Atkins – Written evidence (AUV0047)

Q1
The range of potential applications for autonomous vehicles is significant, we are already seeing solutions in farming, mining and ports and from there, over time, we can see opportunities to further unlock economic value, increase efficiencies and improve safety.

In the roads sector, examples potential applications include road maintenance, asset management, platooning vehicles, passenger movement through private vehicles, small pods and buses. The airport sector has some near term opportunities that leverage existing technologies and are arguably less problematic to implement that in the roads sector.

Examples include air side solutions around plane movement, baggage movement and landing bridges. Clearly air craft already have autonomous capability and we think it will be sometime before full autonomous flights for mass transit are a reality that said for personal travel research and deployment of solutions for personal travel and cargo are nearing completion. Moving landside, we see opportunities around concourse passenger movement, baggage movement, flight connections and onward connections to other modes of transport, examples of driverless shuttles already exist.

We see in rail and mass transit a mix of capabilities, the rail sector in the UK as it progresses on it digital journey that opportunities will arise in the long term (2030+) but in other forms of mass transit that solutions already exist, for example, London Underground and Docklands Light Rail.

Q6. To Q9

Atkins believes that Connected and Autonomous Vehicles are part of a connected ecosystem, and as such, for penetration to be achieved that in turn offers a positive change, the exploitation of an Intelligent Mobility platform that links the various data sets together to provide trusted, reliable, and optimised transport must be at the heart of the UK’s focus.
Atkins believes that more can be done to sustain growth in the Intelligent Mobility market which in turn, will directly influence the use and deployment of Connected and Autonomous Vehicles.

The UK transport network is under increasing pressure to better identify, plan and deliver solutions that address the multiple challenges currently crippling the sector. On-going demands and expectations for a more efficient, accessible network that improves safety and capacity and reduces congestion, is at a pivotal point where innovative provisions are necessary to avoid a race to the bottom.

Expanding and ageing population numbers and urbanisation are a couple of the socio-economic factors impacting on the transport network. In response, the industry has called for the implementation of Intelligent Mobility to successfully support the network in boosting productivity and generating long-term sustainable growth across the nation. This new initiative will harness the potential of emerging technologies to create an integrated network capable of transforming the sector - from future infrastructure design through to service delivery. It brings a new focus to optimising ‘the way we approach mobility’. That is, specifically looking at how to use technology and data to connect people, places and goods across all transport modes in a smarter way. Intelligent Mobility is rapidly gaining momentum and is considered a game changer.

The UK needs a strong Intelligent Mobility market. Although progress has been made in terms of the government’s ongoing support for research and development projects in the field of Connected and Autonomous vehicles, there is still no clear, well defined vision for the market.
Much more needs to be done in order to make Intelligent Mobility a tangible offering. Moving forward, this will mean a pronounced shift in thinking in addition to the realignment of investment and delivery.

There are four core principles necessary to support the implementation of Intelligent Mobility:
- Government and industry must implement a roadmap from conceptualisation to completion with clear parameters suitable to drive efficient collaboration, optimise growth and navigate potential risks;
- An independent authority, like the National Infrastructure Commission, should take on the role of the ‘guiding mind’ - to remove fragmented decision making, create opportunities for growth, make regular assessments on the feasibility of projects and encourage a cross-sectoral approach to delivery; and importantly
- In addition to the current Research and Development awards being made, direct provision must be provided in order to drive the adoption of Intelligent Mobility as a Business as Usual activity.
- The UK needs to establish a policy and regulatory framework that facilitates an ecosystem of innovation.

Atkins understands that a ‘one size fits all’ approach is not possible to achieving an intelligent and fully integrated network and therefore calls on government to set out a cross-party industrial strategy that turns ideas into commercial success while stimulating better outcomes across our transport network.

Technology is increasingly central to our lives both within the public and private realm. However, the pace of change along with the vast array of choices entering the market, is often confusing and challenging for public bodies to understand and to make the best use of new developments in this area. Questions around risk management, safety and security must be balanced against increased capability, new intelligence and skills creation.

In recent years, the concept of Intelligent Mobility (IM) has gathered momentum. Identified by the UK government as a £900bn market, IM is expected to revolutionise the way we travel. The application of new and disruptive technologies is set to impact on the role of transport, customer behaviours and expectations.

The Transport Systems Catapult has identified the primary goals of Intelligent Mobility as follows:
- Make travelling an end-to-end user-centric experience;
- Make our transport system more sustainable and reduce its environmental impact;
- Save many lives;
- Generate billions when moving people and goods;
- Make our transport systems more resilient;
- Make our transport assets more productive;
- Improve accessibility for all segments of society;
- Make transportation of people and goods quicker.

Technology is converging and as new products and systems enter the market, be it Connected or Autonomous vehicles, mobile phone applications or the Internet of Things; they are all interconnected, sharing information about their users and surroundings. This raises several
questions around the management, accountability, governance and commercialisation of data. More specifically:

1. Who is sharing what information and with whom?
2. Who is responsible for the information being shared?
3. How is the process regulated i.e. who is making the decisions based on this new data?
4. How is it being commercialised and how can skills be created in line with market demand?

Technology is an enabler; and as we move from experimental to everyday it will reshape the design and delivery of transportation. If the UK is to compete in the global race and shape the IM market in the coming five to ten years, then government must be proactive in building a robust link between current funding and establishing a credible long-term vision that encompasses all elements of Intelligent Mobility beyond Connected and Autonomous vehicles.

As steps in R&D investment continue to move in the right direction, the challenge rests with government’s ability to facilitate an environment where both public and private sectors are able to capitalise on the opportunities presented by Intelligent Mobility.

The points listed below outline the steps government must take in order for IM to become an exemplar for innovation and These actions will position UK plc as a leader in this market, driving jobs, growth, more efficient and safer journeys for citizens and better connectivity for businesses with customers and supply chains.

1. Develop a nationwide co-ordinated approach to IM and its subsequent implementation.

If it is worth £900bn, how do we make sure we are creating opportunities for the UK? Establishing an industrial strategy that seeks to support Intelligent Mobility in order to encourage economic growth and add value to the current infrastructure pipeline will allow government and industry to capitalise on this new market.

Innovation is part of the UK’s DNA. However, converting this to sustainable and long term growth and job creation must be a central focus of IM in the UK. A national strategy must reflect a global understanding of the diverse market. There are a number of advisory groups operating in the IM sector, such as IM-PACT and the Technology Forum performing UK focused activities in this area. To build on this activity, it is necessary to develop a cogent capability framework in the short term that allows for internal investment to be focused as well as identifying international gaps where UK businesses can play a key role. This will help to deliver a capabilities review for Intelligent Mobility in the UK, which can be benchmarked against global competitors and identify investment opportunities.

2. Create tangible demonstrators linked to everyday performance that highlights the value of IM and prove their worth to the UK plc.

Showcase demonstrators are a key part of the IM value creation. It is important to demonstrate novel capability and expertise that readily highlights the UK’s role in the IM space. It is proposed that this must be taken one step further and linked to an active ‘business as usual’ deployment programme, in order to differentiate from our global competitors, where demonstrator projects are becoming much more prevalent. To ensure sustainable success, this programme must include consideration of the commercial implications as well as
the short to medium term roll out requirements. Demonstrators must be inclusive, highlighting how technology and people are working together to provide a range of socio-economic benefits which includes providing transport solutions for an ageing population.\(^1\)

3. **Make the distinction between Connected and Autonomous and develop a detailed value proposition for their deployment through a robust business case.**

It is clear that Autonomous (Driverless) Vehicles offer an exciting and challenging future to our approach to Transportation, both in the UK and Globally. Unfortunately, it is also very clear that Connected Vehicles (with a driver) are either being ignored or under-appreciated in terms of what they can offer today. Connected capability is linked but separate to Autonomous vehicles. Connected Vehicles must be approached as a distinct offering in the market place, with strong overlaps to the world of Autonomy, but recognising the world where a driver is always in control, but more and more dependent and expecting of services provided through digital connectivity.

Job creation, inward investment and the exportation of capabilities such as intellectual property, products and systems, underpin the UK’s focus on CAVs. Significant expertise exists within the UK automotive industry to drive this forward but only if this is leveraged and maximised. However, CAVs (as one aspect of Intelligent Mobility) reflect a changing world and as a result, an evolving supply chain, from semi-conductor companies to wireless and discrete sensor providers. The business case across the value chain must be fully understood, articulated and supported by on-going validation in line with changes in the technology and OEM focus.

The role of the Centre for Connected and Autonomous vehicles (C-CAV) should be expanded to assume a wider narrative by helping to create the infrastructure (both physical and regulatory) to drive long term investment and enable CAVs to succeed in the UK.

4. **Understand the impact on current and future infrastructure.**

The existing road network is based on principles of design that must be reviewed with the advent of CAVs. For example, the use of crash barriers, lane width and capacity optimisation should be understood from an infrastructure perspective including opportunities for significant financial savings and better land use. Understanding the changes needed now and in the future and how these will be undertaken is key. Risk assessments for network operators and Local Authorities, a defined methodology along with the modelling of new vehicle behaviours must be undertaken to ensure that safe but network optimised designs are created. Existing communications networks must be mapped against future needs and a complete review of legacy equipment and their capabilities must be undertaken in order to understand what can be exploited or needs to be replaced.

5. **Challenge the industry to establish sustainable Mobility as a Service (MaaS) deployments linked to central funds and invest in establishing public and private partnerships for the exploitation of new customer-centric services.**

Local government and associated cities look to central government to form a unified approach to the implementation of MaaS. Without a strategic and policy-led approach, there is a distinct risk that various regions and cities will develop solutions that are then delivered in

\(^1\) It is estimated that between 2015 and 2020, the general population is expected to grow by 3 per cent with the number of those aged over 65 increasing by 12 per cent during the same period.
silos and the overall value to the UK plc is significantly reduced. It is imperative that strong leadership is shown in developing a national perspective on MaaS and that government leads on this. This is significant in light of the devolution agenda and transfer of powers to local authorities. The National Infrastructure Commission may have a role to play in providing recommendations that best support the roll out of Intelligent Mobility across the UK to ensure consistency and establish a delivery timeframe that facilitates regional and national growth.

6. Establish the testing and benchmark conditions for deployment and license of CAVs. Testing and validation of the technology, as well as the user requirements, is central to the success of CAVs. Private test tracks and virtual environments are important, in line with traditional approaches, but a system approach is needed for CAVs. This means that the city, the roads and users for example, must be considered as key elements and the UK must provide a mechanism for testing to take place in a real world environment that is safe and secure by design. Benchmarking, which can establish the UK as a global reference point, must be created in the areas of performance, safety, and risk at a technical, behavioural and local level. The government has outlined its ambition to ‘make the UK a centre for driverless vehicles’ and our forecast indicates that with direct investment and service creation, the development of a world class test facility is feasible. In the case of the Atkins led VENTURER ‘driverless car’ research and development programme, research has indicated that further direct investment in a dedicated test facility will enable the creation of over 10,000 jobs across the South West region in the field of CAV development and testing by 2025.

7. With the convergence in multiple technologies, there must be a co-ordinated business operating model across multiple themes (that links various data sets such as Block Chain, the Internet of Things, Big Data, and CAVs together). There must be an ecosystem, or multi-stakeholder engagement platform, that supports the successful deployment of technologies. For this to be achieved it cannot be done in isolation and the government must define at a national level what is required for a sustainable solution to take shape; one that links a number of companies with competing offers together. The UK can establish itself as market leader by developing a targeted operating model for engagement that protects and optimises the various market offerings. The government should assume the role of an enabler. This operating model must define the engagement across parties as well as the technical requirements, such as data flow and security, necessary for implementation.

8. Define the UK’s role in sharing and exploiting data and its approach to cyber security. Intelligent Mobility is a data rich world. Traditional vehicle manufacturers and new market entrants will generate, as well as consume, huge volumes of data in order to drive their new market offerings. Highways England, Department for Transport and cities have access to a huge amount of existing data. However, to capitalise on this, it must be made clear what the roles of the institutions are going to be and how the organisation, the technology, and the data can be linked together in the most innovative and robust way possible. The UK can be a world leader in establishing a market focused independent data exchange role that allows for data from all providers to be handled in an anonymous way that drives value creation as well as network optimisation.

Transportation plays a critical role in society and as such should be safe by design across the planning and execution of new roads and railways. The design envelope has to consider the digital world we live in today. The National Cyber security centre is a start. However, a cyber
secure framework that puts transportation at its centre must be created and an organisational culture change that creates defined cyber security elements within its operations.

9. Establish the technology, policy and regulatory requirements for CAV for the next 5 years.

As the UK looks to become world leaders in the deployment of Connected and Autonomous vehicles, it is vital that a regulatory framework exists which allows for such deployment to take place. It is important to create an environment where car manufacturers are attracted to invest in testing their services in the UK rather than abroad. As other countries vie for the lead position, regulation and policy on its own will not be enough. In parallel, a defined insurance strategy must be in place as well understanding the business model linked to use of data across the CAV and wider IM market.

10. Drive a national agenda, fully integrating all aspects of transport, ensuring the rural economy is not forgotten.

Around 18% of England’s population live in rural areas and it is estimated that the rural economy will make a substantial contribution of £35 billion to the national fund in the next decade. IM, with its focus on technology driven solutions and user take up, will be dominated by urban opportunities. However, there are significant benefits to be attained in rural environments and it is necessary to make sure that rural applications are not neglected, leading to a two-tier transportation and customer service provision. Businesses must demonstrate, through a focused rural programme, a number of IM based services and offerings that can add value, both economically and socially, through a new approach to transport. This can help position UK businesses as leaders, not just from an urban perspective but a rural one as well. We recommend that the government works to drive the national agenda, full integrating all aspects of transport to boost the development of this sector.

Building a national capability will require a pooling of efforts across industry, academia and government. The identified recommendations, if implemented, will not only allow the UK to establish a strategic advantage with transformative importance to the economy, but will facilitate social benefits for all segments of the population.

It is increasingly important that the UK leads the charge in demonstrating its capabilities in a growing and nationally important market that will facilitate productivity and maintain the attractiveness and competitiveness of Britain’s economy.

The National Infrastructure Commission is in a unique position to make targeted recommendations that will maximise the growth potential of transport infrastructure. Therefore, it is necessary for the Commission to consider the wider implications of Intelligent Mobility; and to adequately assess how to successfully balance the future of infrastructure delivery with the radical shift of technological applications in the transport industry. This must include a clear roadmap that helps to align industry challenges with research and development to propel a modern and fit for purpose network.

Q10. Changes to digital or physical infrastructure

Atkins believes that there will be significant changes to both the existing physical and digital infrastructure. Changes will need to be considered at a minimum in the following areas:

- Provision of information to the travelling public
- The use of on-street monitoring systems
The use of the central reserve and barrier
- Road speed limitations and road widths
- The ownership and sharing of information between vehicle to vehicle and vehicle to infrastructure
- Maintenance requirements and monitoring facilities
- Road user charging
- Big Data Storage and Management
- Vehicle Flows and Traffic capacity management

It is Atkins' considered opinion that the rate of change in technology requires immediate consideration of the above. Atkins is also firmly convinced of road authorities to understand the 'Connected' element of Connected and Autonomous vehicles as it is now available through a number of vehicle manufacturers.

Changes to the digital infrastructure will require an adoption of an end-to-end journey capability brought about through connected and autonomous vehicles and as such, the establishment of enterprise level data management and provision across a number of different sources of data at different timing.

The UK must prepare now for the coming technologies that will fundamentally change how people move and interact with the space around. The actions that cities can take to prepare for CAVs include providing the digital infrastructure required for connected vehicles, considering systems for data capture and exploitation, preparing existing infrastructure for CAVs, considering cyber security requirements and taking on a governance and regulatory role.

Since the publication of Atkins’ White Paper on Connected and Autonomous Vehicles (CAVs) in September 2015, a huge amount of relevant innovation has occurred across the world.

From vehicle manufacturers, to start-ups and government funded projects, many organisations are getting excited by the opportunities that CAVs present. In addition, Electric Vehicles are becoming more mainstream as people look for a more affordable and environmentally friendly solution to their transport choices. New technology such as Internet of Things (IoT) and Blockchain are gathering momentum with vast volumes of data being created at a staggering rate.

With so much going on, what must be done next?

The development of a Mobility Platform that creates the environment for these new technologies to dynamically engage is the key.

Operational excellence, both at a city level and wider, depends on the use of a Mobility Platform to understand how the 4 Ts of Trust, Time, Test, and Transport, are linked across a number of areas and how the various technologies in the connected physical world will merge over time.

**Implications for Infrastructure**
The existing road network is based on principles of design that must be reviewed with the advent of CAVs. For examples, how will the use of crash barriers, lane width, and capacity optimisation change as CAVs become prevalent on the road network? There is therefore a need to understand the impact of CAVs from an infrastructure perspective. Are changes needed now or in the future and how is that undertaken?

Risk assessments and methodology must be reviewed, whilst modelling of new vehicle behaviours must be undertaken to ensure that safe and operationally efficient infrastructure is designed. Existing communications networks must be mapped against future needs and a complete review of legacy equipment and their capabilities must be undertaken in order to understand what can be exploited or needs to be replaced.

**User Experiences and Services Required**

CAVs must be about empowerment. It is an imperative that CAVs do not create a two tier society. As such, the needs and requirements of the wider community must be matched against the capabilities and opportunities that CAVs can introduce. Cities and authorities must assess the implications of private and public CAV fleets and how these can be made to work for the benefit of all, rather than the few. In particular, we need to understand how CAVs can offer new opportunities for independence to a wide user group, such as the older population and those with mobility issues, and the impact this may have on demand.

**Network Optimisation and Secure Transport**

CAVs offer the potential of a safer, more reliable transport infrastructure. A reduction in the number of accidents and related injuries can directly improve journey time reliability and customer experience.

However, it is vital that network operators understand the value that data transmitted to and from CAVs can bring, and as such, understand the requirements this brings for their utilisation. Vehicles that can ‘talk’ to each other about their journey, the congestion they experience, and other known data points such as weather, offer a valuable resource to the network operator.

The operator must understand how these new systems can link to legacy ones and the data analytics required to make sense of it all. In addition, there is a need for authorities to accept that this digital world carries with it a new type of operational risk and as such it must be understood how the security of the data transmitted is monitored and continuously assessed in real time. It is no longer enough to sit and wait for the inevitable to take place. Actions must be taken now to protect the travelling public and the services they rely upon.

**Modelling and the Rules Engine**

It is clear that the implication of CAVs on the wider transport network must be fully understood. There is no clear understanding of what impact such vehicles will have on network capacity. Will CAVs lead to reduced headways? And will the benefits of this be outweighed by an increased use of vehicles?
Modelling of changes in behaviour and driving patterns must be undertaken and benchmarked against real time deployments in order to create reliable and quantifiable models that underpin future designs and investments.

Development of a Rules Engine, complementary to both in–vehicle and network operators’ management strategies must be created and embedded within the deployment of connected transportation. A Rules Engine will help to not only define the benchmarked behaviour of the individual vehicles themselves but also create an optimum starting point for network strategies focused on improved customer experience.

Q11. How might a move to extensive deployment be managed?
Atkins believes that the move to extensive deployment depends on three areas of consideration:
1. The market USP (unique selling points) that the auto industry is looking to establish and a race to be a first deployment, at both a local and global level
2. The consumer market defining their needs across the different user groups
3. Pragmatic insurance conditions linked to clear legislative direction
4. The testing and validation of the ‘connected system’ to allow trusted and secure autonomous and connected vehicles to take place

Testing leading to Trust is a key area of focus for Atkins.

The testing, certification and validation of connected and autonomous vehicles plays a fundamental role in the adoption and usability of CAV based technology. At the heart of any deployment will be validation, ensuring elements of CAV are fit for purpose and provide both the improved user experience, and that the services developed will operate as expected under all conditions. Both within the UK and globally a number of test tracks are or will be in operation but according to a report from the Institute of Engineering and Technology (2014):

*Traditional off-road testing facilities may not be appropriate for the testing of some aspects of highly automated systems. The UK’s dedicated test-track facilities do not have facilities that are configured in an urban layout with blocked sight-lines that may be important in testing how automated vehicles behave at busy junctions where it is not possible to have a direct preview of approaching traffic.*

Issues such as safety, hand over mechanism, cyber protection and useability will all have to be rigorously validated and understood, from both a manufacture’s, country and user perspective. Validation is not just technology driven. Companies will have to ensure that people, the end users, engage with CAV as expected and understand the benefits and usability of solutions on offer.

Testing and the facilities needed to perform the validation and verification needed, is very much seen as a global opportunity. It opens up avenues for job growth and IP creation. In the UK, the DfT have drafted a ‘Code of Practice’ that outlines a practical approach to the testing of autonomous vehicles allowing real-world testing of automated technologies to take place in the UK today, providing a test driver is present and takes responsibility for the safe operation of the vehicle; and that the vehicle can be used compatibly with road traffic law. **From a testing perspective both options must be considered and not in isolation.** The
physical should help optimize the virtual which in turn will be fed back to optimise the sensors and algorithms deployed on-street.

With roads becoming increasingly ‘smarter’ and new types of vehicles with more and more autonomy joining daily traffic, advanced testing is recommended. Behaviour of such vehicles cannot always be predicted and the risk of testing in a real world environment is high - significantly higher than for manual vehicles. The use of simulators is crucial - not dissimilar to in-lab testing of medication before actual consumption by humans.

An automotive simulator provides an opportunity to reproduce the attributes of an actual vehicle, but in a virtual environment. External factors and conditions are replicated to such extent that the passenger – or, in the case of autonomous vehicles, the computer – has the impression the vehicle is operating in a real world environment. Simulator software can replicate real life events and situations with extreme accuracy to create a fully immersive experience. This has multitude of advantages, such as driver safety, reduced risk (no real damage to the car in case of a collision), cost reduction (e.g. fuel savings, reduced maintenance costs), and environmental advantages (reduced emissions) to name a few. The ability to safely replicate dangerous or rare situations gives simulators a unique ability in training or assessing drivers or users of (semi-)autonomous vehicles. This is equally important when assessing how the roads of the future will deal with emergency services such as police and fire - where vehicle navigate chaotic environments at high speed. If some of the surrounding vehicles are autonomous, they will not behave in the same way a human would.

In the case of an autonomous vehicle, a virtual vehicle model is required that will dynamically behave in the simulation exactly as the robot vehicle does in reality; replicating parameters like acceleration, braking distances, cornering speed limits and suspension behaviour.’

Reflection

We are on the cusp of the 4th Industrial Revolution, where the introduction of the digital age will allow people, places and goods to be continuously connected morning noon and night. The rate of change and development with technology is truly staggering. A new ‘gizmo’ and mobile app is launched nearly every minute, with announcements on Connected and Autonomous vehicles made nearly every day. With this in mind, it is important to understand the short term implications and opportunities that exist with disruptive technologies. Equally important is understanding the changes that must be made today to make the transport solutions of tomorrow relevant to our operations. Our roads are beset with congestion, lack of customer engagement, and increasing levels of pollution and risks to users. The aspiration is to reduce these to Zero, to create a ‘Road to Zero’ where we have truly capitalised on the technology and information that his new digital age brings us.

Intelligent assets linked to the revolution taking place in Internet of Things, are becoming increasingly mainstream. The improvement in sensor technologies as well as consolidation of testing in the digital environment across this new connected world, makes it ever more important that we fully understand our role and relationships across the ‘capture/process/understand/action’ trail.

Connected Vehicles as well as infrastructure will play an increasingly important role in network monitoring, allowing operators to begin to implement proactive rather than reactive
strategies – imagine if a car can tell you in real time that an accident is occurred, or that air temperatures suddenly dipped and salting is needed, or that weather is deteriorating and new timing strategies must be implemented. Platooning, where one truck leads and makes the decisions for those behind that connect as a road-train can allow for improved safety, fuel usage. These scenarios aren’t as far-fetched as they might seem, with co-operative Intelligent Transport Systems being deployed as you read this. There is an impact across a wide supply chain that can be clustered together in four main areas: Infrastructure, Services, Data Management and Customer Experience.

Short Term

Technology and what it can do for us is changing before our eyes. Lots of new sensors are becoming available, both fixed and virtual, with a challenge to organisations as to how best to exploit them. Examples of this include Mobile phone data and how it can now be a source of new and vital strategy and planning information, providing origin and destination details at a granular level. Internet of Things is a burgeoning technology and market space, and it seems particularly applicable to helping traditional assets become smart and interactive. In tandem with this, with an ever growing importance of connectivity, it is important to understand and trial a number of new communications networks in order to understand at a simple level how they work and the value of them, but more fundamentally, how we can fully exploit them across the whole digital environment. This includes WAVE, or G5, networks, LiDar on street, in-vehicle congestion management and automation etc. Technology provides the capability, but people and their tailored needs and requirements must be placed at the heart of everything we do. Scenarios where freight management schedules are linked to traffic light adoptions, dynamic priority combined with electric vehicles, automated congestion relief linked to incentives to turn off at service stations, automatically responsive junctions to dynamic loading, including cycle and pedestrian priority, are all either possible or in the early stages of implementation.

It goes without saying almost, but we cannot dare to ignore the implications around CAVs. Testing and Validation are absolute necessities in order to ensure the safety of these new systems.

Medium Term

The key question here really is what is the Medium Term? With Ford and others announcing the deployment of Autonomous vehicles on the road by 2021, the horizons for change are becoming increasingly closer. It’s not just about CAVs, though they will play a central part. It is also about the services that will be opened up to people and the provision of frictionless travel and information. Journey Management as a “system of systems” approach to creating an ambient and responsive capability, will not only capture but fully engage with customers.

It is at this stage that intelligent sensors/analysis will become increasingly the norm and with customers becoming more aware of the digital world in which they travel and the improved and interactive services that come on stream. A number of technology proof of concepts will now begin to morph into limited business as usual with an increased focus on delivering a ‘single source of truth’. This means that all the data sources, all the information existing both internally and externally will begin to come together in a way that the travelling public really begin to trust and relate to the information they are being exposed to. Interoperability, long
used as a term for technical discussion is just as important now but from a different perspective. Services delivered for people, places and goods will need to be truly interoperable.

**Long Term**

This is the ideal state, a future world where there are no accidents due to driver error, where there is no harmful emissions thanks to electric and alternative fuel types, and where congestion is a thing of the past. This is the **ROAD to ZERO**. Road to Zero can become a reality, with technology enabling a fundamental change in the delivery and experience of transportation services. Fully deployed intelligent assets and vehicles ensuring a comprehensive and user centric experience through dynamic real time information and choices across the network. This will be achieved through a dedicated connected and automated intelligent motorway coupled to cutting edge communications network. Data will flow seamlessly across the various ‘actors’ and a Strategic Commander capability will be on offer to the network operator and authorities, balancing the needs of all modal types in real time. Fully automated vehicles will flow across the network and people will demand Mobility as a Service transport solutions for their end to end journey requirements.

What is our appetite for change and our fear of failure? Can we make Road to Zero happen in our lifetime and can we be brave and bold and challenge the ‘norm’ in order to achieve the ‘brilliant’?

**Q12. Cyber Security**

**Cyber Maturity Framework**

Cyber security is a key component of any connected and digital ecosystem. Data and information must be protected from external and internal attacks that will occur. Large global companies must both ensure and protect the flow of data across their organisation. It is vital that organisations maintain a real time understanding of the security of their network, and the threats, mitigations and weaknesses that exist 24/7. In order to achieve this the UK Government and private bodies must:

1. Understand the importance of cyber security and how their organisation addresses it
2. Define the ‘ideals’ behind their day to day security, such as ‘always protected/always monitored’ etc
3. Create the capability to deliver a ‘snap shot’ assessment of all parts of their digital chain, from devices, to communication, to information feeds etc and the impact factor associated with a breach
4. Deliver a range of counter strategies that factor in the operational and brand impact for the organisation and their customers
5. Operate a secure and resilient monitoring system for real time integration of all steps outlined as well as a reporting mechanism and chain of command structure for decision making.

A cyber framework model will help deliver this. It is a tool that will quantify the cyber effectiveness of the digital ecosystem within an organisation, focusing on the overall system as well as identifying the strengths and weaknesses relating to cyber for each sector within
the organisation itself. It can be used to drill down into the deployed systems, assets and architectures etc. in place for effective measurement of safety and vulnerability.

Additional Question:

Q. How can UK Government exploit the immediate market opportunities of Connected Capability?

New technologies have changed the way people live their lives. In particular, real-time information technology has played an important role in improving transport users’ journeys and their expectations of the network performance. As a result, there is a need for road network authorities to be agile and customer focused in the adoption of new technologies.

It is clear that Autonomous (Driverless) Vehicles offer an exciting and challenging future to our approach to Transportation, both in the UK and Globally. Unfortunately, it is also very clear that Connected Vehicles (with a driver) are either being wilfully ignored or under-appreciated in terms of what they can offer today. Connected capability is linked but separate to Autonomous vehicles. The technology is already being deployed in vehicles, with a number of trials already taking place that looks to understand the technical requirements and hazards around sharing information between vehicles, and between vehicle and Infrastructure. Connected Vehicles must be approached as a distinct offering in the market place, with strong overlaps to the world of Autonomy, but recognising the world where a driver is always in control, but more and more dependent and expecting of services provided through digital connectivity.

**System of System Approach**

Technology, whether it is Internet of Things, Block Chain, Connected or Autonomous vehicles etc etc, are converging around the central point of ‘Services’. A Service is a digital consumable that users, either individuals or Network operators, will provide or pay for that enhances their experience. A number of Services have already existed for a number of years, such as traditional Gantry based Variable message signs, or In Car Sat Nav devices. However, technology, and customer expectations have moved on considerably with users requiring the right information at the right time in the right format. We have moved into a Digital Age which is synonymous with personalised real time Information and Choices being provided. The services that can be on offer depend on the appetite for moving with the digital world and understanding the value and relationships that exist across a number of traditionally disparate systems. As such, a System of Systems approach is fundamental to its success. What this means is understanding the impact across a number of areas to fully exploit the potential of connected capability. This includes, but not limited to, leadership and exploitation in a number of areas such as:

- Communications Network
- Hardware requirements on street
- Hardware Requirements in Vehicles
- Emergency Services
- Incident Detection and Management
- Data Management
- Revenue Generation
The challenge facing the industry is very much akin to the one faced by the media organisations, such as BBC, when faced with rival offerings exploiting the availability of internet based services to create personalised and novel services for their customers. It changed its delivery model to include BBC iPlayer as an equal to the traditional methods of operation.

**The impact on the road network**

Vehicles will have the ability to communicate with each other, or with infrastructure, or with a central/distributed cloud based system. What this means is that the road network must consider both a physical and digital infrastructure, such as the best use of Variable Message Signs, the migration towards Mobile App based information exchange, we well as understanding the backbone provision required for communications to take place. The automotive sector are looking at both traditional infrastructure requirements, such as 5G or WAVE, or alternatives that include using mobile or cloud based connectivity. The performance and safety case is not well understood with activity underway via Innovate UK funding to understand the alternatives for autonomous vehicles in more detail.

However, what is clear is that in the very short term, reliable and robust communications must be available for the connected vehicle. For this to take place, a number of points must be considered such as:

1. Developing the business case for investing in a communications backbone that facilitates interoperable communications across all manufacturers, promotes sustainable and long term development, future proof for alternative technologies, and links to brand development and customer experience
2. Understand the technical implications of Connected vehicles, particularly safety and safety related messages
3. Address and model the implication of connected vehicles across the network linked to various levels of penetration and various levels of available connectivity
4. Understand the implications of sharing information, or being part of the information exchange, when accidents or unwelcome behaviour results
5. Quantify the liability to the network operator in the instance of failure and the associated performance of the connected vehicle (ie did not break as the comms network did not get the message across in time)
6. Understand the integration requirements across various systems and timelines for maintenance of key operational requirements

**The impact on the provision of data**

For both Connected and Autonomous vehicles, the availability of data underpins both the operation as well as the services and business models that will be borne out. The data is a fundamental driver to its success, and as such, the network operator can play a key role in both:

1. The delivery of data that enable revenue generating services
2. The delivery and receipt of data that is core to the operation of the network

To facilitate the provision and use of data, it is equally important that a robust non silo’ed data governance and management system is in place. This requires an understanding of the existing data sets, their relevant timeliness, the coverage provided by them, as well as
developing the links between the various data sets linked to network operation (ie cause and effect – does a failure of a certain asset at a certain time cause the perturbation of the network in an unusual way and what are the strategies to refine this). As such, a complete data trail must take place that enables the operator to:

1. Understand in terms of what it says and doesn’t say
2. Assess the reliability and reassurance associated with the data
3. Map the internal and external value that data is perceived to hold
4. Link to the Key Performance indicators
5. Identify services and revenue generation that can be enabled from its sharing with public and private enterprises
6. Identify ownership, performance agreements in place, and collective resilience against failure

Cyber Security

The movement of people places and goods through tunnels is dependent on a complicated digital system, with various levels of maturity, and multivendor system solution that in turn engages with other elements of a digital ecosystem across a city. While some elements in themselves may be robust, it is the link to other elements that offer potential areas of weakness and vulnerability to threat and cyber-attack. Should an attack occur, the impact is huge. As such, it is necessary to develop a tool that looks at cyber security from an Intelligent Mobility (IM) perspective, understanding that safe, reliable, and non-compromised movement of people places and goods across all modes of transport, is an absolute necessity. Approaching cyber from an IM perspective, and its links to behaviours and the influence it brings to operational capability, the model will look to establish a portable framework for assessing and quantifying cyber safety and robustness that can then be used in other areas of critical importance.

The Cyber Management Maturity Model must be used in a number of ways including:

- Developing a framework to establish the cyber capability within the organisation against a defined benchmark/criteria for assessment
- Outline the risk level and maturity index associated with current and future systems linked to operational implementation
- Creating a gap analysis based on a review of baseline capability and recommended security levels
- Define a detailed and defined investment plan linked to improved security

Example - Using the model, it will be possible to examine the risk profile of a Network Operator’s traffic infrastructure, including lights, detectors, sensors etc, and outline the impact factor of a breach in security. The model will also outline the coverage levels in place and the mitigating factors needed at both a detailed architectural level as well as a system level.

Decision Support Tool for Modal Shift

Real Time Travel Information (RTTI) has the potential to change completely the use and expectations of network performance through modal shift, i.e. the use of smart phone journey planners to modify travel behaviour that encourages bike sharing or use of autonomous vehicles based on up to date information on capacity, congestion, journey times,
road works etc. However, it is particularly difficult for road authorities, with long term business cases and infrastructure investment programmes, to keep up to date, not only with the changes to technology but also to the expectations of the travelling public.

A robust and scalable Decision Support Tool (DST) allowing national road authorities to fully understand the impact of RTTI is key, along with a definition and design of the building blocks that support its operation.

26 October 2016