Intelligent thinking about Intelligent Transport Systems

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We are constantly reminded of the speed of technological change

We are constantly reminded of the speed of technological change and the exciting developments coming down the road towards us ï from the mundane paying for the bus with your smartphone to the futuristic promise of driverless cars. These stories generate the impression that there is limited opportunity for delivering improvements to transport with the technologies we already have at our disposal. However, there is already lots of technology already installed across the county to help make our transport systems work better. This includes investments into urban traffic management and control systems in most significant urban centres across the country as well as significant implementation of public transport information for train and bus.

In many cases improvements can be made through limited investments. maybe some additional signs to more widely disseminate the information, maybe a new internet gateway to support wider distribution of information through the range of connected devices people now carry every day. In many places, there is also ongoing work to take advantage of new technology to reduce the operating costs of these well-established systems. The use of cloud based systems can reduce hosting costs and increase operational availability at the same time ï the urge to have a big box in a specially designed room with lots of flashing lights to demonstrate the value of the capital investment has surely passed.

Many places have now moved to using a mix of digital communications technologies, taking advantage of the potential of fibre optics, wireless communications and mobile phone data connections as appropriate to deliver a cost effective and integrated network but there are still opportunities for more improvements. And now these dedicated digital telecommunications networks are spreading across our cities how can those cities get more benefit from their investment ï to connect more sensors, collect more data and maybe move towards the opportunities offered by the smart city

At the same time, though, the demand on the transport networks in our cities in increasing and the opportunities for significant new urban road or rail capacity is limited. We do need to be more effective in the use of the capacity that exists and technology can help with this.

In many cases the systems that are already installed and working can play a bigger role than they do. Too often the systems are installed, commissioned, set up and then left to work by themselves. Intelligent Transport Systems are an operational tool. They are a critical part of managing a complex transport network, but in many cases they don't deliver these existing systems don't deliver the benefits they could. Improvement to operational governance and to building the organisation around that operational approach could deliver significant benefits from that existing investment with minimal additional funding. The results from such an approach would provide better outcomes for transport and improved evidence of the effectiveness of intelligent transport systems. This could ultimately result in increased future investment

in the technologies that we know are critical to the future operation of our cities.

Daniel Hobbs, AECOM

Why Road User Charging is essential in an Ultra Low Emission Vehicle future

The transport sector is currently going through an unprecedented period of change. Developments in communication and vehicle propulsion technologies, the emergence of mobility services and new government policies to address environmental and air quality issues are all impacting the way we travel and the vehicles we travel in. As a result, electric and alternatively powered vehicles are growing in popularity, but what does this mean for vehicle and fuel taxation?

In a future where vehicles are powered by a variety of different fuels, the definition of a road vehicle becomes increasingly diverse and the line between vehicle ownership and transport services progressively blurred. In this environment, we need a flexible vehicle and fuel taxation system that can cope with multiple variations of transport technologies, services, alternative fuels and vehicle ownership models. This solution must extend far beyond the realms of the existing system, encouraging positive behavioural change and allowing freedom of choice for users, without compromising environmental improvements. The only system that can meet these criteria is a time-distance-place Road User Charging (RUC) system, whereby road users are charged for the distance they travel, in a given place and time, based on factors such as the vehicle type and emissions generated.

Recently announced changes to the VED system from 2017 are perhaps an early indication of the inadequacy of the current system, as the proposed changes seem to only recognise the environmental benefits of pure electric vehicles and not other types of Ultra Low Emission Vehicles (ULEVs). Even more confusingly, the proposed VED CO_2 emission bands are not in line with those used for BIC taxation for company cars, creating confusion with regards to what vehicle purchasing behaviour the government is trying to encourage.

Improvements in vehicle fuel efficiencies have already resulted in falling revenue from fuel taxation and the growing popularity of plug-in vehicles will only accelerate this decline further. Currently there is no obvious way of taxing the use of electricity as a transport fuel, or even differentiating its use in transport from use in domestic or commercial premises. Similarly, as the amount of biofuel, natural gas or hydrogen used as transport fuel increases, fuel duty rates will likely need to be revised, which will be difficult to do for a rapidly changing transport fuel mix. An RUC-based taxation system can provide the needed regulation in these grey areas, while also encouraging the use of less polluting fuels and providing the ability to influence traffic and congestion nationally in a meaningful way.

While reduced taxation on transport may well be perceived to be a positive, the changes required over the coming years will require substantial government fiscal support; not just for technology or infrastructure

development and maintenance, but to encourage behavioural changes too. Without a flexible and transparent taxation system that is able to generate the necessary revenue from a variety of powered vehicles, meeting ambitious transport decarbonisation targets by 2050 without damaging the economy is unlikely. So, while a time-distance-place, RUC-based taxation system will require a radical change in how road transport is taxed, arguably it is essential in a ULEV future.

Denis Naberezhnykh, TRL

ITS and city transport

Intelligent Transport Systems include a wide range of services using information and communications technology that already impact our daily lives. Think improved management and information, road tolling services, city-wide traffic signal synchronization, safety cameras, satellite navigation systems, smart ticketing systems for public transport and improved parking services. These tools have done a great deal to improve transportation and mobility. However, to respond to the safety, environmental and economic challenges that we face, we need to do much more than has been achieved so far. We need smarter transportation in order to improve accessibility, efficiency and economic performance; reduce accidents, waste and environmental damage. *Smarter* transportation means using available tools to provide the essential information and communications that balance the supply and demand of our networks better.

Success will mean that travellers will benefit from seamless services and authorities and administrations will reduce waste as network reliability and equilibrium is improved with systems that are more integrated. As a result, industry will have a stable market to service.

Key to this step change in transportation will be transaction systems (integrated ticketing, road user fees, parking lot payments, electronic fee collection), and improved traffic management and information systems that are based on more and better quality data. Key enablers for accelerating deployment and securing the benefits promised by intelligent transport systems include:

- Unlocking information using big data, data analytics and data visualization, and use the resources that we have already collected more effectively.
- The game changing potential of connected vehicle technologies that will both improve safety, and the quality and availability of data.
- Robust business cases that identify clear returns in terms of achieving objectives and investments needed for a breakthrough in deployment.
- Evidence based implementation, stable standards, political stability, and commitment to system and service maintenance.

Deployment of these technologies nearly always leads to new organizational and administrative responsibilities and operations. Clearly new communications and information technology provides the opportunity for wider coverage (or shared services) than the traditional adherence to administrative boundaries, and this means even more political leadership will be needed.

Success will be measured in terms of mobility rather than traditional transportation statistics.

We live in a competitive world, but with transportation we all face similar problems. Major Chris Hadfield, the astronaut who spent six months orbiting the earth in the International Space Station commented, ñThe more I looked at the earth, the less I thought of it as them or us, our country or someone elseøs, and I soon considered it as just us. It is our only home.ò

When industry, academia, politicians, the authorities and administrations work together, we can realize the true potential of ITS and create a better greener future. This is why the links established by ITS UK with ITS national associations around the world are so important.

Richard Harris, Xerox

Is the perfect storm brewing for ITS in the UK?

With funding, policy and technology all aligning, it could be argued that the perfect storm is brewing for ITS in the UK.

The UKøs Roads Investment Strategy (RIS), which was published by the Department for Transport (DfT) just before Christmas, not only announced £15billion of investment in the Strategic Road Network (SRN) but also brought roads into line with the railway and utility sectors defining the first ócontrol periodôof spending from 2015 until 2020/21.

Recent statistics underpin the view that the SRN is the powerhouse that drives the economy. Whilst comprising just 2% of the total road network it carries 33% of all traffic, 66% of all freight and has 4 times more cars per mile than locally managed roads. And, this level of use is predicted to increase significantly.

The RIS states, ñOur road traffic forecasts indicate that, by 2040, around 25% of the entire SRN and 32% of the motorway network will experience severe congestion at peak times and suffer poor conditions at other times of the day.ò

The role for Intelligent Transport, in all its guises, is therefore considerable, if availability, capacity, demand, safety and the environment are all going to be managed dynamically and successfully.

The RIS has earmarked £150million for innovation and a separate £40million fund to support the development of driverless and co-operative vehicle technologies. Given that the lead time for R&D can be considerable, work undertaken within these programmes can be expected to inform the second RIS control period.

The investment strategy also offers a vision for a more connected future ñControl will be returned to drivers, with personalised and predictive travel information leading to improved journeys at more reliable speeds. Intelligent vehicles, which communicate with the infrastructure and each other, are also

likely to become the norm by 2040, and we will look to capitalise on their momentum to deliver a network that can fully exploit technological advances.ò

In support of this vision, the DfT has now released possibly one of the most significant transportation documents for several decades. The ó Pathway to Driverless Carsô sets out a framework for the testing and development for driverless technologies in the UK.

The regulatory review undertaken as part of the development of the pathway document defines in plain and simple terms why our road networks are on the cusp of something huge, ñDriverless vehicles can legally be tested on public roads in the UK today. The UK is uniquely positioned to become a premium global location for the development of these technologies.ò

Later this year the DfT will publish its Code of Practice for organisations wanting to undertake testing and the pathway document is clear in its intent, ñThose wishing to conduct tests in the UK are not limited to the test track or certain geographical areas, do not need to obtain certificates or permits, and are not required to provide a surety bond (provided they have insurance arranged).ò

Significant advances in technology will be inevitable, led in part by the driverless programme and emerging trials, and informed by developments in driver assistance and vehicle/infrastructure connectivity.

We mustnôt just concentrate on the strategic road network. The opportunity for the next generation of ITS will be in connecting people to places and goods to markets with seamless efficiency. The last mile (or few miles) will be key to unlocking a step-change in social/economic mobility and access.

However, none of this is going to be easy. Weôre building upon existing network infrastructure used by very mixed fleets with the widest spectrum of uses and users, but we all have the opportunity to develop transport systems that will really be fit for the future.

Giles Perkins, Mouchel Ltd.

Data differences

Everyone seems to be talking about Data Science and Big Data these days, whether it is senior figures in the industry or the ó Data Geeksô on the Silicon Roundabout. The debate has become somewhat confused and I have found it helps to differentiate between different types and uses of data.

The first type of data being considered is flows from ósource to consumptionô These are the lifeblood of every ITS application and also for the ó Internet of Thingsô more generally. The increasingly ubiquitous nature of these systems promises great potential for delivering new products and services. A key point is that various data quality aspects need to be considered at the system design phase to meet the required level so that the data is fit for purpose for the correct operation of the system. Similarly, data security needs to be

considered for vulnerabilities to attacks and also privacy where personal details are involved [1].

Another type is ófound dataôwhereby the ódata exhaustôfrom existing technologies are put to a secondary use, either though developing real-time applications or deriving insights from historical analysis. As an example, TRL are working with train operators to re-use air pressure data from the suspension systems as a measure of carriage loadings along a train, to help assess the business case for investing in initiatives to optimise passenger loadings.

Related to this is the data exhaust generated by people, which some might call the ódigital footprintô, for example smartphone GPS tracks or Oyster card usage histories. These can be a rich öpassiveô source for data mining, where applications may range from personalised recommendation systems to country-wide traffic state estimation.

With the increasing spread of smartphones, another type of data comes from crowdsourcing, i.e. actively collecting transport data from people. There are several research projects that have developed transport crowdsourcing apps, offering a new way of engaging with transport users, which may particularly be useful for addressing issues identified by passengers [2].

The opportunities are immense for deriving new insights, although this optimism needs to be balanced with caution. One of the main challenges we need to overcome is sample bias. For example, with usage-based insurance, although the business case is strong and there is evidence to suggest it may have a positive effect on driving behaviour, there is likely a strong self-selection bias, i.e. the more risk-averse safer drivers will choose to have it installed to save themselves money. As such, caution needs to be taken when extrapolating any early results to the wider population.

Another large pitfall is in drawing false conclusions on causation in particular in ófound dataô For example, considering Premier League home results from the last five years suggests a correlation between high win percentage and those teams wearing red shirts (62% compared to 43% for those not wearing red). Some might construct a *post-hoc* argument that teams wearing red have an advantage, because their team mates are much more visibleé or perhaps opponents are intimidated by the daunting red colouré Although perhaps more likely it is that by chance three of the most successful teams in Man Utd, Liverpool and Arsenal happen to wear red shirts. This is a silly example perhaps, but it is a useful demonstration that correlation does not always mean causation.

[1] - Ball S D (TRL), Tindall D (TRL), McMurran R (WMG), & Chan E (Ricardo). (2009). *Framework Architecture and Classification for Intelligent Transportation Systems (FACITS), Task 5 - Issues Report. - (PPR 566)*. Crowthorne. Retrieved from http://www.trl.co.uk/umbraco/custom/report_files/PPR566.pdf
[2] - Hopkin, J., Ball, S. D., et al. (2014). *Pilot trial of a transport crowdsourcing smartphone app: final report – (PPR 719)*. Crowthorne.

Simon Ball, TRL

Safety First

Throughout society most organisations operate in sector silos; Transport, Energy, ICT, Finance and Economy, Environment, Health, Education, Social Justice, etc. Whether thatôs in national government, local government or private business/industry, itôs how we divide things up (inevitably) to ensure we deliver relevant goods and services in a (mostly?) effective manner. This also means we tend to tackle problems in this fashion; in our siloes we have our own expertise and understanding, our own specifications, standards and policies ï our own way of doing things. In many cases we can tackle and solve problems, identify cause and effect, produce solutions within those silos.

Yet we are aware that the world in which we live and work is not like this, it is a complex eco-system where all these sectors overlap and interact, where many and multiple inter-dependencies exist.

To use an example from the Transport industry, road safety has demonstrably improved over the last decade or so. Fatalities from road accidents in the UK halved between 2000 and 2012 (3,409 to 1,754), across all road users - only deaths of pedal cyclists have not matched this decline. This is possibly due to improvements in vehicle and road infrastructure, or maybe because of the economic environment (there were significant falls in 2008, 2009 and 2010) [RCGB, Dft, 2013]. Whatever the reason, these are generally undisputed facts ï they are measured and understood in the transport sector; there is a clear causal link between the event and the health impact and we can target solutions to address specific local problems.

Compare this to the increasingly highlighted information regarding the impact of poor air quality on mortality rates, 25,000 to 30,000 deaths brought forward per annum in the UK (2008 ï 2010); 400,000 in the EU (2010); 3.7 million world-wide (2012), reported by a number of sources (DEFRA, COMEAP, HPA, WHO, etc). In the UK (in 2010) 97% of the declared Air Quality Management Areas, identified where a local authority believes it will fail to meet EU targets for key pollutants (primarily particulates and nitrogen dioxide) were transport related.

This appears to be a significantly greater problem than road safety; yet the figures are estimates, produced by models and there are inevitably uncertainties. The causal link is inferred and requires data and analysis across a number of sectors. This makes it both difficult to convince people of the extent of the problem(s) and to identify potential solutions (and create the necessary imperative to do so).

Maybe the advent of recent paradigms will help to address this and enable us to tackle these ñbigò problems more effectively. ñInternet of Thingsò solutions will provide us with spatially and temporally dense real-world measurements across sectors. ñBig Dataò systems will enable us to crunch the vast data sets generated and provide information highlighting cross-sector cause and effect.

ñOpen Dataòwill enable communities to interpret data sets and present analyses and information to help wider understanding.

Paul Rose, Amey

Automated Vehicles

Connected and automated vehicles are continuing to attract column inches in both the technical and popular press. Whilst Googleôs high-profile developments and the innovations being rolled out by vehicle manufacturers are great for sparking the imagination what might such technology mean for our highway networks and those that operate them?

It canôt be denied that Intelligent Transport Systems (ITS) play a significant role in improving road based transportation from management, safety, environmental and information viewpoints. From the underlying communications networks to the detectors, signals and cameras, these technological assets harmoniously support the tarmac, concrete, barriers, lines and signs that comprise the highway itself.

With increasing levels of driver assistance in-vehicle systems such as lane departure and speed sign recognition should arguably be already prompting a change in infrastructure maintenance requirements. Will wide scale adoption of adaptive cruise control, crash avoidance and, in the future, platooning, have an impact upon motorway capacity and performance? How should semi-autonomous and autonomous vehicles operate, should they ólearnô independently or use ódigital infrastructureôand who should collect and maintain this dataset?

Setting aside the regulatory, legal, security and human factors surrounding the development of such technology there will undoubtedly be an impact on the design standards, systems, asset mapping and performance characteristics of our highway networks. At some stage there will also be a tipping point where investments in ótraditionalôITS infrastructure will have to make way to systems and infrastructure that support new generation vehicles.

There is already the suggestion of European harmonised standards for lines and signs to aid the in-vehicle automation of lane detection and sign recognition, a simple aspiration but with significant practical challenges. Whether vehicles need to interact with infrastructure is a complex one leading to the consideration of a whole set of standards, investment and maintenance considerations. The debate surrounding how future óintelligentôvehicles will negotiate their surroundings has significant implications. self-learning vehicles will need to óseeôinfrastructure consistently, whilst vehicles dependent on an óelectronic horizonôof mapped infrastructure will need extremely accurate and timely data.

The expectations of those developing connected and automated vehicle systems might at best be slightly misaligned with network operator priorities and aspirations, at worst they could be completely at odds. With the rate of change in the fleet, the uptake of automated features will only accelerate and the bundling of automated functions then starts make for a very different

ánimalôon our roads. Long-term investment decisions will have to take account of changing access, technical and performance requirements which may be led by organisations that have never needed to consider in detail the infrastructure on which their products are used.

Incremental automation in driving is already happening, perhaps now is the time for those designing the vehicles of the future and those who will be designing, operating and maintaining the highways of the future to really get to know each other?

Giles Perkins, Mouchel

Green flag or red flag for autonomous vehicles?

Motorised transport has brought massive societal, industrial and geographical changes to our environment. Whilst most of these changes can now be seen as beneficial, in the 19th century there was an initial trepidation about public safety, disruption and nuisance caused by such vehicles. This was reflected in legislation that can seem bizarre from a 21st century perspective. Section 3 of the Locomotive Act 1865 required self-propelled vehicles to be accompanied by a crew of three and attended by a man with a red flag walking at least 60 yards ahead of each vehicle. The vehicle was required to stop at the signal of the flag bearer who also had duties to assist the passage of horses and carriages. Fortunately, the so-called ñRed Flag Actôwas repealed before the motor car had become prevalent; a decision celebrated by the 1896 London to Brighton ñEmancipation Runô This is now established as an annual veteran car run from the capital to the same seaside destination and is the worldôs longest running motoring event.

It wasnôt just the UK that enacted such laws. Perhaps the most extraordinary was that unanimously passed in Pennsylvania in 1896. This obliged motorists in charge of horseless carriages on encountering cattle or livestock not only to stop their vehicle immediately; they were also to disassemble the vehicle as rapidly as possible and ñconceal the various components out of sight, behind nearby bushesòuntil the animals were sufficiently pacified! Only the executive veto of the state governor prevented this from becoming law.

The advent of autonomous vehicles could bring the biggest transformation in transport since the invention of the motor car, with anticipated benefits to safety, mobility and efficiency among others. The excitement about their introduction is often tempered with caution in relation to the difficulties associated with creating a suitable regulatory and legislative framework to enable the technology to flourish. Questions surrounding liability, insurance and public acceptance of highly or fully automated vehicles are frequently raised. These are rational concerns ï vehicle manufacturers and component suppliers need to be able to quantify their liability exposure in order to determine the extent of the commercial opportunity that may exist.

Furthermore, until the technology is proven in the real world and in real situations, it may be deemed essential that regulations are created to provide the public and industry with the confidence needed to proceed. However, of

these new regulations, which will our successors consider bizarre ï what will be the 21st century equivalent of the Red Flag Act?

Dr Nick Reed, TRL

Social Media

There has been much discussion about social media and transport. With the recent public flotation of Twitter this is a good time to review how these media are developing and affecting travel.

The ôinformed travellerô is a key stepping stone towards intelligent mobility. During disruption, and particularly on public transport, people want to be informed about what is happening so they feel they at least have some control of the situation.

Twitter is an increasingly commonly used tool, especially for train travellers, to find information. National Rail Enquiries, signs at stations and on the platforms provide good real time information about delays being experienced, but they donôt always tell you what is happening and why. As a frequent traveller, I often check twitter for information about my journey. Due to my frequent use of the service, I can now use my personal experience to determine whether the events unfolding are likely to still be an issue that impacts on my journey and of the alternatives open to me.

So, at least to me, these twitter services are worthwhile. But is it just for regular travellers? My perception of social media is that, because the individual has complete control of they choose to follow, it is easy for people to stay within their comfort zone.

Can it be a tool to encourage public transport? There are those on twitter with large followings that cross the boundaries between these various networks, but they donôt often tweet about transport. For example, @nationalrailenq has a following of some 160,000 which isnôt much more than the number of train passengers going through London Bridge station during a weekday morning peak. There are of course retweets, but does the message get to those who arenôt already connected to this world?

The effectiveness of social media is dependent on individual connections, so the aim has to be to build a network around the users of a particular journey or route, so they inform each other about what is happening. This approach is likely to increase the trust in the information, as there is evidence that people trust other people more than they trust the corporations pushing information at them.

There has been discussion about making wider use of data from social media. Data could be collected from social media and then broadcast as part of other transport information services. But is the data that is collated in this way representative enough to be meaningful outside of those individual networks? Is this a route to helping create more personal networks around more journeys? The challenge ahead is going to be harnessing and encouraging these informal networks to make this medium a real stepping stone to a greater number of informed travellers.

Daniel Hobbs, AECOM