

Digital innovation: The route to the highways systems of the future

October 2017



Foreword

Firstly, I would like to express my thanks to everyone at ADEPT and our project partners – EY, Ringway, O2 – who have all undertaken to support the acceleration of digital innovation across our highways systems.

The Government has set out ambitious plans for the UK to be at the forefront of global digital technology and innovation. An effective, sustainable, digitally-enabled highways system is a central part of this vision to which the Government has committed unprecedented levels of investment, we welcome the Government's recently published Clean Growth Strategy, which highlights the transport sector as a major focus for investment in innovation.

However, we fully recognise that to be truly effective, our vision needs to be delivered locally in all our regions, cities and communities. In England, that requires all 150 Local Highways Authorities to be enthusiastic champions and advocates of change.

Aimed at the Government and the numerous public, private and community players in transport and mobility, this report provides an analysis and many practical suggestions for improving digital infrastructure and services across the highways network. It articulates a number of initiatives Government will consider as we 'Move Britain Forward' and aims to encourage further conversation on this area.

I hope this report is well received by all those involved in bringing the highways systems of the future to fruition. I expect local authorities and their partners to play a full and positive role in UK mobility, and to continue to be a major contributor to the achievement of national priorities and programmes into the 2020s and beyond. This report provides considerable material to support that aim.

Simon Neilson
ADEPT President 2017/18



ADEPT partners



Contents

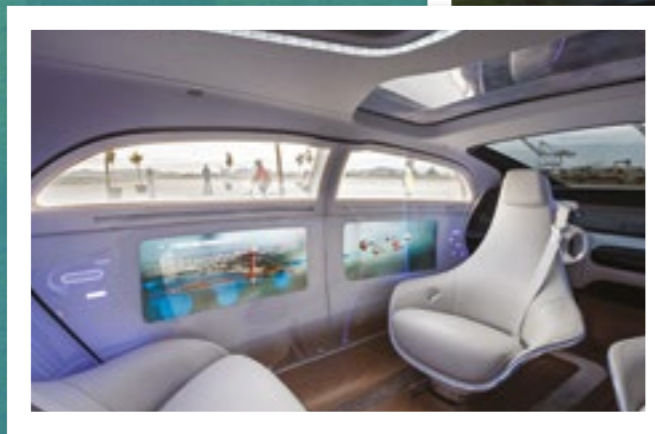
Foreword	02
Executive summary	04
About ADEPT and project partners	08
Chapter one: Introduction	10
Chapter two: Background and context	12
Chapter three: Methodology	16
Chapter four: Technology and digital society trends and opportunities	20
Chapter five: Current position and good practice	24
Chapter six: Developing a framework for innovation, diffusion and scale up	30
Chapter seven: New policies, programmes and pilot projects to accelerate innovation	34
Chapter eight: Recommendations and action points	38
Chapter nine: Conclusions and next steps	42
Appendices: Workstream profiles	46



Executive summary

Key findings and messages

- Digital innovation has the potential to be a game changer, improving highways assets, network management and user experience.
- Extensive activity is taking place on the strategic road network and in some large smart cities.
- There is a real risk that local systems – responsible for 96% of the highways network – will either be left behind or deliver the benefits of digital innovation slowly and by piecemeal.
- This report provides a framework that can accelerate local innovation consistently and robustly.
- The report aims to exchange knowledge, build capacity and spread good practice.
- ADEPT will be a champion for these proposals with our members, partners, Government, business and communities.



Real change in the places we live and work

Digital innovation has the potential to revolutionise our highways system, improving roads, network management and user experience. The digitally enabled highways system of the future should operate very differently, and its realisation is fundamental, not only to the future of highways asset management, but as a major contributor to the UK's future success in the global economy.

Technologies to drive this transition already exist, and some are already deployed in increasingly 'smart motorways' and through the availability of real-time user information.

Government's recent plans and strategies want these rolled out on both the Strategic Road Network (SRN) and the impending Major Road Network (MRN) from 2019.

However, the SRN and MRN together amount to only 8,000 miles of the 188,000 miles, or 4%, of the highways network in England. The MRN, together with the remaining 180,000 miles (96%) of the network, is managed by 150 Local Highways Authorities in England, meaning they are responsible for 98% of the road network in total. In contrast, only 2% (the SRN) is managed by Highways England. The Local Highways Authority is the county council or unitary authority for a particular area. Transport for London is the Local Highway Authority for all GLA roads.

What Government strategies do not do, is set out how digital innovation will be delivered outside the SRN and MRN.

So, the question posed here is how will digital and technology innovation be delivered across the overwhelming majority of the highways system? How can performance be improved for the 180bn+ vehicle miles per year it carries currently and at the same time enable the forecast increases in demand to 2040 and beyond?

At present, these questions are unanswered in both Government strategies and in the extensive literature on smart cities and digital society. It is the issue that underpins this research project. This report provides a work-in-progress summary of thinking and practice, and is intended to assist those charged with finding solutions to the very real challenges of leading and managing this transformation.

The research project explores the adoption of innovative technologies to future-proof the road network. It explores how digital innovation – the application of new technologies to existing business problems or practices – can be used to overcome these challenges and deliver the strong alignment between business growth, housing supply, cleaner air, and a healthy natural environment that is demanded over the coming decades.

The report fully recognises that local authorities and their partners face big challenges in constructing, maintaining and operating local road networks and highways infrastructure at a time of increasing demand, greater financial pressures and deteriorating assets. However, it provides a blueprint for how a national challenge can be met through the local management and adoption of innovation.

Our investigations confirm that considerable digital and technology innovation is being trialled and delivered on local roads in some cities, sub-regions, and communities. There is large public, private and non-governmental appetite for smart city analysis and applications. Our report highlights a number of case studies that illustrate this.

However, this activity is too often fragmented, piecemeal, ad hoc, and project-by-project driven. Arrangements and support for replication, scaling up and aggregation of good practice, for consistent knowledge transfer from bodies like Highways England (HE) and Transport for London (TfL) to local authorities (LAs) are immature or not established at all. Moreover, our research identifies major blockages and pressure points that inhibit innovation locally – constraints of scale, resources, capabilities, knowledge transfer, and organisational cultures, amongst others.

The main conclusion of this report is that without proactive intervention, the significant benefits of digital and technology innovation on local highways networks will progress slowly and only partially be delivered.

Network capacity will be periodically overwhelmed or underutilised; asset management will cost more and deliver less; user congestion and services failure will remain a major part of the travel experience; societal goals for business growth, housing supply, cleaner air, and environmental sustainability will be frustrated.

There is no ‘silver bullet’ solution to these conclusions. However, as a project team we have agreed a number of recommendations and proposals that we believe will move these agendas forward.

To move from piecemeal, opportunistic innovation to a much more structured approach, LAs together with local partners need to develop a holistic framework for highways systems innovation and scale-up.



During the course of our investigations, ADEPT and its partners identified **three potential initiatives to accelerate bringing the framework to life.**

- 1** To address the blockages of knowledge transfer, we propose the establishment of a specialist **Knowledge Exchange Capability**. This is a knowledge hub akin to a ‘What Works Centre’ and a Technical Advisory Unit. The hub would focus support on local highways systems innovation and scale up of technology, and digital transformation. The intention is to provide a coordinated approach that LAs can tap into. This might either be a new arrangement, or an evolution of one of the existing support structures and processes.
- 2** To reduce capacity and capability deficits we suggest that the knowledge hub sponsors production of a series of **good practice / ‘how to’ guides and toolkits** on key topics where there is evidenced LA demand. For example, the highways systems of the future Local Transport Plan, smart procurement to incentivise innovation, the ‘Mobility as a Service’ (MaaS) supermarket, new business models, open data and Application Programming Interfaces (API) eco-systems.
- 3** To address the currently limited examples of innovation at scale, we make two proposals – one focused on new development and one on retrofit:
 - **A Garden Towns digital infrastructure platform** – to test and develop (at scale) advanced highways systems infrastructure and services in new settlements.
 - **A retrofit maintenance demonstrator at scale** – a major smart infrastructure programme over both an urban and rural area to fully deploy sensors, connectivity and digitally-enabled maintenance regime on existing highway infrastructure. Examples could include smart gullies, smart footways and crossings and smart lighting, amongst the many possibilities.

Each of these proposals will directly increase collaboration and therefore reduce ‘reinventing the wheel’ resourcing across the 150 local highways systems. We also believe they will accelerate culture change from highway engineering to place-based mobility and smart place outcomes.

This report begins to sketch out how that breadth of local success can be achieved and outlines how ADEPT will support these aims – we have an opportunity to take the lead and drive coordination, helping to foster a more collaborative, consistent approach. We hope you will join us in completing a vibrant, dynamic ‘highways systems of the future’ canvas.

Proposition – There are major digital innovation opportunities which will deliver step change improvement in transport systems.

Evidence – Considerable good practice and R&D already going on. But major pressures delay adoption and scale up locally.

Actions – ADEPT can act as an advocate and catalyst for a small number of interventions.

Results – These will deliver improved innovation performance and better transport contributions to national and local priorities.

About ADEPT and project partners

ADEPT

Association of Directors of
Environment, Economy, Planning & Transport

The Association of Directors of Environment, Economy, Planning and Transport (ADEPT) is a membership based voluntary association. It comprises around 75 'Place' Directors from county, unitary and metropolitan local authorities (LAs), together with 15 Local Enterprise Partnership (LEP) and 15 Corporate Partner members. The LA members of ADEPT are responsible for the maintenance of the local road network.

ADEPT represents members' interests by proactively engaging central Government on emerging policy & issues, promoting initiatives aimed at influencing Government policy, and through the development of best practice.

ADEPT periodically undertakes more detailed research projects on key questions of policy and practice. In 2017 we determined to focus on accelerating technology innovation on our road systems and highways asset management functions.

EY is a global leader in assurance, tax, transaction and advisory services. EY's insights and services help build trust and confidence in the capital markets and in economies the world over.

EY's Local Public Services team are trusted advisors to local authorities and public organisations across the diverse range of challenges being faced by the sector, including how to achieve innovative, commercial, and efficient services in the face of financial austerity and external disruption.

The team includes specialists with a strong track record delivering highways and transport transformation, and are passionate about supporting clients in building resilience into existing infrastructure as well as taking advantage of emerging technological opportunities.



Ringway is one of the leading providers of highways services. The company operates and maintains more than 50,000km of both local and strategic road networks on behalf of highway authorities throughout the UK.

Ringway has been delivering services to local and central government highway authorities for more than 40 years, including construction and major maintenance works such as road construction and resurfacing. In addition, the company provides core services of planned and reactive highways maintenance, winter planning and delivery, highway emergency response, gully cleansing, street lighting installation and maintenance, grass cutting and traffic management.

The company operates on long-term contracts throughout the country, including Bracknell Forest, Cheshire West and Chester, Hertfordshire, Milton Keynes, North Yorkshire, Shropshire, Swindon, Wiltshire and Worcestershire. It also

maintains the Highways England network in the south west covering the strategic network within Devon, Cornwall, Somerset, Bristol, Wiltshire and Gloucestershire.

In addition, two 25-year Private Finance Initiative contracts (PFIs) in the London Borough of Hounslow and the Isle of Wight encompass design services, asset management, integrated traffic control and information systems management and maintenance.

Founded in 1976, Ringway has achieved continuous growth and currently has an annual turnover of £320million and a workforce of over 2,600.



O2 is the commercial brand of Telefónica UK Limited and is a leading digital communications company with the highest customer satisfaction for any mobile provider, according to Ofcom. With more than 25 million customers and 450,000 business customers, O2 runs 2G, 3G and 4G networks across the UK, as well as operating its nationwide O2 Wifi service.

O₂

At the core of our business customer strategy is our commitment to building long-term partnerships. Working with organisations including TfL, Network Rail, Highways England, and more, O2 offers a holistic approach to enabling public sector organisations achieve their goals, helping join up their IT, people and communications, thus reducing costs and becoming more efficient, flexible, agile and streamlined.

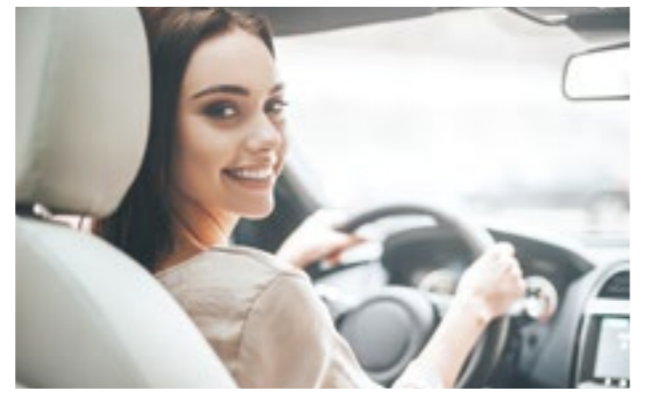
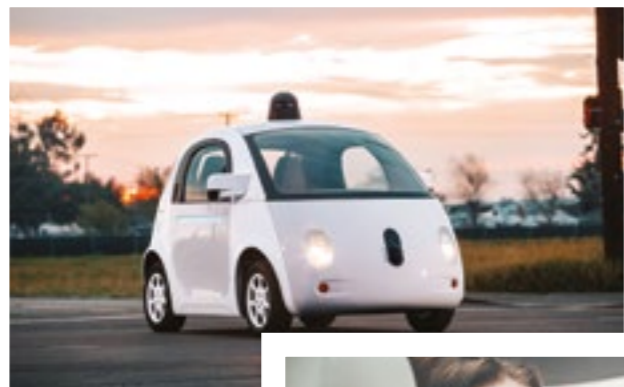
Our digital portfolio includes O2 Smart Steps, which provides customers with data insights that are a powerful and cost-efficient alternative to traditional mass movement and demographic data capture methods (road side interviews, surveys, counts, cameras) at scale. O2 Smart Steps' anonymised and aggregated data is used to determine crowd movement, location, journeys, dwells, trip type and mode of transport, empowering organisations to make better infrastructure planning and operational decisions.

The project team would like to thank David Marlow, Third Life Economics for compiling this report.

Chapter one: Introduction

Chapter summary

- ADEPT and project partners EY, Ringway and O2 worked between March – July 2017 in five workstreams to answer the following research question:
 - How can the adoption of innovative technology be accelerated for the construction, maintenance, operation and use of highway assets in the context of increasing demand, greater financial pressures and deteriorating highway assets?
- Our approach included desk research, surveys, workshops and a Project Management Board to pull together the final results.



Digital innovation has the potential to revolutionise our highways system, improving roads, network management and user experience. Our highways system of the future should operate very differently from now – the journey to realise this ambition is fundamental to both highways asset management and the UK's future success in the global economy.

A number of technologies to drive this transition are already being used on our highways, for example, in smart motorways and via real-time user information. We know that recent Government strategies and plans want these rolled out from 2019 on the Strategic Road Network (SRN) and the impending Major Road Network (MRN) from 2019.

ADEPT periodically undertakes more detailed research projects on key questions of policy and practice. In 2017 we agreed to focus on better understanding how to accelerate the uptake technology innovation on our road systems and highways asset management functions.

This research project explores the adoption of innovative technologies to future-proof the road network. It explores how digital innovation – the application of new technologies to existing business problems or practices – can be used to overcome these challenges and deliver strong alignment between business growth, housing supply, cleaner air, and a healthy natural environment that is demanded over the coming decades.

We hope the report will be helpful to LA colleagues and partners in delivery locally. It is also intended to assist Government policy implementation of 'Moving Britain Ahead', and related policies like the air quality plan for nitrogen dioxide (NO₂) in the UK. It is also intended to contribute to wider thinking on the roles of transport infrastructure in the Government's Industrial Strategy, and in meeting future economic, societal and environmental challenges.

We thank all colleagues and partners who have brought this piece of work to fruition.

The SRN and the MRN amount to

just **4%**
of the **highways network in England.**

The remaining **96%**
of the network and the MRN is managed
by 150 Local Highways Authorities.

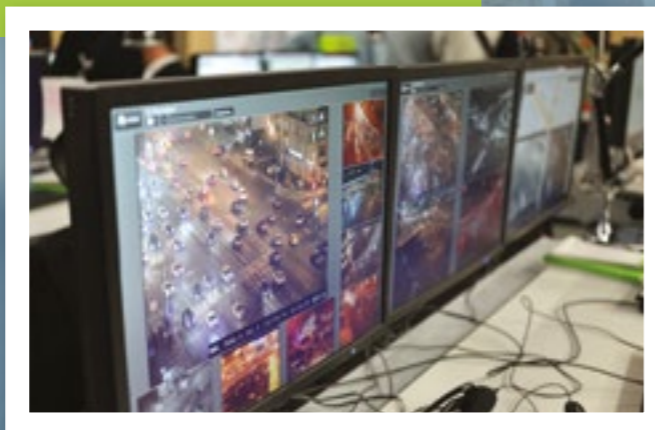
The main focus of this report therefore is about how digital innovation will be rolled out to the overwhelming majority of the highways network. It also considers how performance can be improved for the 180bn+ vehicle miles per year it carries currently and at the same time enable the forecast increases in demand to 2040 and beyond.

These questions are unanswered in current Government strategy and policy. This report is intended to assist those charged with finding solutions to the very real challenges of leading and managing this transformation.

Chapter two: Background and context

Chapter summary

- The Government has major ambitions for transport systems and the highways network to meet economic, social and environmental challenges.
- Digital innovation is an important part of policy decisions.
- Devolution is shifting responsibilities for delivery regionally and locally – but the institutional landscape is still emerging.
- However local authorities (LAs) own and manage 98% of the public highway.
- National priorities, therefore will need bespoke local solutions which are:
 - Effective for the size, scale and challenges of LA highway assets' construction, operation and management.
 - Affordable and mobilise new sources of finance.
 - Align transport policy and practice with wider local and national priorities and maximise its contribution to them.



Digital innovation has the potential to deliver the highways systems of the future, improving roads, network management and user experience. The Government understands the importance of transport and technological change over the next few decades and has set out a commitment to transformation driven by digital, technology and social innovation.

Transport services will be integrated into a single demand-led service, defined as 'Mobility as a Service' (MaaS) and driven by digital, technology and social innovation.

MaaS describes a shift away from personally owned modes of transportation and towards mobility solutions that are consumed as a service. This is enabled by combining transportation services from public and private transportation providers through a unified gateway that creates and manages the trip, which users can pay for with a single account.

Electric, connected and autonomous vehicles will become the preferred modes of transport on highways, transforming how we travel and transport goods across the country. Some radical technological changes and innovation will be driven by the universal connectivity of sensors known as the Internet of Things (IoT) – how devices connect using multiple forms of internet connectivity. The IoT, along with big data and data analytics, provides users with real time information that is ultimately designed to improve user experience and make optimum use of network capacity.

As a result, the construction, operation and maintenance costs of highways are set to reduce through the introduction of advanced equipment and materials, lifetime asset management and improved business processes.

The 2040 highways systems should operate very differently, and deliver a radical improvement in user experience, compared to today.

To fully embrace, and even lead these changes, we need to understand the barriers to change. The adoption of some existing technologies has already taken place with the building of new 'smart motorways' and the increased availability of real time data. The Government's recent plans and strategies have credible approaches to rolling these out on the SRN from 2019, and in due course, could also apply to the MRN. Large national agencies like Highways England (HE) and mature regional players like TfL are at the leading edge of this process. Large national agencies like Highways England (HE) and mature regional players like Transport for London (TfL) are at the leading edge of this process.

However, Highways England manages just 2% of the highways network in England, while the SRN and MRN together amount to 8,000 of the total 188,000 miles. The remaining 180,000 miles, together with the impending MRN, mean that 98% of the network is managed by the 150 Local Authority Highways Authorities in England.

Context: Current strategy and policy

A brief overview of the current situation, strategy and policy reveals a complex picture.

The **2016 England road network**¹ amounted to 188,542 miles of highway. Just over 4,400 (2%) of the network is managed by Highways England as the Strategic Road Network (SRN). The majority of the network, the remaining 184,100 miles (98%), is managed by the 150 Local Highways Authorities in England (55 Unitaries; 36 Metropolitan Boroughs; 32 London Boroughs; 27 County Councils).

Latest Department for Transport (DfT)² figures suggest the England network supported 277bn vehicle miles in 2016 – up more than 17% over twenty years. This is forecast to rise by a further 19% – 55% by 2040 under different scenarios. Around two-thirds of vehicle miles are on LA roads – and almost all journeys will start and finish on them.

The Government's **Industrial Strategy**³ Green Paper flags the quality of transport infrastructure as second lowest among G7 countries and only 24th globally. It seeks increased alignment of national investment with local growth priorities, and infrastructure developments making the most of UK digital capabilities. This is supported by investments from the National Productivity Investment Fund, Industrial Strategy Challenge Fund and other Government programmes (e.g. the £1.1bn for local roads and transport networks, and the £2.3bn Housing Infrastructure Fund). Enabling this local growth and development is a fundamental responsibility of all LAs, and a primary and increasing purpose of the local transport network.

The Government's July 2017 **Transport Investment Strategy: Moving Britain Forward**⁴ sets out four aims for transportation investment:

1.

A reliable, less congested, connected network that works for users

2.

Enhancing productivity and responding to local growth opportunities

3.

Increasing inward investment and global competitiveness

4.

Supporting new housing

These aims command a £61bn investment programme over the five years to 2020/21, with an additional £2.6bn from the National Productivity Investment Fund. Most of these programmes continue to support major national and local interventions throughout the 2020s.

The Investment Strategy confirms that from 2019, the Government intends to designate a Major Road Network (MRN) funded alongside the SRN from Vehicle Excise Duty. This is expected to double the size of the 'national' network to 8,000 miles, albeit the current Government proposal is for the MRN to continue to be run by Local Highway Authorities. This will then sit alongside the remaining 96% of the network operated as currently.

¹ <https://www.gov.uk/government/statistics/road-lengths-in-great-britain-2016>

² <https://www.gov.uk/government/statistical-data-sets/road-traffic-statistical-tables-index>

³ https://beis.gov.uk/citizenspace.com/strategy/industrial-strategy/supporting_documents/buildingourindustrialstrategygreenpaper.pdf

⁴ <https://www.gov.uk/government/publications/transport-investment-strategy>

⁵ <https://www.gov.uk/government/collections/road-network-size-and-condition>

⁶ <http://www.asphaltuk.org/wp-content/uploads/ALARM-2017.pdf>

⁷ <https://www.gov.uk/government/publications/air-quality-plan-for-nitrogen-dioxide-no2-in-uk-2017>

Government estimates⁵ £3.6bn of maintenance expenditure on LA roads in 2015/16 – 61% structural, 30% routine and 9% on additional items (including some types of information, enforcement, impact assessments and research). These total figures fluctuate year-to-year, but have remained fairly constant (+/- 10%) over the time series since 2003/04. However, four of the five lowest years of total spend were 2012/13 – 2015/16. Moreover, routine maintenance of minor roads has fallen every year throughout the decade.

It is significant that the **ALARM survey 2017**⁶ (Annual Local Authority Road Maintenance Survey) estimated a requirement for £12bn in catch up repairs and an annual deficit of around £650m (so over 18%) to maintain the network in good working condition. Highways assets are estimated to be worth over £400bn. The survey tracks a rise in structural failures, and a significantly higher cost of reactive as opposed to planned maintenance.

The most recent **Plan for Tackling Roadside NO₂ emissions**⁷ puts LAs at the forefront of addressing national and local hotspots as an immediate staging post to longer term removal of petrol and diesel vehicles from UK roads. Digital and technology innovations will be crucial to facilitating this.

In summary, the highways system is central to UK policies and priorities, and facing increasing demand and user expectation. It commands large expenditures – albeit finance is highly constrained. In addition, the delivery landscape is becoming increasingly complicated and is still emerging at sub-national and sub-regional levels.

However, incrementally improving a 'business as usual' status quo may not be enough. The whole pattern of how the network is used is subject to transformational change.

Sub-national transport leadership and governance in England is far from straightforward and is in a period of profound change. Between the Department for Transport (DfT), and HE nationally, and the 150 Local Highways Authorities there are a mixture of intermediate tier transport bodies. Some, like TfL and successors to passenger transport authorities/executives (PTA/PTEs) that serve metropolitan city regions, are statutory and longstanding. Others, like Transport for the North and Midlands Connect are more recent and still developing their roles.

Local Transport Boards (LTBs) Often aligned with Local Enterprise Partnership (LEP) geographies – have investment prioritisation roles. The new metro-Mayor Combined Authorities give Mayors considerable transport powers and budgets – but it remains to be seen how these will play out in practice.

Transport for the North, Transport for the South East, Midlands Connect, and England's Economic Heartland have been identified as probable 'Sub-National Transport Bodies' (STBs), established by legislation and positioned prominently in the national strategy. They are intended to provide regional and local prioritisation, insight for DfT investment programmes, and coordination regionally and locally. They also possess considerable delivery and management capabilities through their membership. All STBs include LAs and Combined Authority members, where these have been established.

The building blocks for sub-national leadership and coordination, therefore, very much reside with LAs. However, LAs themselves need to evolve over the coming period to make the most of the intermediate institutions of which they are members.

Chapter three: Methodology

Chapter summary

- ADEPT and project partners EY, Ringway and O2 worked from March – July 2017 in five workstreams to answer the research question:
 - How can adoption of innovative technology be accelerated for the construction, maintenance, operation and use of highway assets in the context of increasing demand, greater financial pressures and deteriorating highway assets?
- Our approach included desk research, surveys, workshops and a Project Management Board to pull together final results.



This Digital Innovation Research Project seeks to shape and develop digital innovation regionally and locally – to find the route to the highways systems of the future’. Bodies like ADEPT have a key role in advising on how these changes are executed.

In collaboration with sponsor and partner Ringway and project partners EY and O2 we established a project team who worked from March to July 2017 to answer the research question: ‘How can adoption of innovative technology be accelerated for the construction, maintenance, operation and use of highway assets in the context of increasing demand, greater financial pressures and deteriorating highway assets?’

We tackled this digital innovation research project in five workstreams. Each workstream sought intelligence and insight from different stakeholders. The following theme leads undertook a range of desk research, survey and stakeholder workshop activity:

A. Vehicle Manufacturers workstream – led by ADEPT (Essex County Council)

This focused on vehicle manufacturers, and the advent of electric, connected, autonomous and perhaps hydrogen vehicles.

B. Professional Services workstream – led by EY

This considered new technology and innovation from a Professional Services Firm (PSF) perspective.

C. Academic workstream – led by Professor Mischa Dohler of Kings College

Provided academic insights, particularly into the major technology trends impacting on MaaS.

D. Digital Infrastructure / Internet of Things workstream – led by O2

This looked at advanced Digital Infrastructure provision and its implications.

E. Highways Infrastructure – led by Ringway

This sought views from infrastructure construction and maintenance providers on the development and impacts of digital technologies – both client and contractor.

This final report pulls together the outcomes of the workstreams with other contemporary material. For detailed summaries of each workstream, please see the appendices.

It refines our original research question into a number of propositions:

- Digital and technology innovation offers step change opportunities for improvements in highways networks and asset management.
- However, a number of barriers and pressure points need to be addressed if these opportunities are to be realised locally.
- Collaborative interventions – perhaps championed and enabled by ADEPT – can begin to remove these barriers and pressure points.
- As a portfolio of activity, these will begin to deliver results that can become the norms for the best **highways systems of the future**.

The working hypothesis of those interviewed as part of this project is that two types of vehicle manufacturers will emerge:

1.

Those who stick to the traditional model of production and sale.

2.

Those who reposition themselves in the value chain, extending beyond manufacture and into the market of transport provision, moving away from traditional sales to pay as you use models. This will break the normal pattern of car ownership that we see in the UK. This paves the way for a much greater level of utilisation than at present and a reduced volume of vehicles overall.

The report is structured to develop these propositions in greater detail and recommend action points that will progress the highways systems of the future over the short and medium terms.

Chapter two puts our initial research question into context and suggests why it is important, while Chapter three provides the methodology. Chapter four examines trends and opportunities and considers technology and digital innovation potential. Chapter five outlines current highways systems good practice, and the constraints and barriers to achieving this consistently.

In Chapter six we present a framework for innovation, diffusion and scale-up of digitally-enabled highways network and asset management. Chapter seven, together with appendices, populates that framework with a selection of our findings. Chapter eight makes recommendations and suggests action points for moving these agendas forward. In Chapter nine we present concluding remarks.



Those who reposition themselves in the value chain, extending beyond manufacture and into the market of transport provision, moving away from traditional sales to pay as you use models. This will break the normal pattern of car ownership that we see in the UK. This paves the way for a much greater level of utilisation than at present and a reduced volume of vehicles overall.



Chapter four: Technology and digital society trends and opportunities

Chapter summary

- Digital and technology innovation is creating opportunities for radical changes and new business models.
- Key technology drivers of change include wireless communications, smart devices/Internet of Things; Artificial Intelligence/Robotics; big data; energy storage etc.
- These innovations can improve infrastructure and network performance, user experience and affordability – with implications and read-across to broader societal goals and challenges.
- However, delivering the transition from prototyping to mainstream operations is slow; and developing smart city solutions that can retrofit or run alongside traditional processes is particularly challenging for local areas.



Digital technologies are radically changing the way we live our lives, and the businesses and institutions we interact with. The evidence is compelling that deeper, and broader, digital innovation can deliver major results across the local, as well as national, highways system, and contribute to wider societal priorities. Mobility as a Service (MaaS) and new business models (Uber and similar services are often quoted) will radically transform movement by 2040.

The Government's National Investment Strategy sets out the opportunities for new technology and innovation to achieve transport goals and contribute to the UK's wider economic success. It highlights key technologies such as smart ticketing, ultra-low emission vehicles, battery technologies, connected and autonomous vehicles, advanced material and condition monitoring and includes the 'future of mobility' and innovation in other emerging technologies.

There is now a rich landscape of research, development and innovation (RD&I) institutions, networks and programmes exploring the breadth of technological aspects of transport systems and mobility.

These include the Transport Systems Catapult, other Catapults and national RD&I – e.g. Advanced Manufacturing, Digital, Future Cities, the UK Collaboration for Research in Infrastructure and Cities (UKCRIC). There are industry and academic centres and capabilities, and even some more locally founded arrangements like the Transport Data Initiative (TDI).

Much of this activity is being tested or is under development in specific places or institutions. As the case study here shows, there is momentum in infrastructure engineering becoming more digitally enabled, moving up the levels of Building Information Modelling (BIM) and Technology Readiness.

CASE STUDY:

Intelligent Assets for Tomorrow's Infrastructure

The Institute of Civil Engineers (ICE) and the Cambridge Centre for Smart Infrastructure and Construction (CSIC) have produced a Guiding Principles paper (**Intelligent Assets for tomorrow's infrastructure, 2017⁸⁾**). This paper suggests how advances in sensing, data management and artificial intelligence decision support can allow assets to 'think for themselves' with regards, for instance, to repairs and maintenance.

The concept of intelligent bridges, tunnels and gulleys (as we suggest in one of our demonstrator projects below) offers completely different models of digital engineering skills requirements and business processes, which can redress many of the intractable challenges of maintaining traditional infrastructure.

The report proposes major upgrades in the levels of Building Information Modelling (BIM), as it applies to the design, construction and maintenance of the Built Environment including highways infrastructure.



Our project workstreams identified a number of these trends in current network and asset management, but they also identify opportunities and blockages that require further attention.

- 1 The **Vehicle Manufacturers workstream** sought to understand the new demands and opportunities that advances in vehicle technology provide for highways infrastructure and transport management. These include electric, hydrogen, connected and autonomous vehicles. It suggests how hybrid, connected, and autonomous vehicles will stimulate demand for improvements. It considered the reductions of cost in battery technologies, and in other materials and composites.
- 2 The **Professional Services workstream** considered how connectivity and big data applications can improve road and traffic management, user experience, construction and maintenance, environment and social development. It identified major barriers to innovation – none of which are technological per se. National forums and intermediaries like the TDI, the Institute of Engineering and Technology (IET) and the new Infrastructure Industry Innovation Platform, i3P, can assist LAs with knowledge transfer, experimentation and scale up were assessed in an accompanying workstream.
- 3 The **Academic workstream** was a horizon-spanning piece by King's College London. It identifies the major technology trends that will accelerate delivery of MaaS and smart transport locally over the next 5-10 years. Although there will be local differentiation, all network and asset management systems need to embrace intelligent connectivity – universal communications and IoT/sensor coverage; increasing automation and robotics; storage, handling, sharing large quantities of data. Each of these need to be deployed in a united way, to integrate strategy and operations, involve the user, and improve their experience of the network. These should have profound impact on a council's infrastructure strategy, workforce development, citizen engagement, business processes like procurement, open data and innovation eco-systems.
- 4 The **Digital Infrastructure / IoT workstream** considered the implications of Internet of Things (IoT), data management apps and analytics on digital infrastructure and services. Somewhat similar to Professional Services, the issues of commercial confidentiality, standards and protocols, data capabilities, and trust are as much inhibitors of innovation as technical issues. The need for start-up investment to address this is acute.
- 5 The **Highways Infrastructure workstream** considered the development of new and smarter materials with higher performance for network and asset management. It identified key areas where digital technologies are impacting highways operations – from equipment to communications, to business processes and systems at all stages of the programme management life cycle. A particular challenge is the multiplicity of solutions, and the processes of identifying and scaling preferred ones across large numbers of Local Highways Authorities.

More detailed summaries of each workstream and their findings are described in the appendices. The workstream results show there is no shortage of technology ideas, R&D, experimental and pilot projects, and there is even some operationalisation on a project-by-project or function-by-function basis.

Opportunities

What is missing is the collation of the considerable opportunities identified into a single seamless narrative that:

1. Puts highways construction, operation, maintenance and asset management into the wider context of societal challenges – such as demographic, sustainability, inclusion, urban living and resilience.
2. Recognises the differing scales, scopes and ambitions of individual places to fashion their own bespoke solutions and approaches.

EY has made the case for strategic planning and service management of smart infrastructure as a major driver of growth and development in **'Routes to prosperity via smart transport'**⁹. The returns from smart, effective investment include a step change in reducing congestion and pollution, while better meeting the challenges of logistics and advanced urban services. It makes better use of network capacity and realises value from highways assets.

Effective transport provides the platform for increasing productivity and performance improvement as well as new jobs and business opportunities in high value industries. Most importantly it improves quality of life. Both EY and **McKinsey**¹⁰ make clear the importance of place. They expect different types of cities and communities to develop different solutions and scales of infrastructure and network management.

⁸ Intelligent Assets for Tomorrow's Infrastructure, ICE, CSIC, London 2017
⁹ [http://www.ey.com/Publication/vwLUAssets/EY-routes-to-prosperity-via-smart-transport/\\$FILE/EY-routes-to-prosperity-via-smart-transport.pdf](http://www.ey.com/Publication/vwLUAssets/EY-routes-to-prosperity-via-smart-transport/$FILE/EY-routes-to-prosperity-via-smart-transport.pdf)
¹⁰ <http://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/an-integrated-perspective-on-the-future-of-mobility>

In the struggle to deliver the transitions from prototyping to mainstream operations, national and international strategies are needed to address many of the inhibitors such as legal frameworks, standards and protocols, backbone communications infrastructure, security, and privacy.

For digital innovation to be delivered successfully throughout the country, the mechanisms need to be in place to translate major trends and national policies into local systems and solutions.

While LAs and increasingly Combined Authorities already participate in many of these initiatives, their involvement tends to be project-by-project. LA engagement may often follow behind the national agencies like Highways England or the more established major regional players like TfL. The EY analysis, for instance, quotes London and TfL as a good practice example. Other workstreams quote major city approaches like Amsterdam and Stockholm.

Lessons from international, national and sub-national players need to be adapted for local, often non-metropolitan, places. In turn, the process by which LAs feed their learning into sub-national and national evaluation and policy-making should be more consistent and thorough.

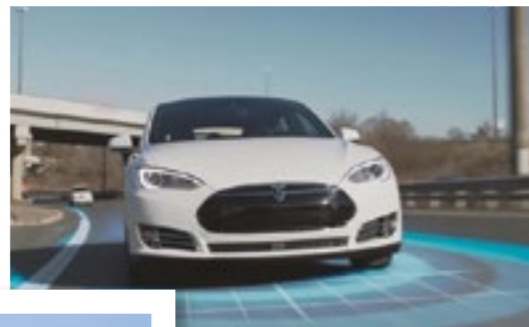
For the foreseeable future, Local Highway Authorities will be on the front-line of managing the interfaces between these highly advanced, smart mobility solutions and business-as-usual transport systems. The challenge of retro-fit and operating both advanced and historic systems will fall mainly on LAs until at least 2040.

Fully digitally enabled trunk roads and the MRN may be necessary for smart transport systems and to achieve MaaS, but unless the other 96% of the network is an integral part of this process it will be far from sufficient. This is where our initiative seeks to add value.

Chapter five: Current position and good practice

Chapter summary

- The sub-national transport institutional landscape and LA highways functions continue to evolve.
- LAs have a track record of change and innovation over recent decades, but best practice is not consistently shared.
- The key blockages and constraints inhibiting change – scale, resources, capabilities, knowledge transfer and cultures – need to be addressed if we are to accelerate and scale up innovation.



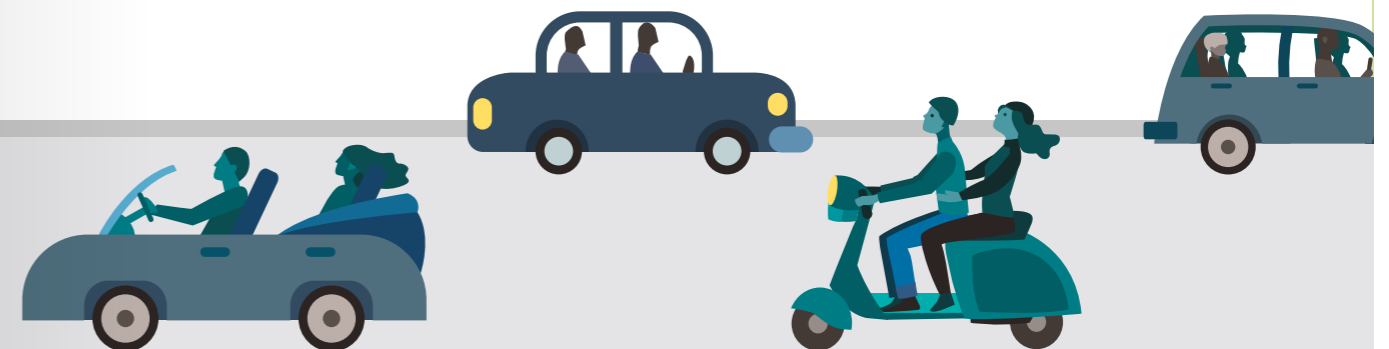
150 Local Highways Authorities in England are responsible for maintaining 184,000 miles of public highway, amounting to 98% of the network. They work closely with Highways England, which has responsibility for the 4,200 miles of Strategic Road Network and increasingly, with the intermediate tier of transport bodies identified in Chapter two. Of the intermediate tiers, TfL is the largest and most established.

Proposals for further responsibilities for Transport for the North (TfN), Midlands Connect (MC), England's Economic Heartland and Transport for the South East are emerging. Together with the integrated transport budgets that are the responsibility of the six Combined Authority Mayors – this intermediate tier of regional and sub-regional transport bodies is likely to grow in importance and significance. Moreover, the Government has announced the intention to establish a Major Roads Network of around 3800 miles of A-roads, funded alongside Highways England's SRN from Vehicle Excise Duty.

The institutional complexity and evolutionary character of highways and network management creates significant variations in construction, maintenance, asset and network management regimes. Bodies like the **NAO (2014) commended Local Highways Authorities**¹¹ for their operations and track record of innovation, in the face of very constrained budgets and increasing demand from users. However, the resilience of the system in the long term is far from assured, with periodic breakdowns and failures likely without the acceleration of future proofing.

In recent years there have been multiple examples of sensible moves towards output-based specifications for constructing, operating and maintaining the network including early contractor involvement in firming up specifications, framework contracts, new payment regimes related to results, and joint procurement between and across highway authority boundaries.

The Highways Maintenance Efficiency Programme (HMEP) provides advice and guidance, while the current system accommodates a mixed delivery regime from major PFI contracts to functional out-sourcing. Up to 50% of LAs retain most operations in-house.



Functional areas like street lighting have seen improvements service provision and overall costs. Invest to Save strategies have produced energy efficiencies from new lighting technologies and cost reductions from longer life products. Central management and reporting centres have reduced response repairs and routine maintenance, and the management of light sensitivity adjustable to conditions and users.

Across the network, elements of digital infrastructure and services are already highly visible. Users have multiple sources (public and private) of mobile phone/GPS/SatNav information – much of it real time. Construction and maintenance operations increasingly use Building Information Modelling (BIM) and life cycle management tools and techniques – with the **Digital Built Britain**¹² BIM Level 3 focusing particularly on digital infrastructure. Sensors collect data, while cloud platforms and Big Data services are available to store and handle it.

At the most sophisticated levels, several LAs are at the forefront of smart city and smart transport experimentation and piloting – with prominent examples like Milton Keynes for Autonomous, Connected Vehicles, and ‘Green Wave’ trials in many cities including Birmingham and York.

The challenges for LAs, though, are the patchy, fragmented character of innovation, good practice diffusion and adoption, how this measures up to best of class nationally and internationally, and how fit for purpose it is in meeting the radical changes ahead.

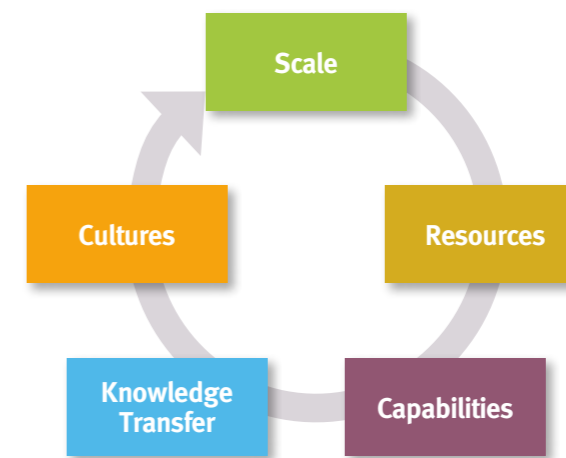
¹¹ <https://www.nao.org.uk/wp-content/uploads/2015/06/Maintaining-Strategic-Infrastructure-Roads.pdf>
¹² <http://digital-built-britain.com/>

For instance, at a very practical level, we know that drivers spend an average of four days a year searching for a parking space and that this has huge economic, social and environmental costs. We also know that keeping gullies clear of blockages can significantly reduce the risks of flooding. Most councils suffer major financial penalties – often from ‘no win, no fee’ legal practices – for injuries suffered on badly maintained roads, footpaths, cables, and pavements. Available digital and technology solutions exist, and are in use in some areas, to radically reduce the costs of these issues, but their applications are inconsistent and disjointed.

The workstreams identified five major pressure points that too often fuse together. This magnifies barriers and constraints to innovation and the application/scale up of effective solutions. These need to be addressed if local networks, cities, communities and users are to reap the benefits of innovation more consistently and comprehensively.



The five pressure points identified are:



Scale: In reality, highway systems in England exist at national, regional, sub-regional and local levels. Within each level, geographies often overlap. Institutionally, there are arguments for both larger and smaller systems management. Larger transport bodies can mobilise resources and capabilities with which a smaller Highways Authority might struggle. They can also roll-out solutions at scale once they have been identified and tested. At the same time, smaller institutions can be flexible, responsive and sometimes more innovative, with a higher-risk appetite than larger bureaucracies.

Resources: Relatively static or declining LA resources and increasing demand and expectations have driven local highways systems innovation up to a point. However, there is now an acute need for non-traditional financing that incentivises innovation; further invest-to-save instruments; resources for experimentation, piloting, demonstrators and scale-up.

Capabilities: It is one of the paradoxes that the UK has some of the best transport and digital engineers in the world. Smart city innovations in high profile locations like Singapore, Barcelona, San Francisco, new Chinese and some Scandinavian cities are well regarded, and often advised by UK experts. However, there are limited means and instruments for deploying these types of expertise locally. Meanwhile, in day to day transport planning and management there are skills shortages and large demand for a new cadre of digital engineering professionals and technicians.

Knowledge exchange: The workstreams identified many innovative projects and good practice developments both across, and within, local highways systems. But there is a lack of systematic evaluation and dissemination of successes and failures. Competition between places and commercial confidentiality between operators can sometimes deter knowledge transfer.

Organisational cultures: At their best, LAs are in unique positions in terms of legitimacy and perspective on place leadership and coordination. Business involvement can bring access to expertise and dynamism that adds value to local leadership. However, highways engineers can also operate in a professional silo, divorced from place management and partnership working.

Client/contractor splits can inhibit learning, ‘engineer out’ innovation and discourage cross-fertilisation of ideas, while competition and commercial confidentiality in business and academia present barriers to open innovation.

There is uncertainty about how and when the new business models (like Uber in transport or G-Cloud in digital and big data) will develop in publicly funded highways systems. The incentives to progress new partnership models – for instance with insurance companies – is too ad hoc and piecemeal.

Overall, the potential of place-based leadership and open innovation eco-systems in LA structures and processes, with business and community partners remains a work-in-progress for highways functions. The tests of leadership, resources, and capability are particularly acute outside national bodies like Highways England, Transport Scotland, and TfL in London. Those institutions have the scale and are much better funded than STBs and LA transport functions.

Therefore, while all areas have a large appetite for innovation, investment in smart cities and mobility innovation is heavily focused on London, metropolitan and larger conurbations.

The five pressure points restrict the adoption of digitally driven innovation at scale. They also restrict the potential to adopt integrated solutions across transport modes, adding value to wider economic, social and environmental interventions in most local geographies.

The evolution of STBs and the MRN might provide a catalyst to accelerate and spread adoption of Highways England and other national best practice at local level. But there is a case for interventions to encourage this and additional bottom-up measures to secure increased local innovation and scale up.



CASE STUDY: LED/CMS lighting incorporating EV charging points



The London Borough of Hounslow has implemented highways projects that have provided significant early investment, digital innovation and substantial cost efficiencies.

Ringway Hounslow Highways converted over 14,000 existing street lighting lanterns to LED and introduced a new Central Management System (CMS) that allows Hounslow to implement flexible lighting strategies across the borough, controlled remotely from the control centre. As a result, energy consumption for street lighting has been reduced by 45%.

In a further development scheme, 40 electric vehicle charging points providing 230V of power in a single phase were installed in street lighting columns, in partnership with German company, Ubitricity. Initial findings have shown that over 50% of the charging points are being used daily.

Incorporating electric vehicle charging points into new lighting columns within LED/CMS invest-to-save strategies, makes the best use of the available power sources without increasing the proliferation of street furniture.

CASE STUDY: Staffordshire Connected Roadworks

This project established a smart city platform to identify collaborative works opportunities between works promoters (e.g. water & gas utilities, telephone companies and highways maintenance) who perform maintenance, repair or construction activities on the road network.

The project:

- Reduced roadworks occupation on the Staffordshire network by 52 weeks across 31 joint initiatives.
- It produced a social return on investment of £58 for every £1 invested.
- In Staffordshire alone it is predicted there could be 2,000 fewer days where roadworks occupy the network if this approach was fully deployed.
- This could generate £4.5 million worth of travel time savings to the economy of Staffordshire through reduced congestion.
- Improved roadworks planning using a technology assisted collaborative approach can save significant amounts of time, resources and cost savings to the local authority, private and public interests.
- Amey are currently looking at wider implementation of this approach – it could be applied with great effect in local authorities nationally.
- Led by Amey with partners Staffordshire County Council, Staffordshire University, Tenshi Partners, Elgin and Future Cities Catapult.



Chapter six: Developing a framework for innovation, diffusion and scale up

Chapter summary

- LAs should consider adopting a more comprehensive framework for planning and managing change.
- We present an illustration of one such framework and populate it with the types of questions LAs should address in using it to accelerate innovation and scale up of good practice.



Local authority leadership, management and partnership working can provide locally appropriate highways infrastructure and services that use digital technology to improve local economic, environmental and social wellbeing, and reduce public expenditure. However, our research has found that resources, capabilities, culture, and scale up make the pattern of innovation and improved results inconsistent and sub-optimal.

To address these inconsistencies, LAs and partners would benefit from constructing and applying a strategic, holistic approach. These should be rooted in the roles LAs can play locally to deliver change effectively; and the results to which the highways systems of the future can be directed.

This chapter presents one illustration of what such a framework might look like. It envisages leading Local Highways Authorities demonstrating:

Thought leadership and policy development

Shaping and adapting national policies and international good practice so they are appropriate for local priorities and circumstances; and providing strategic leadership for planning and management of the outcomes sought from highways reforms.

Partnership and collaboration

Convening and working with public, private and local partners and communities to build support for change and deliver it effectively.

Technology experimentation and piloting

Providing a supportive environment and test-beds for prototyping, trying out new ways of working, pilot and demonstrator projects.

Dissemination and commercialisation – popularising existing good practice so that it can be deployed more widely, and being open to adoption at scale of examples from elsewhere to deliver the wide-reaching benefits of:

- **Digitally-enabled infrastructure construction and maintenance** – sensors, analytics, skilled work force and automation, to improve highway performance and reduce unit costs.
- **Optimal use of network capacity** – with smart network management tools and techniques.
- **Improved user access, choices and experience** – with real time information, intelligence and telematics to better meet user needs.
- **Contributions to wider economic, environmental and social goals** – with transport enabling economic, housing and environmental ambitions locally, regionally and nationally.
- This framework, and illustrative checklists for a leading Local Highway Authority using it, is presented in the figure below. We believe the template can be flexed locally as required.

An illustrative framework for accelerating digital innovation in LA highways functions

LA roles and operating styles Goals/ Future- proofed results	Thought-leadership and policy development	Partnership and collaboration	Technology experimentation and piloting	Dissemination and commercialisation
Fully digitise infrastructure construction and maintenance	Does the LA have a plan, business case and processes for roll-out of an advanced, digitally-enabled highway systems?	Is the plan supported nationally, regionally and locally by key partners who know and are committed to their roles in delivering it?	Has the LA identified relevant R&D and pilot projects it wishes to participate in?	Is the LA aware of good practice and have a process for appraisal and adoption of appropriate innovations?
Optimise use of network capacity	Is a comprehensive, multi-modal, network management regime in place over local and wider sub-regional and regional geographies?	Is the LA part of wider data capture, analytics and control processes that deliver real time network management information over those geographies?	Does the network management area have capabilities for implementing R&D and demonstration projects?	Are processes in place for appraisal and scale up of appropriate innovations arising from R&D and demonstrators?
Improving user access, choices and experience	Does the LA have detailed intelligence and understanding of user needs, and does it use this to drive priority investments and programmes?	Are robust social media and other channels operational, with coverage of most users, and bespoke arrangements for specific target groups?	Is there a rolling programme of 'test beds' with citizen, community and other user groups to test new approaches?	Are processes in place for appraisal and scale up of appropriate innovations arising from the test beds?
Contributing fully to wider societal grand challenges	Are highways investments and services contributing fully to wider local strategic priorities (economy, housing, environment, etc)?	Is this part of a 'whole council' approach with wider public-private-social partnerships? Is their full LA participation in STB, LEP and other bodies?	Is there structured engagement with academia, RD&I communities, Catapults, Innovate UK, etc., locally and nationally?	Is highways systems operations and development part of a credible, coherent smart city, smart-region approach?

CASE STUDY: Highways England Trip Information System



The Highways England Trip Information System (TIS) is a database of trip information and a web-based interface which allows users to extract origin/destination data for motorised road or rail trips.

The database has been built for Highways England by O2 Telefonica using data extracted from its UK mobile phone network. The database contains anonymised trip records covering Great Britain (the UK mainland) for the whole of 2016.

TIS is the result of collaboration between O2 Telefonica/Jacobs and Highways England. It was developed primarily to support the traffic modelling activities of Highways England, which form the basis of appraisal work highway improvement schemes.

Traditional methods for collecting this data, such as road side interviews, are disruptive, expensive and result in small data samples. Replacing these traditional sources with mobile phone data results in high sample sizes, no inconvenience to traffic and reduced cost per trip record.

The TIS website and database is available for use to support the business activities of both Highways England and the UK Department for Transport (DfT).

Local authorities can also acquire the data for transport modelling activities. A user guide has been published and the interface is available at www.tripinformationsystem.co.uk



Chapter seven: New policies, programmes and pilot projects to accelerate innovation

Chapter summary

- We have identified a number of interventions that merit further development:
 - Establish a Knowledge Exchange Capability that focuses specifically on local asset and network management (a ‘Knowledge Hub’).
 - Produce of a portfolio of toolkits and guidance by the Knowledge Hub.
 - Deliver at least two demonstrator programmes at scale – one for new developments (Garden Towns) and one for retrofit of existing infrastructure (smart gulleys and/or footpaths).
- Government is also encouraged to accelerate production of standard, protocols and guidance that can be readily applied in local transport systems; and to encourage more consistent exchange of good practice between national bodies like Highways England and LA operations.



The framework outlined in Chapter six provides a template that can be applied flexibly by LAs and partners for individual places, and across sensible economic and transport geographies sub-nationally. This might include LAs and neighbours, CAs, STBs and other arrangements. Each area would respond to the checklist questions in a manner appropriate to their local ambitions, priorities and baseline starting points.

We are not being overly prescriptive in how this might be applied. However, we consider some sort of structured framework is needed, otherwise digital innovation will continue to be ad hoc and piecemeal carrying the risk that the opportunities for scale up and the dissemination of good practice may be lost.

During our research, a number of ideas for future acceleration of digital innovation were suggested such as a National Skills Academy for highways digital engineering (along the lines of the Railway Academy). Other ideas included creating new forms of Smart Mobility Partnerships, local neighbourhood test-beds and ‘living laboratories’. Another idea was to develop a MaaS Supermarket pilot – a consumer-facing provider of bespoke travel solutions – as envisaged in some of the smart cities literature. We did not appraise these thumbnail sketches in any detail, but they provided a pertinent illustration of the breadth of ambitions of ADEPT members and our partners in this area of activity.

For the purposes of this project we identified a manageable number of priorities which we consider have particular merit in specifically targeting the five pressure points outlined in Chapter four – scale, resources, capabilities, knowledge transfer, and culture.

These specific initiatives and their core characteristics/results are:

The establishment and operation of a specialist Knowledge Exchange Capability – Something akin to a cross between a ‘What Works Centre’ and Technical Advisory Unit that supports local highways systems innovation and scale up of technology and digital transformation.

A Garden Towns digital infrastructure platform – To test and develop at scale advanced highways systems infrastructure and services in new settlements. This might either be a demonstrator project across a portfolio of Garden Towns and Villages, or development of a more general template for all new settlements and developments.

A retrofit maintenance demonstrator at scale

– A major smart infrastructure programme over both an urban and rural area to fully deploy sensors, connectivity and digitally-enabled maintenance regime on existing highway infrastructure. Examples could include smart gullies, smart footways and crossings and smart lighting, amongst the many possibilities.

Production of a series of good practice/ ‘how to’ guides and toolkits – On key topics like a ‘highways systems of the future Local Transport Plan’, smart procurement that incentivises innovation, the MaaS supermarket, new customer services business models, open data and Applications Programming Interfaces that make different transport systems work well together.

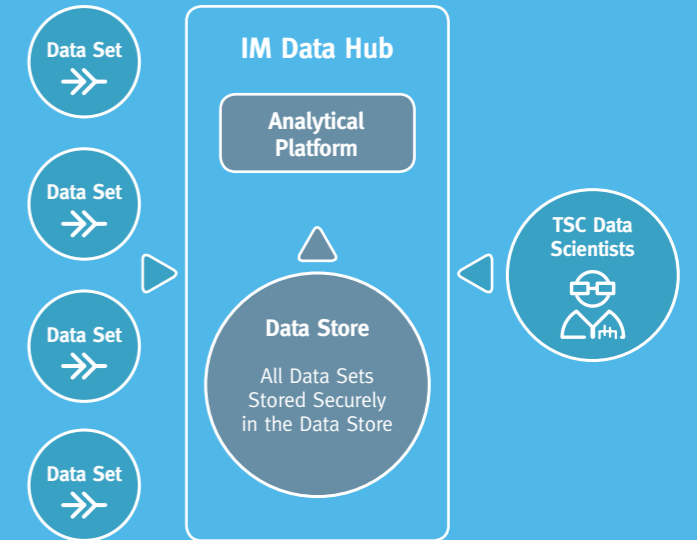
Thumbnail sketches of proposals

Initiative	Rationale	Intermediate Results	Indicative costs
Knowledge Exchange Capability	LAs do not have the scale and resource to mobilise all the knowledge they need internally. Can provide a ‘neutral space’ for open innovation and reducing ‘reinventing the wheel’. Aggregation will reduce costs – whilst keeping a focus on local highways systems. A cross between WWC and TAU.	Provision and/or brokerage of demand-led expert advice to LAs and other relevant role players. Establishment and operation of depository and observatory of expert resources. Facilitation of networks/ working groups on key issues. Commissioning of guides, toolkits, and demonstration projects (see below).	+/-£300kpa for a three-year period providing both a small secretariat, core collateral, and pump-priming funding for demand-led project activity.
Guides and Toolkits	Can support building capabilities at local level for digital and technical innovation. A number of ‘live’ challenges identified by the project that can be produced relatively quickly.	Production of a portfolio of collateral on priority topics: <ul style="list-style-type: none"> • A new model Local Transport Plan • New model highways asset management plan • Smart procurement incentivising innovation • Open data and API protocols • BIM L3 applications for Local Highways Authorities 	Some costs included in Knowledge Hub budgets, but need provision of +/- £20k per specific product, say £100k.
Garden Towns Digital Infrastructure Platform	Number of garden towns and villages in various stages of development. Need to future proof infrastructure. Opportunity to deliver at scale.	Production of exemplar infrastructure specifications and delivery plans for pilot and demonstrator developments. Lesson-learning how to guide and toolkit for all new developments.	£100k per pilot in production of specification and plan. £20k for follow up toolkit.
Retrofit Maintenance Demonstrator	Major challenge is to digitise and retrofit existing assets, vehicles etc at scale. A number of ‘live’ challenges can be identified to test the approach.	A ‘smart gulley’ pilot over an extended area to improve flood prevention and relief. A smart footpath pilot to improve safety and user experience.	£100k per pilot pump priming. £20k for follow up toolkits.
Qualitative Output Results	Improved knowledge, capabilities and systems in Local Highways Authorities to accelerate and diffuse innovation. Increased collaboration and knowledge transfer – LA – business – academia; and between national, STB and LA systems.		+/-£500kpa in total – pump-priming over three years, augmented by demand-led services paid for by end-users.
Qualitative Outcome Results	Improving highways systems network and asset management performance across England. Increased transport contributions to wider economic, social and environmental goals. UK performance in smart cities and smart regions at exemplary levels of global competitiveness.		

CASE STUDY:
Transport Systems Catapult Intelligent Mobility Data Hub

The IM Data Hub provides a powerful platform to store, analyse and process large volumes of transport-related data in a secure and cost-effective environment that respects privacy whilst encouraging open innovation.

This involves a considerable resource and demands local innovation, but it also illustrates the potential of a well-founded knowledge exchange facility with a local focus and reach across ADEPT members and our partners.



Aerial photography by Skyflicks Media - www.skyflicksmedia.com



Chapter eight: Recommendations and action points

Chapter summary

- Local authorities and partners need to adopt approaches that consistently deliver good practice, local experimentation, increased collaboration and collaborative working with transport integrated into holistic place-based leadership and management approaches.
- National government and agencies can provide a context and some funding from existing or proposed programmes that support local change and encourages good practice exchange between national and local institutions.
- Business and academia should consider how to reconcile commercial confidentiality and competitiveness with open innovation and knowledge exchange.



To increase acceleration and uptake of digital innovation requires coherent and committed efforts by a range of national, regional and local institutions from the public, private and third sectors, local communities and users. A lot of this work is already underway or being developed. The challenge for ADEPT and our project partners is to add value and to propose additional measures where there appear to be gaps.

The major gap the project seeks to close is the adoption of holistic approaches to local network innovation, especially in non-metropolitan areas. The holistic approach needs to allow consistent transfer and scale up of good practice between institutions, and from major national and regional to local role players.

Action points

In order to progress this, we recommend the following action points:

LA place-based leadership and management teams should:

Action Point #1: Ensure they are aware of local good practice being developed in terms of MaaS, highways construction, operation, maintenance, asset and network management – and regularly consider how this is shaped and incorporated in local priorities, policy and practice.

Action Point #2: Seek participation in locally relevant R&D, pilot and demonstrator projects – convening partnerships and preparing funding proposals for these where necessary.

Action Point #3: Package future procurement exercises to encourage closer partnership development with business providers, incentivise new business models in digital and technology innovation, customer/user services, and in outcome-based charging and payment.

Action Point #4: Promote a whole council approach to digital innovation, big data, data analytics and social media in which improved highways and place management is prioritised, and cultural change to welcome digital transformation is embraced.

Action Point #5: Deepen productive relations and (where relevant) partnerships with Highways England, STBs, Combined Authorities, LEPs, neighbours, business, academia and social sectors that leverage highways digital innovation for wider economic, environmental and societal value and benefit.



Government, Highways England and UKR&I (including Catapults) should:

Action Point #6: Accelerate drafting and adoption of standards, protocols and guidance that incentivise adoption and scale up of effective digital innovation in these areas of work.

Action Point #7: Task Highways England and other relevant large commissioners (e.g. TfL, Network Rail) with making available their experience, expertise and advanced digitally enabled systems to emerging STBs, Combined Authorities, and to existing Local Highways Authorities on the local roads networks where they are approached for this assistance.

Action Point #8: Ensure that RD&I, investment funding and invest to save programmes are available for innovative initiatives on the 96% of local roads outside the SRN/MRN system; for local asset and network management; and for non-metropolitan cities, rural towns and areas.

Action Point #9: Invite bottom-up proposals to establish new arrangements that support local areas with mobility futures and highways asset management capabilities, as proposed in our Knowledge Exchange Capability, toolkits, and demonstrator project proposals.



Professional Association and intermediaries:

Action Point #10: National associations, think tanks and networks like i3P need to consider how they accommodate distinctive and differentiated local challenges and opportunities in their projects and programmes.

Action Point #11: LAs should determine how they wish to position and resource TDI in the agendas outlined in this report.

Business and academia should:

Action point #12: Consider and make proposals on how commercial confidentiality can be reconciled with local open data and innovation eco-systems proposals identified in this report.



Although we do not wish to be prescriptive, we believe there are opportunities in existing and proposed DfT, Highways England, and Roads Infrastructure programmes, such as Local Growth Fund, Housing Infrastructure Fund, Industrial Strategy Challenge Fund, Future Catapult and Urban Living programmes and in any future replacement of EU programmes. This is alongside local public and private resources. We shall also actively explore whether businesses like the insurance industry (e.g. for smart gullies and footpaths) or major ICT/big data providers are potential beneficiaries, and therefore investors and partners, in these initiatives.

If tangible progress is made on most, or even all, of these action points over the next 12–18 months, we believe that acceleration of digital innovation take-up can deliver significantly improved results. If only a minority of these are progressed, improvements locally will remain fragmented, inconsistent and at sub-optimal scale.

The next steps ADEPT will take to ensure consideration, evolution and adoption of this report's suggestions are outlined alongside our concluding remarks in the final chapter.

CASE STUDY: Vehicle connectivity

Using low power, low cost hardware and the latest machine learning algorithms and computer vision research, Vivacity Labs are deploying a network of intelligent sensors, able to monitor real-time transport at city-wide scale. In the VivaMK project, Vivacity Labs are giving Milton Keynes Council the unprecedented ability to understand, model and optimise multi-modal transport networks, while also providing citizens with next-generation journey planning data, such as the quickest route to an empty car parking space.

To achieve this, Vivacity Labs are installing c.425 traffic sensors across c.850 carriageways, and c.1,800 parking sensors across c.12,500 parking spaces, along with the cloud based infrastructure with code using the latest in machine learning to remove privacy concerns, minimise data costs delivering data to bespoke front ends to display and serve the data to clients in standard web browsers. Vivacity Labs are also using the latest in AI research to provide accurate predictive forecasts of the transport network giving 15 minutes, 30 minutes, hourly and day ahead forecasts.

The system is being funded through £1.7m from Innovate UK sponsored by the Department for Business and through a further £1.3m of private investment raised by Vivacity Labs.



Chapter nine: Conclusions and next steps

Chapter summary

- Extensive work is going on in transport innovation and smart cities, but there is a risk that this will progress slowly and in a piecemeal, fragmented way across the 150 Local Highways Authorities.
- ADEPT will act as a catalyst to champion and promote the recommendations in this report:
 - Advocating greater Government focus on local assets and networks.
 - Testing the framework with members and partners.
 - Preparing feasibility and business cases for other proposals where there is an appetite to progress them.



This final chapter reflects on the research question we asked ourselves back in March 2017, the progress we have made on providing a credible answer to it, and what ADEPT should do next to sustain and build momentum on these agendas.

Our original research question was: ‘How can the adoption of innovative technology be accelerated for construction, maintenance, operation and use of highway assets in the context of increasing demand, greater financial pressures and deteriorating highway assets? We recognise that this is a very big question. Our exercise has only scratched the surface of an answer to it.

We also recognise that a huge amount of work is ongoing in this domain. The Government regards the answers as important. They have positioned mobility and transport issues as major foundations of current transport, industrial and environmental strategies. There are also significant pockets of local excellence and experimentation being pursued on this and wider smart city agendas.

We cannot, and should not, be technology or solutions-specific at this stage. We expect and welcome considerable local variation for meeting future local mobility demand and needs. However, it is clear impending challenges include:

- The roll out of mass market electric, connected and autonomous vehicles, probably on phased and zonal bases, until these become the accepted transport of choice.
- The establishment and operation of large civic big data, data analytics and API platforms, covering smart city agendas including mobility, across metropolitan and sub-regional geographies.
- Achieving mass deployment and effective usage of near-universal coverage of IoT/sensors, wireless connectivity, big data platforms and analytics, with increasing AI and robotics, integrated control centres, and multi-functional teams and task forces.
- Rolling out agreed standards, protocols and guidance to make this happen seamlessly both across areas, organisations, and between transport and other goals and priorities – for instance in smart city agendas.

We concluded that, without proactive intervention, the significant benefits of digital and technology innovation on local highways networks will progress slowly and be only partially delivered.

Network capacity will be periodically overwhelmed or underutilised; asset management will cost more and deliver less; user congestion and services failure will remain

a major part of the travel experience; societal goals for business growth, housing supply, cleaner air, and environmental sustainability will be frustrated.

There is no ‘silver bullet’ solution to these conclusions. However, as a project team we have agreed a number of recommendations and proposals that we believe will move these agendas forward.

To move from piecemeal, opportunistic innovation to a much more structured approach, LAs together with local partners need to develop a holistic framework for highways systems innovation and scale-up. For ADEPT Members – as ‘Directors of Place’ – we need to ensure any framework is an integral part of place-based leadership and management. We present a template that illustrates the type of checklist that might be applied – but this is not prescriptive. Rather, our key message is that LAs need to take a structured, holistic approach.

Next steps – During the course of our investigations, ADEPT, together with our project partners, identified three potential initiatives to accelerate bringing the framework to life.

- 1 To address the blockages of knowledge transfer, we propose the establishment of a specialist **Knowledge Exchange Capability**. This is a ‘Hub’ akin to a ‘What Works Centre’ and a Technical Advisory Unit. The hub would focus support on local highways systems innovation and scale up of technology, and digital transformation. This might either be a new arrangement, or an evolution of one of the many existing support structures and processes.
- 2 To reduce capacity and capability deficits we suggest that the Knowledge Hub sponsors production of a series of **good practice/‘how to’ guides and toolkits** on key topics where there is evidenced LA demand. For example, ‘The highways systems of the future Local Transport Plan’, smart procurement to incentivise innovation, the MaaS supermarket, new business models, open data and Application Programming Interfaces (API) eco-systems.
- 3 To address the currently limited examples of innovation at scale, we make two proposals – one focused on new developments and one on retrofit:
 - **A Garden Towns digital infrastructure platform** – to test and develop (at scale) advanced highways systems infrastructure and services in new settlements.
 - **A retrofit maintenance demonstrator at scale** – a major smart infrastructure programme over both an urban and rural area to fully deploy sensors, connectivity and digitally-enabled maintenance regime on existing highway infrastructure. Examples could include smart gullies, smart footways and crossings and smart lighting, amongst the many possibilities.

Each of these proposals will directly increase collaboration and therefore reduce ‘reinventing the wheel’ resourcing across the 150 local systems. We also believe they will accelerate culture change from delivering purely infrastructure based services to complementing them with mobility and smart city initiatives.

ADEPT can be a key point of contact between DfT, strategic authorities and other partners when they need to communicate with LAs. As such, ADEPT aims to facilitate these agendas.

- We will strengthen how our transport membership contributes to broader place-based leadership and management of cities, towns and communities.
- We will launch a call for trialling and developing the framework following feedback on the report.

- We suggest Government and other national bodies accelerate the adoption of international and national standards and protocols that will be helpful locally. They should ensure the expertise and systems of Highways England and other large commissioners (e.g. TfL, Network Rail) are more routinely available for application on the local network. We encourage them to support our specific interventions subject to business case development.
- National associations, think tanks and networks should engage more with the challenges facing less urban areas outside London and other large cities. Businesses need to consider how to enable issues of commercial confidentiality and competition to be managed in these developments.
- The highways systems of the future are crucial to securing national prosperity as the UK moves forward. It can also be a key factor of local success if delivered consistently across the breadth of the country.

If there are gaps in this work, they are in translating global and national advanced practice into locally appropriate solutions and in spreading and scaling up local exemplars.

We believe that a framework is required to enable the acceleration and take up of digital innovation and provide a needed source of consistency. We have provided suggestions on how this might be constructed and set out a number of appropriate initiatives that could be included to stimulate further innovation and scale up.

The Government’s economic, transport, digital and environmental strategies are rightly highly ambitious, and of global quality. However, they need to be tailored and largely delivered locally. They absolutely require that highways operations and asset management is sustainable environmentally and financially, and provides increasingly positive user experience both economically and socially.

This project has made strategic and tactical suggestions for meeting local requirements. ADEPT invites partners to provide feedback on this report and to work with us to bring the improvements we have identified to fruition.

Following publication of this report, ADEPT will:

1. Consult widely with members, Government and partners on our findings and suggestions.
2. Invite ADEPT local authority members – ideally in different geographies and institutional contexts – to test and develop the framework/ checklist approach to defining the highways systems of the future. Thereafter we shall promote the results of this exercise.
3. Prepare feasibility and business cases for the Knowledge Exchange Capability and demonstrator projects, where there is significant appetite for and commitment to progressing them further.
4. Seek Government, member and partner funding – perhaps through one of the programmes or industry collaborations mentioned in chapter seven – for undertaking and delivering this work. This might be either on an individual project or on a portfolio basis.

Appendices:

Workstream profiles

A. Vehicle Manufacturers

Purpose

How do advances in vehicle technology assist with the management and maintenance of the highway network?

Headline summary

Connected and Autonomous Vehicles are the data capture devices of the future. If they become the predominant mode of highways transport they present a major opportunity to reduce the numbers of cars in the UK and therefore increase the efficiency of use of the network.

Methodology

The research to inform this submission was undertaken via face to face interviews and discussions with key contributors. Group discussions were considered, but avoided because of the potential commercial confidentiality issues associated.

Core questions

- What does the next five years hold?
- What future do EV's have?
- What infrastructure will be required to support their role out?
- What does the advent of connected vehicles mean in reality?
- What is the vision for the longer term?
- Wider implications as a result?

Contributors

Ford, RAC Foundation, Jacobs, DfT, INRIX, White Willow.



Key findings

Electric vehicles

- Vehicle manufacturers see plug-in hybrids as the immediate future of electric technology.
- The wholesale roll-out of EV charging points on the highway network is potentially unnecessary.
- Range anxiety issues will be a thing of the past with the advent of improved and affordable batteries.
- The charging network roll out will centre around residential properties.
- As the technology becomes more widespread we are likely to see knock on impacts for petrol filling stations and other parts of the service industry.

Connected vehicles

- Vehicles are seen as the data capture devices of the future, replacing traditional methods deployed across the network for traffic flow, air quality, condition assessment etc.
- Access and ownership of the data gathered will be key; should it have a value or be open source?
- Driver information will be relayed directly to the vehicle, negating the need for expensive roadside VMS signing.
- Given the time it will take to for the UK vehicle fleet to be replaced, we need to find practical ways to retrofit existing vehicles.
- Vehicles will need to be connected to highway infrastructure in the future to maximise the efficiency of the network.

Autonomy

- The mixed economy of autonomous and driver controlled vehicles will present challenges to the operation of the network in the future.
- Issues of risk, insurance, liability and public perception will all need to be tackled before the technology can go mainstream.
- Once the tipping point is reached in terms of market penetration, there are likely to be some interesting implications for land use planning in our urban areas.

Areas for further analysis

- Ownership models for vehicles will change dramatically, with vehicles being seen as just one option among a range of movement options for the consumer.
- This change from ownership to use will see a significant reduction in the number of cars in the UK.
- Traditional car manufacturers will need to re-evaluate their business models as disruptive new players enter the market.
- Reduced need for travel combined with more efficient transport networks will see a reduction in the need to build significant new infrastructure.

Further information

Workstream Lead – Andrew Cook, Essex County Council, on behalf of ADEPT.

B. Professional Services

Purpose

To identify key digital innovation themes and areas which professional services firms are leading on and investing in, and the further work ADEPT might suggest to make the most of these trends for future highways and transport systems innovation.

Headline summary

A number of key, emerging themes were identified, potential barriers to innovation highlighted, and recommendations provided for four future focus areas for ADEPT to take forward.

Methodology

Reviewed existing and current research in topics relating to digital innovation in highways. A desktop study was completed, from a wide range of related sources, to identify emerging themes from recent/current topics relating to digital innovation in highways.

The themes were then reviewed through a separate workshop to obtain wider perspectives on specific facets of highway use, maintenance and operations. In addition, views were sought on the areas which ADEPT should focus on for the next phases of the project in order to deliver most value and effectiveness.

The workshop included representation from the following organisations; HTMA, ITS UK, Catapult Transport Systems, Mott Macdonald, Colas,

Key findings

Emerging themes and potential barriers to innovation were identified with recommendations for future focus in four keys areas; Use of data and data sharing, Active asset management, User interaction, Traffic Management.

Areas for further analysis

As digital innovation evolves and ADEPT takes forward the recommendations from the report, further work should re-assess and re-evaluate the relevance of the recommendations and determine any additional emerging themes that enable the focus to be maintained on delivering optimum value and effectiveness.

Further information

Workstream Lead – Neil Sartorio, EY.



C. Digital Infrastructure / Internet of Things (IoT)

Purpose

To better understand how advances in IoT and digital infrastructure assist with the management and maintenance of the highways network.

Headline summary

In the next five years one can anticipate massive expansion of sensor coverage in both vehicles and infrastructure. The integration of data provides major opportunities for improving asset and network management, reducing costs, and generating a revenue income stream for the public sector. To realise these benefits, standards and protocols need to be agreed, security and privacy issues resolved, and there will need to be step-change enhancement of capacity and capabilities in digital engineering and data analytics.

Methodology

Research was undertaken face-to-face or by phone bilaterally with key role players including the Government, O2, Interdigital, RAE, Digital Catapult and four Universities with particular digital strengths.

Core questions

- How do advances in IoT & digital infrastructure assist with the management and maintenance of the highway network?
- What infrastructure will be required?
- What are the current barriers?
- What do the next five years hold?

Key findings and conclusions

The Government is putting a lot of effort into both the policy framework (e.g. ‘Digital Britain’, Cybersecurity, etc) and into pilot and experimental projects and data hubs. The unit costs and coverage of 5G and 4G digital infrastructure and of data storage are becoming more affordable and more comprehensive quite rapidly. The barriers to mainstream deployment at scale in highways and network management are both general and specific. In general terms the major issues of trust and security, and of standards and protocols need to be resolved. More specifically, LAs need to have the resources and capabilities to deploy the new technologies and manage the data effectively.

Areas for further analysis

The key areas to progress are referenced in the findings. The recommendations of the report seek to impact positively on the major local barriers of capacity and capability – e.g. knowledge hub and hub products; and scale up – e.g. the demonstrator projects at scale.

Further information

Workstream Lead – Alastair McMahan, O2.

D. Academia

Purpose

A horizon scanning exercise to identify business and operational opportunities for a council like Buckinghamshire County Council from digital innovation.

Headline summary

Digital will transform all aspects of the council's operations, stretching from asset monitoring to predictive asset maintenance. It will break procurement barriers and enable real-time interaction with citizens.

Methodology

Conclusions were drawn after consulting a large amount of literature and engaging with leading companies in the field, such as Worldsensing.

Key findings and conclusions

LAs need to focus on five major themes to make the most of digital and technology innovation:

1. From asset monitoring to predictive maintenance: Arguably the biggest opportunities lie with the digitisation of the Buckinghamshire assets. Used properly, these techniques can be very powerful to optimise maintenance cycles.
2. Digitising the Buckinghamshire workforce & processes: Another area of huge potential is in completely digitising the workforce and associated processes. In itself a huge undertaking, it promises to save costs mid to long term. Cloud, drone and other technologies are an important enabler here.
3. Breaking procurement barriers: Digital, and in particular the Internet of Things (IoT), can help to break down procurement barriers and make the entire process much smarter. Using digital technology, early engagement can be guaranteed and procurement itself can be made a much 'smarter' process.
4. Real-time interaction with citizens: An interesting opportunity around digital innovation is the ability to engage with the customer/citizens in real time well after sales/installation of assets.
5. Building an open data & API eco-system: And finally, if all of the above digital approaches are accessible to third parties, a service economy can be built on top using suitable APIs.

Areas for further analysis

Further work is required which identifies the business models of the above themes and the budget needed to commence with the most promising approaches.

Further information

David Aimson, Buckinghamshire County Council on behalf of ADEPT and Professor Mischa Dohler, Kings College, London.

E. Highways Infrastructure

Purpose

To survey leading practice and issues arising from digital and technology innovation in LA highways construction, maintenance, operations, network management, and any wider issues.

Headline summary

There are some notable successes in the use of technology, and clearly recognised opportunities to do more. However, the evidence of comprehensive approaches and cross-service, multi-functional collaboration is still modest.

Methodology

A survey of +/-500 ADEPT members and contacts covering the topics identified in the purpose – with a 5% response rate from councils, DfT, Transport for Greater Manchester (TfGM) and the Highways Term Maintenance Association (HMTA).

Key findings and conclusions

Major themes emerging from survey response and follow up discussions include:

- Construction – considerable advances in BIM, information management, use of sensors and drones, and a range of other technologies and business processes. Would benefit from increasing good practice sharing and guidance, standardisation of systems to encourage scaling and efficiency savings.
- Maintenance – significant examples of digital workforce empowerment, sensors and drones recording faults and identifying repair needs. However major potential for continuing digitisation and increasing cross-service and cross-functional collaboration and interoperability of systems.
- Network operations – considerable use of traffic management and GIS systems to improve operations, but potential for further integration across both public transport operators, with other public services, and with users.
- Network usage – increasing availability of real-time information for both LAs, partners and users across transport and related functions. Also, the beginning of usage of information products for modelling, service and commercial returns. Again, the challenge is integration and interoperability across and between functions.

Areas for further analysis

The issues of integration and scale-up are dealt with directly in the report recommendations – e.g. knowledge hub, good practice guides, and adoption of a comprehensive framework. Key barriers are not technology per se, but rather the issues of scale, resources, capabilities, knowledge exchange and culture identified in the report.

Further information

Workstream Leads – Yogesh Patel and David Binding, Ringway.

ADEPT

Association of Directors of
Environment, Economy, Planning & Transport