Intelligent Transport Systems

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This paper discusses the need for Intelligent Transport Systems (ITS) and the key factors influencing the Government's Integrated Transport Policy. Typical ITS projects and applications in the UK are reviewed and conclusions drawn.

KEY WORDS

1. Land. 2. Communications. 3. Information Systems. 4. Telematics.

1. INTRODUCTION. 170 years ago the opening of the Liverpool and Manchester Railway heralded the start of the transport revolution. 100 years ago the first motor vehicles appeared on the roads of Great Britain. 75 years ago the first traffic lights were switched on, and 40 years ago the first British motorway was opened. All these developments have contributed to traveller mobility on a scale undreamed of by past generations. They have also contributed to the prosperity of the country by assisting the efficient manufacture and distribution of goods, and by allowing, at least in theory, all people a wider choice of employment opportunities.

But, as we are all too acutely aware, progress comes with a price. Between 1985 and 1997 the total number of licensed road vehicles increased by over 27%, road traffic increased by 45% and passenger transport by car increased by over 40%, yet the total length of public roads increased by only 6%. Over the same period passenger transport by bus decreased by 12%, by rail increased by 11% and by air increased by 89%. (These figures are from the Government Statistical Service.) Increased motor traffic resulted in a rise in the number of people killed or injured on the roads, more traffic congestion and pollution, and greater isolation for those who do not have access to their own transport and are served by shrinking public transport services.

Although there is no single solution, it is now widely accepted that the development and introduction of technology in both road infrastructure and more sophisticated vehicles will play a key role in addressing these problems. Intelligent Transport Systems (ITS) is the name given to this technology which is usually characterised by three features: communications, integration and information. This paper examines the contexts and policies that are driving ITS forward and outlines past, current and future developments in ITS, particularly the driver information revolution including both infrastructure and in-vehicle developments.

2. TRANSPORT REVOLUTION. Times are changing in transport and travel as well as in other areas of life. New transport revolutions are now taking place.

Changes in economics, politics, technology, commerce and social trends are all affecting the demands for mobility and the means to deliver it. There are many key factors influencing transport and travel in Britain at the beginning of the 21st century.

2.1. *The Government's Integrated Transport Policy*. The Government aims to integrate transport policy within and between different types of transport, with the environment, with land use planning and with policies for education, health and wealth creation. The policy arises from recognition that we face dramatic increases in traffic over the next 20 years: left unchecked, car traffic could grow by 30% and commercial vehicle traffic even more. The consequent congestion and pollution would be a nightmare as an increasing vehicle population competes for the same amount of road-space.

Early in 2000, the Government strengthened the Integrated Transport Policy by publishing Transport 2010, a ten-year *route map* to deliver the goals set in the White Paper: reduced congestion, better integration, and a wider choice of quicker, safer, more reliable travel by road, rail and other means of transport. If these ambitious targets are to be achieved, emerging technologies will need to be exploited to the full. Key areas of work are in network and traffic management, travel information and vehicle safety systems.

2.2. *Public Transport*. A major emphasis of the ten-year plan is support for public transport. Currently this is often inadequate and unco-ordinated, and too unreliable for travellers to depend on as their first choice. It is particularly unsatisfactory for the one-third of homes without a car, who have no alternative. Even basic timetable data and information on alternative routes to a destination has been difficult to access. Falling customer levels have led to under-investment and poorer service, and the spiral of decline has taken over. These problems have been widely recognised in both public and private sectors, and both are keen to support measures to make public transport more attractive, more reliable and better informed.

2.3. *Freight Distribution*. As the demand for goods continues to increase at a significant rate, new trends in freight distribution result with road transport as the main means of delivery. Trends in shopping style with more impulse buying, longer opening hours and seven-day trading increase freight transport needs. The trends in supply chain management with just-in-time deliveries of smaller, more frequently delivered quantities also increase the demand for freight transport. The trend away from major out-of-town shopping, such as the Trafford Centre and Bluewater, towards revitalising town centres again puts pressure on transport needs.

2.4. *e-commerce*. e-commerce arising from the internet revolution is also affecting transport. The largest impact on freight distribution is coming from the growth of internet, mail-order and interactive television retailing, all of which potentially increase the demand for small quantity deliveries. e-commerce is also making travel and transport opportunities better known and by pricing mechanisms allowing the possibility of flattening out the peaks and troughs of travel demand.

2.5. *Safety and Environment*. Safety and environment are also key issues. In the United Kingdom, road transport is the fastest growing contributor to climate change. The current annual rate for emissions of carbon is approximately 40 million tonnes per annum. Transport accounts for approximately one quarter of the CO^2 emissions. Although the UK has a relatively low rate of road casualties compared to other countries, 3000+ fatalities is still 3000+ too many.

2.6. *Social Inclusion*. A key part of the political agenda is social inclusion. The trend is to make greater opportunities available for transport and travel for those disadvantaged by disability or visual impairment. Special attention is being paid to vulnerable road users such as pedestrians, cyclists and the elderly. Cyclists have been given a boost with the opening of the National Cycle Network this year. The aim is to include all, regardless of geographic location.

2.7. *Sustainability*. Sustainability is an important aspect of any solution to traffic and transport problems. Solutions need to be sustainable in terms of technology, financing and reliability. This means that the transport solution has to be practicable and built on a strong financial basis for the whole-life cost of the project. There would be little point in devising a solution that is costly to maintain and operate.

2.8. *Private and Public Finance*. Last and by no means least, the partnership between private and public finance has enabled new projects to be developed with more appropriate allocation of project risks. Whilst there may be controversy over the private financing of the London Underground, there are well-established precedents for public-private partnerships in the provision, operation and maintenance of motorways. Recent government announcements have extended this to urban applications such as street lighting.

3. THE DRIVER INFORMATION REVOLUTION. In parallel with these trends, technology developments in communications, in information and in processing are enabling change to take place. There is a major revolution in the information available to vehicle drivers. In the present technological age, people are perhaps more prepared to accept and use information sources than they were in the past. However, those sources must be reliable, up-to-date and accurate if the information is to be believed. Information provision and dissemination is central to any ITS strategy and is potentially very wide ranging. At one extreme is the straightforward display of off-street car park space availability. At the other is comprehensive real-time journey information giving, for example, estimated journey times, advance notice of problem areas or public transport timetables and running schedules. In between are other possibilities associated with traffic control, such as temporary diversionary routes or air quality information. The appropriate information can be potentially displayed inside a vehicle or accessed remotely.

The driver information revolution is part of the wider traveller information revolution. For all travellers there is a demand for much better and timely information, but it must be given in time for action to be taken. It is no use arriving at a rail station, bus stop or motorway junction only to find that a problem exists. Development of the mobile phone network and travel kiosks potentially offer a way forward. If this problem can be solved, and many more people given access to the information, it is probable that public attitudes will change and real use will be made. Compulsion is unlikely to work.

There are several potential suppliers of information, whose data must be gathered, matched and any gaps filled before dissemination to the driver and traveller in an integrated form. A simple example is off-street car parks, where different operators must supply occupancy data and accept that direction of drivers to particular car parks to avoid highway network problems is for the common good. In the transport area, most bus and rail operators have their own information systems, and appropriate software and data systems must be developed to allow these to interface. On-street infrastructure will inevitably be introduced in phases as control systems develop and new or enhanced applications arise.

4. INFORMATION PROJECTS. Several new initiatives, enabled by new technologies, are seeking to deal with these issues and to deliver working solutions. Typical projects and applications in the UK, some with a long history as well as an influential future, are described below.

4.1. *Motorway Information.* In the 1970s, inter-urban motorways in the UK were equipped with emergency telephones and simple vehicle detection facilities with limited CCTV coverage. These facilities were monitored from local police control rooms. The Perry Barr motorway centre in Birmingham, commissioned in 1972, was a forerunner for systems that monitored traffic and set variable message matrix signals to provide lane control over a wide area of the motorway network. Incident detection algorithms were also developed and installed at trial sites, and the first major integrated motorway control and surveillance system was implemented in Glasgow in 1980. This system has now developed into the Scottish Office's NAtional Driver Information and Control System (NADICS).

NADICS was formally launched in 1996, and is capable of covering all of Scotland. The system is already proving its value on the National Network in the central area of Scotland where 'real-time' information about incidents and congestion is passed to drivers using variable message signs. NADICS can be readily configured to implement existing and future traffic control techniques.

Another long-distance traffic monitoring and strategic system operational in the UK is the Midland Driver Information System (MDIS), now installed in a 200-km envelope between London, Birmingham and Nottingham. It monitors all traffic within this envelope and then, via a series of strategically placed variable message signs, advises drivers of possible problems on the roads in the network. A similar system, developed from the EU PLEIADES project, is in operation on the 100-km links between London and the Channel tunnel and ports.

4.2. *MATTISSE.* The MATTISSE system has extended the provision of traveller information beyond that provided to drivers on Midlands motorways and offers real-time traffic and travel information in the Midlands area. The Midlands has some of the busiest motorways in Europe and contains several urban areas. Travellers in the region often have alternative routes but previously lacked the means to find details of delays and disruptions.

Travellers can now obtain a wide variety of information on, for example, congested stretches of road, severe weather conditions, planned road works, and major disruptions to the public transport network. The information is collected from national and local road networks, the police and public transport operators, and is then made available via a dedicated terminal, an internet connection or by radio and TV broadcasts. The service helps travellers in pre-trip planning and in avoiding trouble spots during the journey. The system is modular and enables additional providers and users of information to be added easily.

4.3. *Highways Agency Traffic Control Centre.* The next stage in development is the Highways Agency's plan to implement the Traffic Control Centre (TCC) project, for the management of traffic at a strategic level on the nationally important core road network in England. The benefits of the TCC project will be: better balancing of network and modal usage as a result of high quality traffic and travel information; better roadside information after incidents that will smooth flows and minimise stop-start conditions; improved monitoring of the network performance, aiding better management; and an organisational and technical framework for the introduction of new systems.

The TCC will provide strategic traffic control based on real-time information on traffic conditions over the whole national network including alternative routes. This will be collected in a real-time database and used in a computerised network model to predict traffic conditions several hours ahead. The TCC will also provide co-ordinated traffic and travel information, which will be made available via a computerised 'Traffic Information Highway' (TIH). From this, driver information service providers will be able to access relevant, reliable and consistent information for their customers. The TCC will also aid the Highways Agency in network performance monitoring and in accident and incident management.

Operated as a public-private partnership, the TCC managing company will take over and run the TIH. This distributed computing system environment, with capability for handling all modes of transport, will be promoted by the Highways Agency as the basis for the future commercial exchange of multi-modal travel information.

4.4. *ITS City Pioneers.* The breadth of ITS solutions now emerging calls for discipline in their application, particularly in the public sector. ITS City Pioneers is a European project, managed by ERTICO, the Intelligent Transport Systems Europe Organisation. The project has developed a framework of guidance to help cities make use of a range of tools and applications. In the ITS City Pioneers toolbox there are over 30 tools for application in urban areas, including tools for: traffic management, payment systems, collective transport management, freight transport management, security and emergency management, and traffic and travel information. Following DETR funded trials of the ITS City Pioneers methodology in Devon and Lancashire, the information has now been widely disseminated.

4.5. *UTMC – Urban Traffic Management and Control.* Urban Traffic Control technologies are well established in the UK. Indeed, the SCOOT (Split, Cycle and Offset Optimisation Technique) system developed here is now in use in over 200 towns and cities in the UK and worldwide. Under SCOOT control, traffic signals are automatically set to reflect the changes in traffic flow to achieve network wide optimisation and to reflect current traffic management strategies. This is being further developed with UTMC, the 5-year DETR R&D programme intended to assist network management in an urban area and to help make best use of the available road space. Over 100 academic, research, manufacturing, consulting organisations and local authorities are participating in some 25 projects.

UTMC systems are being specifically developed: to create modular systems capable of expansion and interoperation; to integrate with existing urban traffic control systems; to use open system architectures allowing competitive supply; to maximise flexibility for evolving needs and new technologies and to provide quality information for travellers. The key components of a typical UTMC system installed in a city will include gateways to external systems, a selection of monitoring, analysis and strategy functions, a common database and a communications network to street equipment. Just over half way through the R&D programme, UTMC is already delivering results and demonstrating benefits.

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4.6. *Trafficmaster*. Trafficmaster plc was perhaps the first major organisation in the UK, if not the world, to seize the business opportunity for driver information. Trafficmaster provides dynamic driver information and is a key player in the commercial development of intelligent transport systems. Established in 1989, the company has achieved high levels of growth and is a pivotal player in Europe's telematics marketplace.

The core business of Trafficmaster is the provision of live traffic information. The company's network of nation-wide sensors and transmitters gathers and distributes traffic data over 8000 miles of motorway and trunk routes in the UK. Developed by Trafficmaster, the system gathers data at the their headquarters in Milton Keynes, England and delivers it to the customer through a number of screen or speech-based receivers, including the YQ^2 and Oracle/Freeway units, mounted in the vehicle. In early 2000, a pan-European expansion programme began that will deliver live traffic information in Germany in 2000 and France and Italy in early 2001.

Trafficmaster Oracle is an OEM product included as a standard fitment on some Vauxhall and Citroen models in the UK market. The integration of traffic information onto a GPS navigation system marked a breakthrough for the technically advanced Jaguar Cars 'S'-type. This will be the first in the world to feature the overlay of dynamic national traffic information onto the navigation system map screen. Trafficmaster is continuing the development of in-car systems and is working closely with other motor manufacturers including Land Rover, BMW GB, Citroen UK and Renault UK.

Early in 1999, Trafficmaster formed a joint venture company with the Royal Automobile Club (RAC) – RAC Trafficmaster Telematics Ltd (RTT). With the combined strengths of the RAC brand and Trafficmaster's unique technologies, the new company provides a range of services to motor manufacturers, RAC members and other customers. The first product from this partnership is RAC Trackstar, a GPS-based vehicle security system, which instantly pinpoints the exact location, speed and direction of a vehicle.

4.7. *RDS-TMC*. The UK TMC consortium is a private-public partnership set up to undertake the commercial demonstration of TMC in the UK. The consortium members and their roles are: DETR as facilitators; the Highways Agency, providing new real-time information from congestion detectors; the AA and RAC, providing high quality dynamic traffic information; and C&MT, a radio communications company, which broadcasts this information using Classic FM's transmitters. The consortium is supported by Oscar Faber, as technical project managers.

The demonstration is funded from contributions from the EU and by the consortium. It has strong political backing, being an example of the innovation proposed in the UK Government's White Paper on Transport to give drivers better travel information, both pre- and in-trip. The demonstration is intended to test the commercial market for a TMC service, and provides answers to questions on market size and take-up. The technology is already proven and is being successfully used across Europe in Holland, France, Germany and Sweden, as well as in the UK. It is intended to roll out to a full national service following the demonstration.

User evaluation includes almost 500 TMC users with Blaupunkt Viking and Volvo RTI sets. Four hundred AA and RAC members have Viking units installed in their vehicles, and these members provide feedback through driver diaries, telephone interviews and focus groups. This information has already been used to improve the performance of the service, and to gain information on the use of TMC and the potential size of the UK market.

4.8. *Road Traffic Advisor*. The Road Traffic Advisor (RTA) project is a collaboration between a number of leading companies, academic organisations and government departments, part financed via the Technology Foresight Challenge. The project is managed by the Transport Research Laboratory (TRL).

The aims of the RTA project are to create in the UK a new system of vehicle-roadside communications to improve transport efficiency, safety and traveller satisfaction; to provide a national test site for telematics technology that will be a showcase for new UK products and for academic research; and to provide a high quality scientific base for future projects within a co-ordinated industrial/academic environment.

The project area has a test-bed of beacons along 350 km of motorway between Swansea and London Gatwick Airport. RTA includes verification of the concept of an open applications architecture system, using two-way short-range microwave communication (5·8 GHz) between vehicle and roadside, provision of relevant short and medium range information services to drivers and passengers in a controlled and safe manner, and assessment of the embryonic information services market. The principal RTA applications are driver information, vehicle-derived network information using probe vehicles, speed advice and bus passenger information.

The growth in telematics brings with it a considerable increase in the volume of information presented to drivers from external sources, in addition to the already expanding in-vehicle information. To minimise distraction to the driver, the presentation of information is an important requirement. This is addressed within the RTA project by the Dialogue Manager development, which presents information on a display with auditory support where appropriate.

Probe vehicle information gathered includes average speed, headlight, foglight and wiper information. This is then output as visibility, precipitation, and flow and average speed with measures of confidence. The information is collected from RTA equipped vehicles and may then be transmitted to regional control centres for processing and data fusion with information from other sources.

The dedicated roadside beacons also repeat the information given by the gantry-mounted, variable-speed controlled signs on the M25. On this stretch of motorway, enforceable speed limits are set according to prevailing traffic conditions, and the limits are displayed to the driver above each lane on a Controlled Motorway Indicator. RTA displays the mandatory speed information to the driver in the vehicle. The speed advice application will demonstrate the potential to offer indirect support to drivers to comply with dynamic, variable speed limits. The liability for the speed of the vehicle will remain firmly with the driver, not with the infrastructure provider.

5. CONCLUSION.

In addition to the specific projects outlined above, there are several commercial organisations now active in the field of ITS service provision. One example is Global Telematics, who developed Orchid, the vehicle telematics service providing real-time fleet monitoring for commercial operations. This service allows internet tracking of Orchid-equipped vehicles. Another example is ITIS (Integrated Transport Information Services), who provide traffic and travel information to the logistics industry and cellular networks. The growth in telematic services for both commercial and private vehicles seems set to continue to grow.

We all travel, whether it is by road, rail, air or water; on business or for pleasure. Some journeys are short, others long. Sometimes we want to take the quickest option and sometimes a more leisurely journey is sought. Whatever the journey, technology in the future will allow us all to be much better informed about travel options. Information will also be available to us during our journey so that we can be alerted to problems and seek alternatives. Mobile phone systems will ensure that walkers and cyclists will for the first time be able to take advantage of these technological innovations. We live in exciting times, but perhaps the biggest challenge technologies face is to ensure that these opportunities include all in society.