The Digital Evolution of Highway Infrastructure Asset Management

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THE FUTURE OF TRANSPORT SERIES – Edited by Dr Phil Martin

Foreword

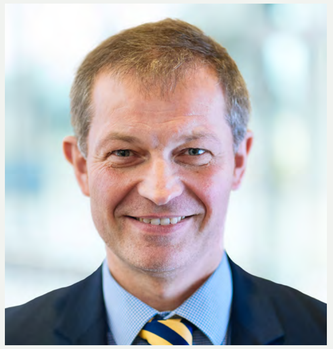
The highways infrastructure sector is firmly embarked on the early stages of its journey towards a digital evolution. This transformation is fuelled by data, and the information and insights that can be derived from it.

New data sources and data capture technologies, better processing capabilities and storage capacities, emerging and evolving business models and markets all contribute to a rapidly-changing ecosystem. Leveraging this can bring a wealth of opportunities to improve the way we design, build, maintain, and operate infrastructure.

Adapting to and capitalising on this developing digital ecosystem brings many challenges. Evidently, highways infrastructure owners and operators must overcome these challenges in order to keep pace with this change and fully leverage the benefits of digital transformation across the sector.

Through this Future of Transport report, we combine Futures Thinking methods with TRL's deep expertise in highways infrastructure asset management to explore the technological, commercial, economic and legal challenges presented by the digital evolution of the sector. We consider emerging technologies and data sources, their potential impact on highways infrastructure asset management strategies and identify the key actions for stakeholders to ensure they leverage the full benefits of embracing this digital evolution.

The insights within this report positively contribute to influencing and informing how highways infrastructure owners, planners, operators, and the supply chain can all approach the challenges of successful digital transformation — to deliver a clean and efficient transport system that is safe, reliable and accessible for everyone.



Richard Cuerden

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TRL Transport Foresight

This report is the first in TRL's Future of Transport series of reports and is brought to you by the TRL Transport Foresight team.

TRL's Future of Transport series couples applied Futures Thinking methods with TRL's deep expertise in transport system and mobility solutions across the sector to shine a light on the trends and uncertain futures affecting a rapidly evolving transport system. Each report aims to inform readers by anticipating and understanding change, identifying opportunities to remove barriers and realise benefits and preparing for an adaptable and resilient future.

The TRL Transport Foresight team specialises in applying Futures Thinking methods, tools and skills to transport system and mobility challenges. We support organisations with their strategic foresight needs by identifying and analysing the impacts of emerging trends and technologies, engaging with expert and citizen stakeholders through participatory methods and shaping the creation of future-orientated and resilient long-term strategies and policies.

Introduction

Over the last 25 years, the concept of Asset Management has become common for Highways Authorities across the World. They have adopted and implemented Asset Management practices to collect, record, manage and use asset data to make informed decisions on the management of highway assets.

However, technological improvements over the last decade in the collection of data from Assets, as well as for their management and operation, have changed, and will continue to change, the way infrastructure assets are used, and the way they are maintained and constructed. This Digital Evolution in Asset Data has created uncertainty around current Highways Asset Management processes, and established an imminent requirement for transition from "Traditional" to "Intelligent" Asset Management. In this paper we identify some of the key actions required to deliver this transition in Asset Management practice, and hence to maximise the benefits of the Digital Evolution.

Traditional Asset Management

The Traditional Asset Management process (see Fig 1) defines the physical properties of the Asset, and then uses established techniques to measure and understand deterioration in those properties, and hence identify maintenance (and financial investment) requirements.

The Asset Management Strategy and Plan describe the actions needed, in accordance with current best practice guidelines and standards.

This approach is well developed, tested, and proven to be efficient in meeting current industry expectations. However, this situation is changing with the Digital Evolution of Asset Data.

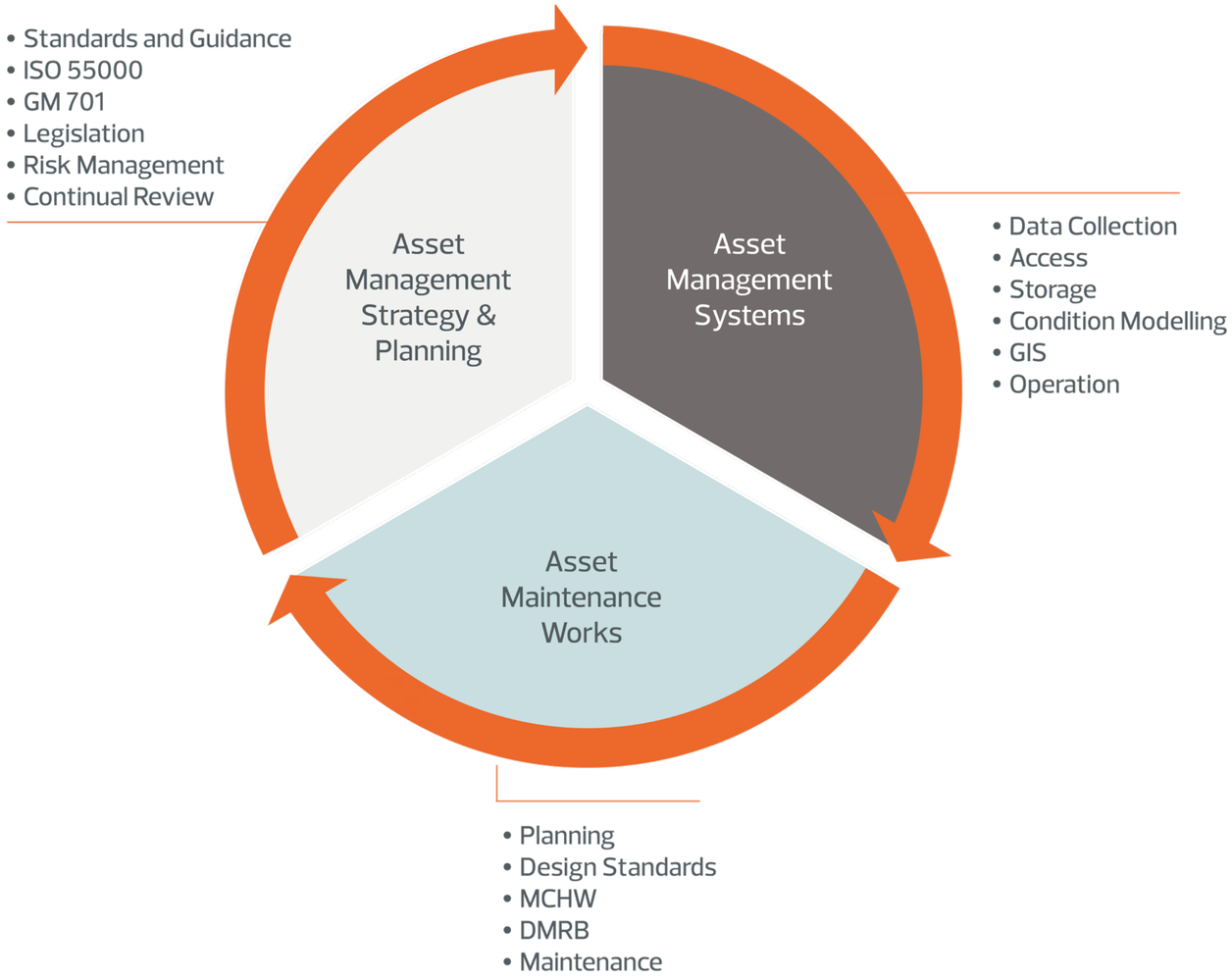


Figure 1: Traditional Asset Management Process

Driving Factors for Change

The availability of a wide range of new data is expected to transform ''Traditional Asset Management''. In the current model, asset data collection systems are ''outcome driven'', providing data in standardised formats in line with the requirement of asset management systems to support decisions about the Asset.

Conversely, new types of data can now be obtained from many different sources to support a wide range of asset management decisions. The potential of these sources such as Surveys, Crowd Sourcing, Internet of Things and Remote Sensing have been discussed in TRL's paper on the New Toolkit for Highways Asset Management (Fig 2). However, the options available to best exploit these data in Asset Management have not yet been fully explored.

Data from New Technologies

- Airborne, terrestrial, drone technology
- Satellite Data Monitoring
- Internet of Things (IoT)
- Connected Sensor Networks
- Probe Vehicles and Autonomous Vehicles with vehicle sensor data
- Smartphones (crowdsourcing)
- Advanced Data Processing techniques i.e. artificial intelligence, machine learning, etc

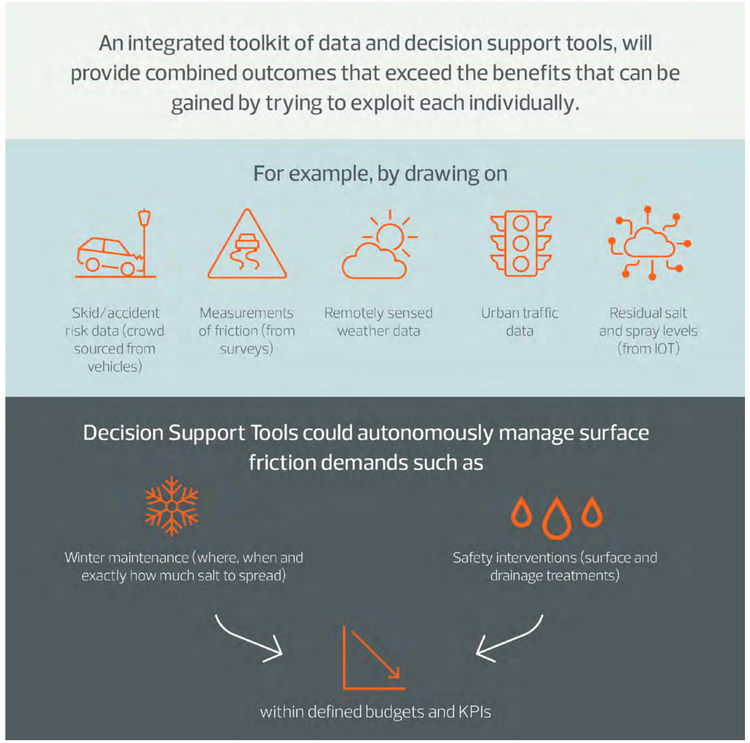


Figure 2: Potential Asset Management Process Using New Data Sources

Key Enabling Factors of the Digital Evolution

Typical strategies, policies and standards for asset management do not currently provide the ability to fully exploit new types of data or technology – for example to support design, planning, operations, reactive and predictive maintenance, understanding of user experience, etc.

Therefore, although TRL's toolkit has suggested a number of steps that could be taken to open up a wide range of uses for new data and technologies, once these have been defined, Asset Data Management Strategy and Policy will need to be upgraded to support the implementation. Data management strategies will need to identify how Asset Data Management Systems should incorporate / integrate / ingest these data. Policies will need to address the uncertainty, accessibility, ownership, format and referencing.

To incorporate new data and technologies in the decision-making process, the standards (e.g., DMRB, UKPMS etc) and the key performance indicators (KPI) used in Asset Management Planning and analysis will need to be re-defined, overarching Asset Management Strategy & Policy updated, and Standardisation achieved for example via ISO 55000.

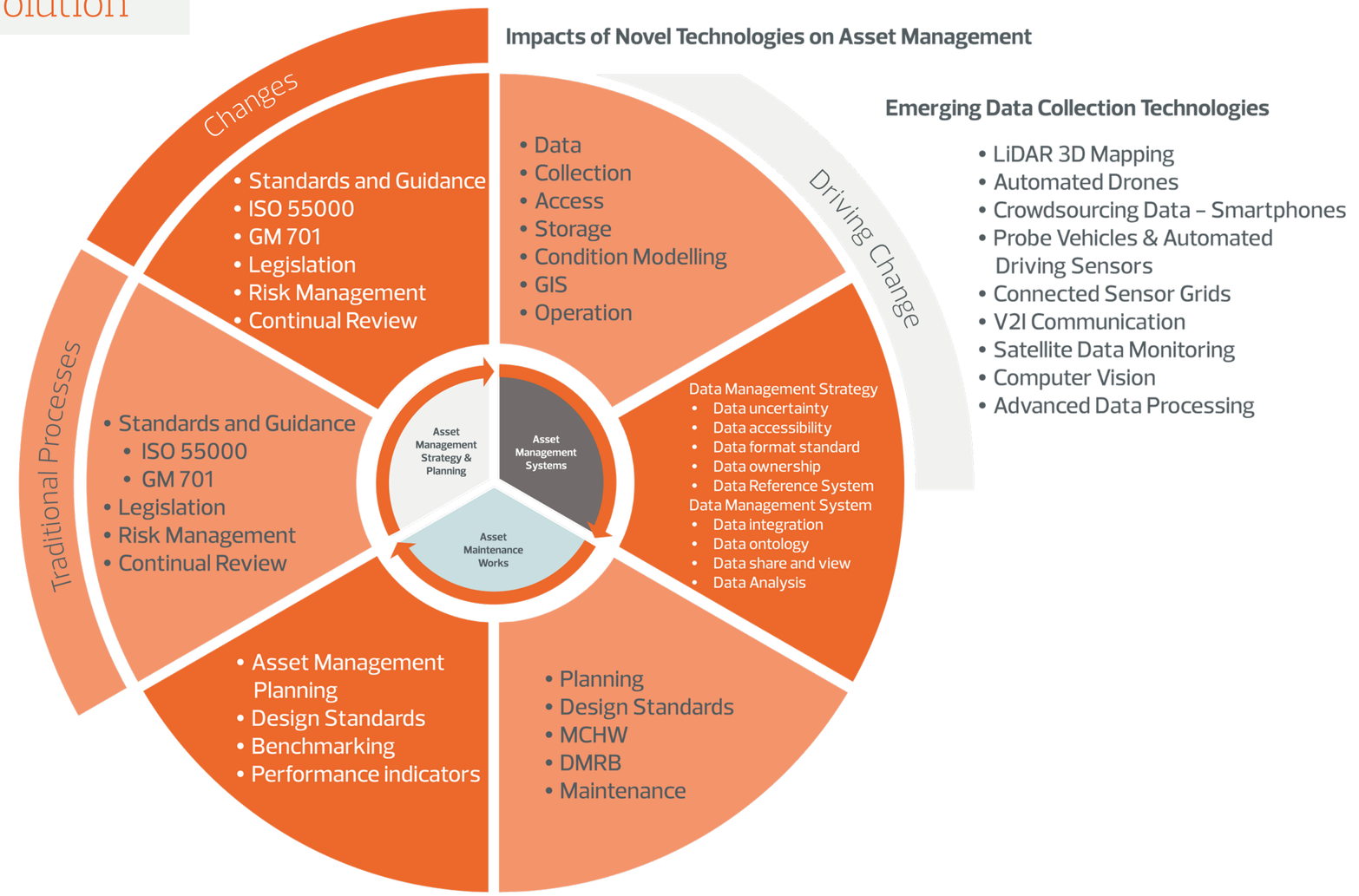


Figure 3: Key enabling factors for Digital Evolution of Asset Management

Five Pillars/Steps/Action for Success

We have identified 5 main steps/actions to support the digital evolution of Asset Management (Fig 4).

Figure 4: Five Steps to Success

Step 1

- WHAT Data is required
- From WHICH Technology
- COST associatied

Identify

The first step will need to establish the uses for the new data within AM, the purpose it will deliver and the costs associated with achieving this. This step requires research, and horizon scanning of data and technologies in collaboration with relevant stakeholders, to identify the types of data that can be collected using different technologies on different Assets, the frequency and format of the data collected, its reliability, quality, and consistency, and the direct and indirect costs of making that data available to AM systems. This step would also identify the ways to leverage new techniques so that they can be integrated with existing processes, and the organisational changes required to implement this.

Step 2

- Framework/Methods for Optimum Efficiency

Evaluate

Step 2 will develop processes to establish the value of the data, in terms of its usability, benefit and cost – drawing on the evidence established in Step 1. To evaluate the technologies and data that will be useful to the Asset Management process is a challenge in itself, due to the rapid and continuous transformation in technology. Hence there will be a need to develop a flexible evaluation model to help Asset Owners to identify/choose/decide their requirements now, and in the future, based on the operational value of the data/technology and the processes they support.

Step 3

- Benefit Cost Model

Business Case

The creation of a Business Case Model that provides justification (Efficiency and Cost) for delivering new data into the Asset Management System could stimulate the investment needed for the required integration or transformation. Once the Evaluation Model is developed, it should be applied to "real life" scenarios to provide the justification for the investment required to implement the changes needed. These business case model should consider the costs of both organisational and systems changes within the organisation (e.g., Asset Owners). At the end of this step, the Asset Owners would have developed a framework to support informed decisions on the data and new technologies that should be incorporated into their Asset Management Process.

Step 4

- Conventional and / New Tech

Integrate / Transform

This step would determine how new data/technologies can be integrated within the existing Asset Management data, processes and systems, and establish the transformation required to draw best value from them. This step should also identify the new/updated standards/specifications needed, and how asset management systems would need to develop to integrate new types of data. New data types are likely to follow a different format than currently used in AMS and may not be easy to integrate with current systems. Hence this step would also explore ways to integrate the data into different types of data management systems, including BIM, to future-proof the inevitable transition to Digital Twins. There have been several research initiatives (e.g., AM4INFRA, INTERLINK, CODEC) which have incrementally delivered progress to establish the processes required to integrate data, provided by a range of different technologies, into Asset Management Systems. However, these projects have also identified the need for greater collaboration between technology/software providers and Asset Owners and Standardising bodies (ISO and IFC) to stimulate progress.

Step 5

- Specification around New Data
- Specification for upgrade existing data collection methods

Implementation

The final stage will undertake the specific actions needed to implement the changes identified and agreed through Steps 3 and 4, delivering the transformation of Asset Management specifications, standards, policy , systems and organisation.

Step 5 is not the end of the process – thanks to ever changing and rapidly evolving technology. However, these five, process driven, steps would not only help Asset Owners make the Digital Evolution happen now, but will also provide a platform for stakeholders to evaluate new data and future technology, and hence make decisions on the ongoing transformation of Asset Management.

Delivering the Vision / Actions for Key Stakeholders

Step 1 Identify

- WHAT Data is required
- From WHICH Technology
- COST associatied

Actions for :
Asset Owners, Asset Managers
Software providers and SMEs

Undertake horizon scanning of data and technologies

Identify the ways to leverage new techniques

Identify organisational changes required to implement that

Step 2 Evaluate

- Framework/Methods for Optimum Efficiency

Actions for :
Asset Owners, Asset Managers
Software providers and SMEs

Develop a process to evaluate the "value" of the data
Evaluate technologies and data that can be useful to the Asset Management process

Step 3 Business Case

- Benefit Cost Model

Actions for :
Asset Owners, Asset Managers
Software providers and SMEs

Create a Business Case Model

Provide justification for the investment needed for the required integration

Step 4 Integrate / Transform

- Conventional and / New Tech

Actions for :
Asset Owners, Asset Managers
Software Providers, SMEs and Standard / Legislative Bodies

Determine how these data can be integrated within the existing Asset Management Data, Processes and Systems

Identify what standards/ specifications need to be changed and how asset management systems need to develop to integrate the new type of data

Step 5 Implementation

- Specification around New Data
- Specification for upgrade existing data collection methods

Actions for :
Asset Owners, Asset Managers
Software Providers, SMEs and Standard / Legislative Bodies

Carry out the changes required in Asset Management specifications, standards, policy, systems and organisation

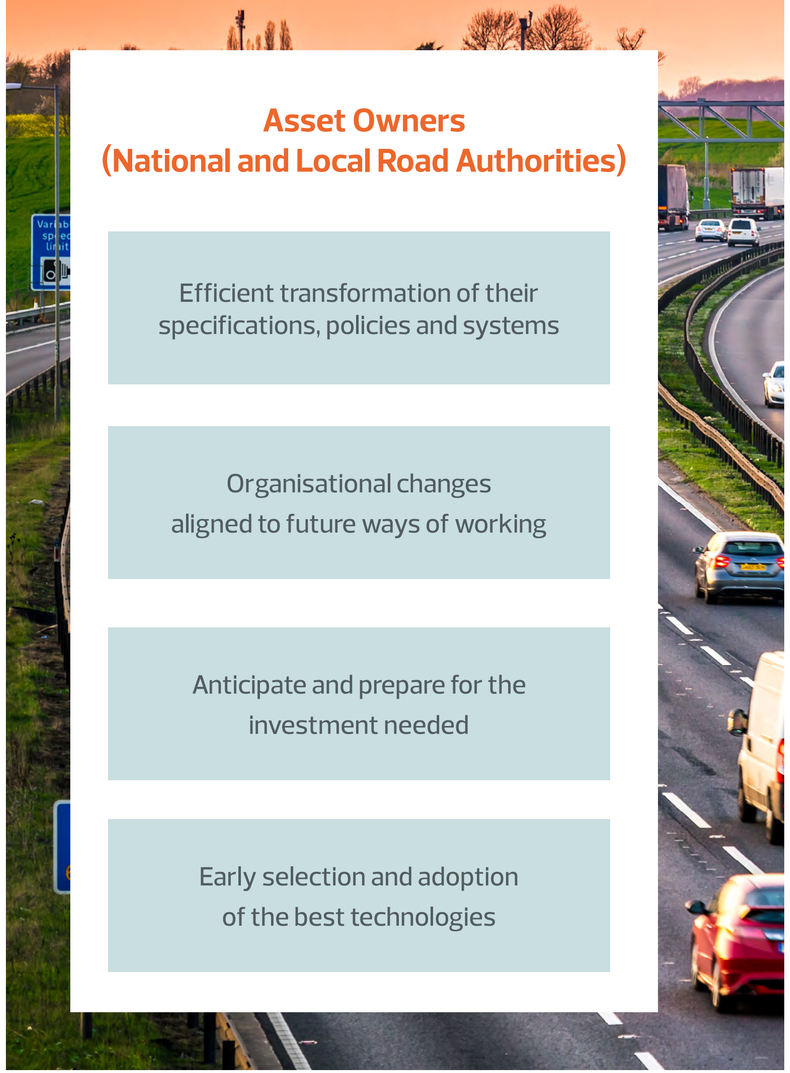
Figure 5 : Key Actions to Deliver the Vision

Digital Evolution Working Group with Stakeholders and Subject Matter Experts (SMEs)

Collaboration between all stakeholders will provide the key to the delivery of this Digital Evolution journey. Collaboration between Asset Owners (e.g NH, DfT, ORR, European NRAs and Local Authorities), Standard/Legislative Authorities (e.g ISO,IFC), Technology providers, and Software companies is essential to successfully make best use of the new technologies and data in Asset Management. As primary stakeholders, Asset Owners could establish a Digital Evolution Working Group or Hub with Subject Matter Experts (SMEs), to bring the industry together to deliver the vision. By establishing a short and a long-term Road Map and collaborative investment programme, research, projects and industry workshops could support the delivery of the five step programme (Fig 5).

Although ongoing developments in technology will help asset owners progress and improve Asset Management, without collaboration to a common objective progress will continue to be sporadic and inefficient, with lessons being relearned across the sector. A joined up collaborative approach will help us to rapidly achieve the benefits of the Digital Evolution of Asset Management.

The Benefits for Individual Stakeholders

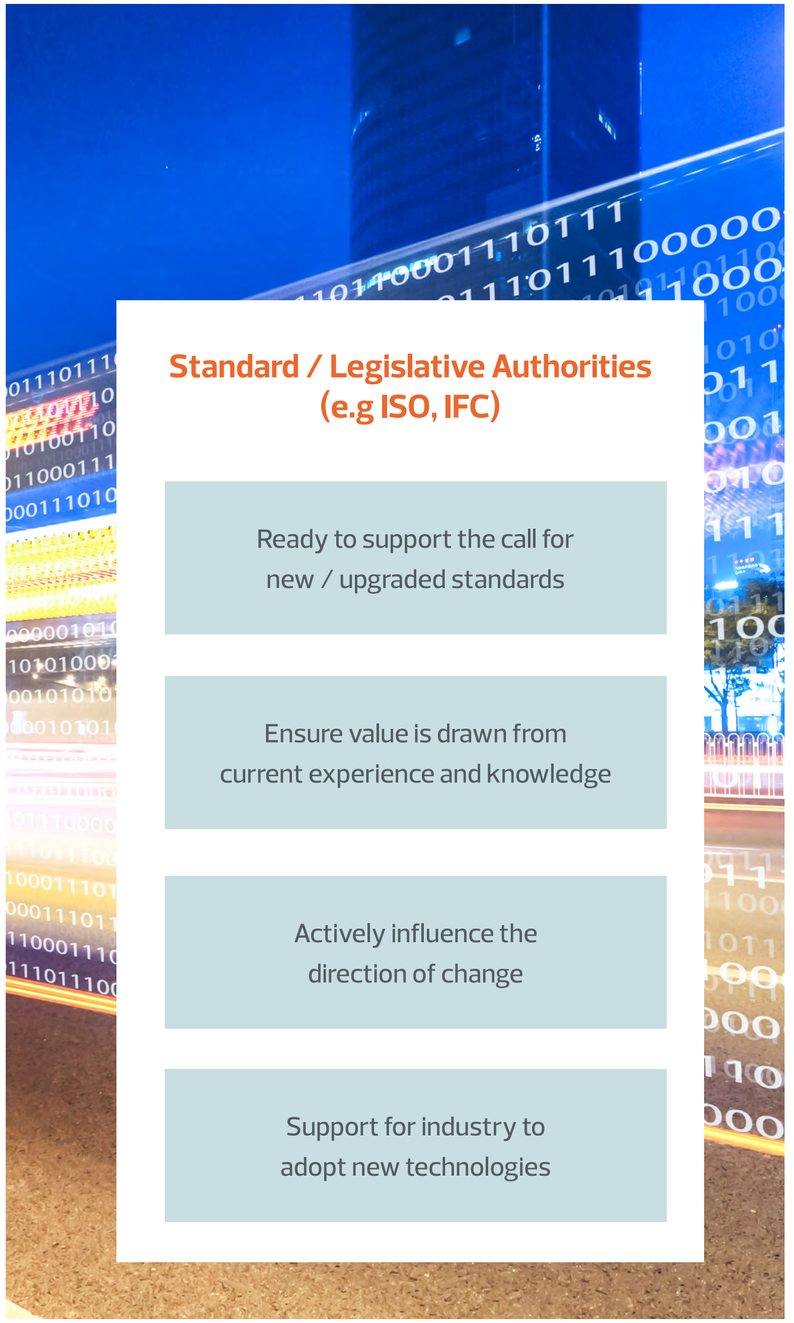


Asset Owners (National and Local Road Authorities)

- Efficient transformation of their specifications, policies and systems
- Organisational changes aligned to future ways of working
- Anticipate and prepare for the investment needed
- Early selection and adoption of the best technologies

Technology & Software Providers

- Scope the emerging opportunities for applying new data
- Foresight of requirements in preparation for system developments
- Skills and knowledge development
- Identify and exploit new business opportunities



Standard / Legislative Authorities (e.g ISO, IFC)

- Ready to support the call for new / upgraded standards
- Ensure value is drawn from current experience and knowledge
- Actively influence the direction of change
- Support for industry to adopt new technologies

About TRL

Our mission: Creating clean, efficient transport that is safe, reliable and accessible for everyone

TRL is a team of expert scientists, engineers and specialists working together with our clients and partners to create the future of transport.

- We publish software that helps the world's largest cities, and many smaller towns too, reduce pollution, carbon footprint and congestion with advanced traffic management, better road design and good asset management
- We conduct leading edge research into infrastructure, vehicles and human behaviours which enables safer, cleaner, more efficient transport
- We deliver detailed incident investigation, structural survey and other high value field services to help clients to improve the service they give their customers
- We work with universities and other partners to invest in basic and applied research that will underpin future needs
- We have built, with partners from government and industry, the Smart Mobility Living Lab: the world's first physical and virtual testbed in a global megacity (London) that lets companies test new mobility products and services safely on live public roads
- Established in 1933 as the UK government's Road Research Laboratory, the renamed TRL was privatised in 1996 and today has more than 1000 clients in many countries. Our headquarters are in Crowthorne House, near Bracknell, and we have offices in Birmingham, Edinburgh, London, Germany and India

Transport Research Foundation (TRF)

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