequate coverage of all legitimate concerns and to minimise future resistance to change or litigation.

Governance challenges

Governments are likely to face a range of challenges in introducing new data-driven policies. While most challenges are hard to predict, those which currently seem the most likely are described below. The challenges related to the introduction of traditional policy innovations are not covered here, but should also apply for data-led rules and enforcement of road freight.

Using a two-tier system

Practical implementation of data-led enforcement approaches is likely to require the use of two-tier system to allow both high- and low-tech players similar access to the market and guarantee a level playing field. At any given time a technical innovation, especially one that requires new technology to appear on-board the assets of a company, will be constrained by the replacement speed of those assets. Therefore the challenge is to design the transition to the new approaches to regulating road freight in a way that does not discriminate between actors in the road transport market depending on the technological characteristics of their vehicle fleets. But, as mentioned above, incentives for quicker transition could be conceived and deployed.

Shortening implementation periods

The long transition periods that legislators are currently proposing for implementation of associated technologies can be a barrier for adoption, because they slow down full implementation and its expected benefits. For example, the introduction of "smart" tachographs for new vehicles starts in 2019, but they will not to be mandatory for all vehicles before 2034. These "smart" tachographs record speed, distance, start

and final location and enable downloading and remote checking of data via wireless data transmission to control authorities.

In cases where rules are designed based on the data from these new devices, the relatively slow penetration of technology means that the application is not possible throughout the market; or that derogations for these unequipped vehicles have to be designed in a non-discriminatory way to allow market access until the end of their life.

Dealing with the uneven regulatory landscape

An uneven regulatory landscape could slow the implementation of data-led enforcement, because currently vehicles of various sizes are regulated differently, thus requiring a different set of on-board equipment. For example, tachographs need only be used if the total weight of a vehicle is more than 3.5 tonnes. Therefore smaller vehicles are not usually equipped with tachographs. This means that the implementation of new rules that use data from tachographs would be constrained to the fleet that is equipped with them.

Outsourcing some functions of competent enforcement authorities

Outsourcing to private companies might be required in the context of setting up novel regulatory framework for data-led enforcement. The enforcement of traffic rules is usually performed by competent enforcement authorities, but is possible that private companies with better technological competence could do this in a more cost-efficient way. This could be perceived with suspicion by the haulage industry, and is an issue which will likely need to be addressed.

Convincing actors to participate in data sharing

Data generated in the course of carrying out road haulage operations may currently not be available to the government for enforcement proposes. Voluntary data sharing might be required for implementation of at least some of the data-led approaches. As an example of the incentives for quicker transition, positive data sharing approaches could be used for this, where the entity that is sharing data benefits from doing so. An example of a positive data sharing approach is the Intelligent Access Programme in Australia (see Box 1). Another approach would be to make the collection and storage of certain data on heavy-goods vehicles mandatory, but that requires a good technical justification and political will.

Adjusting procedures for procurement

The development of a new approach for regulating and enforcing rules in road freight with undefined standards and technologies is likely to present a challenge for public procurement. The most cost-efficient technical approaches for implementation could be sought using methods like smart procurement, market consultation, or other less prescriptive approaches. Open standards should be adopted for the data sets required and their transmission to the authorities.

Tackling the cost and revenue sharing amongst the actors

The cost implications and split amongst the stakeholders of the new data-led enforcement systems should be clearly defined. The introduction of new technology will be associated with costs for road freight transport industry, infrastructure managers and enforcement bodies. Enforcement, however, will generate cost reductions and a revenue stream. The challenge is to develop a balanced model for splitting the associated costs and benefits (revenues as well as reduced costs and improved safety) across all the stakeholders.

An emerging challenge: Automated vehicles for road freight transport

As discussed above in the context of emerging related systems and technologies, a key development is the application of the quickly evolving field of vehicle automation to the road freight sector. Vehicle automation is now a clear trend, with governments, Original Equipment Manufacturers (OEMs), and the IT sector competing worldwide for leadership in this space. A large variety of implementation scenarios in different sectors and environments are being developed. Due to the clear business case and comparably controlled environment, automation of road freight vehicles on motorways (ranging from twinning to platooning and full automation) has generated much interest. Traditional vehicle manufacturers as well as new players are entering the market with approaches such as retro-fitting of existing fleets trucks with high-levels of on-board safety and driver assistance functionalities, and freight-matching platforms combined with fleets of fully automated vehicles.

These developments, which may come about in the short- to medium-term future, will have a very direct effect on all related legal and regulatory frameworks. There will be a large element of interaction between manually operated vehicles and automated vehicles (the level of automation can also vary amongst fleets and amongst the composition of vehicles using the road network simultaneously) in the transition period. In addition we might see the emergence of vehicle automation systems, which as a first step, still require a driver to be on-board at all times (with varying requirements to monitor vehicle performance and being able to take over control of the vehicle) or the use of control rooms staffed with operators able to regain manual control of vehicles whenever necessary.

Given both the specific implementation environment of vehicle automation for road freight, i.e. the whole motorway network, or specific high demand corridors, and the technical requirements for such operations, a very data-rich space with high data connectivity is likely to emerge. This is likely to enable the implementation of the novel data-driven regulatory approaches described above, based on all necessary data being directly collected and in principle being readily available through such a system (see earlier discussion on the potential need to mandate access to data vs. incentives for voluntary access). This will cover most, if not all, of the underlying policy objectives for market-based and vehicle-based rules. In addition, driver-based rules (e.g. driving hours, rest times) can also be covered, but here the requirements and the rationale behind the existing rules is likely to change based on the characteristics of such a scheme and the exact role and responsibilities of a driver/operator.

In the transition period we are likely to see solutions, where a driver will always, or on parts of the trip, be inside the cab being able to immediately take control of the vehicle in a pre-defined time span and based on a hand-over protocol. The driver could gradually regain control of the vehicle either in case of system malfunction, or when entering parts of the network not equipped for full automation (e.g. part of the overall motorway network not equipped or leaving the motorway and going into more complex urban areas where full automation would be more difficult). In this case, the driver workload would be drastically reduced, allowing more flexible rules regarding working hours; this is also likely to be the key business case for logistics operators to invest in these new and likely more costly vehicles.

In the case of automation in conjunction with a control centre, regulations for working environment and working hours for these operators might have to be formulated. Furthermore, rules might have to be put in place to allow safe operation of manually operated and automated vehicles interacting in a mixed environment. In the (probably more long-term) scenario of full autonomy of vehicles without any drivers/operators inside the vehicle or in a control centre, the category of driver-based rules would not apply anymore, but this then requires a precise definition of roles and responsibilities of logistics companies, OEMs, and infrastructure owners/managers, in order to have clear understanding of liability in case of incidents.

The question of universal applicability

The discussed data-led governance might not be directly implementable in every country of the world, because the development level of IT, road infrastructure, entrepreneurship environment and truck fleet is different in each country, as well as the legislation related to data security and privacy protection. This dictates the requirement to adjust depending on the local situation.

4. Concluding discussion

There appears to be an increasing gap between policies for road freight transport and the underlying policy objectives. This leads to undesired outcomes and can create specific challenges for the enforcement authorities. The emergence of big data in transport and with it the opportunity for more data-driven policy making holds the promise of bridging this gap with more targeted and flexible regulatory frameworks and more efficient enforcement mechanisms based on quantifiable activity and performance indicators.

A key related development in this context is the envisaged automation of road vehicles, including those for freight transport. This will affect both how these vehicles and the wider logistics industry will be organised and need to be regulated, as well as the necessary data-rich environment with high levels of data connectivity providing an enabling setting for highly sophisticated data-driven policy approaches. For this a two-step evolutionary approach can be envisioned, with as a first step an improved enforcement regime using currently underutilised data sources and contents, and eventually a completely new framework.

This new framework would involve the move towards a fully data-driven policy-making approach. For this quantifiable activity and performance indicators would have to be defined together with mandated or incentives-based voluntary access to commercial or proprietary data sources combined with data contents already in the public domain and potentially some other data as well. Given the use of this data for regulatory purposes, a high level of trust, reliability, consistency, and continuity is required for the data sets to be used, therefore much of the contents of wider big data might be problematic at this stage.

In addition, further developments in data science itself might be required as a foundation for implementing such approaches successfully; the blockchain approach can be seen here as a key technology emerging in its application to the transport sector, promising a solution to many of the current concerns in this space, particularly regarding safety and security of data handling by the diverse actors. Many other horizontal issues applicable across sectors also need to be addressed as part of such new regulatory framework going forward, including safeguarding commercial and private data and protection against cyber-crime.

Whilst clear potential value of such schemes can be identified, a number of specific challenges need to be overcome in order to allow wide-spread implementation. No level playing field exists internationally in terms of technology readiness, policy approaches, and economic development. This will require the use of a two-tier system allowing a minimum level of functionalities or even a specific separate system for some users. Here the wider issue of shortening implementation times of technologies and systems, and the increasing time lag of policy and regulatory response to these developments also plays a role. Some issues arise due to the innovative characteristic of such a scheme requiring different roles and responsibilities of the stakeholders involved, including an outsourcing of some tasks traditionally performed by public authorities to the private sector, and encouraging all data owners to open up and share data for such a scheme.

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International Transport Forum

Data-led Governance of Road Freight Transport

Improving compliance

This report examines ways to improve compliance with road freight transport regulations through the use of new data sources and technical solutions. It also reviews possibilities for new approaches to the broader governance of road freight as the availability of Big Data in transport facilitates more data-driven policy making with more targeted and flexible regulatory frameworks as well as more efficient enforcement mechanisms.

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