A future state for the UK motorway network

October 2024

How technology can deliver a safer, more efficient and lower carbon strategic road network

Intelligent Transport Systems UK
Empowering Transport Technology

its-uk.org

Contents

FOREWORD

Colin Wilson
ITS UK Future of Motorway Technology Group Chair

It has been the view of past and present Governments that the future of roads does not necessarily mean 'more roads'. This looks set to be the policy for the strategic road network across all nations and regions in the UK. Clearly, however, this puts the onus on the current infrastructure, and the technology we use, to ensure we can deliver an effective roads system.

With RIS3 on the horizon, and the ending of the Smart Motorway Programme in April 2023, there is a moment of clear reflection for the transport technology sector.

Intelligent Transport Systems UK (ITS UK), the voice of the transport technology sector, convened an expert group to discuss the crucial question – what next for technology on the Strategic Road Network?

The question took us back to the first principles of technology on the road network – why do we require it, what are the benefits and what challenges will come to the further roll out of technology? Through our discussions we set out a 'Future State' for the network – one where technology supports a safe, low carbon and efficient system for all road users.

As we go forward, technology will play a more prominent role in all parts of our lives. Our transport sector has the opportunity to utilise these technologies – from the growth of AI and data services to video analytics – to improve how we travel, increase mobility, reduce the risks of driving and to support the decarbonisation of the transport sector. It provides an exciting opportunity, and one that we must grasp if we are not to be left behind by other countries or industries.

This Report sets out what a Future State could look like for the motorway network, the opportunities that technology can provide and some of the key barriers that we need to overcome. It sets out how we must manage ageing assets on the network, adopt a more holistic, multi-agency approach to technology renewal and prepare for the changes in mobility that we know are coming including connected and automated vehicles. Ultimately this will require a long-term National Motorway Technology Transition Strategy and Programme that learns the lessons from past programmes.

We hope this Report provokes a valuable and insightful discussion on these issues. I would like to thank all members of the Expert Group who contributed to this Report – it would not be possible without them.

Colin Wilson

ITS UK Future of Motorway Technology Group Chair

Executive Summary

Over the years, the UK has invested in many forms of technology to help improve safety, capacity and customer experience, with world-leading success. Yet, the challenges our motorway network faces - congestion, reducing harm and decarbonisation to name a few - continue to grow and evolve. All this at a time when a growing proportion of technology on the motorway network is reaching the end of its operational life.

The state of technology across the Strategic Road Network varies considerably. Facing the challenges of the motorway network will require an approach that works with the various states, including technology that is:

- At or beyond its operational life, which is costly or inefficient to maintain;
- Reaching (or passing) its original operational life but still performing as planned;
- Currently being rolled out across the motorway network;
- Under test and validation in advance of operational rollout;
- Innovative, eg involving AI or relating to connected and future automated vehicles.

Recognising these operational and financial constraints, a working group of experts brought together by Intelligent Transport Systems UK (ITS UK) believes the path to technology-driven solutions must be long-term, planned evolution rather than short-term "big bang" schemes. This evolution must consist of a programme of stages set out below.

Stages of a Programme Summary

Stage 1: Current interventions

- "Keeping the lights on"
- Continue to rollout existing, proven technology
- Develop a long-term programme of renewal technology

Stage 2: Short to medium term interventions

- Prepare for and embrace Connected Mobility
- Align aspirations of stakeholders

Stage 3: Longer term interventions

- Autonomous Mobility in a meaningful proportion of vehicles
- Clearly defined validation pathways

Stage 1: Current interventions:

- **"Keeping the lights on"** - Keep existing motorway technology, which is delivering what it is expected at acceptable costs, operational;
- **Continue to rollout existing, proven technology** where there are clear benefits and acceptable cost;
- **Develop a programme of renewal** to address life expired and/or low reliability technology, but focus on retaining high reliability, low maintenance technology, in a similar approach to that taken by the automotive and telecoms sectors.

Stage 2: Short/medium-term interventions:

- **Embrace Connected Mobility**, rolling this out across the new and existing national vehicle fleet, with the growth of connected mobility expected to gather pace in the coming years;
- **Align aspirations of stakeholders** such as automotive manufacturers and road operators to define:
  - How existing technology can be used to support Connected Mobility;
  - Where additional technology is required on motorways;
  - Build outcomes into broader plans for renewing motorway technology.

Stage 3: Longer-term interventions:

- **Autonomous Mobility in a meaningful proportion of vehicles is a longer-term intervention.** It will require planning to understand at a national level what will be required to support and facilitate autonomous vehicles on motorways, alongside conventional ones and what a realistic, safe and effective transition looks like;
- **Clearly defined validation pathways** (such as on-road trials) to test and validate evolving Autonomous Mobility will be essential. Clear validation pathways, where the public sector authority is supportive and invested, will make for better partnerships between the public and private sector, allowing innovation to flourish.

Delivering these stages will involve cross-cutting activity including:

- Ensuring the safety of everyone "using" the motorway;
- Identification and embedding of national best practice into every aspect of the design, operation and maintenance of motorway technology;
- Comprehensive driver and broader public education ensuring a better understanding of how technology facilitates safe and effective motorway operations;
- Ensuring user behaviour and human factors are at the heart of the design and operation of technology deployed on motorways;
- Asset renewals, with realistic plans for updating life-expired assets. This will require balancing ongoing operational and maintenance costs and performance, with costs of replacement and expected improvements;
- Integration and effective collaboration with the automotive sector;
- Contribution to decarbonisation solutions;
- Continual evaluation and refinement of Corridor and Network Traffic Management strategies as the mix of vehicles evolves over time;
- Digitisation and Digital Services for roads.

To get to this Future State, this report has two key recommendations.

Recommendation 1

Achieving this Future State requires a funded programme of consensus-building, agreement, planning and coordination to ensure appropriate operational consistency is maintained across the UK's motorways, irrespective of the pace at which different road operators progress their own plans.

ITS UK believes that delivering this fundamental consistency will best be achieved through a long-term **National Motorway Technology Transition Strategy.** This would also bring together motorway and local authorities with national and sub-national ones to provide a holistic long-term view on how emerging technologies can be integrated alongside existing ones, in a coordinated and structured way. This will ensure:

- Efficient and cost-effective use of technology
- Safe use and operation of all the national motorway network at all times.

This needs to be based around how technology can deliver commonality across motorways while reflecting each devolved government's own objectives, geographies and operational characteristics. It also needs to embrace cross-border operations at every level.

Recommendation 2

ITS UK recommends that this Strategy is best delivered through a new **National Motorway Technology Transition Programme.** There are several ways to deliver this but we recommend a programme approach which would:

- Ensure a consistent approach to common themes where necessary and appropriate.
- Improve procedures, maturity of business and delivery operationally.
- Allow for the identification and integration of best practice.
- Ensure lessons learned can be quickly integrated into developments.
- Allow different agencies to work towards common goals at different speeds.
- Deliver consistent reporting on benefits and impacts to stakeholders.
- Embrace innovation by supporting test and validation of new technology, to integrate innovations as they emerge and become deployment-ready.
- Support rapid scale-up from research and development through to deployment readiness.
- Coordinate the rollout into business- as-usual operations.

Where next?

ITS UK, as the voice of the national transport technology industry, will seek to work with key decision makers across the transport network to explore how these recommendations can be implemented, particularly ahead of the Road Investment Strategy 3 (RIS3).

If you would like to discuss this report, please contact us via email at contact@its-uk.org

Key Components of the Future State for the Motorway Network

Corridor & Network Traffic Management

- Integrated Logistic Hubs
- Future Operational Control
- Controlled Motorway
- Use of Emergency Refuge Areas and Stopped Vehicle Detection Technology

Digitisation & Digital Services

- Increasing use of data & analytics
- Digitalisation of design, construction & operations
- Connectivity integration

Embedded Best Practice

- CEDR Excellence
- International Learnings
- Sector Bodies, such as ITS UK, TTF and AESIN

Automotive Integration

- Connected Vehicles services
- In-vehicle signage
- Shift to automated mobility

Efficient Delivery

- Skills and resources
- Vision, leadership and strategy
- Project Control
- Scaling up of technology

Operational Technology

- High reliability technology
- Construction Plant
- Focus on renewals

Decarbonisation

- Electric Vehicle Charging
- All Fuels Strategy
- Driver Tools

Guiding Requirements:

SAFETY | CUSTOMER | DELIVERY

02 Scope of this Position Paper

This Report proposes a way forward for transport technology on the UK motorway network, ahead of the Road Investment Strategy 3.

Following the closure of the Smart Motorways Programme, we have explored the potential for technology in responding to a range of challenges on the motorway network, including:

- Meeting ambitions around the elimination of death and serious injuries from UK motorways.
- Meeting net zero emissions goals, including reducing vehicle emissions, zero emission charging/ fuelling options, improving vehicle utilisation and improving public transport services.
- How best to harness the benefits from the proliferation of digital services for motorway design, construction, operation and user interactions.
- How to safely and securely integrate vehicle connectivity and automation as these become prevalent across vehicles.
- Monitoring and managing the lifecycle of the existing road asset; obsolescence, renewals and maintenance.
- Integration of motorways with other networks including local roads and intermodal logistics hubs.
- How to charge users fairly for their use of the motorway network as fuel and vehicle duties diminish with the growth of electrified powertrains.
- Skills and resources; building the investment case and workforce capabilities to exploit fully technology.

Our firm belief is that technology will be a critical contributor to UK's road authorities in achieving their strategic objectives for safety, sustainability, customer service and delivery in a variety of uses including monitoring, management, maintenance, enforcement: and driver/customer information.

Although this report primarily focuses on, and uses examples from, the English Strategic Road Network,our recommendations are applicable to wider UK motorways, including for road authorities in Scotland, Wales and Northern Ireland.

Intelligent Transport Systems UK
Empowering Transport Technology

About Intelligent Transport Systems UK

ITS UK is the national association representing the transport technology industry. ITS UK provides a national platform to support the roll out of technology for a cleaner, safer and more effective transport network, both at home and abroad. We support our 175+ members – from both the private and public sector, and covering all sizes and disciplines – through advocacy to policy makers, connecting people and organisations, promoting the industry overseas and supporting innovation across the intelligent transport ecosystem.

www.its-uk.org

03
Background

A critical challenge in national transport policy is how to meet current growth in demand for the mobility of people, goods and services.

Transport authorities, build, manage and operate road networks to address this challenge, accounting for factors that include safety, sustainability, environmental impact, societal acceptance and cost effectiveness. Their influence means the relative appeal of traditional approaches to increasing network capacity, such as road building or widening, has diminished and alternative options must be considered. What's more, improvements in the sophistication, capability, reliability and value for money of technology for improving safety and efficiency roads mean their breadth and depth has grown.

In 2004, a report from the National Audit Office[1] criticised the Highways Agency's[2] approach as lacking innovation, citing the success of hard shoulder running to increase capacity on motorways in The Netherlands and Germany. So to address the challenge of growing traffic in a safe, sustainable and cost effective manner and responding to this criticism, the Agency implemented the UK's first hard shoulder running in 2006 - the M42 Active Traffic Management (ATM) pilot. Building on existing gantry-based technologies to set variable speed limits, ATM utilised additional technologies to implement, monitor and enforce opening and closing the hard shoulder as an active running lane and to mitigate risks of the loss of the hard shoulder as a continuous emergency refuge. This was a flagship of how technology can help to improve motorway performance.

The success of ATM (increased capacity, improved journey time reliability, reduction in personal injury collisions[3]) led to a wider rollout known as 'Managed Motorways' and, from 2013, 'Smart Motorways'. This is now an umbrella term for where technology is used for monitoring, management (opening and closing lanes), variable speed limits and signs and enforcement (e.g. speed and lane compliance). This description applies to around 10% of the SRN, including some of its busiest stretches. They come in three categories:

- **Controlled motorways:** Introduced in 1995 on the M25, these have three or more lanes controlled by gantry signs and messages. A hard shoulder lane remains.

Dynamic hard shoulder (DHS): Introduced in 2006 on the M42 (as ATM), the hard shoulder can be opened up to traffic at busy periods to increase capacity and maintain journey reliability. Currently, sections of the M1, M4/ M5 interchange, M6, M42 and M62 are configured this way.

- **All lane running (ALR):** First introduced in 2014, all lane running is where the hard shoulder is used as a permanent 'live' running lane. By contrast with DHS, ALR motorways have longer intervals between emergency areas and use roadside variable message signs (rather than always using gantries). Currently, sections of the M1, M3, M4, M5, M6, M20, M23, M25, M27, M56 and M62 are configured as ALR.

DHS and ALR have been particularly controversial with concerns about absence of a permanent hard shoulder increasing risk that a vehicle will stop in a live lane. However, statistics continue to demonstrate all three types of smart motorway are safer than conventional motorways in terms of deaths or serious injuries[4]. Furthermore, while the hard shoulder provides relative safety, it is by no means completely safe with data showing that 8% of all motorway fatalities occurred on the hard shoulder between 2014 and 2017[5].

However, public perception of smart motorways is that they are less safe,[6] reinforced by high profile media coverage of incidents involving vehicles in live lanes. These concerns meant that smart motorways came under scrutiny by the House of Commons Transport Committee and monitoring from the Office of Rail and Road. One area of concern was the shift in approach from the DHS to the lower cost ALR configuration. A 2016 report[7] indicated that the Committee felt that permanent removal of the hard shoulder was a more radical change than being a mere evolution of DHS.

In March 2020, the then-Government announced a package of 18 measures to address concerns about smart motorways. One was for ALR to be the standard for smart motorway schemes following evidence to the Transport Committee in which the then-Chief Executive of Highways England indicated that DHS was "too complicated for people to use".[8] It was asserted that ALR would inspire driver confidence by providing a simpler, more consistent experience and (in free flowing traffic conditions) offers four lanes in which vehicles can operate at 70mph. The package of measures also accelerated deployment of radar-based stopped vehicle detection on motorways without a hard shoulder. This uses radar to detect stopped vehicles and alert control rooms.

Concerns remained and, in January 2022, prompted the then-Government to review the cost and safety of smart motorways and implement a five-year moratorium on future construction to allow additional safety measures to be taken and collection of data on their comparative safety performance. However, in April 2023, it was announced that all future smart motorways would be cancelled due to "financial pressures and in recognition of the current lack of public confidence felt by drivers".[9] As part of the announcement, £900m was confirmed for safety improvements on current smart motorways.

IMPLICATIONS OF THE ANNOUNCEMENT

Whilst the announcement clarified that no new ALR or DHS smart motorways will be built, it is crucial that the UK continues to apply the technologies that have proven their value in the smart motorway programme to deliver safety and efficiency. It also raises questions as to how new technologies such as artificial intelligence or connected and automated vehicles might be integrated to address safety, sustainability and capacity concerns.

[1] https://www.nao.org.uk/wp-content/uploads/2004/11/040515.pdf
[2] 'Highways Agency' was the name for National Highways, before it became a government-owned company (it was called 'Highways England', 2015-2021, and 'National Highways' thereafter).
[3] https://aetransport.org/public/downloads/BBUJg/3937-514ec5c76aa6e.pdf
[4] https://nationalhighways.co.uk/our-work/smart-motorways-evidence-stocktake/
[5] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936811/smart-motorway-safety-evidence-stocktake-and-action-plan.pdf
[6] https://www.autocar.co.uk/car-news/industry-news-tech%2C-development-and-manufacturing/yougov-poll-finds-most-brits-oppose-smart
[7] https://publications.parliament.uk/pa/cm201617/cmselect/cmtrans/63/63.pdf
[8] Response to Q53: https://committees.parliament.uk/oralevidence/9707/html/
[9] https://www.gov.uk/government/news/all-new-smart-motorways-scrapped

04

The role of technology on the motorway network

Our roads increasingly exploit technology to support users in making safe, more efficient, and informed journeys.

The technology on the motorway network is the primary communication platform to road users. Around 34,000 assets make up the digital infrastructure portfolio and play an important role in safe and reliable journeys through:

- **MONITORING** – observing the network to detect incidents that could have an impact on the safety of customers or their journey times.
- **INFORMING** – providing customers with the information they need to make safe and informed decisions.
- **DIRECTING** - controlling the flow of traffic on the network, and where appropriate, enabling enforcement.

As an example, the portfolio of roadside technology assets on National Highways' Strategic Road Network currently includes:

8,750
traffic detectors

4,000
CCTV cameras

10,500
electronic signs

900
traffic signals

1,900
miles of fibre-optic cable

7,200
emergency telephones

The main technology systems are as follows:

Motorway incident detection and automated signalling (MIDAS): This is used to detect queues and manage congestion on motorways. It comprises detectors to monitor traffic. While traditionally inductive loops would be used, many have now been replaced with radar and some magnetometers. Data is then processed through algorithms and rules to automatically set speed limits to slow drivers approaching congestion or queues.

Stopped Vehicle Detection (SVD): This identifies vehicles that have stopped in a live lane, or an Emergency Area (EA) to enable actions to reduce risk for the occupants and other road users. An automated 'report of obstruction' message is set on signs when an SVD alert is raised in the Regional Operations Centre (ROC), until the alert is verified by an operator.

Ramp metering: This manages the number of vehicles joining a motorway at peak periods to prevent or delay onset of flow breakdown by managing the entry slip road.

Closed-circuit television (CCTV): These are used as a surveillance tool to monitor flow and detect incidents. Operators use them to assess and respond to accidents, congestion, and other disruptions.

Variable Message Signs (VMS): Signs displaying real-time traffic information, such as speed limits, lane closures, incident alerts, and recommended routes. They help drivers make informed decisions. Signs have words and pictograms displayed whereas signals are lane specific informing drivers, if the lane is available or not, or if a change in direction or speed is needed, for example.

Emergency roadside telephones: These are installed at regular intervals on the motorway, enabling road users to communicate with control centres in the event of an emergency, breakdown or for assistance.

Fibre-optic cable: The backbone of the network that operates and maintains the telecommunications services, linking the roadside assets to the Regional Operation Centres (ROCs) and the National Traffic Operation Centre, enabling the operator to manage and operate the network safely and efficiently.

Enforcement cameras: Camera systems that are strategically located to provide automatic detection of speeding violations and red X lane infringements.

Rules-based Incident Response: Such as those run by Traffic Scotland and CHARM (automatically setting VMS, variable speed limits, and lane closures in response to an incident).

BENEFITS OF OPERATIONAL TECHNOLOGIES

These technologies form part of the current services on motorways for monitoring, informing and directing, and deliver benefits in the following ways:

A. Safety

On the motorway network, systems such as SVD enhance the earlier detection of stationary vehicles and incidents on motorways, appropriately informing the operations centre. Once this stopped vehicle alert is verified, action may be taken to close traffic lanes, using a Red X signal, and set speed limits. SVD mitigates the risk of a secondary incident due to a stopped vehicle, and not the risk of a stopped vehicle event in the first place.

Similarly, MIDAS identifies the presence of a queue, and, based on rules using traffic data as input, automatically sets mandatory speed limits to slow down the traffic and protect the end of the queue. In an early study, it was estimated that the MIDAS queue protection system results in a 13% reduction of incidents. As part of this service, VMSs are vital for appropriate and timely information to road users. The forthcoming ability to share information directly with vehicles' systems will provide the ability to not rely solely on roadside infrastructure, to further increase safety in cases of stopped vehicles or queues.

Even though CCTV is not continuously

monitored, it provides an additional tool to directly monitor incidents, and accelerate response and management.

B. Efficiency & Capacity

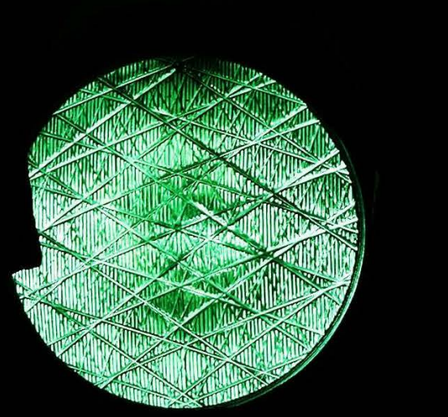
Technology can significantly reduce delays via:

- Less congestion and improved traffic;
- Higher throughput during peak periods; and
- Smoother and more reliable journey times.

SVD and CCTV also benefits efficiency, by improving management of incidents as operators are better equipped to respond quickly, reducing the congestion due to reduction in road capacity (i.e. closed lanes).

C. Road user satisfaction

On English motorways this is measured through the Strategic Roads User Survey (SRUS), conducted by Transport Focus. The questions measure journey time, feeling of safety, information/signage, roadworks management and general upkeep of the road (e.g. satisfaction with road surface). Technology informs all of these factors, and can be utilised to improve the user satisfaction scores.



Safety is a key priority for the transport network, helping to contribute to the goal of zero harm by 2050. Operational technologies and services play a key role in this.

05
Current Strategies and Policy for Motorway Technology

Several Government strategies and policy documents together with those generated by National Highways and other transport authorities have synergies with this paper.

Details of the references are in the Appendix. A summary of the conclusions and recommendations of these strategies are:

GOVERNMENT STRATEGIES

UKNET: The UK Government recognised the need for a UK wide strategic transport network (UKNET) in the Union Connectivity Review. This will combat issues where the costs and benefits in different nations lead to different scheme priorities. This would be a multi-modal, pan-UK network based on a series of principal transport corridors with the aim to improve journey times, cost, reliability, frequency and the environmental impact of their travel.

Transport Data Strategy: In the Transport Data Strategy the DfT aims to harness the benefits of data to help grow and level up the economy, reduce environmental impacts and improve transport for the user. This report recognised that transport data resides in silos and is not shared. The review recommends interventions to see faster change in data enabled innovation in transport to help solve key societal challenges, and create seamless, low emission, less congested journeys through integrating transport systems.

The role of the SRN in Government's Strategies

The SRN is said to have an essential role in supporting the Government's Net Zero commitments. Policies aim to reduce car dependency, increase the safety, reliability and efficiency of journeys. Government has also recognised that the UK transport network must work for everyone. Papers have specifically identified that:

- Mobility innovation must help to reduce congestion through more efficient use of road space.
- New mobility services must operate as part of an integrated transport system.
- Data from new services must be shared where appropriate.
- A changing age demographic is impacting transport. Not all users are comfortable with technology, and some may not be able to afford it.
- There are proven health benefits when people are supported to get around, helping to combat loneliness, for example. There is a rise in on-demand public services.
- There is public perception of invasion of privacy if more journeys are monitored and data collected.

The Government also supports the rollout of self-driving vehicles with a new Automated Vehicles Act passed in May 2024. In the Act, the Government has set a cautious approach to ensure safety, particularly focusing on resolving access to data issues, verifying road-worthiness, legal liability and insurance implications.

They have also set out the need for self-driving vehicles to have well-maintained roads and signage, nationwide connectivity, and up-to-date digital information about the road network.

TRANSPORT AUTHORITY STRATEGIES

Alongside UK Government Strategies, a summary of transport authority strategies, generally, set out to:

- Improve sustainability by increasing choices for travel, adding capacity through technology rather than civil engineering and facilitating low carbon travel;
- Increase safety;
- Operating increasingly connected roads, more proactive maintenance, making technology more resilient and investing to deliver safer, more reliable journeys; and
- Evolving customer and community services by improving information provided to customers.

National Highways Strategic Vision 2050: This sets out how the SRN in England will be part of a seamlessly integrated transport system that meets customers' needs. It does this by connecting the country safely and reliably, delivering economic prosperity, social value and a thriving environment. It sets nine key principles, amongst which they introduce the concept of national CAV-enabled corridors.

National Highways Digital Roads Strategy: This states that the organisation will harness data, technology and connectivity to improve the way the SRN is designed, built, operated and used. One core area is Digital Operations which focuses on intelligent asset management, enhanced operational capability and digitally enabled workers.

Digital For Customer: This is National Highways programme for delivery of information (accurate, consistent, and close to real time journey information), customer engagement (receive better quality data from customers) and partnerships and alliances (work with others to improve customer experiences).

National Highways Operational Technology Strategy: This supports all the main aims above and also picks out the following specific areas:

- Continue to enhance speed of response to incidents by 2030;
- Eliminate implementation of roadside technology requiring maintenance by 2035;
- World leading seamless end-to-end management of operational technology by 2035; and
- Be a leading advocate of regulatory change to support in-vehicle technology by 2035.

Scottish ITS Strategy: The Scottish Future of Intelligent Transport Systems Strategy was issued in 2017. This cited a 10 year plan to support four priority areas:

- Investing in people and infrastructure in a sustainable way;
- Foster a culture of innovation and research and development;
- Promote inclusive growth and create opportunities through a fair and inclusive jobs market and regional cohesion; and
- Promote Scotland on the international stage to boost trade and investment, influence and networks.

This is aligned to Scotland's Strategic Priorities and the overall National Transport Strategy outcomes. These are to deliver a safe and efficient network, inclusive, sustainable economic growth, embrace innovative solutions and be customer focused.

The Strategy concentrated on six themes:

- **Theme 1:** Asset Management and Operational Services - making the most of ITS already installed;
- **Theme 2:** Quality Traffic and Travel Information - for individuals and information service providers;
- **Theme 3:** Environment and Sustainability – using ITS to complement initiatives on air quality and alternative fuels;
- **Theme 4:** Intelligent Mobility, including Connected and Autonomous Vehicles – adapting to the expected increasing presence of CAVs and the broad needs and potential effects that might result from Mobility as a Service;
- **Theme 5:** Economy, Connectivity and Freight – assisting the path of goods to market whilst reducing detrimental effects of freight traffic with technology;
- **Theme 6:** Data, Innovation and Collaboration using communications, connectivity, analytics, security, and asset management information.

There is a willingness within Governments to improve the safety and customer experience across the UK roads to provide more accessible, reliable, efficient and sustainable travel options for all users.

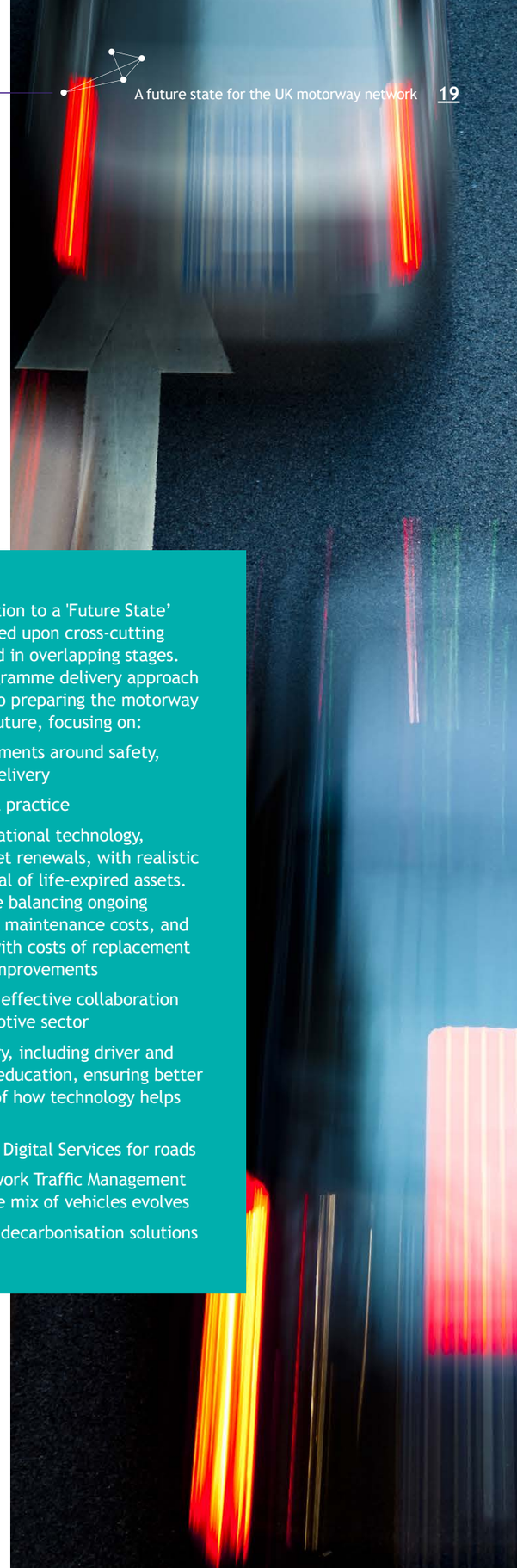
06
The Future of Motorway Technology

Over the coming years, technology and digitisation will continue to evolve and be increasingly important in the design, construction and operation of the motorway network.

Meanwhile, the needs of customers and service providers will continue to change with a growing appetite for digital services and greater information. AI, decarbonisation, connectivity and automation are all set to impact the UK's roads in unforetold ways.

We foresee evolution to a 'Future State' of motorways based upon cross-cutting themes embedded in overlapping stages. We believe a programme delivery approach should be taken to preparing the motorway network for the future, focusing on:

- Guiding requirements around safety, customer and delivery
- Embedding best practice
- A focus on operational technology, particularly asset renewals, with realistic plans for renewal of life-expired assets. This will require balancing ongoing operational and maintenance costs, and performance, with costs of replacement and expected improvements
- Integration and effective collaboration with the automotive sector
- Efficient delivery, including driver and broader public education, ensuring better understanding of how technology helps safety
- Digitisation and Digital Services for roads
- Corridor & Network Traffic Management strategies as the mix of vehicles evolves
- Contribution to decarbonisation solutions



Key Themes of a Future State

GUIDING REQUIREMENTS

Motorway technologies can allow operators to communicate in a far more nuanced and effective manner to improve the safety, efficiency and capacity. This needs to be managed carefully to avoid distraction and cognitive overload but being able to provide driving-relevant, vehicle-specific, lane-specific information to drivers will allow them to use motorways more effectively, confidently and safely.

EMBEDDING BEST PRACTICE

The Future State will only be delivered effectively with collaborative engagement and delivery across Government, the public and private sector. This means adopting proven programme management methodologies and utilising experience in successful delivery of technology to mitigate risks of scope creep, cost overruns and under delivery. All programmes should seek to embed the Future of Mobility Strategy principles.[10]

The future state of the motorway should include a transition of the motorway management from reactive to proactive. Instead of reacting to events or incidents, road traffic authorities shall be able to take preventative measures minimising the likelihood of incidents or, at least, minimising consequences. This is important for a range of factors, including road safety, for congestion management and net zero.

Engaging with UK industry associations who provide a national platform for expertise, will be critical. Organisations active within the transport technology and automotive electronic systems sectors include:

- Intelligent Transport Systems UK (ITS UK);
- The Transport Technology Forum (TTF); and
- The Automotive Electronic Systems Innovation Network (AESIN)

Embedding best practice will also require embracing international practice, such as tunnel systems technology in Nordics, Sweden & Switzerland.

[10] https://assets.publishing.service.gov.uk/media/5dcd8417ed915d071ca239e9/future-of-mobility-strategy.pdf

Future of Mobility Strategy: Principles[11]

1. New modes of transport and new mobility services must be safe and secure by design.
2. The benefits of innovation in mobility must be available to all parts of the UK and all segments of society.
3. Walking, cycling and active travel must remain the best options for short urban journeys.
4. Mass transit must remain fundamental to an efficient transport system.
5. New mobility services must lead the transition to zero emissions.
6. Mobility innovation must help to reduce congestion through more efficient use of limited road space, for example through sharing rides, increasing occupancy or consolidating freight.
7. The marketplace for mobility must be open to stimulate innovation and give the best deal to consumers.
8. New mobility services must be designed to operate as part of an integrated transport system combining public, private and multiple modes for transport users.
9. Data from new mobility services must be shared where appropriate to improve choice and the operation of the transport system.

[11] https://assets.publishing.service.gov.uk/media/5dcd8417ed915d071ca239e9/future-of-mobility-strategy.pdf

A FOCUS ON MOTORWAY OPERATIONAL TECHNOLOGY AND ASSET RENEWALS

An ageing asset with obsolescence, performance and reliability problems requires regular maintenance and renewal. Issues can also be compounded by poor resilience within power and communication networks.

However, this offers an opportunity to deploy high reliability, zero maintenance technology and embrace standards from the automotive & telecoms sectors. The opportunity to deploy 'standalone' traffic management systems to monitor, control & inform traffic at construction sites provides the chance to integrate construction plant and automation into renewals with safety, cost and programme benefits.

As the UK Government plans for RIS3, there needs to be a renewed focus on poor reliability. For example, typically more than 22%[12] of VMS and Lane control technology on the SRN is 'not live' at any one time.

UK Government should set out additional funding for operational technology maintenance and renewal based on the procurement of high reliability, very low maintenance solutions.

INTEGRATION AND EFFECTIVE COLLABORATION WITH THE AUTOMOTIVE SECTOR

Greater collaboration between the wider roads sector and the automotive industry could yield significant benefits. For in-vehicle services, there is scope to make greater use of current technologies. eCall is already extensively deployed and can automatically provide alerts for stopped vehicle hazards on the SRN but is not yet utilised. Similarly, allowing greater connectivity between vehicles and infrastructure is enabling a shift to in-vehicle messaging, where the driver can be alerted to changing conditions thereby reducing reliance on roadside signage. In-vehicle messaging is more eco friendly and can provide greater information to road users and operators too.

Connected and Automated Mobility (CAM) will also have a significant impact. There are now increasing levels of automation of driving and vehicles have increasingly advanced driver- assistance systems (ADAS). Over the coming years, we will see more and more automated driving with benefits to safety and driver comfort. However, there are also new risks that might emerge, particularly relating to transitions between automated and human control and misunderstanding about automated driving.

Adoption will take place over time and policy makers need to consider that, even in the long term, roads will continue to have a mix of vehicle types. These include unconnected vehicles; connectivity enabled vehicles such as through devices like smartphones; fully connected vehicles and fully autonomous vehicles. This means roads will need to be flexible and adaptable, and not adopt a 'one size fits all approach'. In particular, those who don't have access to connected vehicles may be the more vulnerable that society has a responsibility to help.

A National Connected Vehicle Strategy is required. The DfT's Connected Vehicle Strategy Report (2020) should be revisited and developed further[13]. The communications systems needed to support connected vehicles need to provide sufficient coverage (signal, bandwidth and latency) to deliver quality connected services, so there should be a focus on improving coverage at a basic level rather than pockets of high performance. There is also a concern that connected vehicle services are not being utilised due to the siloed nature of vehicle manufacturers, mobile network operators and road operators.

EFFICIENT DELIVERY

Success will be, in part, due to a skilled and effective workforce. This requires continued support particularly in STEM, and a commitment to continuous professional development. A strong domain knowledge, with relevant technical and delivery experience, will be essential in delivering the Future State. Crucially, changes facing motorways will require new education for road users as to how technology can support their journeys. This will require 'taking the public with us' through effective communications.

Efficient delivery will also require the 'scale up' of demonstrator projects and accelerator programmes as often, successful trials are delivered with no following steps to the future roll out. Efficiency will require repeatable, building block delivery of successful schemes, helping to reduce costs.

Vitally, the Future State will require leadership and vision, with a strategy and effective project controls.

DIGITISATION & DIGITAL SERVICES

As technology develops, we will continue to see enhanced digitalisation and digital services enabling a better understanding and use of the road network. Big data analytics is already having far reaching impacts, with more data sources from ITS, mobile and automotive equipment than ever before. Design, construction and operation will increasing become digitalised, and as new technologies like quantum and emerging LEO Satellite constellations come online, there will be even greater scope to enhance the services we provide to road users.

CORRIDOR AND NETWORK TRAFFIC MANAGEMENT STRATEGIES

The Smart Motorway programme formed a technology solution to address capacity and congestion issues. Its cancellation leaves a void. But historically, much of the technology on the SRN such as controlled motorways addressed safety rather than capacity. This remains valid today.

With evolving connected data and service provision, traffic management and control could eventually be replaced by automatic real-time control system with every vehicle movement known and guidance to vehicles and drivers projected second by second. As technology evolves, the live condition of motorways will always be visible and other forms of detection and monitoring will become obsolete. Most vehicles will be connected with guidance and alerts to drivers and direct control interaction, for example, slowdown in response to a hazard ahead, communicated to a driver (manually driven or automated). This will require a step change in traffic management systems driven by AI.

Going forward, there needs to be a renewed focus on:

- Journey time reliability (such as through the continued roll out of Controlled Motorways);
- Transport integration, including through logistic hubs, rail, ports and local authority roads; and
- Delivering traffic operations of the future and more traffic officer services.

CONTRIBUTION TO DECARBONISATION

The Government mandate to end the sale of petrol and diesel vehicles by 2035 will require greater investment in vehicle charging and alternative low carbon fuel infrastructure. Completion of a national EV charging network is required.

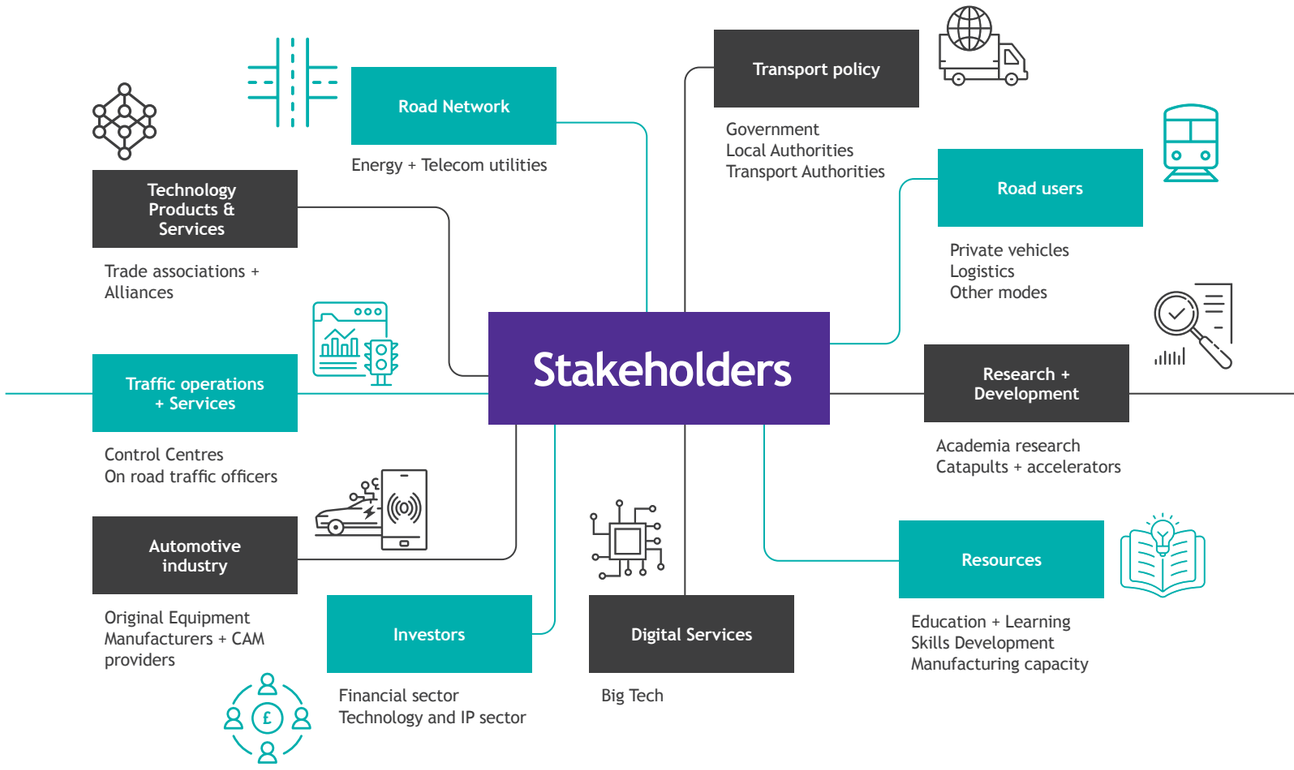
There will also be a mix of fuel types, including electric, hydrogen and internal combustion engines. This means the road network will need to be flexible and adaptable, and yet again not adopt a 'one size fits all approach'.

Crucially, industry will need to consider low-environmental impact interventions.

Traffic authorities are continuing to assess how they can increase capacity without large scale civil engineering, due to environmental impact. There will also be a need to use existing technology to greater purpose or implementing newer technologies with lower footprint. Reducing the infrastructure burden with lower maintenance and greater service life solutions will also be key.

WHO DO WE DELIVER THIS WITH?

Delivering the Future State will require collaboration. The stakeholder community is broad and diverse as shown below.



[12] NTIS DATEX II Service, VMS and Matrix Signals data feed

[13] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/937425/SPATS-Framework-Connected-Vehicle-Data-Research-Project-accessible.pdf

07

Constraints and barriers - and how we overcome them

To achieve the Future State set out in Chapter 6, we need to consider constraints and barriers ahead, and what the industry can do to overcome them.

A. SILOES

There is also often a divide between the ultimate goal (safety, efficiency, net zero) and the willingness to adopt new technologies.

There is also a lack of understanding of roads by automotive and data professionals, and vice versa. Often the industries speak a different language, use different standards and methodologies, and consequently make assumptions that are often wrong. Far better cross understanding is needed so that, for example, ADAS in vehicles works well on imperfect roads, and that road authorities understand the opportunities of data from vehicles.

In addition, there are siloes between the road safety community, the roads operations and technology community and users. A better understanding would enable better acceptance.

What is the solution?

All parties need greater understanding and engagement. Road operators should present a clear point of contact for future technology and industry bodies and forums should focus on better co-operation. This will also stop duplication of work, which often occurs due to lack of awareness of developments elsewhere.

B. OBSOLESCENCE OF CURRENT TECHNOLOGY

Many of the CCTV, VMS and signals on the network were installed 30 years ago and have a 30 year design life. They were installed with the expectation that either connected vehicle services would be ubiquitous or that better infrastructure would have come along that is more affordable. Yet, neither scenario has emerged and now much of the equipment is hard to maintain as it uses older technology. In addition, the skills to install and maintain this older technology are no longer taught, and there are fewer professionals with the necessary capability. And whilst data from vehicles could replace sensor data (for example in MIDAS), messaging to drivers will need safety-critical legally enforceable technology for some time.

This equipment also provides an opportunity. We can use current infrastructure and efficiently manage motorways through data analytics, with machine vision and AI to support better operations.

The hiatus and ending of the Smart Motorways Programme has impacted the supply chain. The finishing of the rollout means there has been little incentive for the supply chain to develop new technology that may not have a client. Worse still, as an innovative nation, we're now facing the very real prospect that any ITS innovations are more likely to be adopted by other countries far more quickly than our own.

What is the solution?

Going forward, we need this technology to work in the “messy middle” between todays’ world and the future connected “naked roads” for a considerable time. Industry will need to decide whether to replace time expired equipment like for like, try to keep it working for an unknown future time or accelerate connected services (eg CCTV from vehicles rather than poles) – or a combination of these.

C. COST OF TECHNOLOGY

Roadside technology like a CCTV camera isn't just the cost of a camera - it's the pole it sits on, power, comms, a hard standing for maintenance and maintenance costs. And it includes the cost of systems maintenance and fragmentation in the market, in the case where systems are not interconnected. A rough estimate shows that the whole life cost of a CCTV camera over 10 years could be around £100,000. Smart motorways moved from a largely technology led basis, to major civils work with the installation of concrete barriers at the same time. Equally, installation costs, access to sites, and communications costs all add to the whole cost of any roadside infrastructure.

What is the solution?

This is an issue that will continue to need both industry and public sector engagement. A focus on effective procurement, visible pipelines, continuous learning and economies of scale from larger schemes will help.

Moving to an 'all information in one system' approach, that provides analytics for all parameters - operational efficiency, road traffic, costs etc in real time, will also be important.

D. BUSINESS CASE

Many new technology solutions delivered across the world have significant safety and operational benefits. However, the business case in many instances have a tendency to show net disbenefits when using the Government’s standard BCR appraisal process.

What is the solution?

The Government should look at reviewing how the business cases for new technology solutions, including controlled motorways, are assessed in order that safety and operational benefits are taken into account.

E. PUBLIC ACCEPTANCE AND USER BEHAVIOUR

Throughout motorway history, compliance has been an issue. Mandatory speed limits and enforceable red X signs have started to change this, but compliance is still poor despite education. Getting user behaviour right will be increasingly essential as we move to in-vehicle technology, as drivers will need to follow messaging and warnings, and eventually, understand the safety requirements around automated vehicles.

A key lesson from the Smart Motorway Programme was a need to focus on user behaviour and how members of the public perceive technology. Although perceived as being unsafe, these roads are, in many ways, some of the safest in the country.

What is the solution?

There may be considerations around penalties and use of technology that could improve compliance, but fundamentally, it is clear we need to get the public, and media on board.

A greater focus on behaviour will be required across transport, as more technology feeds through. Greater support and focus for behavioural science and human factors will be essential.

F. REQUIREMENT TO UPDATE STANDARDS

As we shift from the internal combustion engine (ICE) to electric and hydrogen vehicles, we will need new standards and policies to suit new roads. For example, the design of crash barriers is based on 1980s vehicle weights, but todays SUVs have far more kinetic energy as they weigh more.

What is the solution?

Standards will continue to need review, in partnership with industry.

Going forward, with vehicles being able to brake much more rapidly than the Highway Code data suggests, with automatic emergency braking, we may need to review MIDAS configuration or consolidate with other technology to support better queuing interventions.

G. DEMOGRAPHICS

The future population demographics are changing with a more elderly population, and an increasing percentage of younger people in urban areas. There are health benefits from ensuring that people are not isolated, so availability of mobility options in all geographic areas is key. This leads to challenges for technology to ensure that motorways are available to all.

The older population may be at a disadvantage as they are more likely to be uncomfortable with technology, and may not have access to devices. Those on low incomes or in socially deprived areas are also potentially excluded due to the costs of accessing the systems.

What is the solution?

It is essential that an integrated transport network ensures that mobility options are available for all. Public sector bodies and industry will need to ensure it's catering for all digital abilities and demographics.

08
Conclusion

Technology has a key role to play for many of the challenges facing the motorway network. These include helping to ensure operation remains safe, effective and efficient as the vehicle fleet's connectivity and their powertrain changes.

In this paper, ITS UK has set out an approach to help address these challenges, embracing the broad range of technology which is, or could be soon deployed:

- Older technology at or beyond its operational life which is costly or inefficient to maintain;
- Similarly ageing technology reaching (or even passing) its original operational life but still performing essentially as planned;
- Proven technology currently being rolled out across motorways;
- New technology under test and validation in advance of rollout;
- Technology innovations such as artificial intelligence which, subject to successful testing and validation, could be deployed in the near future.

There will be operational, financial and legal constraints to rolling out a technology solutions, so this paper advocates a long-term, planned evolution, focusing on three stages, including current interventions, preparing for connected mobility in the short to medium term, and focusing on automated mobility in the longer term.

Delivering these three stages will involve activities across a number of cross-cutting themes of activity, set out on Page 5, which will need to be considered in tandem as part of the journey to the Future State.

RECOMMENDATIONS

To achieve the above, we believe there needs to be a long-term National Motorway Technology Transition Strategy, bringing together local authorities with national and sub-national transport authorities to provide a holistic long-term view on how emerging technologies can be integrated alongside existing technology in a coordinated and structured manner for:

- Efficient and cost-effective use of current, emerging and future technology
- Safe use and safe operation of all parts of the national motorway network.

This Strategy should be based around how technology can deliver the operational commonalities across the motorway network in England, Scotland, Wales and Northern Ireland while also reflecting each devolved government's own strategic objectives, network geographies and operational characteristics.

Secondly, ITS UK recommends that this Strategy is best delivered through a new National Motorway Technology Transition Programme. There are several ways to deliver this strategy but recommends a programme approach for:

- Consistent approach to common themes where necessary and appropriate
- Improved operational procedures, maturity of business and how it delivers an operational service.
- Integration of best practice
- Lessons learned can be quickly integrated into developments
- Allowing different agencies and schemes to work towards common goals at different speeds
- Consistency in reporting benefits to all stakeholders
- Rapid scale-up from development, piloting and evaluation through to deployment
- Embrace innovation by supporting test and validation of new tech
- Look to integrate relevant innovations as they emerge and become deployment-ready – eg remote management of vehicles
- Coordinated rollout into business-as-usual.

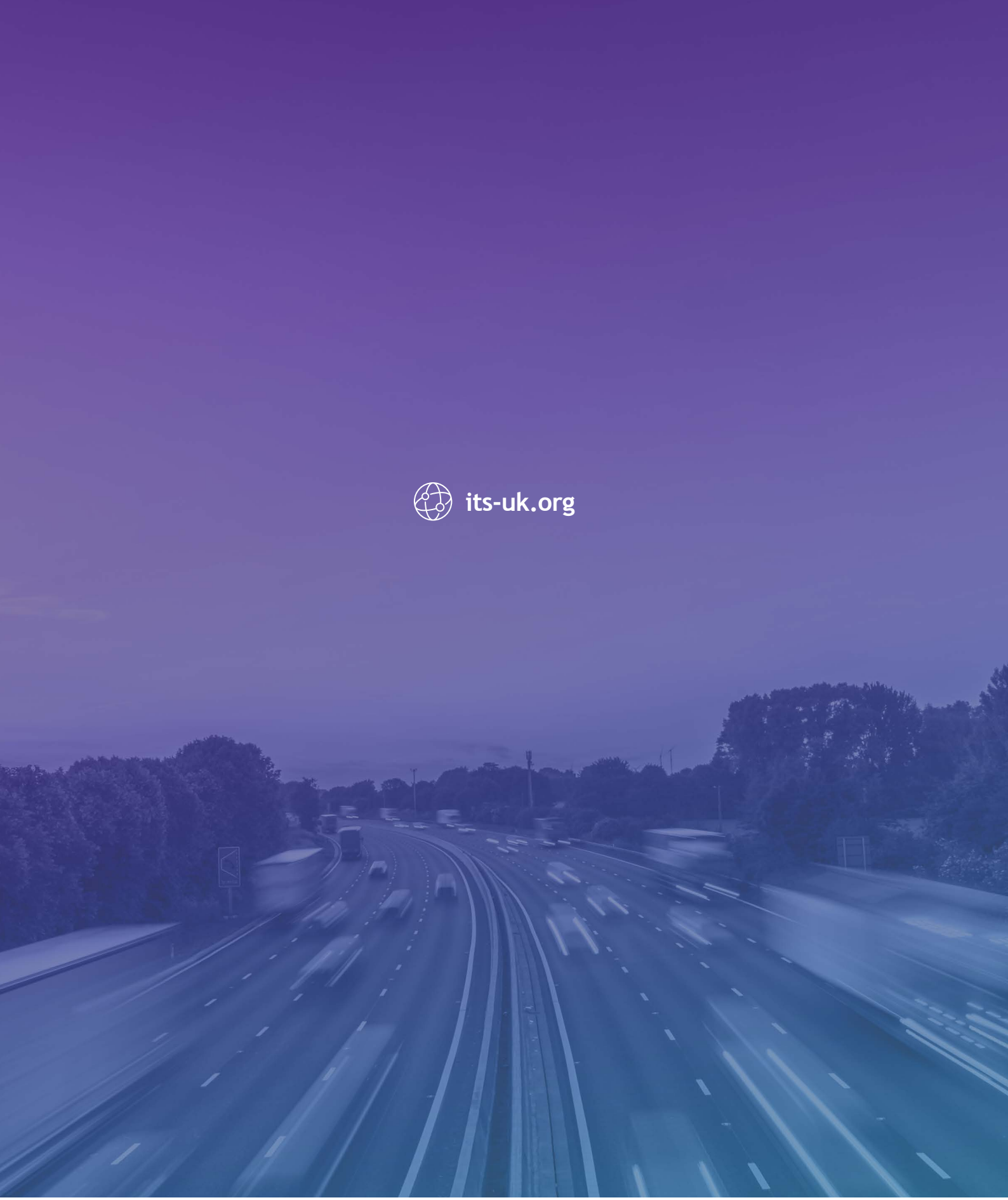
We look forward to working with Government, transport authorities and all key partners to support a National Strategy and Programme for Motorway Technology.

Contributors

ITS UK would like to thank the following members of the Future of Motorway Technology Group.

Chair: Colin Wilson, Director – UK and Ireland Transport Technologies Lead, Intelligence, Arcadis
George Brown, ITS Consultant, KL Systems
Mohammed Dakri, Technical Director, Amey
Louise Early, Marketing and Commercial Director, Navtech Radar
Sam Glaze, Principal Safety Consultant, TRL
Andy Graham, Principal, White Willow Consulting
Steve Hardcastle, Chief Technical Officer, Clearway Group
Allan Hill, ITS Consultant, Get Journey Smart
Sue Openshaw, Professional Head ITS Solutions, Jacobs
Eduardo Pitts, Public Affairs & PR Executive, Intelligent Transport Systems UK
Dr Nick Reed, Founder, Reed Mobility
Richard Schofield, Consultant, Banktop Consulting
Max Sugarman, Chief Executive, Intelligent Transport Systems UK

Observers
Vivi Michalaki, Head of Intelligent Transport Systems, National Highways
Stephen Davies, Head of ITS Operations, Transport Scotland



Intelligent
Transport Systems UK
Empowering Transport Technology