This is the PBA submission to the 2017 Wolfson Economic Prize, prepared by a cross-disciplinary group of young planners, economists and engineers. It does not seek to predict the future, but to paint one view of the future of mobility. It raises many questions about the social, economic, environmental and physical infrastructure implications of the emerging changes in the world of transport, and our role in creating places for people in the future. Any inaccuracies or misinterpretations are entirely unintentional and should not detract from the general intent of the authors.

THE INTERNET OF MOVEMENT
Non Technical Summary

The Question: How can we pay for better, safer, more reliable roads in a way that is fair to road users and good for the economy and the environment?

We are in a period of significant change. Technology, demographic, taxation, and planning policy have combined to start a period of transformation in how we travel which seems set to continue and indeed accelerate. These changes are introducing greater uncertainty into our ability to forecast the future and therefore predict how transport will change, so if we are to deliver better, safer and fairer travel in a way which is better for the environment, we need to take a different approach. Our approach has been to imagine what a desirable future travel environment would look like, and then work backwards, working with the grain of current changes, to see how that future can be achieved over time.

Our proposition is the delivery of a fully integrated transport network where consumers pay for their journeys, on a ‘per trip’ basis or through a mobility service package.

This proposition requires the transfer of the road system into an asset base through an investment model for existing and new road infrastructure, and a transparent charging system for vehicle operators and end users. This would replace the current motorist taxation system.

Our proposition, combined with external market and technological changes already taking place, will deliver a package that is good for:

- **The economy** – improved reliability, travel time certainty, and best use of capacity
- **The environment** – reduced noise, air quality and CO₂ emissions
- **Safety** – improved through minimum road safety standard for asset owners and vehicle technology
- **Health** – significant healthcare savings through reduced accidents & injuries, emissions, and improved mental health

The operators and end user charging system will be regulated in a way that can be used to influence travel choice to deliver wider benefits in a fair and transparent way.

The Challenge

The various challenges facing our roads are well documented, with individuals and businesses suffering the consequences of failures in the current system.

Part of the reason for this is underinvestment in new infrastructure and safer systems, coupled with a maintenance backlog. This is also down to the fact that governments do not fully capitalise on the value our transport networks can bring (in terms of economic, social and environmental benefits), and the fact that ‘end users’ are not treated as consumers.

We need to start thinking about road users as contributors to economic wellbeing and consider all trips as adding value. We believe the fundamental failure in the current system is the lack of investment in truly integrating our transport systems to help achieve this.

Our Approach

We have taken a holistic view of what access and movement could look like in the future (by all means of travel), and set the use of roads within that context. We have built our approach on an expectation of a reasonable level of service, to ensure that any end user payment for access to the road system would be fair.

This is based on pre-selected preferences of what access and journey option you are buying into before you start your trip.

We have also set out our proposition for ‘how we pay for our roads’ to ensure the adopted model could fit within a fully multi-modal mobility service package.

Our approach will need structural, political and organisational change to be delivered, but this can be achieved in phases as the fully developed model is worked up.

Our starting point establishes what is likely to happen over the next 30 years based on current operational and technological developments. This means the development and mass production of new vehicle technologies that are:

- Low energy
- Low emission
- Driverless and fully autonomous
There is limited need for structural change or intervention to ensure this happens, since significant private sector investment is taking place to respond to environmental and policy challenges and developers/investors will continue investing to achieve a long term return.

Significant reductions in environmental impacts and road casualties will also be realised through the above changes.

Our vision presumes a continuing societal shift in priorities for personal expenditure. This may be in the form of reduced private car ownership and a shift towards a ‘sharing economy’. This will be combined with a change in working patterns that lends itself to increasing flexible working and ‘off peak’ travel.

**Our Proposition**

Our proposition is to manage a transfer of the road network into a privately owned regulated asset base, and to enable operators of transport vehicles to make use of the road network on a point of use charge basis.

Investors would buy into an asset base that would form part of a competitive market. The asset base would be controlled by a regulator, and would be required to deliver a series of requirements and performance standards including:

- Availability of network;
- Capacity;
- Safety;
- Journey time reliability.

Operators would be charged for the right to use the road network. Operators could include public transport providers, freight operators, and taxi companies, and would themselves offer a set of guarantees or performance standards to their customers.

For the consumer, the range of expectations might include:

- Duration of journey, or required departure/arrival times;
- Comfort and service factors (e.g. communications/entertainment);
- Space;
- Access requirements.

People should rightly expect to pay for their travel in a simple and integrated way, without the need to compare complex option choices taking account of vehicle excise duty, insurance, wear and tear, fuel prices etc.

The asset owners would be required to work with the regulator and major operators to ensure best and most effective use of the road network through regular network performance monitoring.

This would enable use of the network to be managed more efficiently using price differentials to reduce the risk of oversaturation, and to reduce environmental harm. Additionally, variable charging would be used to cross subsidise schemes, for example, environmental mitigation schemes and essential road travel in rural areas.

**Financial analysis**

Our initial financial modelling demonstrates that a reasonable return on a long term asset investment could be achieved (c3%), allowing for a level of maintenance expenditure and future investment in line with the higher level of historic trends. There is an expectation, however, that longer term maintenance costs will reduce due to a rapid ‘catch up’ on current, spend combined with efficiencies in design, longer lifespans, and whole life costing of assets.

In terms of operators, a ‘charge per use model’ has been developed with a target 10% return. This would be in the form of a pre-purchased package, or a pay at the point of use option. An average charge per mile option has been tested but this could vary by time of day and type of road used.

**Steps Towards the Vision**

We are aware that there are many challenges to be overcome if our vision is to be delivered. We believe that setting out the vision is a key first step, because this then allows identification of the key steps needed to guide change over time towards the desired outcome. We set out the technological, organizational and policy issues that need to be considered to guide change over time, both to permit our vision to be delivered technologically and economically, and also to demonstrate that this change can deliver beneficial outcomes and thus build trust with future voters and politicians whose support any such substantial change will need.
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Section 1: Introduction to the Internet of Movement
Introduction

How can we pay for better, safer, more reliable roads in a way that is fair to road users and good for the economy and the environment?

Travel and transport are an integral part of our daily routine and journeys form part of the fabric that constructs our lives.

We rely on our transport network to distribute goods, people and services across the country. Road infrastructure shapes our experiences and interactions with places, as well as impacting our health, the economy and the environment.

Our roads provide a service and road users should therefore be able to have reasonably high expectations of the level of service and the standard of the transport network. We believe that road users are not currently thought about as consumers, whereas they should be at the heart of how the road system is paid for, managed and operated.

Our proposition in response to the Wolfson Prize Question is centered around the road user as a consumer. We recognise that there is a huge variety in relation to journey purposes and travel patterns that need to be catered for from commercial users to day-to-day journeys made by members of the public. However, we are in a period of significant change.

Technology, demographic, taxation, and planning policy have combined to start a period of transformation in how we travel which seems set to continue and indeed accelerate.

These changes are introducing greater uncertainty into our ability to forecast the future and therefore predict how transport will change, so if we are to deliver better, safer and fairer travel in a way which is better for the environment, we need to take a different approach. Our approach has been to imagine what a desirable future travel environment would look like, and then work backwards, working with the grain of current changes to see how the future can be achieved over time.
Travel in the UK is changing

Over the last twenty years, there have been significant changes in our travel patterns, which have been driven by changes in vehicle and communication technology, awareness of environmental sustainability and consequent changes in transport and land use policy, taxation, and the balance of investment in road and rail. The end result is that personal travel per head in England has ‘decoupled’ from economic growth, and has fallen by 7% since 2007. In addition, car driver mode share of travel has fallen by 2 percentage points since mid-1990s whilst the rail mode share has increased by 4 point, and annual miles per car have fallen by 9% since 2005.

More interestingly perhaps, men between 17 and 34 are travelling by car much less than 20 years ago - car driver miles per person are down 47%, whilst for women in this age group, the reduction is 15%, and for men between 35 and 59 the reduction is 24%. Car travel by other age/gender groups have increased, particularly the over 60’s, but the total numbers this represents as a proportion of the total is small.

Because of these changes total car/van mileage for personal travel is no greater now than 20 years ago despite a 13% increase in population, and in spite of increases in car ownership and car availability. The variation in age group in particular suggests that there is an increasing response to these issues, and that there is a likelihood that these changes will continue and even gain pace.

Similarly, for road freight activity the vehicle distance for freight vehicles has decreased by 20% since 1990, although the number of licensed goods vehicles has increased significantly. The number of heavy goods vehicles has increased from 2.1 million to 3.5 million from 1994-2014. In addition, the weight of HGVs is increasing in general with a significantly higher proportion of HGVs over a weight of 41 tonnes in recent years which puts additional strain on our road infrastructure. The proportion of freight goods moved by road is an overwhelming majority of 73% so effective operation of our roads is key for continued delivery of goods across the UK.

How we pay for roads

As consumers, we currently pay for the use of our road system through the Vehicle Excise Duty (VED) which is an annual payment required to be paid by owners of vehicles, and a fuel tax which is charged per litre of fuel. The exceptions to this rule are a number of toll roads across the country, for example, the Dartford Crossing which users pay for per use, and the London Congestion Charge, which is a daily charge payable for travel within the Central London zone.

Currently, all taxes and duties are paid directly into the government’s main fund, and monies provided for roads are allocated from this budget. Major roads in the UK are funded by central government and are managed by Highways England, Transport Scotland, in Wales by 3 Trunk Road Agencies, and in Northern Ireland (NI) by Transport NI (which is responsible for all roads in NI).

Local roads are the responsibility of the Local Highway Authorities and the monitoring, maintenance and improvement of these roads are funded through local council taxes, fees, and central government grants.

Road user tax revenue is falling

The changes in travel trends are creating significant shifts in road user tax revenue. Fuel tax is reducing as fuel efficiency improves and alternative technologies begin to take hold; and VED is reducing as vehicles become more carbon efficient. The overall road related taxation is currently reducing.

In response, the government is implementing new thresholds for VED in April 2017 to correlate with the falling CO₂ emissions of newer cars.

Motoring taxation is therefore being modified to account for changing fuel technologies and vehicle ownership trends. The current situation provides an opportunity to revisit and re-evaluate the road tax system. In particular, we see an opportunity to consider the ‘fairness’ of the current system and how road taxes are collected and distributed.

For many years, revenue raised from road related taxation was in balance with what was spent on the roads. However, this has changed very substantially, and in 2012, fuel tax/VED raised £30.7Bn, but only 24% of this figure was spent on Britain’s road networks.

This has contributed to a lack of transparency about road user taxes, and a lack of public acceptance about alternatives. However, road use related taxation does now have much wider implications for public spending beyond the ability to invest in road maintenance/improvements. Given the wider implications of our road networks and the impacts on health and environment, this redistribution of road tax across other government spending could be seen to be justifiable, however, there is a lack of visibility of where road revenue is spent.
Road investment requirements are increasing

In parallel to a reduction in road tax revenues, the requirement to spend money on the road network is increasing:

- There has been underinvestment in road maintenance, and this urgently needs to be rectified because the bill for addressing this increases exponentially as road integrity deteriorates;
- There is an increasing and quite reasonable expectation that our road network should perform to the standard of the rail network and air travel. Currently, traffic accidents lead to 65 fatalities or severe injuries daily, and the Road Safety Foundation (2016) have highlighted that a lifetime of care for one victim can cost ~£20million\textsuperscript{xi};
- There are differing views about what might be needed to allow the highway network to adapt to new vehicle technologies, in particular the use of autonomous vehicles. Nevertheless, investment will be required;
- Despite per capita reductions in travel, the highway network continues to be under pressure from aggregate traffic growth, now primarily related to population growth. With changes in travel patterns and technology, there is not a requirement for wholesale additional capacity, but there is a requirement for major road investment to permit better management of the network, at the least; and
- With population trends in the UK set to continue, and accompanying growth, and for example, with projected annual housing delivery of up to 100,000 homes, the increasing need for commercial and freight travel are set to continue\textsuperscript{xiii}.
Taken together, there is a major road investment requirement, and, in all likelihood, a falling road user tax take.

**Key criteria for changing the way we pay for roads**

In reviewing the options for changing the way we pay for road maintenance, improvements and new roads, there are six key criteria which need to be met:

1. Better roads
2. Safer roads
3. More reliable roads
4. Fairer road user charging system
5. Good for the environment
6. Good for the economy

We have examined each of these in turn, in order to guide our response to the question.

**Better roads**

The condition of our road network is a growing concern. In 2014/2015, 2.5 million potholes had to be filled at a cost of £136 million\(^{xxi}\), whilst the damage caused from cars hitting potholes costs £684 million a year for drivers\(^{x}\). In 2014, a DfT survey found that only 30% of the public were satisfied with the conditions of the roads and the speed and quality of repairs\(^{xxi}\). Deteriorating road conditions also have an impact on safety.

Our roads could be better designed, constructed to last, and maintained as part of a high quality integrated transport system.

**Safer roads**

Great Britain has one of the best road safety records in the world\(^{xxii}\). However, with ~65 people killed or severely injured on our roads every day\(^{xxiii}\), it is evident that safety issues still remain a key issue for our road networks. The UK government estimates around 2% of total GDP is lost in road crashes\(^{xxiv}\).

Existing infrastructure can be improved and upgraded by ensuring that simple safety features, such as safety barriers and safe junction layouts are implemented on busy roads. Since road crashes that result in serious trauma are now largely preventable, it is expected that improving our road networks in this way will help reduce accidents and road deaths\(^{xxv}\).

**More reliable roads**

Congestion not only has direct and indirect economic implications on specific locations, but also has an effect on the health and wellbeing of the population. A study conducted by INRIX and Centre for Economics and Business Research has estimated that on average British drivers spend 124 hours stuck in grid lock annually, which is predicted to rise to 136 hours by 2030\(^{xxvi}\). Based on these predictions, it is estimated that the annual cost of congestion in the UK will rise to 63% by 2030 to £21 billion\(^{xxvi}\).

If we are to make improvements to our road network we should focus on reducing congestion and time spent in congestion, and improving the reliability of our roads through delivering consistent journey times.

**Fairer road user charging system**

As alluded to above, there is a debate around how fair the current road user charging system is. Fairness to road users can be judged in a number of ways, but the key issues are:

- Transparency of payment systems, and justifiable departures from current relationship between what revenue is raised, and where it is spent;
- Equitable payment between road users, taking into account demand for road use dependent on location/time of day/ability to pay, and the extent to which a road user is captive to that mode for example key workers commuting to city centers;
- A reasonable balance between personal and freight users, for example a fair reflection of the imposition on the network in terms of capacity and structural impact; and
- The available choice of alternative modes for consumers.

The last point, in particular points to the need for any solution for road user payments to be viewed in the context of the wider transport network.

Equally, fairness in the system needs to cover the perspective of not only those who pay to use roads, but also how funding is allocated and spent on the delivery, improvement and maintenance of road infrastructure.

**Good for the environment**

The development of transport networks is a key driver for economic growth enabling the movement of goods and people, however it is also associated with a range of environmental impacts. Direct effects of new transport infrastructure can include: damage to habitats, biodiversity loss, depletion of natural resources and increased air pollution.

Current air quality figures are a major public health concern, with ~23,500 early deaths each year in the UK caused by NO\(_2\) pollution\(^{xxvii}\). In addition, the transport system in the UK accounted for ~29% of UK carbon dioxide emissions in 2015\(^{xxviii}\). Significant
reductions in the sector will be required to meet UK carbon budget targets of a reduction in Greenhouse Gas Emissions of 80% below 1990 baselines by 2050\textsuperscript{33}. Reducing the impact of road travel on the environment is a worthwhile ambition, and is tightly interwoven with rationalizing the approach to road infrastructure, with the focus on maintaining and improving existing infrastructure where possible.

If the payment system is to be good for the environment, it needs to encourage travel in a way that leads to reductions in pollution including air quality and noise, as well as increasing resource efficiency related to the delivery and maintenance of infrastructure.

**Good for the economy**

Any future revenue raising system must be efficient, and incentivise economically beneficial use to be made of the road network by managing demand across the transport networks. This is linked to the above measures and future revenue should optimise network capacity, reduce spend on maintenance and new construction, and reduce the incidence and consequences of road collisions. In parallel, road infrastructure should support access to employment, education and leisure destinations, and improve socio economic and health outcomes for individuals.

There is a growing debate relating to the introduction of road user charging as a solution to finance our current and future road networks, with many favouring a national charging system. The government have recently considered the potential implementation of a road user charging system across the Strategic Road Network\textsuperscript{33}\textsuperscript{33}. We need to start thinking about road users as contributors to economic wellbeing and consider all trips as adding value to our economy.

**The Internet of Movement**

Our proposition supports the contention that the future operation and payment system for roads should be considered as part of a wider network of movement, with choice between routes and modes being available, and with comprehensive information being universally available to inform choices.

As discussed further in the following section, this vision will be combined with a move towards autonomous vehicles as part of a wider Mobility as a Service (MaaS) network, and a system of charges relating to distance travelled and relative impact on the network. These changes, combined, would produce favourable outcomes against the key criteria for paying for roads.

Our proposition is therefore an Internet of Movement – a regulated market in which infrastructure is owned and maintained (road, rail and air), vehicles are operated on the infrastructure, and access and information is provided by mobility retailers.

Our vision is that people will be able to secure information about their travel choices, be able to purchase their travel option from a wide range of options, and that their required travel will then be provided by a service provider. So, it is the way in which we own, operate and charge for road use that needs to change.

In fact, travel in London is not far off this vision, with popular travel apps such as Citymapper already encapsulating many of these factors. However, what is missing from these travel apps is the inclusion of road use options and a truly comparative cost.

The following section outlines our vision further and justifies how changes in the ownership, operation and charging for road use can deliver an integrated vision for an Internet of Movement.
Section 2: The Vision for 2049
The UK is committed to achieving a range of key sustainability targets by 2050, in line with energy security, environmental and economic goals. Our 2049 vision, therefore, presents a suitable timeframe within which to deliver systemic changes to the way in which our transport system operates and to refocus the system on the consumer.

There is a clear general direction of travel in terms of technologies and travel patterns and there are certain trends that we can be confident will continue in the following decades. The following trends are at the heart of our vision and we propose that these advances will be key features of the transport system by 2049:

- A shift towards highly autonomous vehicles and connected vehicles
- An increase in environmentally friendly and energy efficient options for mobility
- Personal devices available relatively cheaply with country-wide high speed internet coverage
- An increase in the sharing economy and provision of movement services and a decrease in private car and vehicle ownership

Evolution is not a constant process so whilst we have cited 2049 for the ‘end date’ of our vision, this end date is not set in stone. However, history proves that a lot can change in a relatively short amount of time. Just 25 years ago the first mobile phone was released, and now two thirds of UK adults own smartphones, with one third of internet users viewing their smartphone as the most important device for going online.

Our proposition highlights that we are on the cusp of a similar revolution of our transport system and that this will be delivered by the same technologies and communication systems that enabled the mobile phone revolution. The following section sets out the end vision and highlights the key changes in technology and infrastructure which will be necessary to deliver this.

**Vision Proposition – The Internet of Movement 2049**

**Service**

Travel and movement of goods and paying for these will be as easy as making a voice call is today. The level of service expectation will be very high (journey time reliability/capacity/weather resilience) leading to much greater productivity, and the negative environmental impacts of movement will be substantially reduced.

The objective is to achieve a transport and communications system with which motorised transport is a seamless part of any journey.

**Vehicles**

Vehicles on roads will be significantly different to those used today with highly autonomous and driverless vehicles available and vehicle to vehicle communications and control systems able to make ‘live’ decisions about speed of travel and route taken etc. Vehicles will have practically infinite and live ‘knowledge’ regarding street layout, route options, journey times etc.

The auto industry and other companies including Google, Apple and Uber are currently working to put highly automated vehicles cars which can operate fully autonomously on restricted roads, in circulation by 2021. It can be expected that these types of vehicles will be available by the early 2020s.

The UK Government is actively supporting the development of autonomous vehicles and sees the UK as a global leader in the development and deployment of these vehicles. It is currently working on legislative issues as well as supporting a number of projects such as those in Milton Keynes and Bristol. Presentations by the Transport Systems Catapult regularly talk of fully autonomous cars available in the showrooms by around 2030 and therefore we would expect to see a proportion of fully autonomous cars on the roads by 2049. The move to fully autonomous vehicles will be very transitional and hence we will see cars which can be switched into full autonomous mode in certain areas even if there are certain road types / areas where driving is necessary.

There will be a range of types and sizes of movement ‘pods’ capable of moving people and goods. Given the restricted use of early autonomous vehicles, the initial use cases are likely to be taxis and public transport.

Shared use pods (known as taxis today) will be rolled out and will have the ability to transmit live data regarding seat availability and access times to pick up/drop off points.

By 2049, vehicles will also be zero emission at source with no localised air quality impacts.

Freight consolidation hubs will also have been developed around major towns and cities, linking ports and major freight distribution hubs. Smaller pods will service local destinations and city centres primarily at night where loading noise can be managed. Movement from hubs will be via driverless vehicles managed through central control systems.
Technology and safety

The use of mainly driverless vehicles will naturally mean that road use is inherently much safer than it is today, since human error is the key factor in all accidents.

With the expected formal roll out by the auto industry of G5 connected vehicle units from 2019 we foresee that all but a few vehicles will be connected by the early to mid-2030’s and we can also expect after sales units to retro-fit older vehicles. These will have significant safety benefits reducing vehicle to vehicle and vehicle to vulnerable road user impacts. In addition, this technology will also provide capacity and energy saving benefits as vehicles are able to platoon and better anticipate traffic lights.

Adaptation of the highway system

Roads will remain the key physical infrastructure for the movement of vehicles in the transport system, but their appearance, operation, scale and maintenance requirements will change.

Although autonomous vehicles will be inherently safer there will still be a need to reduce vehicle/people conflict in space and town and city planning terms. A significant amount of road space planning will still be needed to ensure available capacity is managed strategically and efficiently in the form of a framework. ‘Personal use’ or ‘on demand’ vehicles would be able to decide for themselves the most suitable route within that framework. ‘High volume’ movement corridors would need to be served primarily by higher capacity pods, and some form of road use priority and timetabling for higher capacity vehicles would still need to be in place. In terms of physical form of roads, there will be a transition towards:

- No clutter or signage (other than for streetscape and walk/cycle travel)
- Reduced traffic signals (self-managing junctions and interchanges)
- No vehicle restraint barriers or road markings
- Lighting only for individual use / safe environment / townscape needs
- Walkable City concepts being the norm with mobility pods to aid visual and movement impaired
- Reduced width requirements

Future roads could have Internet of things (IoT) sensors built into road or replace cat’s eyes. These sensors can then relay information which could include:
- Congestion lengths and times
- Accidents and vehicle breakdowns
- Road surface temperatures
- Road wear and condition

Solar roads could be used to generate electricity for the National grid.
Electric charging lanes could be incorporated to enable electric cars travel greater distances between stationary charge ups.

Roads will also still function as corridors for other services (utilities/communications) and potentially for energy generation.
2017

Traffic signals required at junctions

Large road footprint required for amount of vehicles on road

Car parks required

Pedestrian crossing at set places

2049

Traffic signals no longer required in certain areas

Vehicles can travel closer together, communicate with each other reducing safety distance between them. Smaller road footprint. More room to integrate cycle lanes and infrastructure within road footprint

Car parks no longer required – developable land available for investment which could be used to fund road infrastructure

Narrower road width allows pedestrians to cross at more locations.
End user perspective

Our vision is that people will be able to gain then information about their travel choices, and be able to purchase their travel option from a range of alternatives. Users will choose how they want to make a trip based on parameters, such as:

- Price
- Journey time
- Time of travel
- Safety/risk associated with travel route
- Number of people travelling
- Size/weight of goods to be moved
- Number of changes of vehicle
- Sharing of vehicle – e.g. willingness to share with others for the whole or part of the journey or need to be completely private (akin to shared taxi, bus, train, plane etc)
- Seat / space availability
- ‘In journey’ services – e.g. personal space, desk, cooling system
- Environmental impacts

This would effectively be a ‘mode neutral’ travel system because the vehicle ownership element of trip choice, which is a key factor today, will be substantially reduced.

Parameters for the trip would be pre-selected by the purchaser and the cost automatically charged to a mobility service account. These would be in the form of pre-pay or PAYG options similar to mobile data and energy services today. They would be mainly

cashless systems but also with ‘one off’ options booked and paid for via mobile devices and at payment points (hubs or service areas) for those without accounts.

Market competition sits in the background to the choice options, and the end user should benefit from the ‘out-turn’ lowest price option for the trip made, similar to when using an Oyster or ‘wave and pay’ option for TfL bus and tube services in London. This system is presumed to incorporate rail options for the trip, but could also incorporate shipping and air travel as part of the movement chain.

The system and packages available would be flexible and suit all user groups. The following case studies highlight how the Internet of Movement would be tailored to cater for all age groups, trip purposes, preferences and economic background.
1. **Mobility pods** - Small autonomous vehicles operate in urban environments.
2. **Smart parking** - Reduced parking space required with automatic monitoring/payment technologies.
3. **Ride sharing and car sharing** - Easy to do and organise through communication technologies.
   - **Smaller buses** - Operate more frequently in rural areas with "dial-a-ride" service.
4. **Working from home** - Easy with good internet service and range of communication technologies available.
5. **Electric vehicles** - Charging infrastructure network has a country-wide coverage.
6. **Rail** - Train links between towns and cities.
7. **Freight consolidation hubs** - Located on outskirts of major towns and cities, with smaller pods servicing city centres.
8. **Cycling** - Cycle infrastructure to encourage cycling in towns and cities. Electric bikes enable longer journeys by bikes. Cycle Share schemes cover large areas of urban environments.
9. **Walkable Places** - Streetscapes and public realms designed and improved to allow and encourage walking.
10. **Autonomous vehicles** - Connected through technologies and used on major roads.
11. **HVG platoons** - On motorways and major roads save space.
12. **Bus services** - Public transport in small towns and villages, with real-time information to users.
13. **Digital Assistant** - Personal travel apps cover all modes and provide advice on journeys.
14. **Integrated fare management** - Electronic payment mechanisms make it quick and easy to pay.
15. **Weather resilient infrastructure** - e.g. self-prediction of ice.
17. **Light rail / Tram / Underground** - Services urban areas and large towns.
Joan likes to get out and about, frequently meeting friends in town for a coffee or for her hobbies. Joan can't walk very far, so mostly travels by bus these days. Joan loves being able to visit her family in Newcastle regularly, but doesn't own a car. Fortunately, Joan has the MaaS app on her tablet, which makes it quick and easy to rent a car. As a cautious driver, Joan is particularly pleased to book semi-autonomous vehicles available that will make her journey much easier. The app also tells her the safest route, avoiding the higher risk A592 road and opting for the low and low-medium risk M6 and A591 roads instead. This provides Joan with the confidence she needs to make this important journey. In addition, Joan is now able to manage her bus travel through the app, with live bus tracking meaning less time standing and waiting at bus stops and more time to spend doing the things she enjoys.

Shivani makes the 6-mile commute from Dinas Powys, a village in South Wales, to her job at the hospital in Cardiff around 4 times a week. Due to the shift-work nature of Shivani's job, a private vehicle is the most convenient mode of transport for her. Her husband, Steven, is self-employed and works from home most of the time. Shivani's employers informed her about the Social Fund scheme for a MaaS package when she started which provides reduced travel rates for key workers such as nurses. She has the MaaS app on her smartphone and the monthly 'Family Package' subscription includes a minibus service that takes the children direct from home to school which is not only convenient, but means that they were able to sell their second car. The parking planner service allows Shivani to pre-book a parking space at work, saving her precious time. Shivani is also able to rent out her car when it is not needed on her days off, or even during her 12 hour shifts at the hospital. These changes not only make their lives easier, but save the family money and benefit the environment too.
Tom lives in Moseley, a suburb of South Birmingham approximately 3 miles south of the city centre. Tom is a single dad between jobs, and so is currently setting up and attending interviews across the Birmingham area. Tom took part in the early trials of MaaS in Birmingham and has therefore had the benefit of the system for a number of years. As Tom is not rushed to travel he has prioritised cheaper options of travel via his travel app, and his off-peak monthly travel subscription gives him a package deal to travel around the Birmingham area via public transport. If he travels at peak times, there is an on-demand, one-off payment automatically charged to his account. His package is subsidised as he is currently unemployed.

One of Tom’s regular travel journeys includes dropping and collecting his son from nursery a couple of miles away. His pre-booked minibus spot is reserved from outside his flat via his travel app, and a daily reminder gives him the option to keep/cancel his booking.

Tom has nowhere to store a bike securely easily at his flat but when the opportunity arises he often uses the Birmingham bike sharing scheme as it’s a great way to get some fresh air and exercise, as well as being very cheap because the service is subsidised. Previously there was a mainly unsigned, or a national cycle network route to get into Birmingham city centre. Now his travel app helps him pick his route on a range of well-signed, dedicated cycle routes.

Gary lives with his girlfriend Jemma, in Coatbridge a town in North Lanarkshire, approximately 10 miles east of Glasgow City Centre. Jemma and Gary are expecting their first child together, so Gary is working overtime to help gain extra cash for the new arrival.

Due to the nature of his work, Gary is constantly driving extremely long hours and is often away from home for long periods of time. This has of course, put a lot of pressure on him and Jemma, especially with a new baby on the way.

Gary works for “HGV First”, a company that values themselves on smooth, fast and efficient deliveries of all commercial goods across the UK. “HGV First” has recently signed a contract with a MaaS Online Package to ensure their staff can travel the quickest routes possible. The company has prioritised options of travel via weather updates, reliable journey times and accident updates. The journey planner service allows Gary to pre-book specific motorway journey routes. The app also tells him alternative routes as soon as an accident has occurred or if weather conditions and visibility worsen on his chosen route. Before this package, Gary would not be guaranteed to deliver his commercial goods promptly or make it home on time to attend hospital visits with Jemma due to delays on the motorway. However since HGV First have signed up to the service, Gary has been able to avoid the most congested routes and arrive home more promptly.
Felicity prioritises her travel based on work and social commitments and is happy to pay the premium subscription in order to travel during peak times. Every morning, Felicity takes the Northern Line from Hempstead Underground Station to Bank Underground Station to work in the City. When she was a young graduate, Felicity enjoyed the hustle and bustle of her busy commute and benefited from the reliability of TfL. However, nowadays Felicity prefers a quieter commute, particularly when she has to travel to an alternative office for business meetings. Felicity’s work colleagues tell her about the ‘Commuter Package’ through a MaaS subscription. Felicity syncs the app with her work and social schedules, so she can easily plan her travel arrangements around specific engagements. As Felicity is happy to pay a premium for her travel she prioritises factors such as comfort, leisure and work commitments.

One of Felicity’s regular journeys includes attending a weekly client meeting at another bank in London. A weekly reminder via her travel app gives Felicity the option to travel at her usual peak time or alternative routes that will be less busy. Additionally, as Felicity has synced her travel app with her work calendar, she is sent reminders when a meeting is being held outside of the City. Felicity has subscribed to an option that enables a pre-booked private autonomous vehicle from outside her home to the location of her next work meeting. These changes have made Felicity’s commute a lot less stressful.
Section 3: The Creation of the Internet of Movement
Introduction

In the previous section we explored how the Internet of Movement operates day-to-day and highlighted how it would provide access for all user groups in a fair, safe and reliable way. This section tackles the nuts and bolts of our proposition, and sets out how the transport system can be operated and run in order to deliver this vision. In particular, this focuses on the transformations required in relation to ownership models, the economic and regulatory framework, and clarifies what the function of different actors and organisations would be within the system.

The Internet of movement is therefore underpinned by a Market for Movement.

Market for Movement Features

Put simply, we propose that the market for movement would work similarly to how our energy market works.

Our proposition is to manage a transfer of the road network into a privately owned regulated asset base, and to enable operators of transport vehicles to make use of the road network on a point of use charge basis. This would require the establishment of a transport ‘utility’ in the longer term, which moves towards being able to charge for Mobility as a Service. This is probably too big a leap in one go, and therefore there may need to be a Highways Utility, which provides for access to roads at the outset.

The aim is to allow a variable access charge to be made, creating a long term revenue stream against which the private sector could raise investment. The charges could be simple and transparent, and phased to account for a transition from central tax revenue, towards a utility charge. Charges could be set to create better balance between modes, and encourage more efficient use of the highway. Charges could also be set to encourage a transition to low carbon, autonomous technologies.

This will provide a framework in which all modes can compete in a market for movement and will provide long term, reliable revenue streams against which investors can raise capital for investment in our transport networks in a regulated environment. The market will be delivered through an integrated network of infrastructure owners and managers, movement service operators, retailers, and consumers combined to create the ‘Internet of Movement’.

Throughout this section, we will frame the discussion around the following three component parts of the transport system:

Infrastructure – the system of road and other transport networks that allow us to travel from a to b, including:

- Trunk roads (A-Roads) and motorways
- Local road networks and highways
- Linking infrastructure such as tunnels and bridges
- Rail tracks, stations and associated infrastructure
- Where relevant other infrastructure such as airports.

Operators – the actors who own and operate vehicles on the network including:

- public transport providers,
- freight operators,
- taxi companies
- other owners of cars and vehicles

Retailers – operators or other companies who sell tickets for customers to travel on the transport network including:

- Operators who sell to consumers directly – e.g. how bus companies currently operate and charge as customers’ travel
- Intermediary retailers who buy bundles of products from operators and sell to consumers- e.g. how train booking sites currently operate
A personal movement choice based on a market offer for movement. Fund of road infrastructure is provided through revenue generation. In addition, retail revenue will cross fund public transport and underpin social need whether that is movement for the disabled, priority movement for key workers or individuals who wish to pay for immediate private movement.
Component parts of the system

A range of changes will need to be implemented in relation to how the road network is owned and operated. The tables below highlight how the road system is currently operated and managed and compares this with how they will run as part of an integrated market for movement. Wider systemic changes would be required to incorporate other modes such as rail into this system. However, it is noted that our rail network is already franchised and fewer changes would be required to incorporate this and deliver the high service delivery expected of our transport system.

The below tables focuses on the road network and the characteristics of the component parts, explained above.

### Asset ownership and management of Road Infrastructure

<table>
<thead>
<tr>
<th>Current system</th>
<th>Internet of Movement system</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Motorways/ major roads- managed by Highways England - Office of Road and</td>
<td>• Highways England is privatised into a plc;</td>
</tr>
<tr>
<td>Rail monitors performance. Highways England is a government company</td>
<td>• County roads are regionalised and managed by private companies- through</td>
</tr>
<tr>
<td>• All other roads are managed by the relevant local transport authority</td>
<td>contracts with Central Government</td>
</tr>
<tr>
<td>• Scottish trunk roads are managed by Transport Scotland and local authorities</td>
<td>• New highways and roads will be invested and delivered through regulated</td>
</tr>
<tr>
<td>manage local networks</td>
<td>independent providers.</td>
</tr>
<tr>
<td>• Welsh roads are managed by the Welsh Assembly and 3 regional agencies</td>
<td>• A new Office for Transport (OfTrans) is set up to regulate asset ownership</td>
</tr>
<tr>
<td>• Northern Irish roads are managed by Transport NI</td>
<td></td>
</tr>
<tr>
<td>• London roads are managed by Transport for London</td>
<td></td>
</tr>
</tbody>
</table>
### Operators and Mode Suppliers

<table>
<thead>
<tr>
<th>Current system</th>
<th>Internet of Movement system</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Buses, public transport services, and operators of HGV’s are provided through contracts established with Traffic Commissioners.</td>
<td>• Fleets / franchises of vehicles- own and lease most of vehicles on our roads-</td>
</tr>
<tr>
<td>• Operators of services such as buses and coaches (PSVs) must hold an operating license</td>
<td>• Smaller vehicles public transport-</td>
</tr>
<tr>
<td>• Private hire vehicle licenses are issued by local authorities</td>
<td>• Licenced Hackney Carriages</td>
</tr>
<tr>
<td>• Members of the public mainly own private cars with some being leased or rented</td>
<td>• Mode suppliers will be licensed to offer public and private autonomous vehicles, rail and air travel*</td>
</tr>
<tr>
<td>• Freight and logistic companies, and businesses have vehicle fleets</td>
<td>• Suppliers will have the ability to support and deliver base movement needs across geographic areas such as commuting and freight logistics as well as capacity movement needs like instantaneous trip generation, network balancing services at peak movement periods, and back up movement offers in times of mode network failure.</td>
</tr>
<tr>
<td></td>
<td>• Service and quality will be regulated by Oftrans</td>
</tr>
</tbody>
</table>

### Retailers

<table>
<thead>
<tr>
<th>Current System</th>
<th>Internet of Movement system</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Consumers do not pay for use of roads apart from Toll Roads, and congestion charging in London</td>
<td>• Users pay a variable charge for use of roads, based on distance and roads travelled on</td>
</tr>
<tr>
<td>• Rail- consumers buy tickets through retailers, or direct purchase from rail operating companies, with some rail/ underground systems with electronic charging mechanisms</td>
<td>• Retailers offer inter-modal options from the operators as ‘bundles’ through a wholesale market</td>
</tr>
<tr>
<td>• Buses- varying charging systems and ‘pay-as-you-go’ capability</td>
<td>• Instantaneous charging systems</td>
</tr>
<tr>
<td></td>
<td>• Retailers work in a competitive market and consumers are free to source their movement choice based on their own personal preference and financial means.</td>
</tr>
<tr>
<td></td>
<td>• A wholesale market for movement would be created as a trading platform for the aggregated demand established by retailers and mode operator services.</td>
</tr>
</tbody>
</table>
Roles and Responsibilities

Regulator - Oftrans

An independent National Regulatory Authority would be responsible for protecting the interest of consumers by promoting competition in the operator market and awarding franchise agreements and licenses to mode operators. This regulator would be responsible for:

- Promoting value for money;
- Promoting security of service and sustainability, for present and future generations of consumers, domestic and commercial users;
- Developing markets and competition;
- Regulating and delivering government schemes;

Duties would also include:

- Allocation of a proportion of the overall targets to obligated suppliers/operators
- Reporting to the Department for Transport;
- Monitoring supplier progress and determining whether they have achieved their obligations;
- Audit, compliance and fraud prevention / detection;

Asset owners

Investors will own, maintain and operate infrastructure and would therefore be required to invest in road maintenance, street lighting, and road safety. This could include private sector investors such as infrastructure private equity firms and pension funds.

The asset owners would be required to work with the regulator and major operators to ensure best and most effective use of the road network through regular network performance monitoring.

For investors, this would mean buying an asset base that would form part of a competitive market for use. The asset base would be licensed by the regulator, and this would encompass a series of requirements and performance standards including:

- Availability of network
- Capacity
- Safety
- Journey time reliability

The asset base would be split into national roads through the privatisation of Highways England, and privatisation of local roads through regional contracts set up by Central Government.

Operators

A charge would be made by the operators for the right to use the road network. This could include public transport providers, freight operators, taxi companies etc, that would themselves offer a set of guarantees or performance standards to their customers. For the consumer, the range of expectations might include:

- Duration of journey, or required departure/arrival times;
- Comfort and service factors (eg communications / entertainment);
- Space;
- Disabled access availability;

Variable charging would be used to cross subsidise, for example, environmental mitigation schemes, disability allowances and essential road travel in rural areas. This would enable use of the network to be managed more efficiently using price differentials to reduce the risk of oversaturation, and to reduce environmental harm.

In order to test how the above components would operate and to evaluate the market economics we've tested a potential investment framework based on current road travel patterns, revenue requirements and the benefits which each component/business would require in order to be self-sufficient in the long term. Permutations of this option are obviously possible and could be further tested to improve the robustness of our analysis. As explained later in this section, we propose a staged approach to implement this market structure and so there would be opportunities for adaptations and flexibility as regulations are changed in a stepped process.

Wholesale market

The National Movement Wholesale Market has overall responsibility as the ‘balancer’ of the movement system. It is required to take actions to ensure that modes are available and demand is matched to supply by operators.

The National Movement Wholesale Market does this through a balancing mechanism which increases mode supply or demand reduction through ‘bids’ within the wholesale market. This can be done at very short notice to ensure capacity is always available.

Mode operators will offer movement capacity into the wholesale market. Retails will buy up capacity based on their customers’ predefined contractual preferences.
The Economic Test

Introduction

Establishing a new investment framework will, as previously discussed, need to ensure fair returns for investors, fair costs to end users and maintain a stable income to the Exchequer to mitigate the impact of road travel in a fair way.

In response to dropping VED revenue the road tax system is already subject to change in 2017 to ensure a more stable level of revenue from road user tax. As previously explored the existing taxation structure is based on car ownership and with a continued drop in outright private car ownership the taxation revenue is projected to continue decreasing. A new investment model is therefore needed.

An economic framework of the Internet of Movement

The economic variables that underpin transport infrastructure, car ownership, fuel and choice of mode are significant and expansive. In establishing a new economic and regulatory framework three tax revenue assumptions have been utilised to underpin our analysis:

1. The revenue to the Exchequer should not be less than £30 billion annually.
2. The fuel tax system and associated revenue will not change in the future as any tax on fuel duty would be maintained and passed on to ‘new fuels’ (e.g. electricity).
3. Insurance premium taxes would be maintained and would be transferred on to the operators and road asset owners rather than the consumer. Additional insurances against loss of service are likely to evolve.

These background parameters drive the economic framework and a series of assumptions were made based on national data and statistics from the Department for Transport in order to develop a basic investment and rate of return model.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Assumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual cost of building, operating and maintaining strategic highways</td>
<td>£1.3 billion</td>
</tr>
<tr>
<td>Annual cost of building, operating and maintaining County roads</td>
<td>£5.6 billion</td>
</tr>
<tr>
<td>Miles travelled on road network (business, logistic and domestic)</td>
<td>320 billion</td>
</tr>
<tr>
<td>Annual vehicle maintenance and depreciation costs (HGV, commercial and domestic)</td>
<td>£32 billion</td>
</tr>
</tbody>
</table>

As outlined earlier in this section we have focused the economic framework on the creation of five separate business entities, namely the national highways asset owner, regional network asset owners, transport operators, retailers and the wholesale market. Each business would target investment returns relating to the relevant investment

risk that may be expected of infrastructure investment. These assumptions are:

<table>
<thead>
<tr>
<th>Asset Owner/Business</th>
<th>Rate of Return</th>
<th>Commentary</th>
</tr>
</thead>
<tbody>
<tr>
<td>National and regional highways and roads</td>
<td>3%</td>
<td>Similar to large long term asset ownership model of major infrastructure</td>
</tr>
<tr>
<td>Mode operators</td>
<td>10%</td>
<td>Similar to private sector transport business such as bus franchises</td>
</tr>
<tr>
<td>Mode retailers</td>
<td>2% to 5%</td>
<td>Similar to energy retail companies with positive margins for service improvement</td>
</tr>
<tr>
<td>Wholesale markets</td>
<td>2% to 3%</td>
<td>Similar to operation of regulated market structure</td>
</tr>
</tbody>
</table>

Based on these parameters it would be expected that the Market for Movement would generate an overall market value of £67 billion.

The market value would include all the expected rates of return for the asset owners and businesses, and includes upkeep of our roads and highways.
Taxation of the system would raise up to £30 billion direct to the Exchequer above the overall market value.

Movement consumers could expect movement to cost between 25p to 30p a mile as an overall average. Clearly, this ‘price’ would vary dependent upon various factors, such as time of travel/congestion level, vehicle type, distance covered etc.

A comparison can be made to the current situation and the norm of car ownership. An average car owner travelling 15,000 miles a year would expect to pay in excess of 30p a mile when considering fuel costs, depreciation, and insurances.

We would expect the vast majority of consumers to pay less than this in the future under the Internet of Movement model, but for an enhanced level of service and a higher quality network.

The final economic outcome of ‘fair to end users’ will be directly linked to lifestyle choice and quantity of movement purchased.

This is obviously a significantly simplified approach to assessing revenue, returns and taxation. Consumer pricing for example would be driven by quantity of miles purchased and the trips that can be scheduled within the wholesale trading mechanisms.

The preferred financial arrangements would adapt in parallel to the evolution of the Internet of Movement proposition. The steps to get to 2049 and a fully integrated market for movement needs to consider previous approaches to privatisation. An outline of how this could work is explored further in Section 4.

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**THE INTERNET OF MOVEMENT TAXATION SYSTEM**

- **Fix income**
- **Retail markets**
  - Revenue from electricity sales
  - Revenue from electricity sales
- **Exchequer**
  - Infrastructure fund
  - Social movement fund
  - Environmental fund

**Public sector funding**
- Crime/police
- Education
- NHS

% of UK taxation need set by government
Section 4: Delivering The Internet of Movement
Introduction
Privatisation is an emotive subject in the UK with a wide range of previous examples of economic failures. For example, the privatisation of the Rail Track in 1996 saw the UK losing out on over £1.5 billion of revenue because the government rushed the sale of shares, and only five years later it had to be placed into administration by the Government.

Failures in privatisation have arguably led to the public perception that our national infrastructure is best placed in the hands of Government as a recent YouGov survey shows. As highlighted in Parts 1 and 2 it is crucial that the consumer is at the heart of the transformation and public support will be required in order to establish the political willpower to make the changes to establish a road user charging system.

On the other hand, there are success stories in UK franchise creation and privatisation. For example, the auction of licences of the UK 3G and 4G mobile phone network raised £25 billion for the UK economy, with British-established mobile phone carriers becoming global brands and innovators in the communications market.

The step changes for the creation of a privately owned road network and the franchising of movement operators is a well-established process. In addition, the privatisation of the UK gas and electricity markets provides a predominantly successful case study from which to learn from. We have used the steps in the privatisation of these markets to set out the likely step changes to a fully developed wholesale market for movement that defines the Internet of Movement.
The Step Changes to an Internet of Movement

The ‘Tell Sid’ campaign of the Thatcher era of energy privatisation set a global precedent for the process of privatising state run businesses with the associated aim of providing net benefit to the service provision for the consumer, and for the economy.

The geography and structure of the UK road networks are comparable to the transmission and distribution networks for gas and electricity in the UK, and both have an interconnected network of linear infrastructure spanning the country.

For the electricity sector the national grid infrastructure was first converted into a plc by offering share purchases to the UK public. The regional distribution infrastructure was transferred to regional operating boards which became Distribution Network Operators (DNO’s).

In a similar vein a view has been taken of structuring the UK road network into national asset and regional franchise operations.

Applying this logic to our road system, the highway network would first be transformed into a National Highway Plc. Similar to the role of the National Grid this company would own and run the highway infrastructure. Following the privatisation of the National Highway infrastructure, the County road infrastructure would be broken into privately owned businesses that run regional networks under licenses awarded by the Government.

This approach balances the need to manage the network within the geographical distribution of the road infrastructure with its economic area of influence.
**Timeframe for the Internet of Movement**

The process and timeframe within which the UK energy networks were privatised has been explored in more detail in Appendix 1 and is summarised below.

The privatisation of the power networks was completed within a 10-year period. With the road assets already in place a similarly progressive timeframe should be achievable for the privatisation of the road network.

In order to do this the regulatory acts and license agreements would need to be created and the National Highways Plc and the Regional Road Companies would need to be formed.

Once the business structures and functions of the businesses have been established public share options for each business can be offered prior to releasing the organisations on the open market. A proposed time frame for this is set out below and this would enable of the conversion of the entire transport system to an open market Internet of Movement by 2035.

The road expenditure we’ve assumed in this model is in line with the upper end of historic trends. Our model assumes that through changes to the transport system, vehicles and technologies, roads will be better, safer, and will have less environmental harm (and provide subsequent health benefits).

For example, through early privatisation of the highways it would be incumbent on the National Highways Plc to adapt the highway infrastructure to be suitable for autonomous vehicles. There is likely to be a cost associated with this that would need to be accommodated for and rules and regulations fulfil need to be set to force the owners to the investment requirements.

There is a risk that a change in the charging system has a negative cost impact on the economy, and this would need to be analysed in relation to wider social and environmental benefits of the Internet of Movement system.

Reflecting on these and a range of other parameters an infrastructure road map would need to be developed to set a plan for minimising risk and maximising the opportunities for profitability and consumer reward. Some example of these parameters have been explored further below.
<table>
<thead>
<tr>
<th>Issues</th>
<th>Classify type of risk?</th>
<th>Further research requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public perception</td>
<td>P, S</td>
<td>Evaluation of public and market perception on ownership models</td>
</tr>
<tr>
<td>Safety and adaptation costs</td>
<td>E, T</td>
<td>Road Network will need to be redeveloped to accommodate new service offer. Higher than anticipated costs before handover to the private sector.</td>
</tr>
<tr>
<td>International context</td>
<td>P, E, S, T</td>
<td>A new movement framework would need consideration of the international context of movement from legal, technical and practical perspectives</td>
</tr>
<tr>
<td>Insurance – how to put cost of claim onto asset owners</td>
<td>E</td>
<td>Explore how the insurance industry would respond to the new market (travel insurance rather than car insurance for example)</td>
</tr>
<tr>
<td>Lack of interest in investing</td>
<td>P, E</td>
<td>Soft testing with potential institutional investors would be required</td>
</tr>
<tr>
<td>Driving innovation</td>
<td>P, E, T</td>
<td>Establish the regulatory framework to ensure investment occurs in the right places to enable innovation</td>
</tr>
<tr>
<td>Guaranteeing infrastructure investment</td>
<td>P, E, T</td>
<td>Regional infrastructure has a legacy of being underinvested. The mechanism to guarantee investment would need to be established. Explorarion into service 'cap and floor' arrangements in relation to revenue distributed to regional asset owners.</td>
</tr>
<tr>
<td>Renationalising underperforming networks</td>
<td>P, E</td>
<td>The process through which Government buy-back is achieved if networks are underperforming</td>
</tr>
<tr>
<td>Social and environment subsidies</td>
<td>S</td>
<td>Structured finance mechanisms need to underpin and support social and environmental betterment</td>
</tr>
<tr>
<td>Additional revenues</td>
<td>E, S</td>
<td>Explore spin off revenues within the system - for example, road and destination advertising</td>
</tr>
</tbody>
</table>
Section 5: The Internet of Movement:
Delivering better, safer, more reliable roads in a way that is fair to road users and good for the economy and environment.
Within this Paper we have explored both the technical and economic framework for ensuring long term investment in UK road infrastructure. Our proposition to respond to challenges facing our road network and ‘how can we pay for better, safer, more reliable roads in a way that is fair to road users and good for the economy and the environment’ is centred on refocusing the transport system to better cater for road users as consumers. Our Internet of Movement proposition creates a fully integrated transport network, where consumers of movement pay for their journey through tailored personal movement packages across an infrastructure network.

The approach focuses on and tackles the key components of the question:

1. To create a **better, safer, more reliable road network**. The Internet of Movement encourages the adoption and rollout of emerging technologies including autonomous vehicles, and the construction and maintenance of safer roads through technology and design;

2. To support a move towards a highway network which is **good for the environment**. The system supports the transition to low carbon vehicles, optimised construction methods, and a rationalised approach to delivering new, resource-intensive infrastructure: To attract private sector investment **to benefit the economy**. The system proposes a reliable, low risk way through which revenue from road use can be collected and redistributed. The investment framework aims to fuel innovation in relation to infrastructure, technologies and operation, in order to ultimately pass these benefits onto the customer;

3. To propose a way of paying for roads that is **fair to road users**. As illustrated through the ‘day in a life’ of different consumers (Part 2), the Internet of Movement would have a transparent payment system that caters for all requirements.

Our proposition requires the transfer of the road system to an asset base through an investment model for road infrastructure, and a transparent charging system for vehicle operators and end users to replace the current motorist taxation system.

The economic framework requires the creation of five separate business entities, namely the national highways asset owner, regional network asset owners, transport operators, retailers and the wholesale market.

A Transport Regulator would be responsible for promoting competition in the operator market, awarding franchise agreements and licenses to mode operators, and guaranteeing the delivery of a high performance system for customers.

Initial economic modelling has been based on a number of assumptions derived from National data demonstrates:

- The potential overall market value of the Internet of Movement could be in excess of £67 billion;
- The framework could offer a stable revenue of £30 billion direct to the Exchequer above the overall market value.
- Customers would expect to pay an average of between 25-30p per mile, which is comparable to the average current costs of owning and running a car.

The first step towards the Internet of Movement would be the privatisation of our trunk and motorway road network through associated privatisation of Highways England, Transport Scotland, Welsh Trunk Road Agencies, and Transport Northern Ireland within 10 years, and the implementation of an accompanying road user charging system.

This is equivalent to the timescales for the privatisation of our energy and utility generation and distribution markets. Following this, we recognise that a stepped approach needs to be flexible and adaptive to the political context, social need and to respond to our international environmental commitments.
Wolfson Stage 2 Exploration

This proposition sets out the holistic concept and economic framework for implementing the future of movement in the UK by 2049. We are aware that there are many challenges to be overcome if our vision is to be delivered. We believe that setting out the vision is a key first step, because this has allowed identification of the key steps needed to guide change over time towards the desired outcome.

We have begun to set out the technological, organisational and policy issues that need to be considered to guide change over time, both to permit our vision to be delivered technologically and economically, and to demonstrate that this change can deliver beneficial outcomes and thus build trust for future users, voters and politicians whose support any such substantial change will need. But we recognize that more work is needed.

Moving forward into the second stage of the competition we would look to refine the following areas.

- Financial and business case for the operation of the road network as part of an Internet for Movement, including impact on users and government revenue.
- The investment requirements and financial structures to ensure the existing road system is adaptable to an autonomous future;
- Private sector appetite to investing in the asset base and operational systems and services;
- Safety and insurance provisions for operating road and movement systems;
- Regulatory regime required to ensure the required transitional and final arrangements;
- The transitional steps required to move the road network into private ownership and longer term the development of the Internet of Movement;
- Wider economic benefits of creating an Internet of Movement, including benefits for the environment, health and safety;
- Public perception of the Internet of Movement and how to build trust in future organisational and market structures necessary to deliver it; and
- International context of growth and the market proposition for the UK to be an exporter of the Internet of Movement.
APPENDIX ONE:

Privatisation of the England and Wales Electricity Supply

Background

We have chosen to look at the history of the electricity supply industry in England and Wales and the way in which it has evolved since its privatisation in December 1990 as there are similarities that can be drawn between these two large scale infrastructure networks and their management systems. There are lessons to be learnt from the successes and shortcomings of the privatisation process for the electricity supply industry that can be fed into any plans going forward for the management of our roads.

Prior to the privatisation of the network, the setup of the electricity industry was similar to that currently in place for the country's road network. A large public body, known as the Central Electricity Generation Board (CEGB) was responsible for the generation and transmission of electricity across the network. The transmission role of the CEGB was synonymous with the current role of Highways England; providing the strategic infrastructure for the country which in the case of the electricity supply industry amounted to transmitting high voltage electricity on a national scale. CEGB then fed electricity to 12 regional area boards which were state owned, similar to the local highway authorities, who were responsible for distribution (on a regional scale) and supply.

During privatisation 12 regional electricity companies (RECs) were set up in the place of the previous regional area boards. Similar to the previous set up, these regional companies were responsible for the regional distribution and supply of electricity but additionally these companies now owned the main body, The National Grid, responsible for the strategic network that provided for the transmission of electricity. Additionally, under the new structure, RECs could supply electricity to other regions outside of their area if they paid a charge to the area REC.

Why it was changed?

It was anticipated that the changes brought about through privatisation would benefit the consumer as market forces would result in more competition. Furthermore, private companies were expected to be more likely to invest in technology so that the network could advance with the latest understanding and offer consumers greater flexibility of choice. It was also anticipated that there would be greater efficiency in managing the network since political interference and restrictions could be limited.

What benefits has it brought?

Although not deemed to be as successful as was expected, there are benefits over the previous management system. Previously the generation market was monopolised by the CEGB so there was no room for competition or innovation. Under this system, prices were deemed to be excessive and the industry was subject to political pressures. An independent regulatory body was set up to regulate pricing after privatisation. OFFER (now known as Ofgem) conducted a pricing review which resulted in cuts to electricity prices of 14% on average in 1995. This shows that the previous system had resulted in excessively high costs for the consumer. This has resulted in a more efficient system as suppliers have had to minimise their own costs to maximise their profits.

There has also been some technological advancement in the industry and smaller companies have been able to compete on the electricity market resulting in increased competition and improvements for the consumer.
What hasn't worked?

Although in the long term there has been a reduction in costs to the consumer, the first few years of privatisation lead to an increase in prices. This is thought to have occurred as a result of a number of factors, including increased sub-contractor costs (since now unregulated), increased wages, changes in structure and new processes with the implementation of the new companies etc.

The industry was never totally able to distance itself from political influence. In instances where the private companies wanted to make decisions conflicting with current government policy, deals were made behind closed doors between management of the private companies and politicians that meant that the industry was still restricted by government policy and control.

Additionally, the electricity industry is a very hard industry for new companies to enter. Most of the new companies who have entered the market have been at the generation stage of the system as there is less opportunity for innovation in the other stages. This has resulted in limited competition in the market.

• What does this mean for the roads?
• More opportunity for innovation in the road industry
• Reduced costs through efficiencies (e.g. gov using money for other services)
• The need for an independent regulatory body
• Competition is good.
References and Notes:

References:

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Additional sources of information: