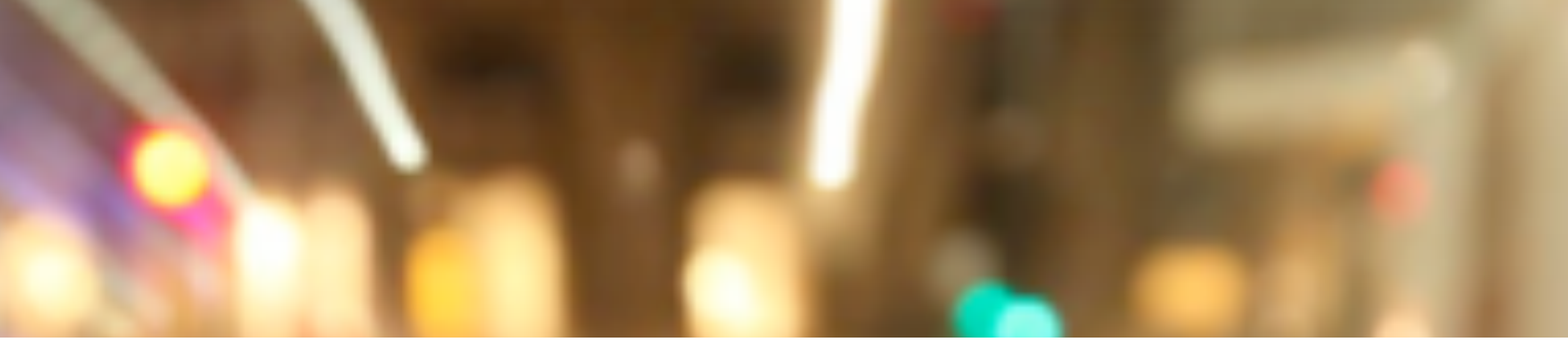


automotive council UK

Intelligent Mobility

A National Need?

November 2011

Contents

Ministerial foreword

Free-flowing transport networks, which ensure the mobility of people and goods around the country, are critical to the UK's future economic growth.

But increasing capacity in the road network cannot be achieved simply by building more roads. Instead, if we are to avoid serious congestion problems, we must become more intelligent in our management of vehicles and roads, using the existing capacity more efficiently while improving safety and reducing congestion.

This approach, known as Intelligent Mobility, could have benefits for all aspects of the economy – enabling businesses to become more competitive as transport and logistics costs are reduced; ensuring journey times are more predictable; and reducing the associated CO_2 emissions as less fuel is consumed.

The technologies that will enable this revolution largely exist already, but we must now accelerate the integration of intelligent transport systems and services into everyday use. Doing so will create substantial new commercial opportunities for UK companies. So I welcome the leadership that our world-class automotive industry is showing on this issue.

Road vehicles are one of this country's most successful manufactured products and the sector continues to outperform many of its competitors, producing high-value, high-quality vehicles that the world wants to buy. If we are to encourage economic growth and maintain our manufacturing excellence, we must ensure that our road network continues to meet the heavy demands we put upon it.

This report, which has been produced by the Automotive Council, begins the process of mapping the way forward.

Achieving Intelligent Mobility will involve collaboration between a number of different sectors and disciplines – automotive; telecommunications; sensors and electronics; infrastructure – each with its own issues, and its own business case for investment.

The report discusses the potential role for automotive companies and those in other sectors, and identifies opportunities for exciting innovation and collaboration between them.

I am confident that the Council's leadership will enable the UK to realise the opportunities created by Intelligent Mobility – and the contribution it can make towards sustainable economic growth, efficient transport networks and a cleaner, safer society.

Vince Cable
Secretary of State for Business, Innovation and Skills

Chairman of the Working Group's foreword

The Automotive Council has produced this report as part of its programme of exploring 'sticky technologies' – those key technologies which are ripe for development in the UK and have a good chance of remaining embedded here as the pace of commercial up-take accelerates throughout the global industry. Intelligent Mobility is a good candidate for designation in this category because of the UK's intense dependence on road transport (resulting in a very active home market); its reputation for world-class research into electronics, communications, and information systems; and its long history of pioneering in the automotive industry. Our work confirms that this is so.

Clearly, the largest part of the UK's mobility need is provided by road transport. The contribution of the automotive industry to ensuring that mobility continues to be more available to all without bringing increases in pollution, transport accidents, and congestion is therefore of paramount importance. Nevertheless, the contributors to this report not only include vehicle manufacturers and their suppliers, but also information and technology consultants, municipalities, and research establishments. As a result, we believe our conclusions apply to all aspects of road transport (not just cars).

The Automotive Council has now identified Intelligent Mobility as one of its five 'sticky technologies' – those primary areas for focusing UK research and encouraging inward investment. It is our hope that the publication of this report will mark the beginning of a long and successful journey for UK enterprise in this exciting area of advanced technology.

John Miles, Arup
Chairman of the Intelligent Mobility Working Group

Executive summary

'Intelligent Mobility' is an exciting prospect. It could enable travellers to plan and execute their journeys seamlessly across the whole spectrum of available transport options whilst enabling more vehicles to flow more freely through our existing infrastructure. The concept is about 'mobility', rather than being about choices between cars, buses and trains as competing systems. As such, it has the potential to sweep away the 'either/or' decision making process between road, rail, or air transport, which characterises the conventional approaches to journey and infrastructure planning. Importantly, Intelligent Mobility emphasises the roles that public transport systems, private cars, freight vehicles, commercial fleet operators, infrastructure providers, and government must all play in delivering those levels of improved mobility which are essential if we are to avoid clogging the nation's transport arteries and stifling our economy.

The key to Intelligent Mobility lies in the interconnections which can be made between a range of different industries and technologies. This range includes: vehicle manufacturing; electronic sensors and controls; transport information systems; communications technologies; logistics & distribution; and infrastructure management. At present, each of these business segments is a fast-moving, independent sector in its own right and there is little formal connection between them all. For this reason, developments in the field of intelligent mobility to date look rather fragmented and the full potential of the concept remains to be delivered. Identifying the interconnections, and making this happen, is the key challenge to those who advocate Intelligent Mobility as an important national goal.

However, new user-focused products designed to assist travellers and drivers are evolving very rapidly and convergence across the different business segments is beginning to occur. This convergence opens the door to the delivery of true Intelligent Mobility, and we might anticipate dramatic improvements in the areas of:

- Reduced congestion
- Improved fuel efficiency
- Increased road safety
- Reduced carbon emissions
- Enhanced journey predictability.

Intelligent systems for transport applications have come a long way since interest in the subject first started to produce meaningful results in the late 70s/early 80s. There are now many examples of ITS operating within our infrastructure, including Managed Motorways and the London Congestion Charging system.

There are also many examples of Intelligent Transport Systems (ITS) that have been adopted very widely by the automotive industry. But, in many cases, they are no longer categorised as ITS (eg Adaptive Cruise Control, SatNav).

The convergence of these singular ITS products into a more comprehensive Intelligent Mobility framework is now beginning to appear in several different parts of the user-spectrum:

- **In the public transport domain**, where a wide variety of travel products and services are now available to assist users plan and execute their journeys. The Oyster Card in London, and the availability of bus and train timetable and movement information at home via the internet are two examples.
- **In the private car domain**, developments have been mainly concentrated in the spheres of 'infotainment', driver assistance and safety. Increasingly, these systems are reaching beyond the car itself to interact with other vehicles and the fixed infrastructure via wireless communications and the internet.
- **In the domain of fleet/commercial operations**, real-time vehicle and item tracking is common-place. Vehicle monitoring/reporting systems are increasingly integrated with enterprise management systems with the goal of increasing operational efficiency and competitive advantage.
- **In the infrastructure domain**, traffic management systems deliver variable speed limits and lane controls on our motorways. A variety of road-side sensors is used to monitor traffic conditions; number plate recognition systems are used to enforce the law; and electronic tolling is becoming common for infrastructure bottlenecks (eg windscreen tags for the Dartford Tunnel and Severn Crossing).

In future, it is likely that the functionalities in the separate domains described above will converge to provide continuous functionality across the whole spectrum of need. This will allow all forms of transport to participate in continuous, 'intelligent', interactions (both vehicle-to-infrastructure, and vehicle-to-vehicle). At that stage, Intelligent Mobility will offer the possibility of relieving those problems of congestion, air quality, safety and carbon emissions which threaten to choke the development of the UK economy over the coming decades.

Given the present constraints on public funding and the recognition that the problems of congestion and air quality, etc are unacceptable economic and social burdens, wise investment by both public and private organisations in the intelligent management of existing infrastructure is essential. To be able to reduce (or remove) these problems without embarking on a major national programme of physical infrastructure upgrades represents a tremendous opportunity for the UK.

However, the route to convergence is unlikely to be an easy one. There are some difficult obstacles which confront the planners and developers of Intelligent Mobility systems. These are essentially business obstacles, rather than technical obstacles, and include the following:

- The short-term user benefits (eg entertainment and driver convenience) are quite different from the long-term user benefits (eg congestion/pollution management at the national scale). Unfortunately, it is not clear that a free-market economy, acting alone, will encourage the transition from the first to the second.
- Associated with the above, the business drivers for the vehicle OEMs are quite different to those for the infrastructure providers and electronic/information communications systems developers. But there is no authoritative forum in which these independent business interests are brought together.
- The product development and product life cycles in the different business sectors are quite different (electronics/communications 6-12 months; automotive industry 3-5 years; infrastructure provision 5-30 years). This makes it very difficult to coordinate development programmes across the different sectors.

A consequence of all these factors is that there has been little strategic interaction between the business sectors in the past and the approach to overall system development has been uncoordinated. The result is the rather fragmented picture referred to earlier in this summary.

Despite the difficulties, the case for developing a comprehensive national approach to Intelligent Mobility is compelling. Indeed, it might be argued that a plan to deal with our problems of congestion, pollution, safety and carbon reduction through the introduction of such systems (rather than through the introduction of expensive new fixed infrastructure, or draconian regulation) should be made a national goal. When viewed in this light, all of the business sectors currently engaged in the independent development of new transport-related products should be encouraged to engage cooperatively in the pursuit of the bigger goal, despite the fact that the short-term economic returns may be questionable.

Despite this lack of immediate business benefit, there are several factors which could still act to accelerate the short-term development of new Intelligent Mobility products. These include:

- The new EU ITS Directive, introduced in August 2010, titled the 'Framework for the Deployment of Intelligent Transport Systems in the Field of Road Transport' (Directive 2010/40/EU). This document puts forward an Action Plan aimed at speeding the deployment of ITS throughout Europe with targets and activities detailed in six key action areas. Delivery dates across these action areas run from now until 2014.
- The needs of freight and commercial operators, where considerable and immediate business benefits can be derived from ITS applications. Examples include fleet management (eg tracking items in transit; improving driver behaviours; and reducing fuel consumption) and off-road vehicles (like construction and agricultural machinery, where the movement of vehicles is already being controlled using satellite navigation and on-board computers).
- The public awareness of carbon and climate change, which will provide a more receptive user-base for products aimed at improving fuel economy and reducing emissions.
- Electric vehicles, for example, are likely to raise public interest in advanced vehicle concepts and provide opportunities for the OEMs (and others) to offer products which both assist the driver and interact with the fixed infrastructure (eg displaying the location of charging points, and enabling billing and information transfer via the grid).

Intelligent Mobility represents an important opportunity for the UK at large. In the long term, it has the potential to provide solutions to some of the most pressing transport-related needs of the nation. Whilst on this journey, there is an opportunity to create UK jobs and global leadership, underlining the claim that the UK is a global vehicle R&D 'Test Bed'. The strong national position in the fields of fixed and mobile communications technologies, software systems, and information services can be mobilised as part of this claim.

Finally, Intelligent Mobility represents an especially important consideration for the UK automotive industry. In the long run, the Industry will benefit from such developments because they will help to prevent the increasing sales of cars being seen as an unacceptable barrier in the struggle against congestion and carbon. Purchasers are more likely to be in sympathy with the Industry if they can see that these downside problems are being taken seriously and effective solutions are being developed.

1 Introduction

The Automotive Council is a high-level Government/Industry body created to address the needs of automotive manufacturers working in the UK. Its purpose is to help ensure the long-term health of manufacturing as part of the UK economy.

This report has been produced by the ITS Working Party of the Automotive Council. Organisations represented on this Working Party and contributing to this report (in alphabetical order) are:

- Arup
- BMW
- Greater Manchester Passenger Transport Executive
- innovITS
- Logica
- Millbrook
- MIRA
- SMMT
- Technology Strategy Board
- Toyota
- ITS (UK)

1.1 Purpose

This report has been prepared by the Automotive Council as part of the Council's continuing effort to encourage the development of UK capabilities in the fields of automotive manufacturing and technology. It addresses the issues of Intelligent Mobility and Intelligent Transport Systems (ITS), and explores the extent of current activities and the potential for their future development.

The term 'Intelligent Transport System' has been used for many years. The roots of the term can be traced back to the early 1980s, where references to 'Intelligent Transport' were used not only to describe the individual devices that were coming to market at that time, but also the wider potential of integrated electronic and communications systems to revolutionise the entire package of traffic management, driver experience, road safety and personal travel. Whilst some of the particular devices cited in those early years came to fruition (and we might include Adaptive Cruise Control (ACC), SatNav, and on-board computers amongst the successes), the wider story of an integrated systems revolution (Intelligent Mobility) has never really been delivered. It remains a tantalising possibility.

Despite the apparent lack of fruition, several important facts are indisputable today:

- Electronic systems are cheaper and more capable than ever before (and the rate of progress in these directions shows no sign of slackening)
- Information is more abundant and more accessible via remote, wireless, connection than could ever have been imagined back in the 1980s
- The core technologies have now been available for many years and are becoming 'mature' (even if the reliability of those technologies when harnessed within wider systems has not yet been unequivocally demonstrated)
- The need for active traffic management systems continues to increase because of the increasing density of vehicles on our roads
- The awareness of noise, air quality, and atmospheric carbon levels makes it increasingly necessary to develop journey management strategies that are optimised to reduce these forms of pollution.

Taken together, these facts have convinced the Automotive Council of the need to re-examine the place of ITS in modern transport systems and to examine, in particular, the role that ITS might play in the next stages of the industry's journey towards the delivery of truly 'Intelligent Mobility' in the UK.

1.2 Definitions and Scope

Before we can address the objectives of this report, it is necessary to define what is meant by the terms 'Intelligent Mobility' and ITS.

'Intelligent Mobility' is a term which has been adopted specifically for this report. Within the context of all that follows, the term is used to describe a concept which focuses on the ultimate goal of 'mobility', rather than the provision of independent and specific modes of transport such as road, rail and air. The delivery of Intelligent Mobility relies on harnessing the 'intelligence' of modern electronic devices and communications systems and using that capability to control and optimise the performance of the overall system. Pursuing this concept requires a different mind-set to that which has underpinned all previous generations of transport planning; one which recognises the roles that public transport systems, private cars, freight vehicles, commercial fleet operators, infrastructure providers, and government must play in delivering improved mobility for all.

Unlike Intelligent Mobility, 'ITS' is a term which is commonly used within industry. However, it has developed different meanings in different circles over a long period of time. Within the body of this report, therefore, we have adopted the following definitions of ITS and the electronic/communications/information systems included within it. These definitions are deliberately broad and have been chosen with the express intention of pushing the limits of what may be recognised as ITS.

1.2.1 ITS – Definition

- Any technology or data that can assist a traveller (or business) to optimise journeys within any chosen set of criteria (eg duration, fuel consumption, carbon footprint, etc)
- Any technology or data that can assist the authorities to optimise management of the fixed infrastructure within any chosen set of criteria (eg safety, pollution, energy consumption, carbon emissions, congestion).

1.2.2 ITS – Included Systems

- Systems within the vehicle (eg passenger information systems; engine management systems, condition monitoring systems, SatNav, cameras, etc)
- Systems outside the vehicle (eg infrastructure-based systems such as arrivals/departures notices, traffic signals, number plate recognition systems, congestion charging systems, lane control systems, etc)
- Vehicle-to-vehicle and vehicle-to-infrastructure communications devices (radio, mobile phones, satellite communications, internet channels, etc)
- Web-based systems for information sourcing and ubiquitous interconnection.

1.3 Structure of the Report

This report begins with a brief look at the national context, summarising expectations for the future growth of transport demand. This is followed by a review of the historical development of ITS, and an overview of the principal achievements to date. Between them, Chapters 2 and 3 briefly set out the 'big issues' (such as safety, congestion, carbon, pollution, etc) and explain where we are now with the current state of the art.

Chapters 4 and 5 deal with the business landscape which surrounds today's would-be system developers, and the likely shape of things to come. The business drivers and the technical, social and political context for future developments, are examined along with the possibilities for creating high-quality, stable jobs in the UK along with a position of genuine international leadership. A route map illustrating the possible road to 'Intelligent Mobility' at national scale is also presented.

The report is concluded by a short Chapter 6 which summarises the conclusions which may be drawn and puts forward recommendations for further action.

Throughout the report, the view is from the perspective of the UK–based automotive industry (the OEMs, their workforces, and their supply-chains). However, the study has been deliberately cast wide to embrace the views of all of the stakeholders who might play a role on the road to Intelligent Mobility in the UK. Accordingly, national and local government, transport agencies and agents, the mobile phone operators, the internet providers, the systems integrators, small entrepreneurs and academia have all been consulted and have contributed to the preparation and presentation of this document. We thank them all for their time, enthusiasm and contribution.

The Bare Facts

- Electronic systems are cheaper and more capable than ever before
- Information is more abundant and more accessible than ever before
- The need for active traffic management grows as congestion increases
- The critical importance of just-in-time delivery strategies to manufacturing, retailing and food/fuel distribution makes commercial fleet operators ever-more dependent on intelligent systems as a means of maintaining business competitiveness
- The issues of noise, air quality and carbon emissions create demand for private and commercial journey management strategies that are optimised to reduce these forms of pollution

2 Setting the scene

Evidence of UK transport challenges

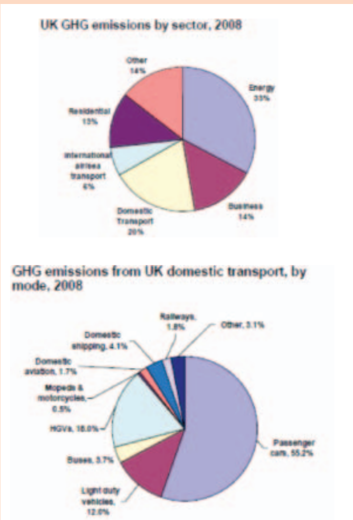
The Prime Minister's Strategy Unit Report on Urban Transport "The Future of Urban Transport" (DfT, November 2009) identified a range of transport challenges faced by UK cities.

The cost problem

The Report assessed the impacts of transport and estimated their associated annual costs under the following headings:

- congestion in excess delays (£12.0bn)
- road accidents (£9.3bn)
- poor air quality in particulate pollution (£4.5 to £10.6bn)
- physical inactivity and the growing level of obesity (£10.8bn)
- greenhouse gas emissions (£1.2 to £3.7bn)
- noise (£2.7bn)

The Greenhouse Gas (GHG) problem



The transport sector (domestic and international) contributes to around a quarter of the UK's GHG emissions, of which 90% is from road transport. (DaSTS, DfT, 2008).

The UK has committed to cutting greenhouse gases to 34% below 1990 levels by 2022 and 80% by 2050.

2.1 The National Perspective

The UK is a wealthy, densely-populated nation. Among the top 25 most wealthy nations in the world, the UK ranks as the 8th most densely populated (in terms of population per square mile) and 5th most congested (in terms of population per road mile). Our dependence on light and heavy goods vehicles for the delivery of food and consumer products, buses and coaches for transport, and (especially) the car for private mobility, is deeply entrenched in our society. With a national vehicle parc of 0.56 vehicles per capita it ranks as one of the world's most intensely road-transport dependent societies. In summary, mobility and the automotive industry are vital components of the national economy.

The trends behind some of these statistics are now giving cause for concern. The population is drifting upwards (see Table 2.1), and road traffic volumes have grown continuously over the past 60 years (see Fig. 2.1). Much of the road network is at the limit of its capacity, and Britain is now more congested than most other developed nations (see Fig. 2.2). A recent study by the Prime Minister's Strategy Unit ("The Future of Urban Transport" DfT, November 2009) identified numerous economic and societal challenges which result from this pattern of increasing congestion (see box).

Some commentators suggest that action to address the increasing congestion, and its related problems, demands a massive

2008	2013	2018	2023	2028	2033
61.4	63.5	65.6	67.8	69.8	71.6

Table 2.1: Estimated population growth in the UK (millions)

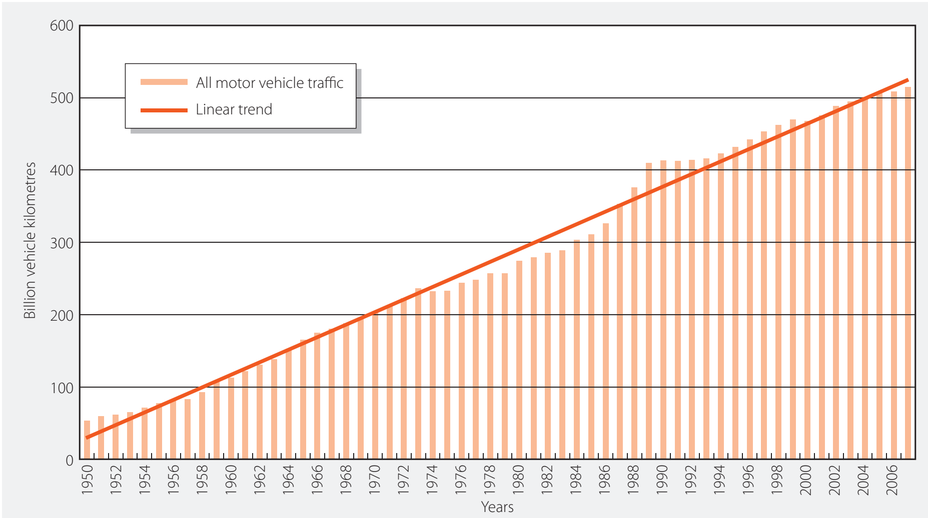


Fig. 2.1: UK road traffic growth trend

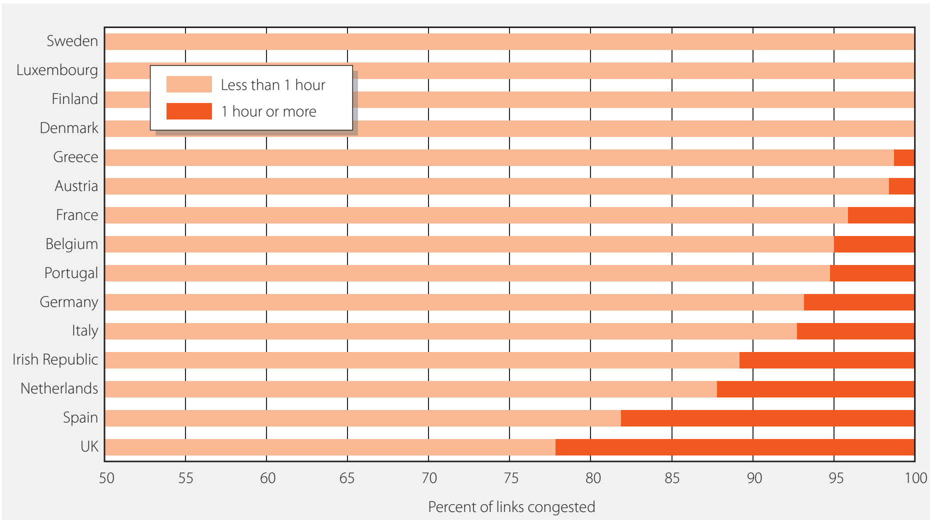


Fig. 2.2: UK congestion compared to other countries

government-prompted 'modal shift' away from the car and towards public mass-transit systems. However, even a superficial view of the picture in London suggests that this, alone, is not practicable (see box). An alternative approach would be to build more road capacity – 'predict and provide'. But, again, a superficial analysis rules this out – it is simply too expensive, too time consuming, and there is a lack of available space (particularly in our urban centres).

Clearly, a 'third way' needs to be found; one which sits between the extremes of legislating vehicles off the road and unconstrained new infrastructure construction. The development of advanced Intelligent Transport Systems (ITS), and their deployment at national scale, could be an enabler to delivering this 'third way'.

ITS have the potential to connect all forms of transport, thus linking the traveller both to his car and to the alternative mass transport systems (road, rail, sea, and air). Such technology therefore enables the problems of 'mobility' to be addressed, rather than simply addressing the problems of the car, the train, or the bus within their respective silos. For this reason, this report has been titled 'Intelligent Mobility' and its intended audience includes bodies beyond the Automotive Manufacturers (OEMs) and their suppliers – including government, cities and local authorities, public and private transport providers, logistics/freight companies, emergency services and traffic information service providers.

2.2 The Road to Improvement

ITS has the potential to improve mobility from a variety of different viewpoints, including:

- Road congestion
- Environmental pollution
- Supporting an ageing population
- Supporting public/private business models
- Road safety.

Road Congestion

Assuming there is continued economic growth, road congestion will continue to be an issue that needs attention for the foreseeable future. Congestion affects the economy through loss of productive time, it impairs quality of life, and it impacts badly on the environment. These factors are a concern for the automotive industry, detracting from the pleasure of driving in the eyes of the traveller and therefore reducing the benefits of car ownership.

Acute congestion also leads to the car being 'demonised' by the authorities. Municipal planners often have a strong preference for public transport systems such as buses, trams and light-rail, and frequently express a desire to encourage a modal shift from the car to these systems. In the long-run, such actions could be damaging to vehicle sales and harmful to the interests of the OEMs. From the user's point-of-view, perhaps the worst aspect of congestion springs from its unpredictable nature. To a limited extent problems like rush-hour congestion can be foreseen and the regular traveller can make specific plans to avoid the problem. But random blockages due to roadworks, accidents, major events, etc make the general prediction of travelling times very difficult. This results in 'congestion factors' being added to every prediction of journey time with resultant wastage, uncertainty and lack of satisfaction. ITS can help to improve travel reliability and reduce costs through systems such as:

- Online journey planners
- Dynamic route guidance and traffic alerts
- Traffic control measures, including urban traffic management control (UTMC), active traffic management (ATM) and parking availability systems
- Demand management measures (such as road user tolling).

Environmental Pollution and CO_2 Reduction

Road traffic imposes a variety of negative impacts upon the environment. Emissions adversely affect local air quality and noise from traffic is another local issue. Broader challenges include energy security, as most vehicles are dependent on fossil fuels, and climate change (carbon dioxide emissions).

Country	Fatalities 1997	Fatalities 2007	% Change
UK	3,743	3,058	-18.3
USA*	41,907	42,642	1.7
France	8,445	4,620	-45.3
Germany	8,549	4,949	-42.1
Sweden	541	471	-12.9
Netherlands	1,163	709	-39.0

Table 2.2: Road safety trends 1997-2007

(Source: WHO Global Status Report on Road Safety, UN ECE Transport Division and Eurostat Data for deaths within 30 days)
* Data for 1996 and 2006

Modal shifts

There is a widespread perception that the solution to urban congestion problems is to encourage passengers to move from cars to public mass-transit systems. But the statistics for London show that it would be inconceivable to replace London's car journeys by journeys on the public transport systems. Personal mobility is an essential part of urban life – and it will remain so. ITS has the potential to ensure that continued high levels of car usage in the urban environment do not lead to unacceptable levels of congestion, air quality, noise or CO_2 emissions.

Heavy rail	22bn	pass-km
Buses	5bn	pass-km
Underground	7.5bn	pass-km
Cars	50bn	pass-km

	2008	2011	2016	2021	2026
60-64	3,639	3,746	3,442	3,840	4,300
65-74	5,155	5,501	6,344	6,551	6,703
75-84	3,440	3,540	3,829	4,360	5,130
85+	1,335	1,447	1,682	1,995	2,413

Table. 2.3: Ageing population projections by age in UK (thousands) Source: ONS 2009

Mathematicians make headway in understanding traffic congestion

A special issue of the Philosophical Transactions of the Royal Society in 2010 was devoted entirely to understanding and preventing road congestion.

At current rates, the number of cars and light trucks worldwide is set to double over the next 20 years, from today's estimated 900m. Figuring out how to use the available road space more efficiently will thus be necessary to keep ever more cars from languishing in jams.

Scientists have been trying to bring order, or at least predictability, to motorway mêlées for decades. They assumed the familiar 'stop-and-go' waves of congestion were due to the sheer volume of traffic. More recently, mathematical models have suggested they may actually be down to drivers' behaviour. With cars moving fluidly in a tight pack even a seemingly innocuous change of lanes may cause a tiny disruption which is propagated backwards for many miles.

One of the Royal Society papers cites timid and aggressive driver behaviour as the main culprit. To arrive at this conclusion the authors looked at actual traffic on a 600-metre stretch of freeway in Los Angeles, and another near San Francisco, and created a model to match the observed data. They found that vehicle speeds drop to zero if just a few drivers accept shorter distances between their car and the one in front, and a handful of others in the same lane prefer a greater gap, relative to the 'equilibrium spacing' which in theory ensures a steady ride.

One way to maintain this ideal gap would be more widespread deployment of adaptive cruise control (ACC), which enables partly automated driving. Such systems have been around since the late 1990s but many motorists remain leery of relinquishing control to a computer. Until that changes they had better steel themselves for more jams.

The Economist, September 11th 2010

ITS has been active in providing tools for private drivers, network operators and fleet managers to address these problems. These tools may be found in the areas of energy efficient routing, driving or control of vehicles, congestion reduction, demand and network management and aids to electric charging.

Road Safety

The UK has an excellent record on road safety when compared with other developed countries (see Table 2.2), but the frequency and cost of accidents remains substantial. The Department for Transport annual report for 2009 recorded 2,222 deaths, 24,690 serious injuries and 195,234 minor injuries. These figures continue a declining trend from the mid 1990s (even though road traffic volumes have increased by 15%), but the cost in terms of life and health is still very significant. The value of preventing these injury-related accidents (and also damage-only accidents) in 2009 was estimated to have been between £15-£30bn.

Road safety has always been a core issue for ITS, especially for the automotive sector engaged with intelligent vehicles. Much of the ITS activity in the automotive sector has traditionally been focused on prevention of crashes rather than mitigation of the effects. Development of technology has been, and is, driven both by customer demand and regulation.

Supporting an Ageing Population

In the UK, along with the rest of the OECD countries, there is an ageing population (see Table 2.3). Increasingly, this population is relatively affluent and has high expectations for quality of life. Although the faculties and physical abilities of an individual may diminish over time, the desire (and need) for mobility does not.

A critical challenge is to maintain mobility options for the elderly whilst ensuring that road safety and other important criteria are maintained. ITS can help to deliver traveller services that cater for a reduction in abilities as well as specific tools to assist ageing drivers drive safely and comfortably. For example, ITS could offer in-vehicle driver assistance and warning technologies which take over some of the tasks from the driver. These technologies include, for example, lane departure warnings, blindspot warnings, parking sensors and electronic stability control.

Supporting public/private business models

Funding is an issue for both the public and private sectors. Road transport depends upon an infrastructure mostly provided by the public sector. Public sector budgets are currently under intense pressure yet there remains an urgent need to improve and expand our transport infrastructure. ITS can help alleviate this problem by increasing the efficiency of existing infrastructure assets without the need for large construction projects.

There is also a growing appetite for transport solutions that depend to a greater extent upon private sector provision, through private tolled highways or other schemes where the business model can sustain commercial profits while delivering public policy goals and private user needs. ITS can provide the technology to support such private sector-led schemes.

The business models for the public sector, the automotive industry and the private transport user are fundamentally different. The challenge is to learn from each and to synthesise new approaches to meet the new challenges; always recognising that it might take a completely new entrant to crystallise the opportunities.

2.3 Autonomous Control and Intelligent Mobility

In the long run, the convergence of all the systems and sub-systems embraced by ITS leads to the ideas of Autonomous Control and Intelligent Mobility.

Autonomous Control describes a state where vehicles are controlled entirely by the system without any input from the driver. This is a contentious concept since it is counter-intuitive to leave critical decisions (like braking and steering) to a machine that is not in the constant care of experts. However, electronic

detection systems (even now) are capable of 'seeing' obstacles and road markings more accurately than the human eye, and actuators can apply the brakes, or turn the wheel, faster than the human limb. It is demonstrating the reliability of the controlling software algorithms, and assuring their fail-safe operation, that currently pose most of the difficulties.

Nevertheless, great progress is being made and autonomous control is already a reality in some relatively benign environments. The operation of agricultural harvesting equipment and off-road construction equipment, for example, is increasingly controlled using satellite positioning systems and in-cab computers. Such realities, plus the continuously increasing access to information streamed from the web and increasingly cheap on-board computer processing capabilities, suggest that autonomous control for road vehicles may not be so far away.

It is often argued that the major obstacle to autonomous control is not the sophistication of the technology that may be required – it is the instinctive human resistance to ceding control to the machine. (And, if not this, then the reluctance of the OEMs to lay themselves open to litigation in the event of system malfunctions). But, already, car-purchasers are choosing to put their trust in automatic systems when they are offered this technology on new cars (particularly up-market vehicles), and the OEMs are moving inevitably towards taking responsibility for the performance of these systems. This subject is discussed further in the section on Advanced Driver Assistance Systems (ADAS) in Chapter 3.

Autonomous Control, however, is only one part of the wider concept of Intelligent Mobility. The ability of the vehicle to have knowledge of local traffic conditions and local public transport movements (eg bus and train timetables), in addition to being able to sense fixed and moving obstacles within its immediate proximity, opens the door to better journey planning for the traveller and optimised traffic flows for the infrastructure manager. The implications of this are huge. Some commentators suggest that the capacity of existing UK roads could be increased by a factor of three to five, depending on context (inner city, suburban, trunk road, rural). To achieve this without the need to upgrade or re-route the existing physical infrastructure, and to enjoy the associated benefits of being able to optimise vehicle movements to minimise carbon emission, maximise air quality, and reduce accidents, is an economic and social opportunity the UK can not afford to miss.

Delivery of this vision, however, is some way in the future – maybe 15 years. Until convergence of the myriad intelligent transport systems arrives, the benefits outlined above cannot be realised – and this poses a real problem. What will cause the convergence to occur? In the long term, the beneficiary, unquestionably, is the national economy. But, in the short-term, this is not the case (because the current disparate systems cannot deliver the combined benefit). In a free-market, therefore, what will be the short-term driver that forces the development of ITS technologies to the point where serious convergence begins to appear? The economic and other forces at play in the market over the coming years, and their likely influence on short-medium term patterns of development, are examined in Chapter 4.

Autonomous Control

Examples of autonomous control can already be found in off-road and agricultural applications. Operators can have their vehicles controlled autonomously by satellite via computers in the cab, thus ensuring precision alignment in groundworks for roads and railways, and optimum field coverage for harvesting and other agricultural applications.

3 The current standing of ITS in the UK

In-vehicle systems

In-vehicle systems include a variety of applications, ranging from infotainment to automatic parking. These systems are designed to ease the burden of driving, either by removing tasks from the driver or by making the time spent in the vehicle more pleasurable.

Systems to provide audio entertainment, cruise control and satellite navigation have become commonplace. More recently, self-parking and overtaking assists have been introduced. Some manufacturers now offer technology which can monitor driver performance. Other offerings include products which can reduce the cost and environmental impact of a journey.

The SENTIENCE research programme in the UK has explored the use of an electronic horizon which can 'see' beyond the normal visual horizon. Actual or virtual speed limits are taken from factual data or calculated using GPS and mapping data, including features such as bends, hills, roundabouts and traffic lights. The system uses an Enhanced Acceleration/Deceleration (EAD) control strategy, in which the vehicle speed is controlled to meet actual and virtual speed limits using an advanced form of adaptive cruise control. Once EAD is operating, the driver simply steers the vehicle but can at any time manually over-ride the system if a change of route is required or for safety reasons.

3.0 The Current State of the Art

There are many examples of ITS which are currently flourishing in the automotive sector. These include Advanced Driver Assistance Systems (ADAS), satellite navigation, traffic data, engine management systems, logistics scheduling, fleet management and emergency vehicle control. Mostly, these systems have been developed by a variety of suppliers acting quite independently. This has been driven either by the OEMs (and their supply chain), where it can be seen to enhance the immediate sales appeal of their product line-up, or by third party suppliers, where some other benefits can be seen (for example, customer revenue streams for traffic information).

However, there have been some coordinated efforts to develop ITS and a 'family tree' illustrating some of the more significant of these projects over the past 30 years may be found in Appendix 1. These coordinated programmes date from the 80s and have been driven largely by government, or inter-government, agencies such as the EU and the UN. System developers in Europe, USA and Japan focused primarily on preventing vehicular accidents. In-vehicle accident prevention systems that either alerted the driver to a hazard, or took control of the vehicle to correct for mistakes, were developed in parallel with design features that mitigate the effects of crashes (ie seat belts, air bags and crumple zones).

To summarise, the general 'state of the art' ITS applications may be grouped under the following broad headings:

- In-Vehicle Systems – aimed at providing direct support to the driver
- Infrastructure Systems – aimed at managing the traffic flows on the fixed infrastructure
- Commercial Management Systems – aimed at the operators of fleet vehicles
- Public Transport Systems – aimed at the travelling public

3.1 In-Vehicle Systems

In-vehicle systems include a variety of different applications spanning infotainment, driver assistance (eg parking sensors), the provision of traffic information, route guidance/SatNav systems, and vehicle condition monitoring systems.

Advanced Driver Assistance Systems (ADAS) sense data from the vehicle, other traffic and the road, and process all of it on-board for the exclusive benefit of the driver.

The most well known examples of driver support systems are cruise control/Adaptive Cruise Control (ACC) and parking sensors. Simple cruise control has been available for decades and is now barely thought of as an ADAS system. But ACC has only been available on some luxury vehicles since around 2000. In addition to the delivery of a constant speed, ACC is able to detect vehicles in front and apply the brakes automatically when required. Other more recent ADAS offerings include overtaking sensors and on-board cameras.

Waiting in the wings now is a burgeoning range of capabilities which includes speed limit detection systems, lane deviation warning systems, pedestrian detection and avoidance systems and remote diagnostic/maintenance systems.

ADAS functionality often appears first in higher-range vehicles as optional extras, before becoming consolidated as standard equipment and then trickling down to the mass-market. Recent take-up patterns for ADAS functionality (2005-2010) are illustrated in Table 3.1.

The development of ADAS concepts remain largely in the hands of the OEMs and their equipment suppliers. The systems are often seen by the automotive industry as a natural extension of the electronic capabilities within their products. Interestingly, they are not commonly thought of, by the automotive sector, as elements within the wider subject of ITS.

Traffic information and route guidance systems which operate in this sphere and need to provide an active connection between the vehicle and the fixed infrastructure. The outstanding examples are satellite navigation, (which has become almost universal over a relatively short space of time) and traffic flow information systems.

Satellite Navigation devices (SatNav) first appeared as original equipment systems provided by OEMs in luxury vehicles. Systems were purpose designed (at great cost) to suit the vehicle specification. However, this pattern of development was subsequently swamped by the introduction of 'Nomadic devices' such

Adaptive cruise control						
	2005	2006	2007	2008	2009	June YtD
Optional	33,721	50,175	91,541	119,556	123,003	67,607
Standard	5,588	3,439	5,476	2,586	4,318	3,732
Rear parking sensor						
	2005	2006	2007	2008	2009	June YtD
Optional	919,486	1,102,912	1,189,471	1,105,009	1,027,848	598,477
Standard	267,813	271,459	355,363	359,148	317,528	236,271
Overtaking sensor						
	2005	2006	2007	2008	2009	June YtD
Optional	-	-	1,670	17,731	20,529	21,630
Standard	-	-	-	-	4,680	3,317

Table 3.1: Take-up patterns for advanced driver assistance systems (ADAS) systems (2005-2010)

Standard navigation system information display						
	2005	2006	2007	2008	2009	June YtD
Optional	1,162,958	1,037,646	1,044,006	912,145	744,570	458,577
Standard	111,322	167,538	164,312	143,903	143,472	120,169

Table 3.2: Take-up of OEM-supplied SatNav systems 2005-2010

as PDAs and mobile phones. These devices deliver virtually the same level of service as the earlier OEM-supplied systems, but they come at a fraction of the cost and are transportable from car-to-car.

As a result, the sales of OEM-supplied SatNav systems have fallen dramatically (see Table 3.2). This provides an interesting insight with regard to the further evolution of ITS technologies; the business driver for SatNav development has become the revenue stream to the communications provider (mobile phone operators) – it is no longer driven by the revenue stream to the OEM. A parallel to the SatNav trend can be seen in the development of driver-oriented traffic information systems. Early systems were developed with the intention of enabling OEMs to provide original equipment in their vehicles. But now there is a trend for the same data to be provided through the internet and hand-held devices.

There is increasing dissemination of digital travel information through a variety of different channels and this now allows drivers to make informed route choices before setting out or whilst travelling. This is a great benefit , but there is a down-side of additional 'driver workload' contributing to hazards associated with driver distraction. As these systems flourish, this problem must be recognised and solved.

Within products that are on the market today, there is evidence that systems are now beginning to converge. SatNav systems are increasingly being linked to traffic information systems in order to deliver real-time route guidance to the driver. What was once two separate systems is rapidly becoming one system, with revenue streams moving away from the OEMs to the communications providers and the information providers. Many mobile phone providers now routinely provide satellite navigation and traffic information services free of charge as part of the wider spectrum of services provided to their users.

The presence of the mobile phone operators, nomadic device manufacturers and the internet services companies has transformed the dynamic of the product development cycle. The pace of product and service development in these fields is completely different to that of vehicle development; new hand-held products are released every six months or so to an expectant consumer, whereas a new vehicle development cycle is typically three to five years. As a consequence, consumer expectations are now very high, product costs are low and the market-place is becoming very 'agile'.

Active Traffic Management (ATM)

'Managed Motorways' are technology-driven approaches to make better use of our motorways. A 'Managed Motorway' has two main elements to it:

- variable speed limits which control the flow of vehicles when the route is congested
- hard shoulder running which provides an additional live traffic lane during periods of congestion.

The pilot on a stretch of the M42 was extremely positive, resulting in the ability to accurately predict journey time increasing by 22%, reduced accident rates, a 10% decrease in vehicle emissions and a 4% reduction in fuel consumption.

Nomadic devices

Why spend £2,000 and leave it in the car when you sell it?

Why not take it with you and fit it into your new car?

Fleet Operations

Masternaut is using its web-based vehicle tracking service to track more than 100 million fleet miles each month, resulting in major fuel savings for customers. This amounts to £4m each month and around 750,000 gallons of fuel. The Masternaut service reduces unnecessary fuel consumption through more efficient, safer, and eco-friendly driving, saving an average of 10 per cent on fuel use.

One customer has equipped 1,000 service vehicles with Masternaut satellite tracking. It has already reduced speeding by 82% and fines by 26%, with a 28% reduction in road traffic accidents. The web-based system enables real-time monitoring of actual progress against work schedules. With the system, managers are able to see vehicles travelling to and from customers' sites and receive automatic alerts on screen and in real time. They can monitor regular rest breaks and conformance with the European Working Time Directive. The always-on vehicle tracking service not only supports operators' duty of care policies, but also encourages employees to drive carefully and consider other road users.

Systems such as these reduce fuel costs and help make our roads safer.

3.2 Infrastructure Systems

ITS has long been used to manage the traffic flows on roads with a view to improving the effectiveness of infrastructure utilisation. Examples include:

- Urban Traffic Management Control – 60 common databases and over 2,000 roadside devices have been deployed to improve traffic flow. The next generation of intelligent traffic signals (3GSRE) are linked with other technologies to maximise traffic flow
- Variable Message Signs – provide a means of informing travellers of the free-flow conditions and disruptions to the road network, as well as safety messages;
- Ramp metering and HOV lanes – localised schemes that intelligently reduce traffic congestion at the most critical locations at the relevant times
- Speed enforcement including spot speed and average speed camera systems
- Public transport measures including selective vehicle detection and real time passenger information.

Electronic Payment Systems

Since the outset, ITS has had the potential to enable electronic tolling.

There is considerable evidence from global experience that road user tolling is an effective means to address, spread, regulate and moderate travel patterns. As the UK's vehicle parc continues to grow, demand management through tolling may have to be considered very seriously.

Although limited in geographic terms, the UK has existing expertise in road user charging including the London Congestion Charge, the London Emission Zone, the M6 Toll and the use of 'smart tags' for tolled crossings such as the 'DART-Tag' – the pre-payment system used at the Dartford River Crossing.

However, it should be recognised that in the UK many, except for the smallest road-user charging schemes, have foundered due to hostile public opinion.

Outside the UK, electronic road pricing experience includes:

- Singapore, which has had electronic road pricing since 1998.
- Germany, which has introduced road pricing for heavy goods vehicles using its motorways, and several other European countries are looking to follow suit.
- Stockholm, which introduced road pricing in 2006.

3.3 Commercial Systems (fleet operations)

Fleet telematics is the use of products which allow fleet operators to improve their operations by achieving higher utilisation factors for their vehicles, improving driving standards and fuel efficiency, reducing emissions and vehicle wear and providing better customer service. As the description implies, telematics covers a wide range of parameter monitoring and processing. Consequently, a large number of commercially available systems has been developed over a long period of time, ranging from cheap SatNav-like devices mounted in the cab to fully comprehensive (and very expensive) logistics management systems that are an integral part of the operators' enterprise management systems.

As part of a wider exercise aimed at understanding the future development of ITS in this field, four major operators were interviewed by the authors to assess their current positions and understand their future business needs. The results of these interviews included descriptions of the current state of the art, and the outcomes are summarised below. More detail may be found in Appendix 3.

For most operators, vehicle tracking is the most important issue because it allows real-time fleet monitoring, thus leading to improved vehicle utilisation and the provision of objective evidence that delivery commitments are being fulfilled. Interest in tracking systems is particularly high in the emergency services (where vehicle response time is of the essence) and very large commercial fleets (where path crossovers are likely). Use of these systems is very common, because of the low cost and high reliability of the technology, and its ability to make a clear contribution to the efficient management of the vehicle fleet.

The connection of vehicle tracking systems to logistics control systems allows vehicle loading and unloading schedules to be automated, and location reports to be provided for individual items of freight. These systems are becoming an essential part of the just-in-time delivery processes that now characterises most industrial, commercial, and retail operations.

There is also an increasing use of fleet telematics to monitor driver behaviour. Fleet management systems are increasingly able to provide information which can be used by operators to reward good driving and penalise bad driving. However, capabilities in this area are limited at the moment because real driver and vehicle performance issues require the responses of the engine, and other vehicle sub-systems, to be monitored in conjunction with load, movement and time data. This requires the fleet management system to have access to data from the vehicle CAN-bus, and problems of standards and inter-operability will therefore need to be addressed before the optimal levels of information integration can be delivered, and pursuit of this goal could pave the way for factory fitted systems to emerge. This is the process that most commercial firms prefer, because it leads to improved reliability. Interestingly, it is opposite to the preferences of private car owners, where factory fitted ITS options are falling from favour.

Both integrated logistical control systems and driver behaviour monitoring systems represent examples of the natural convergence of ITS products, a theme which is becoming increasingly important as ITS technologies mature.

3.4 Public Transport Systems

It must be remembered that the concept of 'Intelligent Transport Systems', or 'Intelligent Mobility', stretches beyond any single form of transport. It is about helping the traveller get from present location to chosen destination in the most appropriate manner (defined, wherever possible, by the traveller's preferences). The preferences of the traveller may revolve around time, cost, carbon footprint, convenience, or other factors; the truly capable intelligent system should be able to respond with all the necessary information to inform the decision at the point of enquiry.

At present, public transport intelligent systems have limited functionality. However, the rate of progress in this area has been very rapid in recent years. Today, for example, the Oyster Card is available within London. This allows universal access to London's train, tube and bus services using an electronic payment swipe-card. This makes travel by public transport more convenient for the individual, because it removes the need for queueing and keeping small change for the purchase of tickets. Entry to buses is faster, reducing the dwell-time at bus-stops during rush-hours. Since the Oyster card was first introduced, its market penetration has soared. It is considered to have been an important enabler to the spectacular increase in the use of London's public transport system over the past decade. London, of course, is not the only city to deploy such cards. The Octopus Card in Hong Kong was introduced earlier, and is considered to be even more successful; other cities around the world have also introduced similar systems.

Another example of the emergence of intelligent systems for public transport lies in the information systems which are increasingly to be found on railway platforms and bus shelters. These give details of the time of arrival of the next trains/buses, and their destinations. An extension of this service also allows travellers to access this information from home via the internet or mobile phone, prior to starting their journey – the time of arrival at the local bus-stop for the next bus to the traveller's destination can be checked before departure, or from a hand-held device whilst en-route.

Public Transport Systems

Smart Card ticketing facilities have been introduced in London via the Oyster card. This makes it easier and much cheaper for citizens to use the public transport networks, resulting in increased use of the city's buses and underground system. Other successful implementation of Smart Cards can be found in several places around the world, including Amsterdam, Hong Kong, Singapore and South Korea.

Passenger information systems are also helping to improve the passenger experience when using public transport systems. For a traveller to know when a bus or train is going to arrive is an important benefit and the extension of these systems into the home or place of work via the internet, is likely to bring even greater benefits.

4 The business landscape

Convergence of Technologies and Business Models

In his October 19 keynote address at the SAE Convergence 2010 conference in Detroit, Derrick Kuzak, Ford Group Vice President of Global Product Development, said that "apps on wheels" are creating new business opportunities.

The enabler for "apps on wheels" happened a few years ago when the company decided to adopt a flexible and upgradeable in-vehicle connectivity solution as a way to address the quick-change development pace inherent with handheld electronic devices – especially since drivers were bringing their personal electronic devices into the vehicle.

Prior to the launch of its latest offerings, Ford decided in 2007 to go with an agnostic platform that leveraged a consumer's Bluetooth device rather than develop an embedded vehicle solution. "This has proven to be the right choice, and one that still sets us apart," said Kuzak. Beamed-in applications are now available through a cloud-based Ford service delivery network that can be accessed by the vehicle owner's Bluetooth-enabled cell phone. "Traffic, Directions, and Information (TDI) services are a great example of a beamed-in application, giving users on-demand access using simple voice commands," said Kuzak. The cloud-based approach means no hardware or software upgrades are required. "We're providing a software development kit to select partners, enabling Sync integration of an application within days," he said.

Developed in partnership with TellMe (a Microsoft subsidiary), TDI provides hands-free access to traffic reports, turn-by-turn driving directions, sports, weather updates, and more.

ITS has come a long way since its original conception in the 1980s. Where it will go in future will be dependent on user demand and the associated business benefits. The forces at play may be summarised as follows:

- The delivery of technology and service convergence
- Market forces and business benefits
- Social and political considerations.

Each of these is examined in the following sections.

4.1 The Convergence of Technologies and Services

The full benefits of ITS will only be delivered if there is convergence between the systems and services that have been described in Chapters 2 and 3. Only through this process will the long-term goal of improving mobility whilst simultaneously improving environmental, safety, and economic performance be achieved at national scale.

Convergence typically makes two things happen. First it reduces, for users, the apparent differences between the component technologies. Second, it widens the span of the enabling technologies. For the user, the sense of specific context begins to diminish as key parts of a service system start to converge and stop being understood as distinctive components.

With this in mind, in the near future we can expect to see vehicle drivers, as users of converged informatics, becoming immersed in a connected transport system with overlapping services. They will probably spend less time in an automotive mindset, thinking more about 'journey planning' than 'driving'. Simultaneously, they will spend less time thinking about where intelligent information or suggestions come from, provided the sources of supply are trusted (branded). 'Service provision' will become more important than device production.

People's interest in connected services (shown by car clubs, smart fare cards, online booking and networked devices) demonstrates that demand is for simpler and smarter mobility tools. As they use transport systems, people will want to experience the benefits from convergence that they feel it should offer – easy access to information, personalised services, trustworthy support for making decisions about time, money and safety.

Convergence of Technology

Road transport consumers – both personal and professional - are increasingly demanding the outputs of a converged approach. The needs and expectations of commercial fleet operators are reported in some detail in Appendix 3 but, in overview, from simple cars to sophisticated fleets, the convergence trend allows users to merge the elements of smart phones, satellite navigation, onboard sensors, data loggers and (in fleet operations) telematics, routing and scheduling software, and core business systems. These devices and services are being mixed in novel, demand-driven, fast launch products and even through informal 'mash-ups'.

However, the convergence between vehicle and infrastructure systems suggests the beginnings of a shift from the philosophy that the driver must always retain control of the driving function. Autonomous vehicle control lies at the end of this path and, with the passing of time, there are likely to be concerns regarding the erosion of driver skills and/or responsibilities and the ability of drivers to respond during emergency situations.

The question of how communications between vehicles and the infrastructure is enabled has been a focus of automotive sector investigation since the 1980s. Early investigations in the 1980s and early 1990s envisaged communications via discrete transponders operating in a defined waveband of the communications spectrum. However the development of mobile communications networks and the explosion in wi-fi capacity over the past two decades means that vehicle-to-vehicle (V2V) and vehicle-to-grid (V2G) communications are more likely to be enabled through these 'open standard' media in future.

V2V and V2G communications technologies enable an ever-increasing range of capabilities to be deployed. Because of the inter-dependence and mutual benefit that arises from these systems, they have become known as 'Cooperative Systems'; crowd-sourced data (see below) and vehicle platooning are examples of applications that are emerging. There is a high degree of developer interest currently being shown in this area and the proposed European COOPERS programme is a good example of this.

Many of the next steps to enable cooperative motoring might seem piecemeal and ill-coordinated, but this is a symptom of convergence creativity. Already the

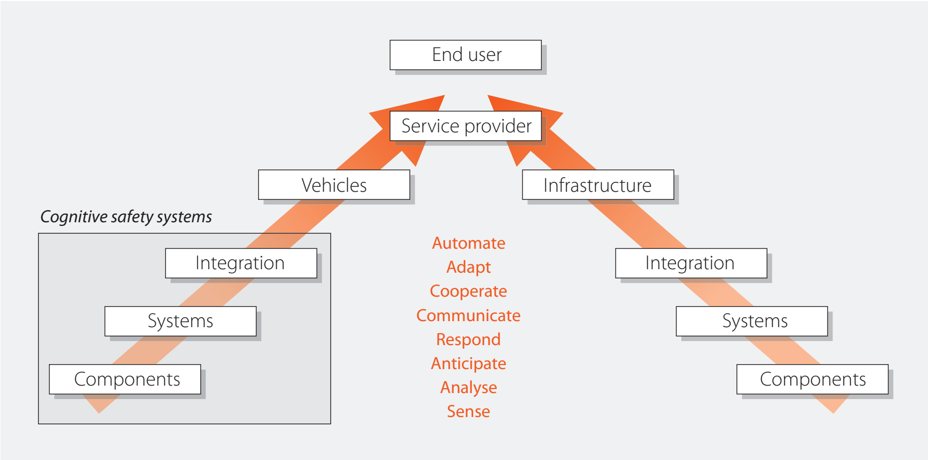


Fig 4.1: Cognitive safety systems

automotive sector can be seen to be responding, no doubt influenced by trends in public transport, fleet management and personal computing and mobility. A move towards significant simplification of solutions and services is already evident.
Moving along the path towards better, simplified services (at lower cost) may well mean that novel development concepts come into play. Examples are making use of so-called 'cloud infrastructure' (pooling the distributed computing capacity inherent in many individual small elements) and 'crowd-sourcing' information (drawing on the experiences of openly-connected individuals inside a situation to inform those approaching it). Both these concepts appear to offer capital cost savings, but in each case there are integration challenges and management issues to overcome to ensure that they work safely and reliably, without generating new kinds of risk.

Convergence of Products and Services

The convergence trend drives ITS market participants to respond by removing functional boundaries and encouraging collaboration. As a result of this process, new business opportunities open up and the pace of change accelerates.

Fig 4.1, developed by TRW Automotive, shows how the work of ITS integrators involved with either vehicles or infrastructure is set to build complexity and value. It shows an expected pathway of business convergence too, resting on shared goals and activities via which industry expects to see closer integration of development activity and less division into camps. It means commonalities are being actively pursued by those who work on smarter vehicles and developing smarter infrastructure.

The industry, especially at component and supplier level, expects to keep working on integration, interoperability and shared protocols. This should foster an ongoing rich mix of innovative business opportunities around novel services.

4.2 Market Forces and Business Benefits

Improvement in ITS technologies and services will only occur when there are clear business drivers and clear business benefits. It is not always possible to see where the drivers and benefits lie with clarity, and the explosion of nomadic devices at the expense of original equipment systems supplied by the OEMs (as described in Chapter 2) well illustrates the business uncertainties that can be involved. At present, there are a large number of user requirements, a large number of device manufacturers, and a large number of service providers all occupying the ITS space with increasingly overlapping interests.

To gain some insight into the possibilities for future ITS business development, it is essential first to understand and identify who are the 'customers'. In other words, who is willing to pay for ITS services in whatever shape or form.

A simple observation of the existing range of ITS activity shows there are distinctive clusters of business interests that are already spending (or willing to spend) to the benefit of ITS. The first of these clusters could be viewed as the transportation infrastructure providers; these include entities like the Highways Agency, the Department for Transport and the municipal authorities as examples. They typically have exclusive control over their infrastructure, and all share the objective to optimise the use of their assets. The second cluster could be viewed as the manufacturers of equipment and providers of services. These include the

	Customer segment	Description	Customer example	Example of service/item required
Public Transport and Infrastructure Providers	Infrastructure Owners/Managers	Transport Network/Road System	Greater London Authority	Congestion Charge Infrastructure
	Public Service Operators	Public Transport (Bus), Emergency Services, Local Authority Vehicle Operators	Transport for London	Adaptive/Reactive Traffic Flow Management System for Public Bus Network
Manufacturing and Service Providers	Car Manufacturers	Vehicle Manufacturers	GM	Onstar: In-car telematic service that enhances driver mobility
	Consumer Electronics and Telecommunications Firms	Mobile Telephony Personal Navigation Units	Apple	iPhone Service that Enhances Personal Mobility
Users	Fleet/Freight Operators	Delivery, Utilities Installation & Maintenance	Royal Mail	Fleet Management System to Optimise Car/LCV Fleet Operation
	Private Consumers	Vehicle Owners	Myself	POI Guidance

Table 4.1: FTS market segmentation

	Customer segment	Key customer requirement	Benefit direct	Benefit indirect	Gov't agencies	Funding own resources	Customer payments	Resource driver
Public Transport and Infrastructure Providers	Infrastructure Owners	Optimise Traffic Network	Optimal Traffic Flow	+ Local Business + Environment	*	**	***	Prescribed charge to user who benefits from the ITS service
	Public Service Operators	Reactive Traffic Network	Uncompromised Mobility	+ Safety + Comm. Welfare	*	***		Genuine requirement for uncompromised public service
Manufacturing and Service Providers	Car Manufacturers	Product Competitiveness	+ Plus Sales + Value Service	+ Cust. Loyalty + Image Boost		**		Plus productivity competiveness successful service sales
	Consumer Electronic Firms	Product Competitiveness	+ Plus Sales + Value Service	+ Cust. Loyalty + Image Boost		**		Plus productivity competiveness successful service sales
Users	Fleet/Freight Operators	Optimise Fleet/ Freight Operation	Lower Operations Costs	+ Cust. Service + Emply. Welfare		***		Plus productivity offsets project/running costs
	Private Consumers	Improve Personal Mobility	Improved Mobility	+ Productivity + Wellness		*		Value of incremental expense VS freely available services

Table 4.2: Segments, benefits, funds and drivers

The stars represent a subjective assessment of the most likely sources of funding for each segment and the probability that they will succeed in raising the funds required to deliver the defined product/service

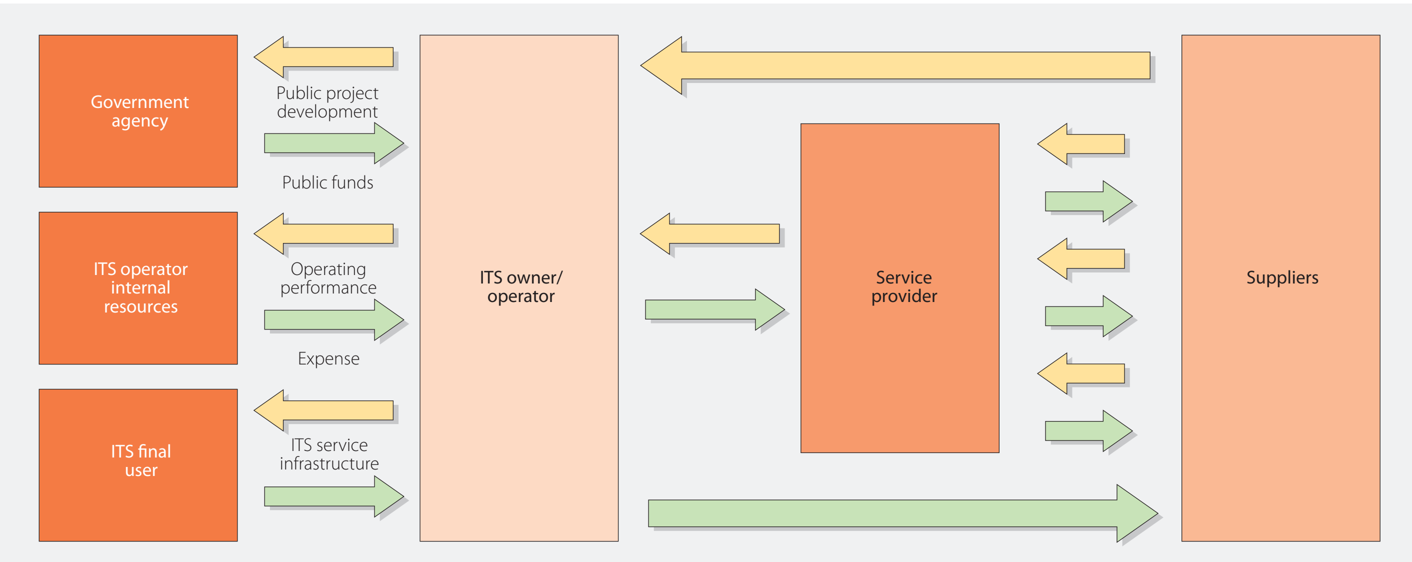


Fig 4.2: The ITS business space

car manufacturers, the electronic component manufacturers (eg SatNav systems and telephony equipment), and the information providers (eg online access to bus and train timetables, traffic flow information services, etc). This cluster invests in product research and development, with the ultimate goal of increasing their sales volumes and returns for their investors. The final cluster could be viewed as the users of transportation products and services. This cluster includes freight companies, commercial fleet operators, the emergency services, public transport providers and private drivers. Their ultimate objective is to improve their mobility, and maximise their transportation experience (eg by reducing costs, improving journey time reliability or raising their business efficiency).

Table 4.1 is an attempt to illustrate the segmentation of the ITS market by taking specific examples from these clusters. Following the segment description, it provides examples of customers and provided services.

Equally important to identifying the various segments within the ITS space is to identify how the various types of customers can raise funds to cover the cost of obtaining ITS products and services.

As previously described, the customer range can span from infrastructure owners to the car OEMs. We can therefore refer to the ITS owner/operator, either of an infrastructure that is offered to individuals seeking mobility, or a networked vehicle offered to a private driver, following the aforementioned range. This ITS owner/operator will seek ITS services from a service provider; this can be a systems designer who engineers the transportation network control system in the case of the infrastructure provider, or a component supplier of telematic devices in the case of the vehicle OEM. In either case, the service supplier would source from a range of multiple tier supplier networks to achieve the required service package or component.

As far as identifying sources of funds in general terms, the ITS owner/operator has access to three types of sources: first, its own funds/budgets; second, public funds if the service is identified of national/community interest; and third, the individual potential contribution of the final service user. This last could be under the form of a prescriptive charge (eg highway toll) for the case of the infrastructure provider, or under the form of a monthly service fee for the case of an OEM provider of telematic services.

By bringing together the identified value/cash flows across the various segments, an assessment can be made regarding the likely sources of funds for each segment, and what is the likelihood for each segment to succeed in obtaining funds to procure the desired ITS product/service. Table 4.2 adopts the previously identified segmentation structure, and provides a summary by segment of key requirements, direct and indirect benefits, as well as a subjective assessment (denoted by number of stars *) and key resource driver or enabler.

In summary, three distinctive groups currently populate the ITS space. These are: the transportation infrastructure providers; the equipment manufacturers and service providers; and the users of transportation goods and services. They can all spend resources to benefit from ITS, and can equally be interlinked within a service/product business model. The current occupation of the ITS business space is shown diagrammatically in Fig 4.2.

Establishing a business value model within this space often requires there to be a uniqueness in the product or service that is offered. Equipment manufacturers compete against a vast diversity of public domain information, and therefore their chances of succeeding in establishing a profitable model will depend on their ability to innovate and differentiate their products. Infrastructure providers have (in principle) a substantial level of control over the management of their assets, and sometimes have further access to special funds as infrastructure can be tagged of interest to the wider community. In turn, however, these providers face significant difficulties of a sociological and political nature being dependent, as they are, on public funding.

4.3 Social and Political Considerations

In addition to the forces of technology advancement and the market place, the development of ITS is affected by the less tangible forces of human perception and political acceptability. These forces cover a very wide span of considerations, including:

- Human Behaviour
- The Regulatory Conditions
- Market Standards
- Manufacturer's Liability
- Local and National Interests.

Human Behaviour

In the long-run, the development of ITS will be limited by the willingness of human beings to cede control of their vehicles to a machine. There is a deeply embedded resistance to 'letting go', and it is possible that this will become a blockage to certain lines of development (autonomous control, for example). On the other hand, there is plenty of evidence to show that society will give-up deeply entrenched positions quite quickly if big enough benefits are offered – the deeply-held resistance to infringements of personal privacy of the 1950-60s, for example, have been overcome by the convenience benefits of mobile phones and credit cards (which between them yield instant access to an individual's location and personal details). On this basis, it is not hard to imagine that individuals will cede control of their vehicles to a machine if this results in more leisure time in which they can , for example, watch movies, perform office work or communicate with friends.

Regulatory Conditions

The state of regulation will always represent a combination of 'driver' and 'brake' on the nature and rate of road vehicle-related technology developments. Historically, governments have used regulations to force movements in the market technology (safety and tail-pipe emissions are obvious examples). Equally, the existence of legislation has sometimes represented an anchor which slows change down.

Given the diversity of technologies that make up an intelligent transport system, it is not surprising that there are many and varied regulations and directives to consider. This complexity is further enhanced with the need for international co-operation to ensure that a car interacting with infrastructure in one country can continue to do so in another, especially where legacy systems are in operation.

There are already some examples of vehicle and infrastructure regulation which fall within the broad area of ITS but, in general, ITS specific legislation is in its infancy. The US launched its 'ITS Strategic Research Plan, 2010-2014' in December 2009, the EU launched the ITS Action Plan in December 2008, followed by the 'Framework for Deployment of ITS in the Field of Road Transport' (Directive 2010/40/EU) in August 2010. Japan launched specific work schedules for each element of its ITS strategy in June 2010. These regulations and directives mark the beginning of a new era in ITS developments and a plethora of further legislation will surely follow.

There are several levels at which ITS regulation is being addressed. The most significant for the UK industry to note are United Nations Economic Commission for Europe (UN ECE) and the European Commission (EC).

UN ECE, through the World Forum for Harmonization of Vehicle Regulations (WP.29), has already adopted 127 UNECE regulations annexed to the 1958 Agreement and ten global technical regulations in the framework of the 1998 Agreement that cover vehicle safety and their environmental impact. Examples of technologies covered by WP.29 include cruise control, on-board diagnostics, electronic stability control and automatically commanded braking. UN ECE also has informal groups, such as the ITS Information Group. Technologies such as lane departure warning (LDW) and advanced emergency braking systems (AEBS) are within the remit of this group.

In August 2010 the EC introduced the 'Framework for the Deployment of Intelligent Transport Systems in the Field of Road Transport' (Directive 2010/40/EU). This document puts forward an Action Plan aimed at speeding the deployment of ITS throughout Europe with targets and activities detailed in six key action areas:

- Optimal use of road, traffic and travel data
- Continuity of traffic and freight management ITS services on European transport corridors and in conurbations
- Road safety and security
- Integration of the vehicle into the transport infrastructure
- Data security and protection, and liability issues
- European ITS cooperation and coordination

Delivery dates across these action areas run from now until 2014. The Action Plan draws on a series of ongoing European Commission initiatives such as the Action Plan on Freight Transport Logistics, the Action Plan on Urban Mobility, the Galileo satellite programme, the Greening Transport Package, the i2010 initiative on Intelligent Cars, eSafety, the 7th Framework Programme for Research and Technological Development, eCall, European Technology Platforms and their strategic research agendas, CARS 21. A list of current relevant EC regulations and directives can be found in Appendix 4.

Market Standards

In recent years, legislative standards have been supplemented by other types of standard which, although they are not mandatory in a legal sense, are nevertheless essential from a marketing point-of-view. This has become the case, for example, with the Euro NCAP standards, where a high star-rating is now regarded as being de rigeur, in marketing terms, for any new vehicle. Changes to the NCAP assessment procedures which are currently under review include a requirement for stability control – perhaps the first movement for this type of standard in the direction of in-car intelligent systems. NCAP and its peers in other geographic regions represent a powerful force in the area of new product development and ITS will likely become a more significant component within the standard rating systems in future.

Manufacturer's Liability

A huge barrier to the rate of development of advanced intelligent systems lies in the reluctance of the OEMs (and their equipment suppliers) to shoulder potential liabilities for future accidents. At present, most ITS capabilities lie in the area of 'driver assistance' – in a position that is firmly described as leaving the driver with ultimate responsibility for the safe control of the vehicle. Anything that might translate this responsibility to the vehicle manufacturer has, understandably, been firmly resisted to date.

However, it is apparent that this territory is becoming greyer. Some of the latest systems on the market are beginning to stretch the idea that the human is always in control – adaptive cruise control, automatic parking, and overtaking sensors are examples which begin to raise questions about who might be responsible in the event of a system malfunction. These trends are, perhaps, the thin end of a wedge which will ultimately see the OEMs providing systems in their vehicles which acknowledge that ultimate responsibility for the safe transit of the vehicle will not always lie with the driver.

Local and National Interests

Important drivers for ITS development come from local and national government bodies and their agencies. These drivers reflect political considerations and they are, consequently, shaped by the transient mood of the electorate as well as by the underlying long-term need (which has been described in Chapter 3). The mood of the electorate can be reflected in the prevailing attitude to regulation, the willingness to tackle issues such as climate change, and the acceptability of taxation (or pricing) as a means of controlling the use of resources (fuel) and infrastructure. All of these issues fall into the category of social and political considerations rather than technical or economic need.

Electronic tolling

Electronic number plate recognition is used to operate the Congestion Charging arrangements in London. Automated detection, payment collection and penalty issue are driven by an integrated system which has been working in the capital since February 2003. Benefits claimed for the system include annual revenues in the region of £80m which must (by law) be re-invested in the public transport system, and a 16% reduction in carbon emissions.

Some other cities around the world have also used road pricing as a mechanism to control traffic flows and densities. Singapore has had a system since 1975 (converted to an electronic system in 1998), and some Scandinavian towns have had systems since the early 1990s. Stockholm has reported a 15% reduction in traffic volumes and a 10-14% drop in carbon emissions since its congestion charging scheme was rolled out.

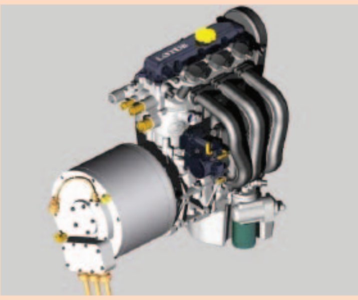
5 Future development paths

Environmental drivers of change

Driver behaviour

Bus operator First's Drive Green initiative uses revolutionary GPS technology fitted to buses to help improve driving styles and reduce the carbon footprint of its buses. The GPS technology detects dozens of driving movements per minute and immediately lets the driver know how well he or she is driving. The equipment picks up on acceleration and braking patterns as well as corner, lane and speed handling. A 'traffic light' LED monitor on vehicle dashboards flashes green if the driver is driving correctly, or amber or red if a bus driver carries out unsatisfactory manoeuvres.

Hybrid power trains



Series hybrid vehicles with conventional internal combustion engines are designed to maximise the ability to operate in electric vehicle mode for the purpose of reducing tail pipe CO_2 and to take advantage of the lower cost of mains electricity over liquid fossil fuels.

Real time knowledge of the planned journey, including traffic conditions and road topography, allows the optimisation of the energy source such that one may end the journey with a depleted battery ready for 'plug-in'.

In this chapter we consider the possible paths of future development as ITS technologies evolve and converge to deliver Intelligent Mobility. There are two strong forces which together will shape this evolutionary path: 'drivers', and 'enablers'. The overlay and interaction between these forces is presented diagrammatically in the Route Map to Intelligent Mobility (Fig. 5.1), and some of the business opportunities expected to arise between now and 2030 as a result of these forces are discussed in Section 5.3.

Finally, Section 5.4 identifies some important issues arising from the Route Map and attempts to set some perspective to them.

5.1 The Drivers

As in all business activities, the key drivers for new developments spring from the needs of users:

- Private users – who increasingly seek (and expect) access to systems which make travelling more convenient and less frustrating and who, in return, provide the business incentives for system development. (This subject was discussed in Section 3.1)
- Commercial users – who are voraciously seeking performance improvement and business advantage. (This subject was discussed in Section 3.3 and Appendix 4)
- National and local government, who ultimately hold the responsibility for constructing, maintaining and managing the nation's transport infrastructure. (This subject was discussed in Chapter 2 and Section 3.2).

Table 5.1 illustrates the main user-needs which we expect to drive the development of ITS-related products in the UK between now and 2030. A long-term result (or 'destination') for each of the principal driver families is suggested in the final column of Table 5.1.

5.2 The Enablers

There are several different families of enabler, some of which are technical and some of which are social or economic. Social attitudes towards the use of public transport and the introduction of road tolling represent typical social enablers/preventers. Tolling, and discounted ticket-pricing in multi-modal transport schemes, represent economic enablers/preventers. These are important factors, but the key enabler is most likely to be technology development, particularly (but not exclusively) in the areas of information processing and communications.

Historically, one of the main challenges to the development of ITS and services has been the fact that, by their very nature, people and vehicles move. This has required a large fixed data infrastructure to enable the systems to work together. However with the advent of mobile technologies such as GPRS (General Packet Radio Service) and 3G, fixed infrastructure data systems are no longer required and a much wider and less capital-intensive range of information transfer possibilities has become available. This trend is expected to continue, making communications systems more powerful, yet easier to deploy. This will bring benefits and new opportunities to developers and users alike.

Simultaneously, the computer processing power available in vehicles will be enormously increased. In the near-term Cloud Computing (where shared information, software and computing resources are held remote from the user, but can be accessed freely via the internet) will quickly allow services to become more connected, powerful and informed. In the longer term, it is expected that Quantum Computing will become mainstream, which will deliver processing power in the vehicle that is more than 10,000 times faster than today's desktop standard.

Supporting this increase in processing power, two enabling technologies which are expected to have significant impact on ITS are 4G communications and the Galileo GNSS (Global Navigation Satellite Systems). Within the next decade 4G communications will allow transfer speeds of up to 100 Mbits/s (compared to today's 3G of 0.5 Mbits/s). This will enable video quality data to be transmitted to the vehicle or mobile device. The forerunner to 4G, LTE, is likely to be available in the UK by 2012, enabling transfer speeds of around 50Mbits/s. Within the same timeframe, the European Union Galileo system will become operational. This programme will start to deploy satellites by the end of 2012 and, when fully commissioned, will operate alongside today's GPS systems to provide mass market timing and sub-metre positioning capabilities. This will, in turn, enable new services to be delivered, such as the Publicly Regulated Service (PRS) and the Commercial Service (CS). These are encrypted services designed to provide secure and accurate signals for government and commercial operators respectively. They will offer secure, accurate and guaranteed navigation overlays for users.

	Short Term Drivers (0-5 Years)	Medium Term Drivers (5-15 Years)	Long Term Outcomes (15-40 Years)
CONGESTION	Demand for journey time predictability More cars – increasing density Pollution	Demand management Increase road capacity without building new roads Electronic tolling	Electronic tolling Autonomous vehicles National traffic management system
ENVIRONMENT	Carbon and climate change (ongoing) Corporate social responsibility Noise and air quality Electric vehicles	Carbon and climate change (ongoing) User incentivisation/tax (eg pollution taxes) Introduction of SmartGrid	Vehicle/grid systems integration (SmartGrid) Autonomous vehicles
NATIONAL ECONOMIC PRESSURES	Recession Tight infrastructure budgets Consumer demand to reduce travel cost (time, fuel, etc)	Rising oil prices National cost of lost time Cost of increasing physical infrastructure capacity	National traffic management system Electronic tolling
FLEET/ COMMERCIAL MOBILITY	Vehicle/item tracking Driver behaviour Fuel and maintenance Cost reductions	Continuous improvement Satellite control Electric vehicles	Autonomous vehicles
PERSONAL MOBILITY	Smart ticketing Car clubs Journey planning Route guidance	Inter-modal systems New vehicle ownership models Electronic ticketing and tolling	'Mobility purchasing'
CONSUMER PRODUCTS	Smart phones Social networks/social media Entertainment (audio/video games) Theft/security	Personal communication Ageing population (maintain mobility) Entertainment (music/video) In-car office products/services	'Immersion products' (cinema, audio, business)
ACCIDENTS AND SAFETY	Occupant protection Pedestrian protection Usage-based insurance Maintenance/recall alerts	Collision avoidance Insurance tolling Critical systems self-diagnosis	Autonomous vehicle control
REGULATION	EU directive – implications for the UK Regulation/legislation – safety, environment, carbon, terrorist activities Standards	European/international regulations Enforcement opportunities – 'soft' and 'hard' (ongoing) –related to current trends, situations, problems	Mandated systems

Table 5.1: The Change Driver Map

	Less than 2 years	2 to 5 years	5 to 10 years	More than 10 years
Revolutionise	• Cloud computing • Smart mobile devices • Location-aware application	• Galileo • Complex event processing • Speech recognition • Long term evolution (LTE)	• Continuous-intelligent systems • Extreme transaction processing • Virtual assistants • 4G and LTE advanced • Augmented vision	• Mesh sensor networks • Quantum computing
High	• Consumer-generated content ('crowd sourcing')	• Storage capacity increases compared to price • Automate "What I need to know" • Predictive event processing	• Context delivery • Speech tracking technologies • Eye tracking	• Computer-brain interfaces • Human augmentaition • Information infrastructure • 5G
Medium	• Mobile application stores	• Biometric authentication • Gesture recognition • Interactive television	• Video search	

Table 5.2: The Technology Enabler Map

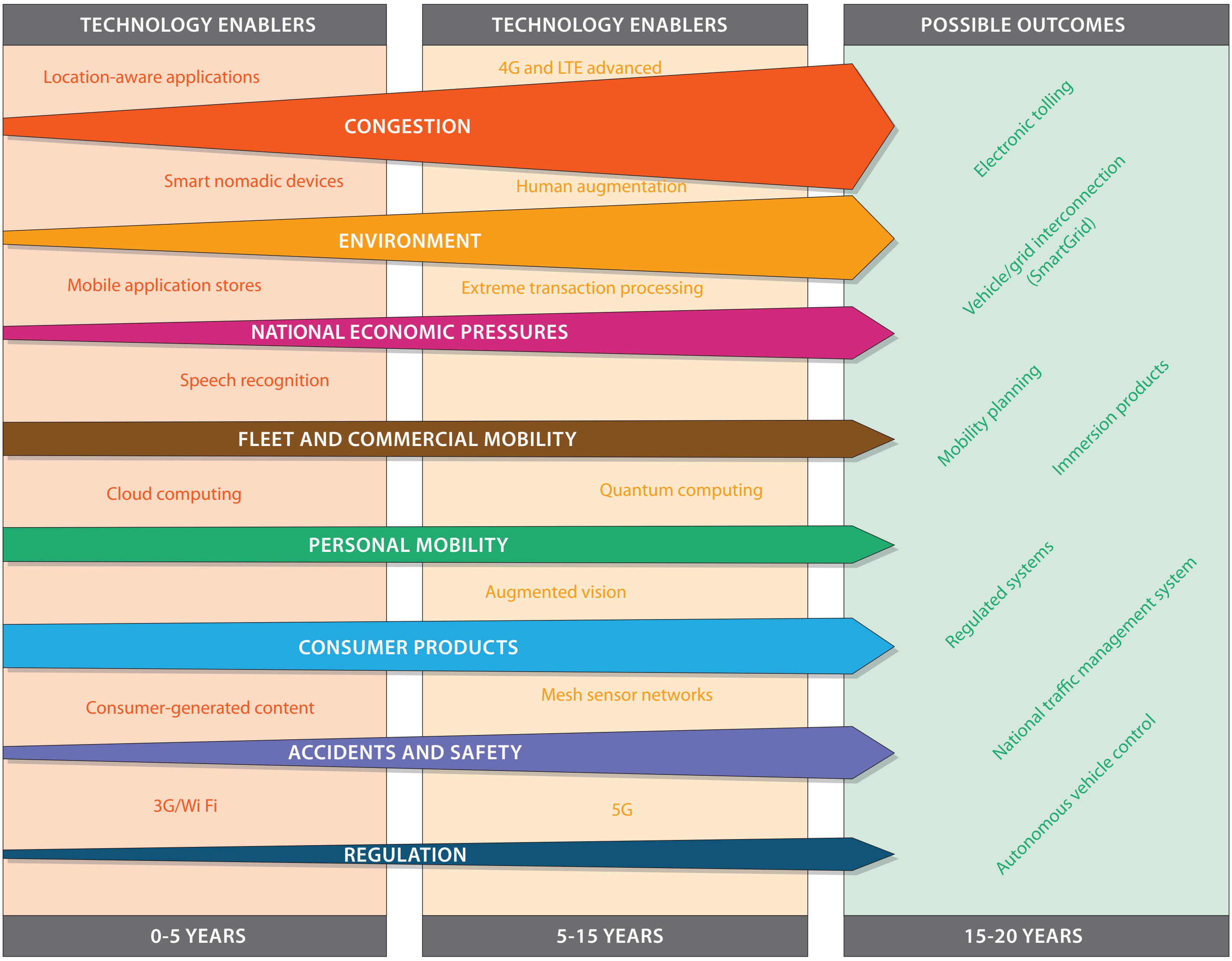


Fig. 5.1: A Route Map to Intelligent Mobility in the UK

A diagrammatic summary of the technology enablers, and their likely scale of impact on the ITS world, is presented in Table 5.2. Some further discussion of these future information/communication technology trends may be found in Appendix 5.

5.3 The Route Map to Intelligent Mobility

Taking the 'drivers', and 'enablers' together, their overlaps and interactions are shown diagrammatically in Fig. 5.1 – 'A Route Map to Intelligent Mobility in the UK'. In this diagram, the key drivers are shown against a background of the technology enablers, with the long-term characteristics of 'Intelligent Mobility in the UK' suggested at the far right of the diagram. The 'drivers' are shown as arrows of variable width, which is intended to convey the relative importance of each driver over the period of time between now and 2030.

5.4 The Business Opportunities

Entrepreneurial businesses recognise and respond to market drivers, taking maximum possible advantage of the existing social, economic, and technical climate (the enablers). The ability to spot a market need and to tailor a product or service to fit that need, is a key characteristic of the free market. The potential to generate good new businesses, thereby securing high quality employment and a position of global leadership, is of critical importance to the UK.

Some of the areas in which future business opportunities may lie are summarised in Appendix 6. This appendix indicates a range of different types of new business and, in each case, gives a traffic-light indication of the perceived level of opportunity for the UK to generate stable jobs and/or develop a position of global leadership. It should be noted that the biggest potential for UK job and wealth creation probably lies in the direction of software systems development and information services, rather than hardware products and electronic devices.

Many other services could also be envisaged in this 'Internet of things', and much of this will emerge naturally in response to market demands. But the regulatory frameworks and over-arching system architectures must allow and encourage evolution – starting with the use of the best existing technologies now.

5.5 Important Issues Raised by the Route Map

There are several important issues raised by the Route Map which require careful consideration. These are:

- The acute needs of the UK as a densely populated nation
- The opportunity for the UK to create high quality jobs and establish global leadership
- The critical importance of the Automotive Industry.

The Acute Needs of a Densely Populated Nation

As has been outlined in Chapter 3, the UK is a very densely populated nation and current trends suggest that this situation is going to intensify. The implications for our rail and road infrastructure are inescapable; if unchecked, the congestion, delays, pollution, noise, carbon emissions, and road safety trends will all move in the wrong direction.

The total vehicle parc in the UK is expected to rise from today's total of around 35 million vehicles to somewhat over 40 million vehicles by 2030. This suggests that the aggregated environmental impact of road vehicles is likely to grow. However, the government is committed to complying with (or, in the case of carbon reduction, even bettering) a range of EU measures which are designed to dramatically reduce, dramatically, the absolute levels of damage to the environment. These conflicting trajectories clearly place the government and the vehicle manufacturers on a collision path.

Already there are interest groups which are beginning to lobby for curbs to be put on the further expansion of the total vehicle parc. The Congestion Charge in London is an early manifestation of municipal action to reduce the use of personal transport and, although other large UK cities have yet to follow suit (Manchester recently rejected a similar proposal), the expectation is that there will be an increase in city centre measures to reduce, or even preclude, the presence of the car. If this mood gathers momentum, the automotive industry risks becoming a pariah in the eyes of the public, and likewise in the eyes of the administrators of the public realm. The industry cannot afford to let this happen.

Looking on the more positive side, 'Intelligent Mobility' offers a potential solution to many of these problems. Using intelligent systems, all of the above targets could (in theory) be met without necessarily introducing tight limits to the further expansion of the vehicle parc, or building expensive new fixed infrastructure, or introducing draconian levels of regulation. The economic benefit to the UK of solving these problems in this way would be huge, and the active pursuit of Intelligent Mobility is therefore much to be encouraged. Indeed, it would make good sense to set some measurable goals for national achievement en route to 2030.

The Creation of High Quality Jobs and Global Leadership

The work presented here on the development of Intelligent Mobility is an integral part of the Automotive Council's wider remit, which is aimed at securing the position of the Automotive Industry within the future economic framework of the UK. The previous discussion of opportunities for job creation and opportunities for developing global leadership are therefore particularly important to the Council.

Critical to the achievement of these objectives is the creation of an over-arching business environment within which secure, high-quality jobs can be generated and sustained. With this purpose, the Council has previously defined and promoted the concept of 'Test-Bed UK'. This concept aims to promote the UK as a global centre for the development and demonstration of new automotive technologies. It builds upon the long history of technology and design expertise which exists at the heart of the nation's skill-base, and seeks to make use of the existing fixed infrastructure and administrative mechanisms wherever possible to enable large-scale demonstration exercises to be mounted.

There are distinct opportunities for job creation within the contexts of Intelligent innovITS ADVANCE

innovITS ADVANCE has been designed to become an internationally recognised centre where organisations can research, develop and demonstrate new systems, standards and applications that connect vehicles, highways and telecommunications. It is the first independent facility in Europe where ITS technologies that are not mature enough, or represent significant risk to the public, can be developed, validated and demonstrated.

Features include:

- Road layouts to simulate an urban driving environment
- Fully integrated, private and independent communications systems
- Capability to test equipment whilst applying specific customisable network and operational effects/ situations
- Safe, secure, confidential private testing environment
- Urban canyon simulation.

Millbrook Proving Ground

Millbrook's has an extensive range of complementary test facilities to enable ITS simulation, including a multilane high-speed highway and 5 miles of hill routes with grades of up to 26%

Mobility and Test-Bed UK. In the case of Intelligent Mobility, the establishment of class-leading expertise can be accelerated by the positions of genuine leadership which are enjoyed by the UK in the fields of communications systems and technologies, software development and information services. The report 'Digital Britain' (2009) laid a heavy emphasis on these leadership attributes.

These skill-based attributes are supplemented by the fact that the UK has a densely-populated, but well managed, road infrastructure which exists in an environment that is innovative and keen to explore new opportunities. To date, this has led to the establishment of world-class facilities such as the innovITS ADVANCE centre at MIRA and the highway/hill route simulation roads at Millbrook (see box), along with the government-supported roll out of an early charging infrastructure for electric vehicles (see box). These are good examples of the type of ITS-related capabilities which could be promoted to the international automotive industry as part of the campaign to attract inward investment.

The Crucial Role of the Automotive Industry

There is a tendency in the industry to dismiss ITS as a subject area that will be developed by others. This is understandable. Infotainment systems, for example, have traditionally been developed by suppliers from the non-automotive sectors with minimal interaction or direction from the OEMs (radios, CD-players, nomadic SatNav devices, etc). The business benefit largely accrues to the suppliers, and the facilities provided rarely make a unique contribution to the sales proposition for the host vehicle. Only in luxury vehicles do ITS systems sometimes deliver significant differentiation and, therefore, direct sales appeal (eg automatic parking, adaptive cruise control, etc).

The result of this 'devolved' thinking is what we see – a fragmented, discontinuous, set of products that only converge where user demands are strong enough to drive specific developments.

But, as we look to the future, and the long-term goal of 'Intelligent Mobility', it is inconceivable that this very ambitious goal could be delivered without the wholehearted engagement of the automotive industry. This is because truly Intelligent Mobility can only be delivered through the comprehensive integration of sensors, devices, and systems which embrace the vehicle, its components, and the surrounding mix of road vehicles, other transport modes, and fixed infrastructure. Access to the vehicle CAN bus will need to be seamless, and the industry will need to engage in the development of standards and protocols which enable this. Signals will need to be processed out-bound from sensors mounted on the vehicle, and in-bound to actuators which respond to the incoming real-time information streams. And all of this will need to be proven fail-safe in relation to safety-critical systems such as automatic braking and collision avoidance. In short, setting a national goal for the achievement of Intelligent Mobility by 2030 (or any other date) would be meaningless without the purposeful and active support of the OEMs from the outset.

Some Words of Caution...

As has been stated previously, there is much to be excited about with regard to the development of new ITS products and the journey towards the delivery of nation-wide Intelligent Mobility. However, there are some serious and fundamental difficulties which lie in the path of realising these ambitions. These arise from:

- The mismatch between the short-term interests of private and commercial users, and the long-term interests of the municipal and national authorities.
- The mismatch between the business drivers for the OEMs and the business drivers for the providers of electronic devices, communications systems, information services, and fixed infrastructure.
- The mismatch between the product development cycles for vehicles (3-5 years); the product development cycles for electronic devices, communications, and information services (6-24 months), and the implementation cycles for infrastructure providers (5-30 years).

A consequence of these inherent mismatches is that there is currently very little high-level interaction between the various businesses and government departments engaged in the ITS scene. It is because of this disconnect that developments to date have been fragmented. If a coordinated approach to Intelligent Mobility is to be developed within the UK, the problems of interaction and communication between the disparate interested parties need to be fixed.

Some of the immediate issues which need attention include the development of a policy framework for 'connected roads' and 'connected cars'. It should be noted that the fullest benefits of 'connected roads' will only flow if we also have 'connected cars' thinking and implementation. (This dependency for transport policy is not always recognised). It should also be noted that 'connected cars' is an international issue, whereas the 'connected roads' vision is more often related to national, or even local, policy.

Successful policy making therefore requires aspects of both scale and international connection to be developed. Unfortunately, from a UK perspective, many of the other European countries have strong industrial interests which tend to drive the European research agendas, and several of these countries host significant collaborative programmes. Examples are the German AKTIV programme; and the Netherlands-based SPITS project and AOS trials. Measured against the leading European nations, the position of the UK is modest; if there was stronger coordination at national level, the UK might wield more influence in European ITS circles.

With this in mind, UK policy responses to the issues raised by eCall and the recently announced EU ITS Directive need serious consideration. Without a pro-active, long-term, services-oriented vision the ITS business models which develop in the UK will be constrained by narrow short term goals. The apparent gulf which can already be detected between the Automotive directives and the RTTE EU directives of the telecommunications world, highlights what can happen if silo thinking is allowed to prevail at policy level. If this happens, many of the service opportunities suggested in the previous sections may never emerge.

Ultimately, all of the above problems of fragmentation and poorly coordinated policy-making can be reduced, or even eliminated, by better coordination between the various different users, providers and government departments that have interests and involvement in the future development of ITS. The establishment of a better cross-industry forum for the promotion of this ideal is a key requirement for the UK.

The EV charging infrastructure?

One of the strong near-term drivers for change in the world of ITS is likely to come from the arrival of electric vehicles on our streets. With the general levels of interest in these vehicles rapidly increasing, a whole new range of customer requirements is beginning to emerge. These include:

- Online information about the location of charging points in the public domain
- Vehicle-to-Grid communication and control
- Automated billing
- Future SmartGrid vehicle interface.

An early example of this type of service provision is the Chargevision product from Chargemaster. All of Chargemaster's units are now enabled with this system, thus allowing Chargemaster to provide its customers with a dedicated service that allows charge post owners to view a range of real time reports, such as how many kWs of energy are used by day, week or month, as well as providing the tools to analyse the data by user or time of day. Chargevision also enables motorists to receive text messages, alerting them to when their charging time expires. Furthermore it provides information on available charging locations and allows motorists to reserve a charging time slot.

6 Conclusions and recommendations

Conclusions

Over the past twenty years the internet has revolutionised markets, behaviours, and the connectivity of individuals. The extent of this revolution has not as yet penetrated throughout the field of Intelligent Transport, but it surely will. Connected vehicles and connected infrastructure will change the transport/mobility market place, just as the internet and mobile telephony have transformed many other markets. There will be big prizes for those businesses which respond to the market opportunities which are now beginning to arise.

But there are other, significant, forces that also demand the attention of the ITS community. In the long-term, the delivery of 'Intelligent Mobility' is important to the continued economic and social well-being of the UK in its widest sense. This is because, without it, our transport systems will become increasingly congested and the social and environmental impacts of vehicles (accidents, noise, air quality, carbon emissions) will become unacceptable. The consequent effects on the national economy will be severe.

Fortunately, the UK is well placed to develop and test the diverse range of existing and innovative Intelligent Transport Systems and services that will enable Intelligent Mobility to be delivered in its entirity. This is because of the UK's inventive capability, its strong historical position in the field of transport technology, its intensity of high quality road/rail infrastructure, and its willingness to explore new ideas. A key factor in the development of ITS is good data, and the UK is increasingly becoming a rich source of high quality information on which the development, and validation, of traffic models and performance analysis systems can be based. The concept of 'Test Bed UK', originally proposed by NAIGT, embraces all of these strengths and should be part of any plan to move forward.

However, there are some serious problems that currently obstruct the path to delivering Intelligent Mobility in the UK. Principal among these is the high-level disconnect which exists between the business leaders of the various interested parties, and the lack of an appropriate mechanism for the resolution of this problem. It is critically important that better partnerships between the vehicle manufacturers, communications providers, information systems developers, and government need to be facilitated.

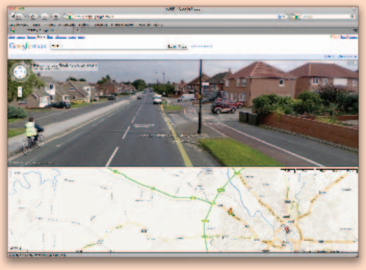
Importantly, in a world of reduced public sector capital, transport policy will need to have a framework and architecture that increasingly allows Intelligent Mobility to grow out of private-sector initiatives. Transport policy will also need to be sufficiently flexible to foster international collaboration on objectives and standards for connected people, vehicles and infrastructure. The recent ITS Directive/E Call 'Next Steps' offers a strong pathway to doing this, but current EU-wide cross-business sector collaboration needs to be energised more strongly to deliver effective results.

In summary, certain parts of the private sector are already energetically engaged in working towards a future environment where Intelligent Mobility will be an integral part of the national transport scene. Clear examples may be found amongst the fleet operators and mobile communications providers. Indeed, the telecommunications industry maintains world class research facilities in the UK and is believed to be willing to enter into collaborative programmes which could provide a basis for the future extension of 'Test Bed UK'. But this level of business enthusiasm is not uniform; it is un-coordinated across that wider spectrum of government and business interests which have to cooperate more effectively if the strategic economic benefits for the nation are to be realised. The government should look to some of the existing mechanisms for encouraging commercial cooperation to assist with this process. The Transport Knowledge Transfer Network (KTN), for example, is known to be interested in supporting these developments, and should be encouraged to take an active role.

The future?

Recent studies by GM have led to the development of the EnV concept – a small urban mobility vehicle which is capable of operating entirely under autonomous control. The vehicle is able to sense other vehicles and fixed objects in the vicinity and automatically navigate itself from one place to another. This leaves the driver completely free to turn his or her attention to other things – work, communication or entertainment.

GM is not alone in this field – many OEMs are developing similar capabilities, with a particular emphasis on urban vehicles. Rather more surprising, however, is the serious participation of some non-auto industry players. Google, for example, has recently announced very ambitious plans to run field demonstrations of autonomous vehicles using information sourced from GoogleMaps and StreetView. Google's activities thus far have accumulated over 140,000 miles of self-driven activity in the USA (mostly in California) using cars that are equipped with video cameras, radar sensors, lasers and sufficient artificial intelligence to 'read' information from road signs and other visual cues taken from the Street View data.



Recommendations

1 Cars and trucks are popular forms of transport in the UK, and the long, steady, growth in the total UK vehicle parc is likely to continue. This future growth in road traffic is unlikely to be matched by a corresponding growth in conventional road capacity. To avoid a serious congestion crisis, which would strangle both economic and social activity and threaten the popularity of automotive products and services, the stakeholders (namely the Government and The Industry) should pursue an Intelligent Mobility solution as a key national strategy. If the UK takes a lead in this area, an attractive, differentiated, opportunity for investors would be created. The UK would be a natural centre from which to develop the necessary R&D capability, especially the extensive software products and information services that will be required to deliver the Intelligent Mobility systems of the future

2 In the short-term, working with BIS and DfT, the Automotive Council should convene an Intelligent Mobility 'Summit'. The purpose of this Summit would be to bring together those potential contributors whose paths do not normally cross during everyday business. It should consider the questions of "What is the Goal?" and "What Next?" Those invited to attend should include leaders from the highest levels of government; the automotive industry; Transport Authorities/Operators; the telecommunications industry; the dot.com industry; the software development industry; the information services industry; the fleet operators; academia; and others as necessary. Summit meetings of this type should be held periodically (annually?) to maintain a fresh and dynamic national approach to the subject of Intelligent Mobility.

3 The Automotive Council should investigate the potential for joint research and development with others where there is a known interest in collaboration (eg the telecommunications industry and the Transport Knowledge Transfer Network).

Appendix 1 – A Brief History of Major ITS Projects

Projects grouped by date

ITS in the 1970s

1973 the Ministry of International Trade and Industry (MITI) funded the Comprehensive Automobile Control System (CACS) – Japan

1973-1979 – CACS Comprehensive Automobile Traffic Control System FM Beacon-based, off-board route calculation, on-board map, National Police Agency and Ministry of Construction – Japan

1978-1995 – Launch of experimental Block-I GPS satellite results in complete constellation of 24 satellites with full operational capability declared by NAVSTAR in 1995 – USA

ITS in the 1980s

1983-1985 – ETAK researches and 'Navigator' in-car route guidance system with licenses agreed with Delcan (USA), Clarion (Japan) and Bosch Blaupunkt (Germany) – USA

1984 – The Ministry of Construction (MOC) and the governmental Highway Industry Development Organisation (HIDO) funded the Road/Automobile Communication Systems (RACS) – Japan

1984 – The Ministry Post and Telecommunications (MPT) conducted the Advanced Traffic Information and Communication System (AMTICS) – Japan

1984 – European Parliament resolution on road safety – Europe

1984 – Delors White Paper on Growth, Competitiveness and Employment – Europe

1984-1987 – EC Framework Programmes established – (FP1 – FP7)
FP1 €3.27bn – Europe

1985 – Eureka Programme – established by Conference of Ministers to strengthen cooperation in advanced technologies, increase competitiveness and jobs – Europe

1985-86 – Studies into information technologies and telecommunications applied to road transport – Europe

1986 – Results of studies from 2 & 3 confirm need for strategic program (7) – Europe

1986-1989 – Siemens launches Ali-Scout that ultimately becomes Philips CARiN prototype and Bosch TravelPilot – Europe

1987-95 – EUREKA PROMETHEUS Project – (PROGraM for European Traffic with Highest Efficiency and Unprecedented Safety) Project Organised under ECMT framework with manufacturers paying 66% and Member States governments paying 33% – Europe

1987 – Commission Proposal for a Council decision for a Community R&D programme (DRIVE) in the field of Road Transport Informatics – 1989-1991 – Europe

1987-1991 – FP2 €5.36bn – Europe

1988-91 – DRIVE I (Dedicated Road Infrastructure for Vehicle safety in Europe) programme included 72 projects – Europe DRIVE distinguishes seven inter-related areas of major interest:

- Demand Management (DM),
- Traffic and Travel Information (TTI),
- Integrated Urban Traffic Management (IUTM),
- Integrated Inter-Urban Traffic Management (IIUTM),
- Driver Assistance and Cooperative Driving (DACD),
- Freight and Fleet Management (FFM), and
- Public Transport Management (PTM).

ITS in the 1990s

1990 – Mobility 2000 group was formed and led to the formation of IVHS America (Intelligent Vehicle Highway Systems) – USA

1990-994 – FP3 €6.6bn – Europe

1990-1993 – need for national coordination and standardisation and international collaboration was recognised and AMTICS and RACS were effectively combined in the Vehicle Information and Communication System (VICS), and comprehensive programs such as Advanced Traffic Information Services (ATIS), Advanced Road Traffic Systems (ARTS) and Super Smart Vehicle System (SSVS) were introduced – Japan

- RACS Road–Automobile Communication System Min of Construction, Highways Industry Development and Research Organisation, automobile & electronics industries
- AMTICS – Advanced Mobile Traffic Information and Communication System Microwave Beacon-based, off-board route calculation, on-board map Japan Traffic Management Technology Association, National Police Agency + Min of Posts & Telecoms
- VICS – Vehicle Information Communication System Ministry of International Trade & Industry, Ministry of Infrastructure and Transport, Ministry of Construction, National Police Agency, automobile & electronics industries
- 1991 – SOCRATES (System Of Cellular Radio For Traffic Efficiency And Safety) demonstrates dynamic route guidance in Gothenburg – Europe

1991 – The Intermodal Surface Transportation Efficiency Act (ISTEA), of which the IVHS program was defined as an integral part, became law in order to develop 'a national intermodal transport system that is economically sound, to provide the foundation for the nation to compete in the global economy, and to move people and goods in an energy-efficient manner. – USA

1991 – ERTICO – Founded at the initiative of the European Commission, Ministries of Transport and the European Industry as a network of Intelligent Transport Systems and Services stakeholders in Europe with the aim of connecting public authorities, industry players, infrastructure operators, users, national ITS associations and other organisations – Europe

1992 – ITS United Kingdom established as a not-for-profit public/private sector association financed by members' subscriptions to provide a forum for all organisations concerned with ITS. Membership comprises Government Departments, Local Authorities, Police Forces, consultants, manufacturing and service companies, and academic and research institutions – Europe

1992 – 1996 DRIVE 2 Advanced Transport Telematics Programme - Europe

1992 – ADEPT Automatic Debiting And Electronic Payment For Transport - Europe

1992 – PAMELA Pricing And Monitoring Electronically Of Automobiles - Europe

1994 – Advanced IT & Telecom Society – Japan

1994 – 1st ITS World Congress - Global

1994 – Christophersen Report on Trans European Networks – Europe

1994 – Bangemann Report on Europe and the information society – Europe

1994 – VERTIS (VEhicle, Road and Traffic Intelligence Society) was established for the purpose of integrating international liaison work in the field of transportation telematics (which is comparable to the European ERTICO organisation) – Japan

1994 – IVHS program was renamed into ITS (Intelligent Transportation Systems) indicating that besides car traffic also other modes of transportation receive attention. In the USA ITS comprises six inter-related system areas – USA

- Advanced Traffic Management Systems (ATMS),
- Advanced Traveller Information Systems (ATIS),
- Commercial Vehicle Operations (CVO),
- Advanced Vehicle Control Systems (AVCS),
- Advanced Public Transportation Systems (APTS), and
- Advanced Rural Transportation Systems (ARTS).

1994-1998 – FP4 €13.12bn – Europe

1995-1998 – TAP – Telematics Application Programme

1996 – ITS Plan – Japan

1996 – US Government policy directive declaring GPS to be a dual-use system and establishing an Interagency GPS Executive Board to manage it as a national asset – USA

1998-2002 – FP5 €14.96bn – Europe

1998 – US Vice President Al Gore announced plans to upgrade GPS with two new civilian signals for enhanced user accuracy and reliability, particularly with respect to aviation safety and in 2000 the US Congress authorised the effort, referring to it as GPS III. – USA

ITS in the 2000s

2002 – AIGT – (Automotive Innovation and Growth Team) – Distribution, Competition and Consumer Group Report. Creation of innovITS as UK ITS Centre of Excellence with vision to be a global centre of excellence for ITS and to help the UK become a leading centre of excellence in transport telematics for sustainable mobility as the UK gateway for industry expertise in the ITS field.

2001 – SMARTWAY

2002-2006 – FP6 €17.5bn – Europe

AGNELLI STUDY

2004 – 1st AASHTO (American Association of State Highway and Transportation Officials) – International Day

2007-2013 – FP7 €54.3bn – Europe

2008 – New Automotive Innovation and Growth Team (NAIGT) launched by Department for Business, Enterprise and Regulatory Reform (BERR) to facilitate the development of a collective strategic view in the period to 2025 of the innovation and growth challenges faced by the UK automotive industry.

Appendix 1 (cont.)

Projects grouped by subject

In car navigation systems development

- 1981 Honda introduce the Electro Gyrocopter navigation systems in Japan
- 1983 ETAK company established in California with $500,000 research budget
- 1985 ETAK launch Navigator in car route guidance system
- 1985 ETAK agree licenses with Delcan (USA), Clarion (Japan) and Bosch Blaupunkt (Germany)
- 1985 Philips launch CD-ROM
- 1986 Siemens launch demonstrations of Ali-Scout
- 1987 Ali-Scout becomes Autoguide for UK demonstrations
- 1988 Autoguide demonstrations scheme in London, Ali-Scout in Berlin
- 1989 Philips CARiN prototype launched
- 1989 Bosch TravelPilot launched
- 1991 SOCRATES demonstrates dynamic route guidance in Gothenburg.

GPS Development

- 1972, the US Air Force Central Inertial Guidance Test Facility (Holloman AFB), conducted developmental flight tests of two prototype GPS receivers using ground-based pseudo-satellites
- 1978, the first experimental Block-I GPS satellite was launched
- 1983, after Soviet interceptor aircraft shot down the civilian airliner KAL 007 that strayed into prohibited airspace due to navigational errors, killing all 269 people on board, US President Ronald Reagan announced that GPS would be made available for civilian uses once it was completed
- By 1985, ten more experimental Block-I satellites had been launched to validate the concept
- 1989, the first modern Block-II satellite was launched
- 1993, GPS achieved initial operational capability
- 1994 a complete constellation of 24 satellites was in orbit
- 1995 Full Operational Capability was declared by NAVSTAR
- 1996, recognising the importance of GPS to civilian users as well as military users, US President Bill Clinton issued a policy directive declaring GPS to be a dual-use system and establishing an Interagency GPS Executive Board to manage it as a national asset
- 1998, US Vice President Al Gore announced plans to upgrade GPS with two new civilian signals for enhanced user accuracy and reliability, particularly with respect to aviation safety and in 2000 the US Congress authorised the effort, referring to it as GPS III
- 2000 'Selective Availability' was discontinued as a result of the 1996 executive order, allowing users to receive a non-degraded signal globally.

Europe

- 1984 European Parliament resolution on road safety
- 1984 Delors White Paper on Growth, Competitiveness and Employment
- 1985 Eureka Program, established by Conference of Ministers to Strengthen cooperation in advanced technologies, increase competiveness and jobs
- 1985-86 Studies into information technologies and telecommunications applied to road transport
- 1986 Results of studies from 2 & 3 confirm need for strategic program (7)
- 1987-95 EUREKA PROMETHEUS (PROgraM for European Traffic with Highest Efficiency and Unprecedented Safety) Project
- 1987 Commission Proposal for a Council decision for a Community R&D programme (DRIVE) in the field of Road Transport Informatics 1989-91 DRIVE I (Dedicated Road Infrastructure for Vehicle safety in Europe) programme included 72 projects.) DRIVE distinguishes seven inter-related areas of major interest:
  - Demand Management (DM)
  - Traffic and Travel Information (TTI)
  - Integrated Urban Traffic Management (IUTM)
  - Integrated Inter-Urban Traffic Management (IIUTM)
  - Driver Assistance and Cooperative Driving (DACD)
  - Freight and Fleet Management (FFM), and
  - Public Transport Management (PTM)
- 1992-96 Advanced Transport Telematics Program
- 1994 Christophersen Report on Trans European Networks
- 1994 Bangemann Report on Europe and the information society.

USA

- 1990 Mobility 2000 group was formed and led to the formation of IVHS America (Intelligent Vehicle Highway Systems)
- 1991 the Intermodal Surface Transportation Efficiency Act (ISTEA), of which the IVHS program was defined as an integral part, became law in order to develop 'a national intermodal transport system that is economically sound, to provide the foundation for the nation to compete in the global economy, and to move people and goods in an energy-efficient manner
- 1994 the IVHS program was renamed into ITS (Intelligent Transportation Systems) indicating that besides car traffic also other modes of transportation receive attention. In the USA ITS comprises six inter-related system areas:
  - Advanced Traffic Management Systems (ATMS)
  - Advanced Traveler Information Systems (ATIS)
  - Commercial Vehicle Operations (CVO),
  - Advanced Vehicle Control Systems (AVCS),
  - Advanced Public Transportation Systems (APTS)
  - Advanced Rural Transportation Systems (ARTS).

Japan

- 1973 the Ministry of International Trade and Industry (MITI) funded the Comprehensive Automobile Control System (CACS)
- 1984 the Ministry of Construction (MOC) and the governmental Highway Industry Development Organisation (HIDO) funded the Road/Automobile Communication Systems (RACS)
- 1984 the Ministry Post and Telecommunications (MPT) conducted the Advanced Traffic Information and Communication System (AMTICS)
- Early 1990s the need for national coordination and standardisation and international collaboration was recognised and AMTICS and RACS were effectively combined in the Vehicle Information and

Communication System (VICS), and comprehensive programs such as Advanced Traffic Information Services (ATIS), Advanced Road Traffic Systems (ARTS) and Super Smart Vehicle System (SSVS) were introduced
- 1994, the VEhicle, Road and Traffic Intelligence Society (VERTIS) was established for the purpose of integrating international liaison work in the field of transportation telematics (which is comparable to the European ERTICO organisation).

EUREKA Programme
PROMETHEUS 1986 – 1995 Programme For European Traffic with High Efficiency And Unprecedented Safety Organised under ECMT framework with manufacturers paying 66% governments 33%.

DRIVE 1 1988 – 1991
SOCRATES System Of Cellular Radio For Traffic Efficiency And Safety
ADEPT Automatic Debiting And Electronic Payment For Transport
PAMELA Pricing And Monitoring Electronically Of Automobiles.

DRIVE 2 Advanced Transport Telematics 1992 – 1994
Telematics Application Programme
1995 – 1998
The EC Framework Programmes

FP1	1984 – 1987	€3.27bn
FP2	1987 – 1991	€5.36bn
FP3	1990 – 1994	€6.60bn
FP4	1994 – 1998	€13.12bn
FP5	1998 – 2002	€14.96bn
FP6	2002 – 2006	€17.50bn
FP7	2007 – 2013	€54.30bn

CACS Comprehensive Automobile Traffic Control System FM Beacon-based, off-board route calculation, on-board map, National Police Agency and Ministry of Construction.

AMTICS Advanced Mobile Traffic Information and Communication System Microwave Beacon-based, off-board route calculation, on-board map Japan Traffic Management Technology Association, National Police Agency + Min of Posts & Telecomms.

RACS Road–Automobile Communication System Min of Construction, Highways Industry Development and Research Organisation, automobile & electronics industries.

VICS Vehicle Information Communication System Ministry of International Trade & Industry, Ministry of Infastructure and Transport, Min of Construction, National Police Agency, automobile & electronics industries.

Appendix 2 – The UK Position within an International Context

UK strengths in ITS

Key strengths arise from the UK's problems as a congested island with a restricted road network creating the need for a variety of systems to make the best possible use of the road network. As one of the world's leading economies, the UK has the transport challenges associated with that status. In addition, the UK is densely populated, but not to the same extreme sense as metropolitan Japan and thus provides a useful and representative test bed for new transport solutions.

Technologies for improving incident management and response times are being trialled and deployed in the UK at a faster rate than the rest of Europe. These UK initiatives help to reduce congestion and emissions and delays to journeys.

The UK is amongst the best for road safety. It has an active regime of safety measures, regulations, road design etc that yield some of the lowest per capita crashes and KSIs in the world. Further improvements are increasingly difficult to deliver. It is thus well positioned for the next generation of Active Safety systems where benefits can be clearly demonstrated without any obfuscation from road safety deficiencies in other aspects of the system. The UK is seen as a global opinion leader on CO_2 reduction and the international response to climate change. In addition, the UK has various projects that pioneer how ITS can deliver improved transport efficiency and thus a reduced carbon footprint.

The UK generally takes a pragmatic view in solving problems, with a very wide skill base in a variety of ITS solutions. The UK is good at innovation and product ideas, and is also good at systems integration. Coupled with this is the UK's intellectual capability to invent appropriate solutions.

The UK has a strong and balanced technology base in the sectors enabling ITS developments. A significant contribution is made from the UK R&D base into these sectors globally. Some of this work is of direct relevance to exploitation in ITS products and services. Figures from the most recent R&D Scoreboard, published by Department for Business Innovation and Skills, are shown below. The combined role across these sectors is more significant globally than automotive in its sector.

Sectors contributing to ITS	Global R&D 2008 (£m)	UK R&D 2008 (£m)	UK role in global R&D
Automotive & Parts	69,404	1,398	2.0%
Mobile & Fixed Communications	8,574	1,499	17.5%
Software & Computer Services	27,536	1,623	5.9%
Technology Hardware & Equipment	69,105	1,069	1.5%
Electronic & Electrical Equipment	27,657	671	2.4%
Total	**202,276**	**6,260**	**3.1%**

The UK is strong in mobile phone technology and the developments of traffic and transport related applications. Other key strengths of the UK include: security, public transport, travel and traveller information, ticketing and incident management.

Stolen vehicle tracking is also very strong in the UK, largely due to insurance company requirements for fitting these systems. A number of UK based companies lead in this sector.

CCTV and ANPR are techniques and concepts which have been successfully implemented, with the UK as a founder and leader in using these technologies.

The UK has high standards of type approval, particularly in enforcement systems that have to withstand legal challenges in the court system. It is argued by some that these standards are too high, for example requiring a criminal level of proof in road user charging instead of regarding it as a paid for service. However, they form the basis for increased confidence in other markets for those that need to conform to these stringent standards in the UK market.

The UK has a good reputation in international standards and specifications, and is well known to have good standards in place.

The Urban Traffic Management Control (UTMC) developments of the last decade are generally seen benefiting authorities in the UK and given industry a sound open-systems architecture for exporting traffic control solutions elsewhere.

Within Europe, London is a key leader in deployment of smartcard based ticketing systems through the Oyster card, and other markets are looking to move to smartcard technology. In addition, the DfT has sponsored a national specification for smart card ticketing, used a by a large number of local authorities and bus operators.

The UK has successfully deployed new initiatives, such as congestion charging and the low emission zone in London, aimed at tackling environmental issues, and the rest of the world uses the UK as a benchmark.

UK weaknesses in ITS

Although the UK is skilled in the technical aspects of automotive ITS, there is little influence on strategy in this area, most decisions being made in automotive headquarters in Germany, Japan and the USA.

The inertia and aversion to risks shown by the public sector, coupled with bureaucratic processes, too often leads to a lack of commitment in decision making. Frequently, there is too much navel gazing, too much research and iterated studies and not enough political will to make things happen.

Although the UK's public sector policies are generally sound, implementation is slow. Sometimes, there are elements of "not invented here" in decision-making, with a mistrust of trials conducted elsewhere.

Local government is risk averse and short term, making planning decisions for new technology solutions more difficult.

The UK is frequently not good at translating research into deployment, partly because we pay more attention to solving the technical issues than solving the institutional issues.

Generally, the domestic market for products is small and therefore product viability frequently depends upon successful exports.

The UK continues to be weak in raising awareness and educating the public on ITS benefits.

The UK authorities are generally not good at recognising the driver/traveller as a customer; seeing things through the customer's eyes could help in deciding priorities. Generally there is too much policy office and not enough customer focus. Essex CC's traffic control centre in the public atrium at County Hall is a good exception to this.

Due to the congested nature of the UK road and transport network and the number of legacy systems, it can be costly to apply new technologies when opportunities arise. In contrast, new cities in countries such as China are a blank canvas.

Although the UK has a good track record in implementing new technologies, some applications have not been fail safe, eg during an Oyster card failure, TfL lost approximately £100,000 in one incident.

UK Opportunities in ITS

Governments are spending less on transport. ITS is more cost effective than traditional measures in many cases; eg the use of active traffic management of motorways in place of the construction of additional lanes. Some of this might be funded by the public sector as a cost saving over those traditional technologies. In other cases, the private sector could take a greater role in initiatives, with clear payback, if the policy oriented benefits can also be achieved.

The UK can build upon its reputation in the international response to climate change and its capabilities with regard to ITS enabled CO_2 reduction, to build a solid platform of systems based business in this area of growing global significance. Examples include the role of traffic management (possibly using cooperative systems) to optimise CO_2 reduction, eco-driving and range assurance for electric vehicles.

Ticketing and congestion charging demonstrate key opportunities for UK innovation to be applied in other countries. New congestion charging technologies are expected to provide opportunities for increased efficiency in revenue collection.

The London Oyster card is recognised as highly innovative for public transport ticketing and is set to reach revenues of £5.8bn by 2015 providing the opportunity for higher evenues.

There are opportunities for UK industry in the USA, particularly in areas where UK's expertise in network management, tolling / charging systems and sensor technologies could be exploited. Signalised roundabouts are a specific opportunity.

The UK is well advanced in PSAP (Pubic Safety Answering Points) infrastructure development, giving the UK aready ability to implement Safety Answering systems (although it should be noted that the pan-European eCall system has not yet been accepted for adoption in the UK. The London Olympics 2012 will provide opportunities to implement and showcase UK technology for managing road and information networks.

UK Threats in ITS

The UK risks being left behind by countries such as Holland and Germany, who have formed close technical alliances with the German motor industry. A good example is the Audi pilot project in Inglestadt, where the municipality's urban traffic control system is directly linked to equipped Audi vehicles, providing information and guidance directly to drivers.

The pace of UK road safety improvements and reductions in casualty rates has slackened in comparison with other European counties and threatens UK's reputation in road safety.

The recession and cuts in public expenditure are impacting current public sector programmes. There is a significant reduction in traffic control work associated with new developments under Section 106 agreements.

Transport generally does not have a very high place on the government's agenda as other matters take priority. Transport is left behind and ITS with it.

Appendix 3 – Fleet Operations

1 Large telecommunications company

1.1 Current Situation

The company has a fleet of over 30,000 vehicles, with vehicles typically travelling 12,000 miles a year. Currently, only a very small proportion is equipped with fleet telematics hardware, but their engineering division is beginning to be fitted with either Green Road™ or Trimble™ telematics hardware, which both feed into the same management software. It is currently only used for vehicle tracking, allowing more efficient vehicle use, since the nearest vehicle can be chosen to meet a call. Also, it provides the firm with some form of proof that the vehicle actually arrived at its destination to fulfil its call. Currently, little data is received regarding the state of the vehicle, and these are totally stand-alone units; for example, fuel usage is not monitored.

1.2 Future Strategy

This small scale implementation of telematics is what the company believes to be the first of three levels of functionality. First, there is basic location monitoring, with little other data being transferred from the vehicle. Then, in the future, they would like to begin monitoring driver behaviour by measuring braking acceleration and so on with the use of stand-alone units. They would use this data to encourage good efficient driving, rather than punish bad driving, so as to avoid distressing the drivers, and to avoid issues with privacy. The final stage, is the eventual full integration of such technology with the CAN Bus. They also intend to eventually roll out these technologies across the majority of the fleet in the future.

1.3 Uses and Drivers

The main drivers for installation of the technology are firstly, the improved logistics management as previously mentioned. Secondly, improved driver behaviour is another incentive, which, due to the low mileage of the fleet, could lead the greatest possible environmental and financial benefits. Maintenance is of low priority as most vehicles have a relatively low mileage so the current yearly inspections suffice. Of greater priority is vehicle security, as the value of the payload can be quite high, and most vehicles are kept by the drivers' homes, rather than in a secure depot, so some form of remote unlocking system at the beginning of the day, could help reduce the likelihood of vehicle being broken into.

1.4 Concerns

One major area of concern they have expressed is regarding interoperability of the various different systems offered; they will refrain from rolling out the technology onto all of the fleet, until they can guarantee the systems are future proof, and can all deliver the same information in the same format. They also commented that they would prefer such technologies to be factory fitted in the future, rather than retro-fitted, but not until such standards have been introduced. The importance of the information over the hardware was also stressed, as ultimately, that is where the benefits lie.

2 Large mail delivery company

2.1 Current Situation

The firm operates approximately 30,000 LCVs in conjunction with 1,500 HGVs from various different manufacturers. A large proportion of the LCVs are fitted with third party tracking boxes, currently from different manufacturers. These allow crossovers of delivery/collection routes to be avoided, improving the utilisation of resources. The previous method of measuring the fuel used and mileage covered by the fleet, was based on records of depot fuel dispensing, but there is some error in the values this method generates, and there is a desire to improve on this. The telematics system offers this possibility and is capable of displaying a wide range of reports, from speeding to harsh braking and excessive engine idling, which is used to track driver behaviour

2.2 Future Strategy

The company runs most of its telematics installations as competitive tenders, which encourages the firms to arrange the interoperability of the technology themselves, as they have an incentive; this is a policy which it intends to continue, although it too would prefer standards to be introduced. It also intends to eventually roll out a system which will allow driver behaviour to be monitored, as well as the state of the vehicle, which would require a well integrated system. For the former, they would prefer there to be some form of display in vehicle, to allow the driver to be both aware of their consumption, as well as how to improve their driving, through an on-board display. This would be encouraged with a 'carrot' as well.

2.3 Uses and Drivers

Due to the much higher mileages of its vehicles, vehicle maintenance is of a much higher priority, so some form of system which would allow information such as battery voltage to be monitored remotely, could allow less frequent maintenance to be carried out, leading to substantial reductions in costs. Driver behaviour could also be monitored, as this could lead to reduced fuel usage, especially since most vehicles are used in urban environments. Since their vehicles have much higher mileages, monitoring of fuel usage is essential, as this is possibly the area in which costs can be reduced the most. Security is of low priority, as the vehicles are generally of low value, and instantaneous reports of incidents would not be required, as these are eventually registered via the daily bulletins already.

2.4 Concerns

As with the telecommunications company, the lack of standards was considered as an issue. They also raised concerns regarding cost, and emphasised how important it is to demonstrate the added value, which is sometimes difficult, particularly, for example, in determining potential reductions in fuel usage.

3 Public sector vehicle operator

3.1 Current Situation

This company operates a fleet of over 4,000 vehicles, of which 1,500 are local authority vehicles, 170 are agricultural vehicles, and 800 are company cars. None of the vehicles which the company owns are fitted with telematics systems, but some of their clients' vehicles do have these, and the company has participated in small-scale trials. Some of the refuse lorries are fitted with sensors, which measure the weight and read RFID chips in bins, as well as cameras, which are used for defence against complaints. Some Dial-a-Ride services offer real time information regarding the location and ETA of the vehicles online, but one of the biggest areas is for sub-contractors of local authorities; it is sometimes stipulated in the contract that these vehicles must be equipped with tracking equipment, so the client can check that the work is being carried out, without having to manually inspect all sites. Some of their clients' gritter lorries make use of sophisticated systems; a conventional car with cameras fitted to it, measures the width of the road, along with the amount of ice and snow there is, and this data is then sent to the gritter, allowing to cover the correct part of the road, as well as know how much salt to release. Their agricultural vehicles also make use of GPS to ensure they travel in straight lines.

3.2 Future Strategy

The company currently has no firm plans to install telematics hardware into its own vehicles any time soon, although many of its customers' vehicles will continue to make use of the technology, particularly local authorities. The reasons for this are that the vehicles which the company owns tend to be company cars, so are not tracked, because that would not be well met by customers, and the mileage is not particularly high so maintenance is not an issue either. On the other hand, local authorities have more uses for the technology, particularly for ensuring that their duty of care is met. It will, however, continue to partake in trials of telematics systems for its customers.

3.3 Uses and Drivers

For the majority of its customers, the main use for fleet telematics will be to monitor driver behaviour, in order to reduce fuel consumption, as with the previous companies. However, some of their customers who need to travel from location to location, such as housing associations, could use telematics to improve utilisation as well. As previously stated, the local authority vehicles which they operate are often fitted with the technology, so as to provide proof that contractual standards are being met. Although strictly not fleet telematics, some of their other vehicles use intelligent systems for other specific technical uses.

3.4 Concerns

As with the other firms, the lack of standards was again raised as an issue, at least for a few essential data streams such as fuel usage and engine speed, which are the most useful. Another problem they suffer with is in making alterations to the existing telematics system in a new fleet of local authority vehicles, which they may have just won the tender for. This means it is sometimes not possible to fully integrate these vehicles into their existing management systems. Lastly, this company too expresses concerns regarding the difficulty in generating accurate values for the potential financial savings, which is important in justifying the large initial outlay.

4. Ambulance service

4.1 Current Situation

As an ambulance service, the 400+ vehicles in this fleet are fitted with very sophisticated hardware. The fleet consists of traditional ambulance trucks, as well as estate cars known as Fast Response Units and other specialised vehicles. Each ambulance is fitted with a small computer, which is connected to a satellite navigation system, as well as a cellular antenna, which is all provided by Terrafix™. When a call is received, pertinent information regarding the incident can be sent to the nearest ambulance over the mobile networks, thus reducing response times. Further updates can also be sent to the vehicle en-route. Whilst on a call, the vehicle sends telemetry bursts every few seconds back to the control room, which include the position and Blue Light status, as well as basic telematics information regarding the handbrake, reverse gear, ignition status and battery power levels, which can help notify the control room if a problem arises. This can also be used to track stolen vehicles. In addition to these technologies, the ambulances are fitted with radios, providing another more versatile avenue of communication.

4.2 Future Plans

This ambulance service currently has medium-term plans to add further functionality to its vehicles. They would like to be able to track vehicle mileages, to allow improved management for fuel usage, which would be more of a consideration for non-emergency calls. They would also like to be able to monitor driver behaviour, as a way to determine if the driver is to blame in collisions involving ambulances, and also as a way to encourage more efficient driving for non-emergency calls. In addition to this, they have plans to continually upgrade current hardware; for example, replacing old PCs with newer faster models.

4.3 Uses and Drivers

Unlike the other companies, the primary usage is for fleet management, particularly to help minimise emergency call response times, but driver behaviour is also a consideration, for both reducing fuel consumption of non-emergency calls, as well as for determining if driver error is to blame for accidents involving ambulances. Monitoring of the vehicles' condition is of low priority, since the vehicles regularly return to the depot, where more thorough maintenance checks can be carried out, although vehicle security is very important, due to the high value of equipment in the vehicles.

4.4 Concerns

The major barrier against the installation of telematics, which will monitor driver behaviour, is from the staff, who dislike the fact that it may lead to blame being apportioned to them if an accident occurs when carrying out an emergency call. Another issue is the high costs of such technologies, which are made worse by the fact most systems fail to integrate with their existing equipment, so would require their own separate cellular connections, which creates additional charges.

Appendix 4 – Emerging Technologies for ITS

One of the main challenges of ITS systems and services has been the fact that, by their very nature, people and vehicles move. This has required a large fixed data infrastructure to enable the systems to work together. However with the advent of mobile technologies such as GPRS (General Packet Radio Service) in 2000 and 3G in 2003, the means of communicating has been transformed and it is no longer necessary to employ large fixed infrastructure support systems. But what other paradigm shifts of this type can be foreseen within the next 20 years.....?

Increased Computing Power

Cloud Computing, where shared information, software and resources are held centrally and connected over the internet allow services such as Google Navigation to provide traffic information and routing to the device from servers in the cloud where no data is necessary to be stored on the device. Cloud moves the computer processing away from the device or personal computer into areas where more collective computation applications can be applied. In the next two to five years, Complex Event Processing is expected to take into account all the events happening within a system, determine the most meaningful one and then takes subsequent action in real-time. With the predicted increase in data, Extreme Transaction Processing will be required to truly benefit from this approach – which has a particular benefit to real-time traffic operations and traveller virtual assistants. However the significant change will occur more than 10 years from now with introduction of Quantum Computing which will deliver processing speeds more than 10,000 faster than those of today which will enable true real-time modelling and event processing to become common place which can lead to genuine real-time driving direction instructions at a personal vehicle level that load balances and distributes traffic based not just on speed of transit time, but also on an environmentally basis.

Increased Data Transfer Capacities

In 2 to 5 years, we will see LTE (Long Term Evolution) which is the pre-runner to 4G mobile data communications. Compared to the data transfer rates of today we expect within the next 2 years data throughput in the networks to increase 4 fold and within 5 years it will increase 10 fold. With this much greater bandwidth, feature and content rich applications will become common place and will be needed, as by 2013, wireless network traffic will reach 400 petabytes a month. In 2009, the entire global network transferred 14 exabytes per month. Towards the end of 2020 we will see LTE Advanced which will be the precursor of the 5th generation mobile network (5G).

Improved Mobile Computing

In the near-term, several new technologies are already having an important impact on the delivery of ITS services to the user. Smart mobile devices, such as the iPhone and Android have put mini-computers into people's pockets and their penetration is expected to double in the next 12 months. This, combined with applications which are aware of their location via GPS or cell location identification (location aware applications), will enable data to be collected centrally, and re-distributed, without a fixed infrastructure. Examples are traffic flows, individual vehicle movements, individual package movements, and automatic tolling.

Improved Satellite Services

The Galileo programme will start to deploy satellites by the end of 2012 and, when fully deployed, will operate alongside today's GPS to provide mass market timing and sub-metre positioning. Galileo will also enable additional services such as the Publicly Regulated Service (PRS) and the Commercial Service (CS) which will offer secure, accurate and guaranteed navigation overlays to users.

New Augmented Systems

We will see the emerging augmented services of today move towards maturity and become enhanced by augmented vision systems within 5-10 years. The augmented data superimposed on the screens of today's mobile devices will be presented visually in front of the user. At the same time virtual assistants will track the journey and suggest travel plan changes to drivers based on perturbations which arise during their journey.

Appendix 5 – The Current Regulatory Position

In August 2010 the EC introduced the 'Framework for the Deployment of Intelligent Transport Systems in the Field of Road Transport' (Directive 2010/40/EU). This document puts forward an Action Plan aimed at speeding the deployment of ITS throughout Europe with targets and activities detailed in 6 key action areas:

- Optimal use of road, traffic and travel data
- Continuity of traffic and freight management ITS services on European transport corridors and in conurbations
- Road safety and security
- Integration of the vehicle into the transport infrastructure
- Data security and protection, and liability issues
- European ITS cooperation and coordination

Delivery dates across these action areas run from now until 2014. The Action Plan draws on a series of ongoing European Commission initiatives such as the Action Plan on Freight Transport Logistics, the Action Plan on Urban Mobility, Galileo deployment, the Greening Transport Package, the i2010 initiative on Intelligent Cars, eSafety, the 7th Framework Programme for Research and Technological Development, eCall, European Technology Platforms and their strategic research agendas, CARS 21. A list of current relevant EC regulations and directives can be found in the Table below.

Region(s) Affected	Legislation Body/ Organisation	Regulation/Directive Title	Introduction Date
EU	European Parliament and of the Council	Directive 2004/52/EC Interoperability of electronic road toll systems	May 2004
EU	European Parliament and of the Council	Regulation 661/2009 (GSR) Electronic Stability Control (Cars, Vans)	November 2011 (M,/N,) – July 2016
1958 Agreement CPs	UN ECE	Regulation 13H/Suppl 11 Electronic Vehicle Stability Control (Trucks, Buses, Trailers)	2011 – 2016
EU	European Parliament and of the Council	Regulation 661/2009 (GSR) Lane Departure Warning System	November 2015
EU	European Parliament and of the Council	Regulation 661/2009 (GSR) Tyre Pressure Monitoring System (M_1)	November 2012
EU	European Parliament and of the Council	Directive 2002/58/EC Protection of individuals with regard to the processing of personal data and on the free movement of such data	July 2002
EU	European Parliament and of the Council	Directive 2002/22/EC Universal service and users' rights relating to electronic communications networks and services (Universal Service Directive)	March 2002
EU	European Parliament and of the Council	Regulation 2006/2004 On cooperation between national authorities responsible for the enforcement of consumer protection laws (the Regulation on consumer protection cooperation)	October 2004
EU	European Parliament and of the Council	COM (2007)698 Amending Directive 2002/22/EC on universal service and users' rights relating to electronic communications networks. Directive 2002/58/EC concerning the processing of personal data and the protection of privacy in the electronic communications sector and Regulation (EC) No 2006/2004 on consumer protection cooperation	TBE
EU	European Parliament and of the Council	Directive 2010/40/EU Framework for the deployment of Intelligent Transport Systems in the field of road transport and for other interfaces with other modes of transport	August 2010
EU	European Parliament and of the Council	Regulation 78/2009 – Reg. 13H/Suppl 9 Brake Assist System (M,/N,)	November/February 2011
EU	European Commission	Directive 2003/98/EC Reuse of public sector information	
EU	European Commission	Directive 2004/52/EC (EETS) Interoperability of electronic road toll systems Decision 2009/750/EC Definition of Electronic Toll Service and its technical elements	April 2004 Oct 2009
EU	European Commission	Recommendation C(2006) 7125 final On safe and efficient in-vehicle information and communication systems: Update of the European Statement of Principles on human machine interface	December 2006
EU	European Commission	COM(2009) 434 final Communication from the Commission to the EP & EC, the European Economic & Social Committee & the Committee of the Regions 'eCall: Time for Deployment	August 2009
EU	European Commission	Code of Practice For the Design and Evaluation of ADAS	October 2006

Appendix 6 – Future Business Opportunities

Opportunity Category	Short Term 0-5 Years	Medium Term 5-15 Years	Long Term Prospects	
EV PRODUCTS	EV charging infrastructure and management of charge points	Intelligent energy management infrastructure for EVs	UK Leadership	Good
	Fleet management products		Jobs	Good
INFRASTRUCTURE MANAGEMENT PRODUCTS	ANPR cameras linked to other IT and ITS systems	Dynamic re-routing/ticketing (parking) across modes	UK Leadership	Good
	Active traffic management – roll out M42 eg ramp metering	Electronic tolling		
	CVIS land monitoring	Road management (maintenance minimisation)	Jobs	Good
	Intelligent road signs	CVIS road/trains 'platooning'		
TECHNICAL PRODUCTS	Cloud infrastructure	Value added services through on-board units	UK Leadership	Good
	On vehicle software harness – APIs	Head up displays on windscreen		
	In-vehicle networks – Bluetooth, WiFi. Individually IDs	In-car entertainment: hands-off systems eg film, videoconferencing		
	Smartphone with every car – App driven solutions	Automated vehicle maintenance data (self diagnosis)	Jobs	Good
	Garage/service alerts (MOT, product recalls, etc)	Connected vehicles		
	Social network 'connectedness'	Internet on wheels (advice anytime, anywhere)		
ROAD USER CHARGING PRODUCTS (note – we may be lagging the EU in this area, esp. wrt infrastructure and back-office services; but there is a product opportunity)	Electronic tolling for goods vehicles	Interoperability across services	UK Leadership	Fair
	Billing services (Tolling, EV, smartcard)	Electronic tolling infrastructure – 'in-vehicle' and 'roadside'	Jobs	Fair
FLEET PRODUCTS	Fleet tracking	Asset security (farm machinery etc)	UK Leadership	Fair
	Logistics handling	Predictive (remote) maintenance		
	Fleet management systems/feedback to 'back office' (efficient fleet operation)		Jobs	Fair
	Operational modelling simulation in real time			
ENVIRONMENTAL MANAGEMENT PRODUCTS	Eco-driving apps for smart phone		UK Leadership	Fair
	Real time fuel use	Environmental monitoring and enforcement systems	Jobs	Fair
	Reduction of vehicle emissions			
MOBILITY PLANNING PRODUCTS	Journey time predictability service (time and/or cost minimisation)	Link to other service packs existing (pay as you go, clubcard etc)	UK Leadership	Good
	Car parking info/booking services and in-vehicle guidance	Driver penalty/ reward. Motivation (debit/ credit)		
	Multi-modal e-cards (eg Oyster)	'Push' marketing to traveller	Jobs	Good
	Car clubs (eg Zip Cars)			
CAR SHARING PRODUCTS (links to mobility planning)	Car sharing	Flexible, on demand mobility	UK Leadership	Limited
	Car share in eg blocks of flats	Virtual capacity and lower cost of infrastructure		
	Community personal use vehicles (sharing vehicles)	Property and mobility integration	Jobs	Limited
	Community personal use vehicles (sharing vehicles)			
SECURITY	Asset tracking	Automatic street lighting/CCTV controls	UK Leadership	Limited
	Immobilisers		Jobs	Limited
	Theft alerts			
SAFETY PRODUCTS (note – here the opportunity is in infrastructure and service provision, not necessarily vehicle products)	Reduce cognitive overload	CVIS enhanced Visibility	UK Leadership	Limited
	Driver training	Collision avoidance systems		
	Letting the emergency vehicle through	Driver behaviour monitoring and alerts	Jobs	Limited
	Breakdown rescue services			

Appendix 7 – Glossary of terms

Term	Meaning
Active Traffic Management (ATM)	This is a collection of roadside technologies and vehicle detection systems to make better use of our motorways by actively managing traffic speeds using overhead signs and variable speed restrictions. Deployed as a pilot on the M42 in England and deployed in Europe and further field
Adaptive Cruise Control (ACC)	Referred to as autonomous cruise control and uses detection technologies such as radar or laser to allow the vehicle to slow when approaching another vehicle and accelerate again to the preset speed when traffic ahead allows
Advanced Driver Assistance Systems (ADAS)	Use to describe a collection of systems to aid the driver in the driving process and provide added safety features, such as adaptive cruise control, advanced emergency braking, intelligent speed adaption etc.
Apps	Software applications
Autonomous Control	A condition where vehicles are controlled entirely by the system without input from the driver.
Cloud Infrastructure	A concept of pooling the distributed computing capacity
Cooperative Vehicle Infrastructure Systems (CVIS)	This is one of Europe's flagship projects for cooperative mobility, providing a universal platform for V2V and V2I communication and services. Co-financed by the EU's 6th Framework Programme for Research and Technological Development, CVIS brings together over 60 leading industrial, government, operator and research organisations from across Europe.
Crowd Sourcing	Web based collaboration through openly connected individuals inside a situation to inform those approaching it
DATEX II	DATEX standard was developed for information exchange between traffic management centres, traffic information centres and service providers. The second generation DATEX II specification pushes the door wide open for all actors in the traffic and travel information sector.
Demand Management	A term to describe methods by which a transport authority can change travellers behaviour by imposing 'controls' to achieve policy objectives. Controls may include, charging a fee, giving certain modes priority, introducing delays to certain vehicles, such as cars at junctions.
DRIVE 1	European Commission research programme (Dedicated Road Infrastructure for Vehicle safety in Europe)
Dynamic Diagnostic Systems	An on board system for determining the performance and operating characteristics of a vehicle
Dynamic Route Guidance	Technology that provides dynamic information to travellers to maintain or alter their journey route in response to delays on the road network
eCall	European Commission project intended to bring rapid assistance to motorists involved in a collision anywhere in the European Union. Information such as airbag deployment and impact sensor information, and GPS coordinates will be automatically sent to local emergency services from a unit installed in the vehicle
eSafety	European Commission initiative, intended to increase road safety by deploying and developing safety systems based on modern information and communication technologies
HOV Lane	High Occupancy Vehicle lanes specifically allocated to a vehicle with more than single occupancy. Usually requires a traffic enforcement aspect to ensure compliance
HOT Lane	High Occupancy Toll lane – a variant of the HOV lane where use of the lane is also provided to those users willing to pay a fee
Informatics	A subset of ITS which considers information collection and dissemination. More commonly used in the vehicle sector. Also used more freely in Europe
Intelligent Transport Systems (ITS)	Combines information and communications technology to transport infrastructure and vehicles to optimise the transport network to deliver objectives that include; safety improvements, fuel efficiency, vehicle emissions, driver stress, congestion etc.
Journey Planner	Static information from Internet based systems to allow travellers to plan their journeys in single or multimode dependent on preset criteria, such as cost, CO_2 emissions and duration.
Lane Departure Warning (LDW)	Providing an alert or message to a driver indicating that the vehicle is deviating from is intended traffic lane
LED	Light emitting diode that can display different colours when energised. Becoming common place in traffic signals and roadside dynamic signs
Logistics scheduling	Similar to a Journey Planner but used in the logistics sector for optimising vehicle loads, routes and returns.
Nomadic device	Refers to a communication device such as a mobile telephone that can be moved between locations and connected between systems
NTCIP	Series of standards designed to achieve interoperability and interchangeability between ITS systems and manufacturers. Promoted and supported by the US Department of Transport. Similar European (FRAME Architecture) and UK (UTMC Architecture) are also available.
OEM	Original Equipment Manufacturer
On Board Unit (OBU)	Intelligent device installed in a vehicle to receive and transmit data to a central system. Usually associated with road pricing and congestion charging schemes
OnBoard Diagnostic-II Port (OBD-II)	The OBD-II standard specifies the type of diagnostic connector and its pin connections, the communication protocols to extract vehicle engine and performance data.
PROMETHEUS	EUREKA PROMETHEUS at European Commission research program from 1987-95 for European Traffic with Highest Efficiency and Unprecedented Safety
Ramp Metering	Roadside infrastructure to regulate the traffic entering a motorway main carriageway to avoid flow breakdown to the main carriageway. Utilises traffic detectors and traffic signals at motorway entry points
RDS-TMC	Radio Data Service – Traffic Message Channel
SatNav	Satellite navigation aid installed in a vehicle or handheld
Selective Vehicle Detection	Roadside infrastructure (or buried detection system) to identify a chosen type of vehicle, most often a bus to provide priority measures
SENTIENCE Programme	A collaborative programme between innovITS and the European Commission focused on fuel efficiency improvements in relation to the use of telematics data obtained from hybrid vehicle systems. The project consortium consists of significant industry stakeholders from the three key Telematics technology domains of Automotive, Infrastructure and Telecommunications
Smart Fare Card	A plastic card containing a microchip with stored information. Used for public transport payment applications, such as Oyster, Octopus Cards. In operation similar to a smart tag
Smart-Tags	A common term to describe the in-vehicle component used to unique data and communicate with the roadside. Also referred to as a component in a Dedicated Short Range Communications (DSRC) system, such as Electronic Toll Collection
Telematics	Early ITS systems for roadside information were also referred to as telematics.
Total Mobility	A concept for describing a scenario transportation where the mode and interfaces between modes become seamless and transport is merely a means to an end
TPEG	The Transport Protocol Experts Group founded in 1997 by the European Broadcasting Union. The group developed the TPEG specifications for transmission of language independent multi-modal Traffic and Travel Information.
Urban Traffic Management and Control (UTMC)	A UK Department for Transport (DfT) initiative for the development of a more open approach to in urban areas. This allows previously disparate data from multiple sources such as message signs, traffic signals and car park data to be amalgamated into a central database.
Variable Message Signs (VMS)	Roadside infrastructure that provided dynamic messages to travellers abut conditions ahead, examples are car park signs, bus stop signs and motorway information signs
Vehicle to Infrastructure (V2I)	Technology and protocols to communicate between roadside infrastructure and a moving vehicle to provide ITS services
Vehicle to Vehicle (V2V)	Technology and protocols to communicate between moving vehicles to provide ITS services