Connected Roads, Vehicles and People
A Key National Opportunity

POSITION STATEMENT

TRANSPORT TECHNOLOGY FORUM

About the Forum

This document has been prepared by the Transport Technology Forum to help drive more effective and efficient management of existing and new road networks, as a key national opportunity.

Road transport will remain a key pillar of how people and goods move across the nation, not just on strategic roads. Improving road travel through technology is a core aim of the Forum. We provide a neutral meeting place for senior policymakers and investors (government, industry and network operators) who are investing in technology for roads management and operation.

The Forum promotes a collaborative culture to open up the opportunity and address the caution which has historically impeded efficiency and innovation.

Roads are a key pillar of how people and goods move across the nation

Executive Summary

There are already at least 3 million connected vehicles on UK roads, with opportunities for additional societal and user benefits from conventionally driven vehicles. In contrast, benefits from autonomous vehicles lie further in the future and are less predictable, and require significant penetration and customer acceptance. Connected vehicles give immediate opportunities for productivity, congestion, emissions, safety and travel cost benefits, including smarter parking, more efficient maintenance of roads and reduced infrastructure costs.

The value to the UK from applying technology to roads is already about £7.3bn per year. Exploiting connected vehicles and other technologies gives an additional potential annual

£6.5bn value to the UK in the near term. These benefits are not dependent on new vehicles, as retrofitted devices and smartphones already provide data with no cost to the public purse for installation as they are increasingly used for insurance and navigation. Connecting older vehicles brings bigger safety, emission and congestion benefits than just from new fleets.

But data availability is not enough - roads authorities need guidance to exploit these developments in the typical British town and city, with confidence to move to new vehicle based solutions. Equally, road users need to see personal benefit and gain confidence in connected vehicles and the use of data from them. This confidence in technology will be vital to uptake of future automated vehicles. Hence user testing and development of business models is of more immediate value than pure technical solution research.

To deliver this benefit, the Transport Technology Forum's strategy is:

Quick wins via connected vehicles for improved network management, productivity, economic growth and other policy and societal objectives such as reduced emissions and safety.

Connecting people, businesses and organisations, especially lubricating the overlap of vehicles, roads and parking technology and businesses, and supporting specifications and standards for roads and connected vehicles. Here the Forum uniquely fills a gap to help both government and industry and facilitate exports as well as UK deployment, working alongside groups like AESIN and the British Parking Association.

Working alongside Government Many services are ready to be exploited but there are still technical and market uncertainties - around communications, displaying information to drivers, business models and, above all, understanding what road users and authorities want and will adopt. So the Forum and its community is already working successfully alongside Government, both national and local, to:

Lever off what is here now for rapid benefit. *Government should encourage collaboration to ensure open and interoperable connected systems. The Forum will help in bringing organisations together and distilling value.*

Showcase benefits. *Government should promote use of learning to help inform specifications, legislation and further investments to ensure UK wide benefits. The Forum is well-placed to promote this sharing of learning.*

Develop market and customer/user confidence. *Government needs to ensure that connected vehicles are considered from the perspective of all road users. The Forum can bring this perspective to increase confidence.*

Improve skills*. Government needs to advise roads authorities on how to make the most of opportunities in the short term. The Forum can particularly help by identifying quick wins and by spreading shared knowledge.*

Value data as well as infrastructure and vehicles*. The Design Manual for Roads and Bridges, WebTAG and other guidance needs to be updated, to help roads authorities' value and deploy links to connected vehicles.*

Prepare roads for connected vehicles. *The practical challenges to road operators of procurement, data security and ownership, data use and promotion to politicians need a collaborative real- world approach.*

Improve connectivity*. 5G may provide a future answer to connectivity, but short-term action to fill gaps in existing communications would bring benefits far beyond those from connected vehicles.*

Deploy, develop and demonstrate for the UK. *Government needs to support user-centred research and pre- commercial deployments with many users in many towns and cities of all sizes, to ensure benefits to all the UK.*

Connected vehicles are not as headline-grabbing as autonomous vehicles, but are a reality that needs to be fully exploited through a new mindset from the roads, automotive and parking sectors. Roads authorities will be key stakeholders and enablers of productivity and societal benefits, and so need to be highly engaged.

The future of better UK roads is not simply autonomous vehicles, but connection to existing ones too.

Connected vehicles and roads – a key national opportunity

The value of road technology

Work by the Forum shows the current significance and value of managing roads effectively in the UK from applying technology is already about £7.3bn per year1. This is derived from the Forum's review of other published data. Most of the value is derived from well-established infrastructure- based technology such as urban traffic control, motorway management, incident detection and warning. However, some is already from using data from existing connected vehicles.

Adopting further technologies gives potential for an additional annual £6.5bn of value to the UK. This can be realised in the immediate and near future, so capturing this potential value is our focus.

The time scales of opportunity to benefit the UK

Connected and autonomous vehicles are evolving at separate rates and so we see different opportunities to benefit the UK at different time horizons:

- There are already at least 3 million[2] **connected vehicles**[3] on UK roads, providing data and receiving information. We should harvest the benefits from this data far more. The rapid rate of technology deployment in new vehicles will bring further opportunities for better connected but conventionally driven vehicles that we should exploit; but
- The societal benefits of **autonomous vehicles** require significant penetration and customer acceptance for capacity gains with existing road infrastructure[4]. Safety improvements are not likely to be as high initially as some headlines suggest. Adoption will be heavily influenced by user and market acceptance, so timescales are unpredictable. When it does occur, wide adoption could offer benefits to UK productivity, industry and transport policy alike but will need trust and user acceptance in technology that connected vehicles can help develop.

New connected vehicles aren't all premium vehicles © Vauxhall

Because of the two speeds and different certainties of deployment, the Forum's focus is on quick wins via connected vehicles for improved network management and driver information, productivity, economic growth and other policy and societal objectives such as reduced emissions and safety.

The short-term benefits

There are real opportunities for benefits to users, authorities and UK Plc's productivity within the next 5 years using existing connections to conventional vehicles and from deploying new ones. We can then use the knowledge from connected vehicles to help design and define how more automated vehicles will derive their potential on real-world UK roads.

These actions will help to maximise the use of existing road infrastructure that cannot be expanded easily or quickly and support the Road Investment Strategy goals. They are therefore a quick win compared to physical infrastructure deployment.

The key is that as more vehicles become more connected, the volumes of data they provide can reduce reliance on fixed infrastructure (reducing costs for both strategic and local road authorities) and improve data used in roads operations and asset management.

This data goes far beyond already proven journey time measurements and origin destination monitoring. It includes the following approaches:

- Data from vehicles on the asset condition — for example potholes, road pavement wear and skid resistance, and temperature for winter maintenance planning. This brings safety and asset planning and management benefits reducing costs which the Forum conservatively values at **£200m per year[5];**
- Data from vehicles to reduce congestion and improve temporary roadworks signals performance6. We see total congestion savings helping productivity of **£500m per year;**
- Data to allow creative ideas in improved emissions monitoring and mitigation measures. We value this at **£200m.** Data into vehicles to support Signal Phase and Timing7 (SPAT) information can also reduce emissions by reducing unnecessary stops;
- Information to and from vehicles for eCall, queue warning, enhanced navigation, roadworks warning, and also identifying hazards involving vulnerable road users bringing **benefits of £100m a year from better information and safety;**
- Using vehicles to monitor parking availability, and as mobile Closed-Circuit TV for incident management; and
- New customer facing services to the vehicle user, such as smart 'one-click' parking8 alongside proven driver coaching, breakdown repair monitoring, fleet management and breakdown analysis. We estimate this could save UK industry **£500m a year.**

Information into vehicles also offers value from virtual variable message signs, reducing the need for new roadside technology on unequipped but nationally important roads[9] and aiding the customer experience on Smart Motorways. It would also reduce costs and delays during installation.

Vehicle Data can assist modelling all forms of transport © TSS

From these sources, we conservatively estimate the near-term value to the UK to **be £1.5bn per annum** from connected vehicles, plus export earnings for UK companies providing innovative services, hardware and consultancy of **£500m.**

These are initial estimates based on published data but are being continually updated.

Many services are offered by the private sector for a key purpose such as insurance but give wider benefits if the data they provide is adopted for other uses. The connection we need is therefore not just of electronic devices and people but also of businesses and organisations.

OBD2 socket supports connecting older vehicles' sensors supports

Connecting all vehicles and customers, not just new ones

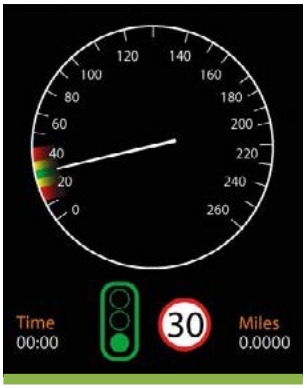
50% of all new vehicles will be connected by 2020[10]. But with 38m vehicles on the UK roads and an average age of just under 8 years[11], we cannot rely on new vehicle technology alone to give the volume of data needed and coverage quickly enough, especially for services requiring interaction such as slow vehicle warning. Use of smartphones and

Older vehicles can use smartphones to provide position data

On-Board Diagnostic (OBD) dongles older vehicles to show their locations to others and to collect and receive information. This increases sample size and service take-up by piggybacking on other services and improving safety for all connected vehicles.

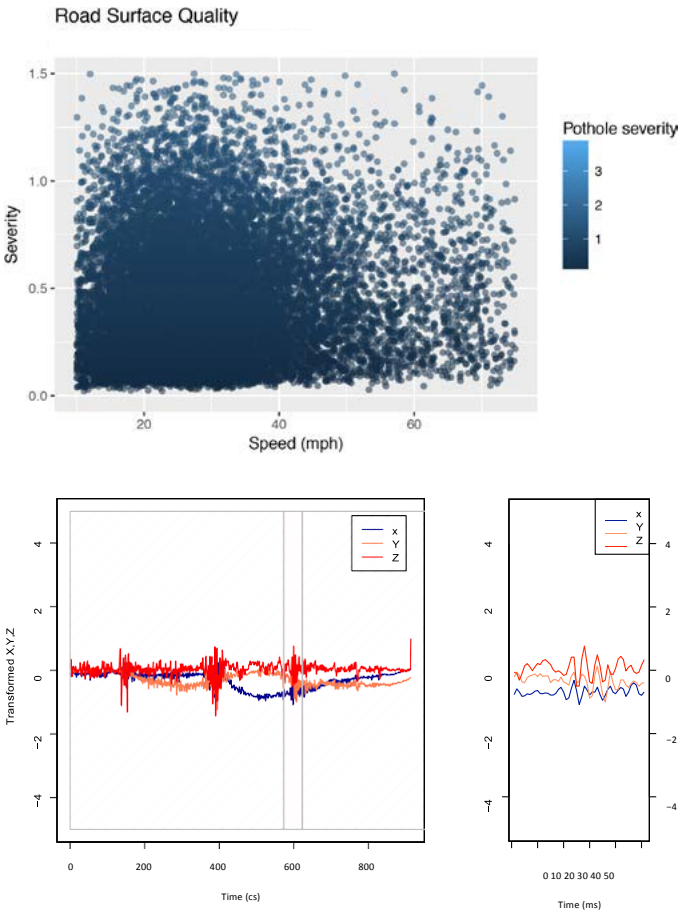
So, older and newer vehicles and the road users in them can be equally connected. This could allow a roads authority to be seen to be inclusive to all its citizens, although new vehicles are likely to offer much more integrated and user-friendly services.

Data from connected vehicles can help all road users of all types, not just those in connected vehicles. And information into vehicles can also improve safety for all.



Connected vehicle speed advice reduces stops at signals

© IDT Ltd



Measuring Potholes using Insurance Black Box Data © Trakm8

Piggy backing on existing investment by industry and users

Freight has already seen the value of connectivity in reducing costs to business — almost every vehicle over 3.5 tonnes now provides data for fleet management. The UK leads the world in fleet management, OBD dongle innovation[12] and floating vehicle data[13]. Connection of freight vehicles offers a low-cost opportunity for rapidly deployed distance-based charging, as in Eastern Europe.

DfT funded and other research / deployment is now looking at using connected vehicle data for freight[14], and reducing delays at signals by giving priority to connected public transport, as well as new approaches that avoid traditional centralised systems[15] and for interurban roads[16].

Many of the above data sources can be provided by smartphones. Increasingly, they can also be provided via black boxes and OBD devices paid for by private drivers, their insurance companies or recovery clubs. This is at no cost to the public purse for installation.

Smart parking already in use in Westminster

© AppyParking

There is a need to prove the market approaches and business models to exploiting this data source.

Increasing confidence in road authority investment

However, data availability is not enough. Roads authorities need to see more examples of how data can be used and receive guidance on how to make the most of developments in the real world of the British town and city. They need support in making investment decisions on new tools and using new data sources, built from evidence from a wide range of use cases and different network types. They need advice in areas such as communications which are not normally in a road operator's skill set.

The Forum has already started this17 but there is a need for technical evidence from UK roads on new communications systems performance in real deployments and on how to connect into legacy systems such as Urban Traffic Control.

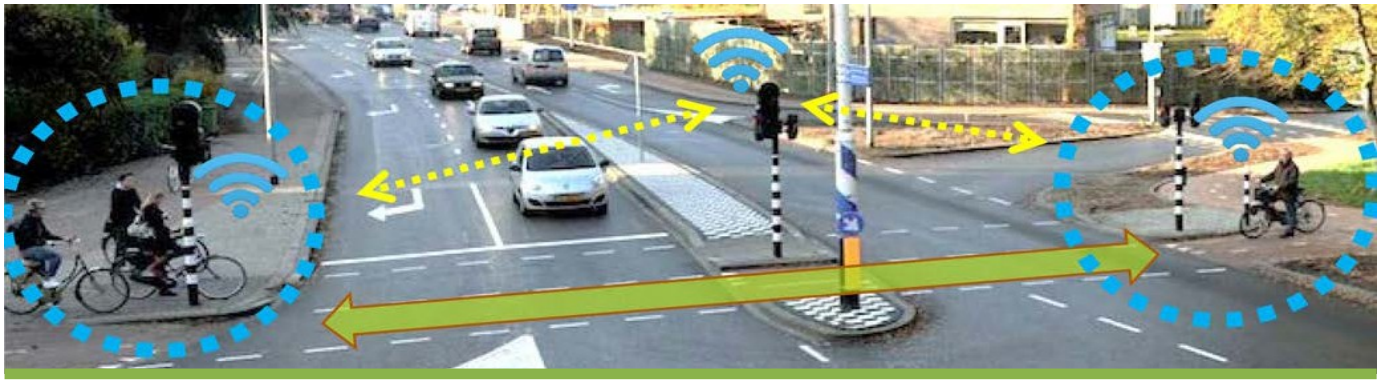
User experience and confidence

The User Experience is fundamental to customer adoption of many connected services – if they don't work well in users' eyes and give a benefit, then they will fail to be taken up.

Roads authorities need confidence to move away from using only the infrastructure they understand, to add the new but unfamiliar benefits from connected vehicles.

Equally, users need confidence and trust in connected vehicles and the use of the data from them.

Customer uptake through a clear personal benefit to them will be vital for use of new information into vehicles, and to the entire future of automated vehicles. User testing and development of business models to remove barriers is of more immediate value than pure technical solution research.



Connected vehicles are not just cars

© Dynniq

The Forum's Strategy

Our strategy for connected vehicles is:

1) To quickly provide this confidence through supporting guides for roads operators and industry on connected vehicles, use of their data in traffic signals and communications choices. Some of these are available on our website and linked in the appendix and we will develop further guides as roads authorities need them. Uniquely, the Forum is already filling a gap by assisting UK Government and industry and highlighting investment opportunities from a roads viewpoint.

2) We see our wider and longer-term role as helping connecting vehicles, roads and parking not just technically but in business productivity, and institutional terms through user facing deployment. We aim to show the value of connected vehicles to supporting policy aims and consumer services as well as road users. This is a unique role for the Forum and one where the UK can lead the world. This report is the first step in that role.

3) We see a role in supporting the development of specifications and standards to support the convergence of roads and connected vehicles — to perhaps move from a *Design Manual for Roads and Bridges* to a *Design Manual for Roads, Bridges and Connected Vehicles* that supports all UK roads and the exports of our highway and traffic management skills as well as connected vehicle expertise.

There is an international perspective here, we must ensure that UK network management and industrial interests are supported by the EU and other standards we will still work with post Brexit. Equally we can learn from international projects and be involved in setting the international agenda especially for connections to roads. We have a specific work strand to assist the development and choice of standards and specifications to bridge the gap between automotive, roads and parking and a Network User Group that offers insight into the customer need for road management.

Our view is that for connected — as opposed to autonomous — vehicles, there is more of a need to develop and deploy solutions with the market, and more user focused research than pure research into technical solutions. Hence our focus is on the short-term benefits to 2023.

Moving forward

There are still some technical and market questions to address. Examples include speed of delivery of data and coverage between different communications options, how to safely show information to UK drivers and the business models for supply of new data. There is a further need to make sure the data provided is secure, private and can be accessed for the public good via a variety of models.

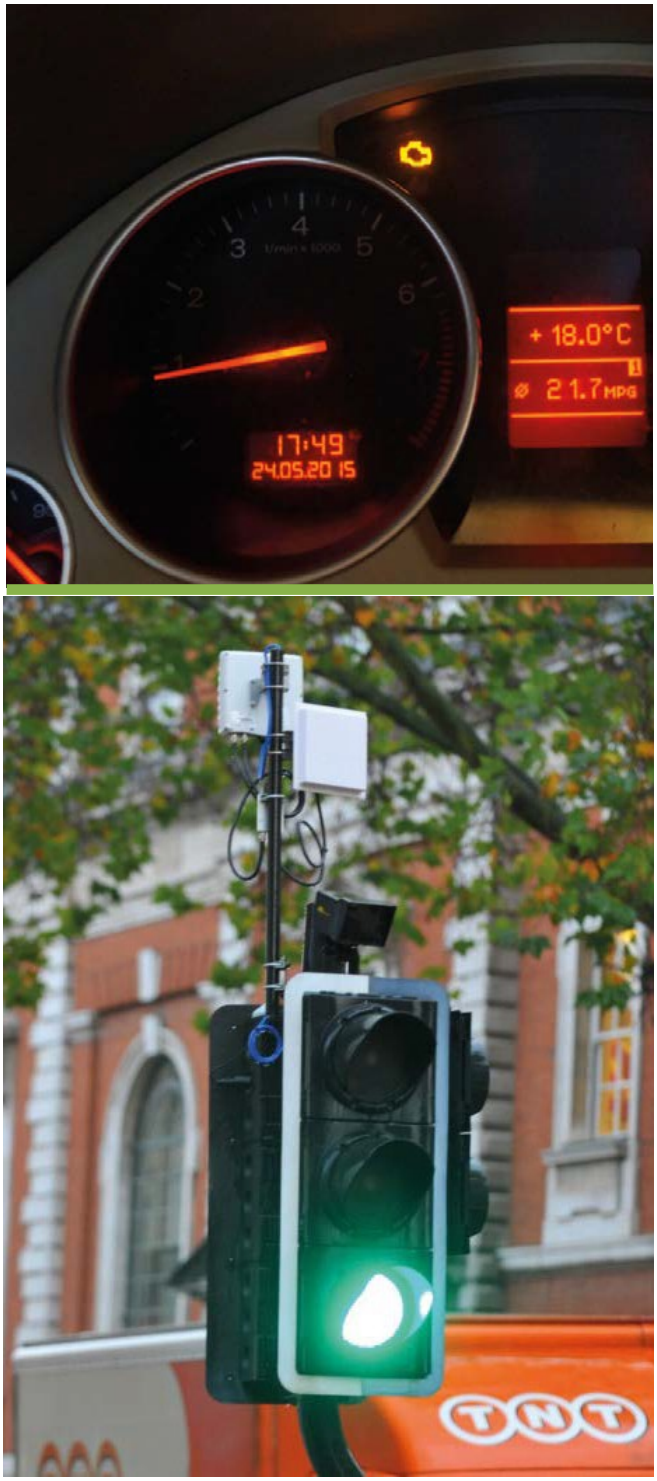
And above all, understanding what road users and road authorities want and will adopt is needed.

Connected vehicle data mapping logistics activity in London

But despite these unknowns, the strategic opportunities are clear. Many services are already in place and ready to be exploited. This is true for both new and older vehicles and much work is underway looking at longer term solutions, but we should not let aiming for a complete answer get in the way of capturing the early benefits.

Key areas where early benefits can be secured include:

- Asset management — helping reduce the cost of maintenance of all roads and structures. Highways England is tasked with a 30-50% reduction in costs and we see connected vehicle data has great value in assisting this, learning lessons from aviation for example[18]. Incremental improvement will not deliver this;
- Emissions management — developing and deploying new creative ideas to monitor and control emissions through better traffic management and user-facing services;
- Congestion identification for infrastructure planning — to better plan interventions and use new capital funds for better value to aid productivity;
- Traffic management – to monitor and increase performance of existing traffic systems, with far greater benefits from future connected vehicles too in modelling and decision making;
- Weather data – for helping inform on floods, icing and road closures;
- Smarter parking, helping reduce congestion and supporting the UK high street;
- Avoiding new roadside infrastructure, to reduce costs and aid new services;
- Road safety — for example levering off the ECall system in vehicles from 2017; and
- Collecting feedback from road users on customer satisfaction and sentiment.



Connecting vehicles and traffic signals could reduce emissions © IDT Ltd

Working alongside Government

The Forum and its community of members is ready and able to help capture these benefits, working alongside Government both national and local. We now highlight areas where together we can deliver change:

1. Lever off what is there now for rapid benefit

DfT's recent Co-operative ITS pilots are a strong start to use of data from vehicles and to vehicles in UK towns and cities for immediate benefit, but the investment is low compared to the research into vehicle automation that has longer payback.

Government should support roads authorities to a far greater extent in the additional use of current and emerging connections to vehicles, to match the emphasis on automated vehicles. The Forum is well-placed to assist this. For example, we propose that the Centre for Connected and Autonomous Vehicles should look in its future funding to large-scale quick-win deployments involving local roads operators. The Forum can provide a direct channel to these. This will set the investment landscape for UK industry and roads operators alike and develop an exportable set of tools and services. DfT should also fund further projects that link its 19 C-ITS demonstrators and several of the CAV1 and 2 projects involving connected vehicles such as UK-CITE to help national rather than piecemeal adoption.

Government should above all undertake user focused research to answer the unknowns of linking UK vehicles and roads, and the Forum will help bringing these together and distilling value.

This means Government encouraging projects across the ecosystem — with collaboration between major suppliers to ensure open and interoperable connected systems facilitated by the Forum.

Government needs to not just look for disruption in technology but evolution, too.

2. Showcase the benefits

Government should make it a requirement that for all funds the societal benefits are captured in a commonly useable way. This would give other users confidence in benefits for further investment. A central depository of cost and benefit intelligence would assist decision-making by local authorities. The Forum is well-placed to capture and promote this learning. Key areas of benefit are emissions and productivity.

Government should then use this intelligence to help inform decisions on specifications and legislation and on further investments and funding.

3. Develop the market and customer/user confidence

There are unknown technical and market areas for future connected vehicles. Piloting and testing these will increase the ability to invest and critically ensure user and customer take-up. Government needs to ensure the new connected vehicle technology is explored not just from a technical perspective and includes all road users. The Forum can bring a road operator perspective that looks at alignment with the various policy aims of UK authorities and hence increase market confidence.

Much of the adoption of systems, such as traffic signal green information in the vehicle, relies on a real user choice, unlike following a mandatory device like a roadside traffic signal. This 'voluntary' aspect needs much more attention in customer facing trials and tests — to address road users' "What's in it for me?" questions. The Forum has already explored many of the unknown areas in customer confidence to help steer such tests but the answers would only come from large scale deployment on UK streets.

The trust gained through exposure of users to connected vehicles is a key step to fuller autonomy.

4. Improve skills

Moving from infrastructure to data means a further demand for skills not traditionally forming the core of roads authorities' expertise. Government needs to advise roads authorities on how to make the most of the opportunities in the short term. The Forum can particularly help here, for example with our recent guides19 but also by identifying quick wins as they emerge and spreading shared knowledge.

Government could help with retraining of staff where there are skill shortages. Equally, UK suppliers and service providers need the skills to support exports.

> Government investment in STEM education in how to exploit the opportunity will help longer term.

5. Value data as well as infrastructure and vehicles

Current transport planning has mature ways of assessing benefits from hard infrastructure but not from use of data. The Design Manual for Roads and Bridges, WebTAG and other guidance need to be updated to help local and national roads authorities know how to value and then deploy connected vehicles and to use the benefits they can deliver. The Forum's work on standards will assist here.

Equally, Government should not see just new vehicles as those that connect, but remember the ability of any vehicle to become connected to give societal benefit and improve productivity.

> Connected vehicles are not just cars, but public transport, freight and logistics vehicles, and the connected vehicle concept can also help cyclists, bikers, pedestrians and other vulnerable road users. This is a key area of the Forum's work.

6. Prepare roads for connected vehicles

Connected vehicles can be a practical challenge to road operators in terms of procurement, data security and ownership, mindset of data use and selling to politicians. The Forum is well placed to address this challenge in real world ways.

Some investment is also now required by local roads authorities to bring their base technology and datasets up to speed and to future-proof it for connected and then autonomous vehicles. An example is Traffic Management Order information held on paper maps that will be needed for smart parking and autonomous vehicles.

> This lack of investment funding is putting us behind our competitor countries in terms of new services but is understandable given these lack of confidence in investment.

The Forum can increase this confidence through shared knowledge but Government help to authorities would assist.

7. Improve connectivity for all

Ofcom data shows significant gaps in mobile phone data coverage even on strategic roads. It is worse in other geographical areas and on other routes. This is a key obstacle. Connected vehicle customer acceptance, service adoption and hence benefit delivery rely on such connectivity.

> 5G may provide answers for the future, but short-term action by Government to fill data coverage gaps in existing mobile or Wi-Fi communications would have benefits far beyond connected vehicles.

The Forum has already helped inform government on the communications options for connectivity from a network operator's viewpoint, and will continue to monitor developments.

We consider that unless there is a base level of 3G and 4G coverage across the majority of UK roads to improve the existing customer experience, user confidence in 5G solutions may not develop enough to support market take up and geographic inclusion of rural and interurban roads. City services alone will not be enough to win over UK customers.

8. Deploy, develop and demonstrate for the UK

User interaction with connected vehicle services has safety and UK network management implications. There is also a need to attract UK user buy-in to services out of the range of existing road authority expertise. Technical research and watching developments elsewhere are not enough.

Government needs to support user-centred research, demonstrations and pre- commercial deployments of connected vehicles services with large user bases.

It did this for the Radio Data System-Traffic Message Channel in the 1990s[20], to inform the industry and roads authorities of the opportunity and understand what UK users really want.

Siemens ESCoS Roadside Unit in Newcastle

Small user focused research led to two UK services and export revenue for the service providers.

The Forum can assist in bringing the user centric results of various demonstrations together as described above for the societal benefits.

The CAV testbed for the UK has a focus on higher levels of connectivity and automation. Connected vehicle developments should be spread geographically to a wide range of towns and cities of all sizes to deliver benefits to all the UK.

Connected vehicle data used to analyse traffic in York © INRIX

Newcastle Connected Corridors © NCC/ Ordnance Survey

Tapping into the value

Connected vehicles are not as headline-grabbing as autonomous vehicles, but they are a reality that needs to be fully exploited. Much data collected today from vehicles is thrown away21 as it has no apparent use, yet it is often the same data that traffic managers have been seeking for many years. For example, a Pay-As-You-Go insurance provider captures accelerometer data from vehicles but until recently did not realise the value of small vertical movements that could provide new data for additional pothole detection.

UK roads can be operated and maintained better through piggy backing off services that road users generally pay for themselves.

There are many opportunities to do more for less but this requires a new mindset from the roads, automotive and parking sectors. The Forum can assist by bringing together the suppliers and users of data across automotive, roads and parking.

The Forum is committed to the collaboration needed to connect vehicles and roads.

The future of better UK roads is not simply autonomous vehicles.

Further obstacles to deployment the Forum can address are:

- Awareness of opportunities for roads authorities, by bridging the gap between roads and automotive sectors due to not knowing each other's business drivers and constraints
  Avoiding Government re-inventing the wheel and funding research of on-the-shelf services;
- Showing roads authorities how to deploy and procure new services; and
- Removing some of the concerns about risk of privacy and data sampling.

Moving towards full automation

Roads authorities will be key stakeholders and enablers in the age of autonomy, with its new revenue opportunities, cost savings and productivity and societal benefits, and therefore should be highly engaged.

The Forum sees the challenge of maximising the value from connected vehicles as our immediate priority, but of course we actively support pilots of high levels of autonomy.

For more information contact Andy Graham:
Andy@whitewillow.biz

The target for our work – improving UK roads in the next 5 years for all users

References

[1] TTF Strategic Business Case – initial assessments now being updated

[2] Assessing the number of connected vehicles depends on various factors but the sample sizes and vehicle fleets given by Here, TomTom and INRIX added together give this figure. Google android location data is unknown but likely to be of a similar magnitude

[3] We regard a connected vehicle as one that at least can report its location in real time either by an on-board device or smartphone app

[4] Work by Atkins for CCAV - see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/530091/ impacts-of-connected-and-autonomous-vehicles-on-traffic-flow-summary-report.pdf

[5] TTF Strategic Business Case – initial assessments now being updated

[6] Work in the Eboracum project by City of York Council funded by the DfT TTRIG programme

[7] Many varied sources – see http://www.cts.virginia.edu/wp-content/uploads/2014/04/PFS_SPAT99_Final.pdf and also http://www.compass4d.eu/en/cities_02/newcastle/newcastle.htm

[8] https://www.gov.uk/government/speeches/funding-for-smart-parking-and-traffic-management-schemes

[9] http://www.reesjeffreys.co.uk/funding-policy/

[10] INRIX data

[11] SMMT data

[12] Trakm8 and other suppliers – see https://www.trakm8.com/ and https://www.theaa.com/breakdown-cover/connected-car

[13] Many companies such as INRIX use UK data science expertise for global services

[14] West Midlands C-ITS project – see https://www.wmca.org.uk/media/1354/dft-c-its-application-form_tfwm.pdf

[15] Eboracum project work in York

[16] The A2/m2 project and UK CITE – see https://www.ukcite.co.uk/

[17] TTF Guide for Local Authorities – see http://its-uk.org.uk/wp-content/uploads/2017/04/Connected-Vehicles-for-LAs-20171.pdf

[18] The Rolls Royce “power by the hour” approach uses continually connected engines to monitor asset performance using data on trends and events, rather than just a time based regular inspection

[19] TTF Guide for Local Authorities – see http://its-uk.org.uk/wp-content/uploads/2017/04/Connected-Vehicles-for-LAs-20171.pdf

[20] The predecessors to DfT funded user research in a 500-user pilot of satnav that lead to 8 million UK users, and 2 UK companies launching innovative services.

[21] Discussion with a major Original Equipment Manufacturer and fleet management provide