Connected Living

Mobilizing Intelligent Transportation Systems (ITS)

GSMA Connected Living Programme

This report has been adapted from the original report
Intelligent Transport Systems
Report for Mobile
By Dr John Walker

Contents

	Introduction	1
1	**Enabling Technology and Standards in ITS**	5
2	**Intelligent Mobility and C-ITS**	8
3	**Enforcement and security**	10
4	**Fleet Management, PayAsYouDrive Insurance & Parking**	11
5	**Road Pricing**	14
6	**Public Transport**	15
7	**Travel information and Traffic management**	16
8	**Conclusions**	17
9	**Further Reading**	19

Introduction

Intelligent Transportation Systems (ITS) is an expanding and diverse subject, with some of its constituent parts overlapping or converging. For example, transport and travel information might been viewed under a Smart Cities agenda, and similarly "connected cars" are a manifestation of Machine-to-Machine (M2M) communications and the Internet of Things (IoT).

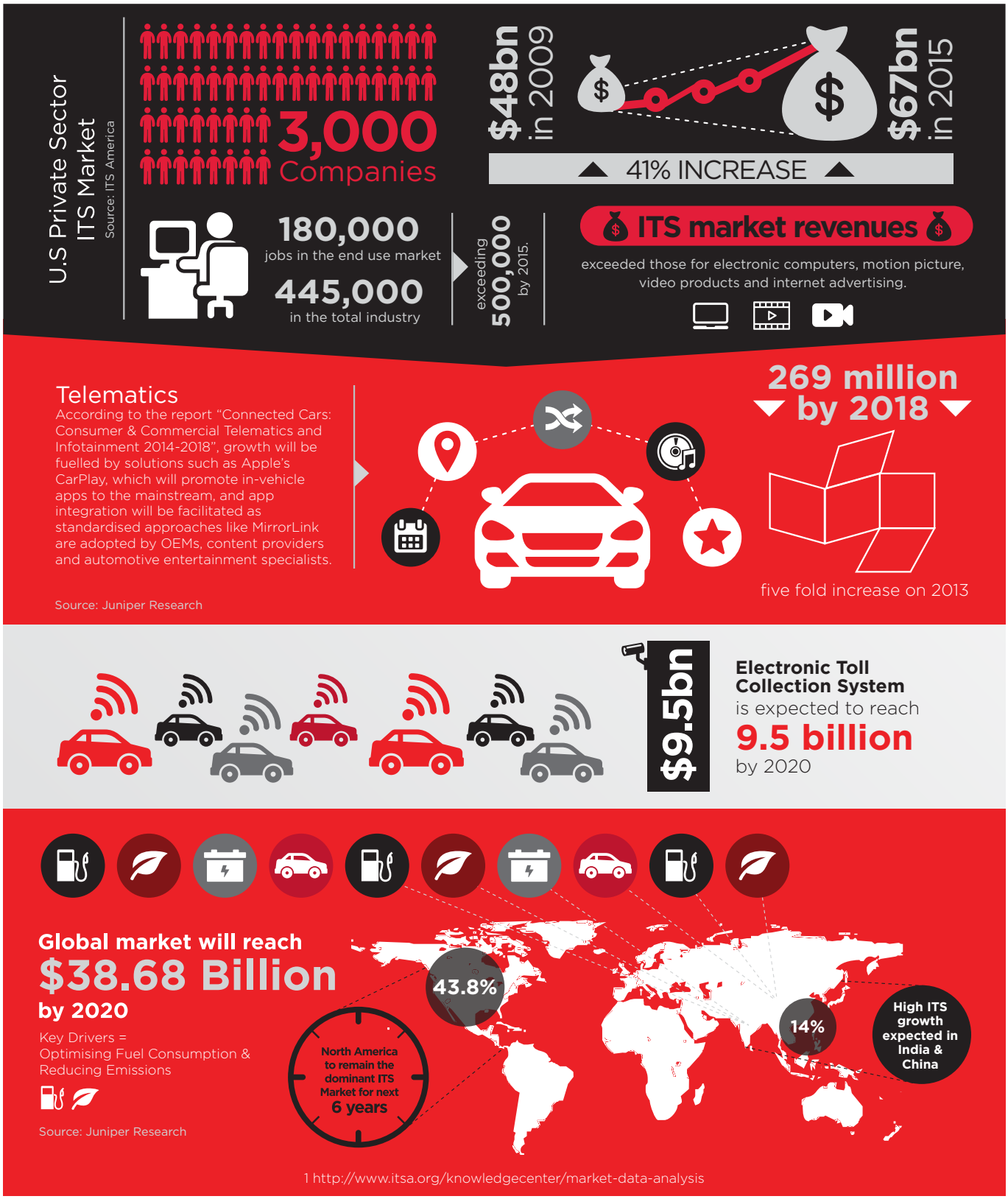
The GSMA believe that mobile is the only solution that offers the agile, robust and secure communications required to mobilise ITS solutions. In addition, mobile operators have many capabilities, beyond connectivity, that make them attractive business partners for transport system operators.

This paper seeks to provide a clear definition of the component parts that make up ITS and highlight the role that mobile operators can play in the strategy, design, implementation and operation of various ITS solutions.

A brief history of ITS

Research on the application of control and information technologies to surface transportation began in the 1950s and 1960s in the United States, including automatic control of the automobile and electronic route guidance. In the late 1980s a coalition of private, public and academic organisations convinced Congress to legislate support for a comprehensive program in Intelligent Vehicle-Highway Systems (renamed Intelligent Transportation Systems or ITS in 1994) to reflect a broader mission, including all parts of public transportation and intermodal connections.

ITS MARKET TRENDS



1 http://www.itsa.org/knowledgecenter/market-data-analysis

A new “hot topic” is “self-driving cars” (aka autonomous vehicles), still in the research stage but sales are forecast to explode over the next decade. Automotive and other companies are racing to develop them, including Audi, Daimler, Google.

- **According to an October 2013 market report from Transparency Market Research “Connected Car Market -Global Industry Analysis, Size, Share, Growth, Trends and Forecast, 2013- 2019,” the global connected car market will reach USD 131.9 billion by 2019, growing 34.7% per year from 2013 to 2019. 4G/long-term evolution (LTE) technology is in a commanding position to supply this connectivity due to its lower operating costs,high data transmission volumes and inherent security compared to other technologies.**

Public Policy

The European Commission’s ‘Action plan for the deployment of intelligent transport systems in Europe’ aims to make road transport, and its interfaces with other transport modes, more environmentally friendly, more efficient, safer and more secure. Deployment of ITS in Europe will be accelerated in a coordinated way and European standards, for example for the exchange of data, are being set.
The EU wants to encourage ‘co-modality’ (the efficient use of different transport modes together and separately), to cut congestion, reduce the number of road traffic accidents, reduce energy consumption, cut greenhouse gas emissions and reduce dependence on fossil fuel. Optimal use of road, traffic and travel data;

- **Continuity of traffic and freight management ITS services;**
- **Road safety and security applications;**
- **Linking the vehicle with the transport infrastructure.**

eCall

eCall is an EC initiative aiming to bring help to motorists involved in a collision anywhere in the European Union. An eCall-equipped vehicle can respond to events such as a driver signaling for help or an airbag deployment by automatically sending a “Minimum Set of Data” including the location of the crash, to the nearest emergency centre via the cellular network, permitting a rapid and potentially life-saving response by the emergency services. An “in-band modem” is used to send data over the voice channel, compliant with the 3GPP specification TS 26.267: “eCall Data Transfer; In-band modem solution; General Description **http://ec.europa.eu/digital-agenda/en/ecall-time-saved-lives-saved**


PARAMEDIC
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SUPERINTENDENT

1 Enabling Technology and Standards in ITS

Cellular radio and smart-phone development are enabling the agile and secure expansion of many areas of ITS.

Cellular networks are constantly evolving, enabling a growing range of applications including vehicle communication. The 3rd Generation Partnership Project (3GPP) is currently study the possibility to utilise LTE mobile networks to ensure connectivity between vehicles, roadside infrastructure and the people inside and around the connected car. 3GPP is currently analyzing several use cases (see 3GPP TR 22885), including emergency vehicle warning, co-operative adaptive cruise control. The current study will be concluded in 3GPP Release 13 and the actual standardisation of the features and adaptation needed in LTE will take place in 3GPP Release 14.
There are several benefits that can be identified in using LTE for ITS applications:

- **Fast rollout, deployment of ITS systems by leveraging already existing MNO's infrastructure**
- **Assurance of a global coverage and interoperability**
- **Lower cost for car OEMs, one chipset for all applications (e.g. infotainment, telematics)**
- **Ability to extend the communication to other users, like pedestrians**

ETSI are urrently working on common standards for ITS: **http://www.etsi.org/technologies-clusters/technologies/intelligent-transport** and it is important to note that there are many standards relating to ITS in general and to communications in ITS in particular – see for example "D3.5b – Standardisation Handbook" (Evensen & Schmitting, 2014).

1.1 Cellular radio

Cellular radio in all its incarnations (2G (GSM, GPRS, EDGE), 3G (UMTS, HSPA, HSPA+), 4G (LTE) and in the not too distant future 5G) is an enabler of many new developments in ITS.

Almost half the world's population now uses mobile communications - 3.4 billion by the end of 2013, and expected to pass 4 billion in 2018, with strongest growth in Asia-Pacific. Two thirds of subscribers will be on 3G and 4G networks by 2020.

Total connections will grow at 9% -10% p.a. due to strong Machine-to-Machine (M2M) connections growth - 1.2 billion connected devices by 2017 (GSMA 2013b). Much of this will be in the automotive and ITS sectors.

"Connected car" penetration will increase globally from 11% in 2012 to 60% in 2017 (and to more than 80% in the United States and Western Europe). Mobile technology can revolutionise the way we use cars, saving lives, improving the driving experience through access to real-time information, allowing remote monitoring of performance and location for more effective preventative maintenance measures, delivery networks and public transport travel information (GSMA 2013b). Payment systems will be facilitated and part or even all of the driving task will be automated.

The GSMA has set up the Automotive Special Interest Group/ Connected Car Forum to enable dialogue between mobile operators and vehicle manufacturers. By working together, manufacturers and mobile operators can share information, resolve barriers to connected car deployment and accelerate the adoption of telematics and infotainment services. The ASIG has set targets for connectivity solutions to be embedded in over 20% of global vehicle sales, and over 50% of cars to be connected, by 2015 – as outlined in the Mission Statement; it hopes to have every car multiply connected by 2025 (GSMA 2013b). See **http://www.gsma.com/connectedliving/events/**

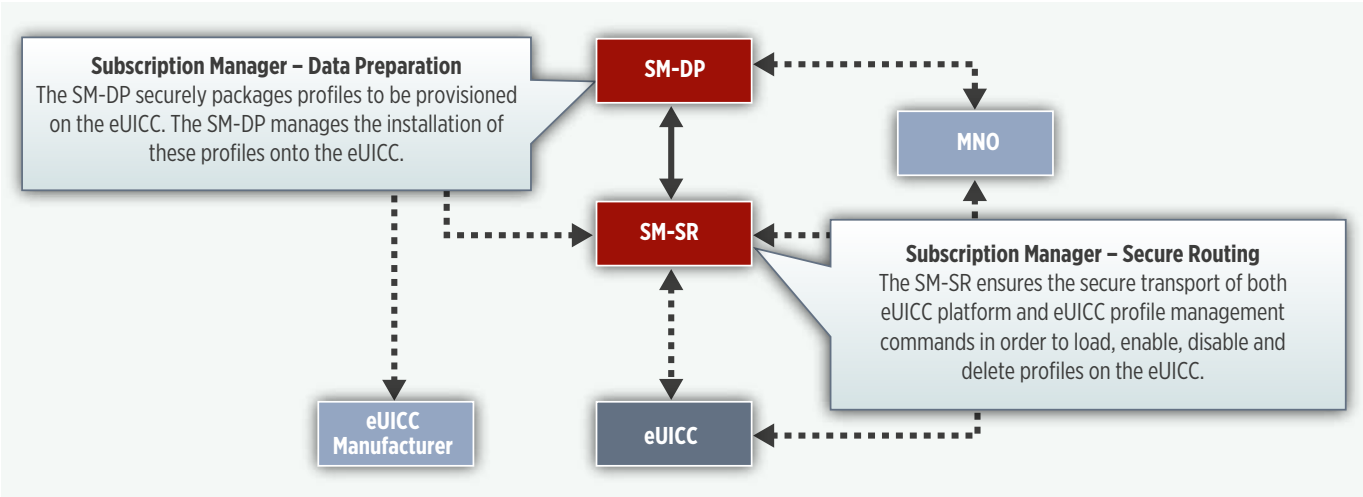
1.2 The embedded Universal Integrated Circuit Card - eUICC

A new type of mobile network user will emerge; automobile, consumer electronics, energy companies and others will see their devices used by millions world-wide. M2M communication will become standard, primarily using mobile networks.

However, there is an issue with the SIM card in these M2M applications. One of the benefits of the SIM is that customers can easily change the SIM and network operator if they wish. But for M2M applications a change of SIM is impractical for a number of reasons; it may be inaccessible, or soldered in to prevent fraud and damage from vibrations. Operators recognised this and developed "GSMA Embedded SIM" technology to allow change of operator, subject to any contractual conditions, if required. The eUICC is an embedded SIM. The GSMA has produced an embedded SIM Specification to accelerate growth in M2M (GSMA 2014e). The specification provides a standard mechanism for remote management of M2M connections, allowing "over the air" provisioning of an initial operator subscription, and a change to other operators subsequently, while maintaining the same level of security as with traditional removable SIMs. See **http://www.gsma.com/connectedliving/embedded-sim/.**

Figure 1 shows the eUICC Subscription Manager architecture. Operators use the Data Preparation entity to securely encrypt their operator credentials for over the air installation within the SIM. The Secure Routing entity delivers the encrypted operator credentials to the SIM and remotely manages the SIM thereafter to enable, disable and delete the credentials as necessary during the product's lifetime. Use of the eUICC could minimise some of the security problems outlined in section 3.2.

FIGURE 1: EUICC SUBSCRIPTION MANAGER ARCHITECTURE



The GSMA Embedded SIM provides tremendous benefits to OEMs, including late-stage provisioning during manufacture and remote provisioning over the air. Additionally benefits for the whole supply chain include reduced costs in handling M2M SIM products and low integration and testing costs and all this with minimal impact to existing systems and network infrastructure.

The eUICC provides new business opportunities for Transport operators and Mobile Network Operators, reducing logistical and operational costs but retaining existing SIM security levels, with minimal impact to the network infrastructure.

The eUICC supports multiple SIM profiles and can also be used with removable M2M SIMs – This would enable, for example, a vehicle may have its infotainment provided via one mobile operator and its remote engine monitoring by another.

1.3 Smart phones

Although smartphones have a history going back to the mid-1990s with the Nokia 9000, they really took off in the mid-2000s with the Blackberry, the Apple iPhone and the Google Android operating system. They have continued to gain in computing power, connectivity (Wi-Fi and Near Field Communications (NFC) as well as cellular), screen size and resolution, and sensor facilities (cameras, GNSS positioning, motion-sensing) – and this trend seems set to continue for the foreseeable future.

This ubiquity, power and versatility of smart-phones, as sensor platforms and as generators of useful data, is driving applications in commerce, financial services, infotainment and many other areas, including transport.

1.4 Cloud-based computing

In Cloud-based computing, data, applications, services and infrastructure are provided in "the Cloud", hosted on remote infrastructure, available from anywhere. The advantages are:

- **Highly scalable implementation; the cloud operator can support sudden changes in computational requirements.**
- **The Cloud operator handles back-up and software upgrades, with resulting economies of scale.**
- **All users can access the latest data.**
- **Terminals & user devices can be of lower computing power.**
- **There is less need for specialist IT skills in the organisation, and no need to understand how the service is provided.**
- **There is no need for large capital outlay; resources can be provided on a "pay as you go" basis.**

In the UK, cloud computing is being increasingly used by Local Authorities, including in transport applications. For example the "National traffic disruptions hub" in the UK has been cloud-based since 2003, evolving from a road-works database. The objective is to unite 175 Local Authorities on a common platform for road-works, incidents and other disruptions. Dynamic traffic management information is provided by 40 UK Local Authorities, and is linked to the UTMC (Urban Traffic Management and Control) systems to give a single integrated view of traffic management information. The data is widely disseminated, including to Google, Here (Nokia Navteq), and TomTom.

As pointed out by the GSMA (2013a), making use of cloud-based or managed smart city services, billed on a pay-as-you-go basis, is likely to be more cost-effective than deploying the city's own dedicated infrastructure.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2 Intelligent Mobility and C-ITS

There are Intelligent Mobility and Cooperative ITS (C-ITS) programmes world-wide, with wireless data exchange from vehicle to infrastructure (V2I) or vehicle to vehicle (V2V). C-ITS includes technologies and applications that allow wireless data exchange within the transport system, between vehicles (V2V), and between vehicles and infrastructure (V2I), but also covers vulnerable road users such as pedestrians, cyclists and motorcyclists.

"Connected cars" and "autonomous vehicles" are "hot topics" globally due to converging interests of mobile operators, automotive companies and ITS organisations, influenced by developments in consumer electronics (In in January 2015 the keynote addresses at the Las Vegas Consumer Electronics Show were given by the Chairmen of Mercedes and Ford, and the show featured self-driving cars from Mercedes-Benz, Audi and BMW).

Priorities of the US Department of Transportation's "ITS Strategic Plan 2015-2019" are: "Realising connected vehicle implementation and advancing automation". Autonomous vehicles have now entered public and political consciousness – largely due to the Google self-driving car.

The term "Intelligent Mobility" has gained currency, particularly amongst automobile manufacturers. The key to Intelligent Mobility is to connect a range of independent industries and technologies such as vehicle manufacturing, transport information systems, communications technologies, logistics and distribution and infrastructure management.

The European Commission has decided to take a more prominent role in the deployment of cooperative systems. To that end, DG MOVE (the Directorate General for Transport and Mobility) is setting up a C-ITS Deployment Platform, a cooperative framework including national authorities and other stakeholders, aiming to develop a roadmap and a deployment strategy for C-ITS in the EU and identify potential solutions to cross-cutting issues, by the end of 2015.

There are 200 million vehicles on European roads and some 13 million jobs in the automotive industry, so Europe would like to be in the lead in introducing new technologies. But connected cars need common technical specifications, including radio frequencies and message formats. CEN and ETSI are currently preparing a coherent set of standards, specifications and guidelines to support implementation and deployment of C-ITS across Europe. For more information, please see **http://release1.its-standards.eu/**

2.1 The connected car

Connected vehicles can communicate with each other and their surroundings. They are equipped with internet access, cellular radio, radar and other communication links including DSRC and an internal wireless local area network, allowing internet access to other devices both inside and outside the vehicle. Benefits to the driver include prevention or automatic notification of crashes, speeding and congestion. Increasingly, connected cars use smartphone apps to interact with the car from any distance. Users can unlock their cars, check the status of batteries on electric cars, find the location of the car, or remotely activate the climate control system.

As indicated earlier, the market size for the connected car is expected to increase dramatically. According to the GSMA (2013c) the global connected car market will be worth €39 billion in 2018, up from €13 billion in 2012. There will be a sevenfold increase in the number of new cars equipped with factory-fitted mobile connectivity to meet demand among regulators and consumers for safety and security features, as well as infotainment and navigation. This rapid growth will be driven in part by positive regulatory action in Europe, Russia and Brazil.

Connected vehicle technology includes the following:

- **Fleet telematics allows emergency services and commercial fleet operators to increase utilisation factors for their vehicles, improve driving standards and fuel efficiency, reducing emissions and vehicle wear.**
- **Links to infrastructure systems which manage traffic flows on roads, including Urban Traffic Management & Control, roadside Variable Message Signs to inform drivers of reduced speed limits, traffic jams and other safety messages.**
- **Communication with public transport measures including selective vehicle detection, traffic light control and real time passenger information.**
- **Vehicle to Vehicle systems (V2V), where vehicles interact with each other using wireless networks, sending information about weather, speed, location, direction of travel, braking, and loss of stability, typically using Dedicated Short-Range Communications (DSRC) at 5.8 or 5.9 GHz, and/or a mesh radio network.**
- **Vehicle to Infrastructure systems (V2I) allow wider area dissemination of traffic and safety information, as well as vehicle tracking and recovery, emergency call (e-Call), the set-up of WiFi and 3G hot-spots, reservation of and guidance to parking spaces.**

Telefónica has an agreement with Tesla to supply connectivity for its in-car infotainment system and remote vehicle diagnostics, in Germany, the UK and Spain. **http://www.gsma.com/connectedliving/telefonica-tesla-agreement/.**

2.2 Driver support and Intelligent Speed Adaptation (ISA)

This includes:

- **ADAS (Advanced Driver Assistance Systems), including collision avoidance which support the driving task by reducing work-load and raising awareness of risk. It can be autonomous (contained within the vehicle) or cooperative by interfacing to other vehicles and to infrastructure.**
- **Autonomous Cruise Control (ACC)**
- **Crash avoidance and Black Box recorders**
- **Intelligent Speed Adaptation (ISA) – advice on or control of vehicle speed and driver advisories. There has been much research on ISA, especially in Sweden, Australia and the UK, including a large-scale trial in London, but the transition to wide commercial use still hasn't happened. It may come about through the widespread availability of smartphones, coupled with the increasing interest in Usage-based Insurance (UBI). Also it is being subsumed into and replaced by the connected car and "autonomous vehicles".**

2.3 Autonomous vehicles and self-driving cars

Self-driving cars are one of the hottest of current hot topics. Research has been carried out in the US, Western Europe and Asia-Pacific for decades, but the topic has now entered the public and political consciousness – largely due to the Google self-driving car.

Autonomous vehicles sense their surroundings using radar, LIDAR (Light Detection And Ranging – like radar but using light instead of microwaves), GPS, and computer vision, and can navigate without human input. Advanced control systems interpret sensory information to identify appropriate navigation paths, as well as obstacles and relevant signage. Autonomous vehicles can update their maps based on sensory input, allowing the vehicles to keep track of their position even when conditions change.

Autonomous vehicles exist mainly as prototypes and demonstration systems. However, as of early 2015, there are self-driving vehicles that are commercially available; these are open-air slow-speed shuttles for use in pedestrianised zones, though many countries are gearing up to run trials and to amend legislation to permit driverless cars on their roads.

3 Enforcement and security

"Enforcement" covers topics such as detection of toll evaders, bus lane and red light running, speed cameras, crime detection and security. A related topic is "vehicle classification systems" (because tolls may be dependent on vehicle size and other characteristics). One hot topic is "average speed zones", where speed limits are enforced by cameras in a road corridor or area, rather than at a single point, with proven safety benefits. By definition, such zones need communications between cameras, or to a control centre, in contrast to the "Gatso" spot-speed cameras.

3.1 Enforcement technology

Technologies involved include Automatic Number-Plate/License Plate Recognition (ANPR/ALPR), which is used to recognise and identify vehicles. There are many suppliers of this technology, which is a very computing and electronics-intensive topic – and is being increasingly used in the US in "video tolling" – see section 5.

3.2 Networking & security in vehicles

An important topic in many areas, not just in transport. Homeland Security continues to be of importance in ITS, especially in the US but also more widely. The UK and the US have just entered into a joint agreement to collaborate on this topic. There are concerns about protecting infrastructure, and about the susceptibility of autonomous and connected vehicles to hacking and cyber terrorism. Chinese students recently hacked a Tesla electric car and opened its doors while it was on the road; US researchers have demonstrated a cyber attack on Toyota Prius and Ford Escape vehicles which could affect steering and braking; but these incidents were in research and test environments; no such attacks have been reported in the "real world" – as yet.

Concerns about these issues have reached the highest levels, including the World Economic Forum. Its Global Risks 2015 report identified the increasing potential for digital attacks on cars.

The GSMA believes that mobile operators are well-placed to contribute to automotive cyber security due to their expertise in authentication and security and emerging technologies such as the eUICC.

The GSMA are developing IoT security guidelines to ensure best practice for the secure connection and management of IoT devices on any mobile network. A unified and robust approach to security will create a trusted, reliable environment that can scale as the market grows. The security guidelines will be out of comment in October 2015 and final release in February 2016.


BUS
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4 Fleet Management, PayAsYouDrive Insurance & Parking

Fleet management includes optimal routing, and monitoring of vehicle health and driving style. At least 80% of freight traffic by weight – more by value - travels by road; it is vital to national economies. The fleet management markets in Europe, Russia/ CIS and China have annual growth rates of 14%, 16% and 23% respectively. Penetration will reach 20% by 2019. GPRS meets the key parameters of area coverage, network latency and data bandwidth and 3G/4G technologies will bring increased uplink speeds and reduced latency, improving the consumer experience and creating opportunities for the ITS ecosystem.

Pay As You Drive Insurance (PAYDI – aka Usage-Based Insurance - UBI) is an expanding field, doubling annually in some cases, as insurance companies reduce costs and acquire more sophisticated tools to categorise drivers, using “dongles” with GPS receiver and SIM card in the vehicle OBD, or smartphone apps.

Helping drivers find parking spaces minimises congestion and pollution. Charges can be sent wirelessly to meters. Motorists can pay from their mobile. Many cities use SMS for parking charges in the US, Europe, Australia and United Arab Emirates.

4.1 Fleet management

Fleet management refers to haulage companies, car hire organisations, emergency services, breakdown/rescue services and others managing their vehicle fleets, including optimal routing, monitoring of vehicle health and driving style. It has been used for 40 years, though in the past it may have necessitated an organisation having its own mobile radio network. But the availability of ubiquitous and affordable mobile communications, satellite location systems, the significantly reduced cost of in-vehicle equipment, and the wish to maximise productivity and customer service while minimising environmental pollution, means that it is an expanding marketplace.

Most freight traffic travels by road rather than by rail – typically 85% according to official statistics, which are usually based on tonne-kilometres – but in terms of value the road freight proportion tends to be higher since much rail freight is low value bulk material. Hence road freight is vital to national economies – it has been estimated that 15% of the cost of everything we buy is a transport cost.

Fleet Management in China

Commercial vehicle fleets are essential to the Chinese economy and its future development. Road transport represents 75% of the freight total by weight - around 31 billion tonnes in 2013. There were almost 17.9 million vehicles in 2011, plus 2.5 million buses. Berg Insight expects steep growth in the Chinese market, and renewal of the vehicle fleet to combat pollution. Fleet management systems will grow at 22.9% annually, from 2.1 million units in 2014 to 5.9 million by 2019. Penetration will increase from 9.0% 2014 to 19.8% in 2019. Track & trace systems dominate the market and the installed base includes low-end systems with limited functionality. Once again, most fleet management systems use the 2G/3G/GPRS wireless networks, with satellite communication in unpopulated areas. The major fleet management suppliers are Chinese, including E6GPS and Etrans. Some Chinese commercial vehicle OEMs have introduced telematics systems, notably Foton and Shaanxi Automobile Group. Automotive suppliers are expected to equip new commercial vehicles with telematics systems following government initiatives.

With the predominance of GSM/GPRS communications set to increase with the move towards 3G and 4G, and the consequent improved service to end-users, Mobile Operators will be critical partners in the innovation, implementation and operation of fleet management services globally.

4.2 PAYDI & UBI

Pay As You Drive Insurance (PAYDI), also known as Usage-Based Insurance (UBI) is a hot topic, with increased interest in the US and Europe as insurance companies seek to reduce costs and to acquire more sophisticated tools to categorise drivers, especially with developments such as the EC ban on charging by the sex of the driver.

Although the percentage of UBI policies is still small (8% in the US in mid-2014), it has doubled since early 2013. Drivers' privacy concerns have also declined, from 42% to 35%, at least according to some reports, though others dispute this. Certainly there are concerns about the "dongles" used in these applications, and the extent to which they may compromise security and privacy. Dongles usually plug into the on-board diagnostics (OBD) port on a vehicle, and typically contain a processor and memory, a GPS receiver to determine location, an accelerometer to identify periods of harsh acceleration and braking, and a SIM card to relay data back to a control centre via a GPRS link. Thus dongles can provide valuable information to insurance companies and fleet managers, including:

- **Start and stop times and locations**
- **Idling time**
- **Journey duration**
- **Roads used and mileage covered**
- **Use of seatbelt**
- **Use of accelerator and brakes**
- **Time, direction and severity of impact**
- **Driver and number of passengers, if camera is installed in vehicle**

It appears that 80% of smartphone owners are willing to download apps to their phones that would track their driving. In the US in 2014 the Allstate insurance company began testing a smartphone app called Drivewise Mobile, which is available in 19 states and Washington, D.C. The UK Automobile Association also has a free-to-download usage-based insurance app for smartphone users. This is important because dongles are relatively expensive. The Progressive insurance company, based in Ohio, announced that it was comparing results of the mobile app with data from its "Snapshot" device in the same car.

Android and iPhone smartphone apps can cut up-front costs, tracking driver habits such as mileage and braking in exchange for reduced policy costs. Google and Apple also have other advantages, including being accepted as big data collectors. Apple's "CarPlay" allows iPhone users to make calls, use Apple Maps, listen to music and access messages by touch or voice commands. The iPhone is connected to the car through a cable, and CarPlay can then be controlled from the car's built-in display or by using Siri, Apple's iOS voice system. Google has introduced the similar Android Auto. Vehicle manufacturers including Audi, Honda, Nissan, Subaru, Jeep, Dodge, Chrysler, Chevrolet, Mazda and Volvo have said they will support both CarPlay and Android Auto.

In early 2015 AT&T and LoJack Corporation, a leader in vehicle theft recovery and advanced fleet management solutions, announced a collaboration to power LoJack's current and future telematics solutions. Both companies are committed to providing machine-to-machine and telematics solutions to the automotive and fleet industries, giving better operational efficiency, improved customer service and increased profitability.

4.3 Parking

Parking objectives, principles and practice

Studies have shown that a large percentage of urban traffic (from 8% to 74% at different times and places) may be drivers cruising around looking for a parking space. Facilitating their task – and tailoring the parking charge appropriately, will help to minimise congestion and pollution. The price should be set so that one or two curb spaces are usually vacant on every block so that drivers can always find convenient parking, but with 85% of spaces occupied all the time. Prices can be variable, with new rates sent wirelessly to meters. Public acceptability is increased if the revenue is spent on local infrastructure (Shoup 2011). According to Cisco (2013), the field of "smart parking" is valued at $41 billion worldwide.

Westminster, London

In 2013/14 Westminster City Council installed more than 3,000 parking bay sensors which detect whether a bay is vacant; drivers can use a smartphone app to view a real-time map of parking spaces, updated every minute, showing where there are empty bays, and directing to the nearest one. This award-winning "ParkRight" app will reduce the time spent driving around looking for a parking space and the congestion on Westminster's roads. The scheme is attracting world-wide attention. Installation of a further 7000 sensors will be considered in 2015. The number of PaybyPhone (PbP) transactions increased by 4.7% in 2013/14, to 669,343, whereas the number of transactions for card-only Pay and Display parking remained constant (Westminster (2014).

5 Road Pricing

Road Pricing incorporates Tolling, Road User Charging, Congestion Charging, Electronic Fee Collection (the EC term) and Value Pricing (in the US). This is an important topic in the ITS area.

'The potential for benefits from a well-designed, large-scale road pricing scheme is unrivalled by any other intervention"[1] - though commercially progress has been slow, because of fears of public and political unacceptability, road pricing appears to be acceptable if it is equitable, revenue-neutral and efficient. Dramatic traffic reduction is achieved with minimal charges, without diversion onto other routes. Satellite technology with mobile communications allows charging by Time, Distance and Place. Germany and Slovakia use GPS/GSM-based truck-tolling schemes, as will Belgium (T-Systems & Belgacom) and Bulgaria. Singapore will migrate to GSM/GPS for all vehicles by 2020. In the US Oregon is trialing road pricing as a "gas tax" replacement, with one option using a smartphone. Verizon is involved in the trial through insurance company State Farm. California and other western states are closely following the trials. Other countries also have declining revenue from motor (especially fuel) taxes. Mobile operators are used to keeping large volumes of sensitive data secure, so are ideally placed to play a role in road pricing; whether city-based or over wider areas, including across multiple boarders.

5.1 City congestion charging

The existing city congestion charge schemes use either microwave DSRC technology (Singapore), or cameras plus Automatic Number Plate Recognition (ANPR) (London, Stockholm, Gothenburg).

Although probably not connected to Singapore's road pricing plans, it is worth noting that Singtel and Ericsson announced in January 2015 a partnership to explore the future of 5G communications in Singapore, including the Internet of Things and "cloud-based computing".

Slovakia

Global Navigation Satellite System (GNSS) / GSM-based charging has been used in Slovakia since January 2010, for lorries of over 3.5 tonnes on 600 km of motorways and 1,800 km of first class roads. The objectives are to finance the operation of the motorway network, and to charge 'through-traffic'. A quarter of a million OBU dongles have been issued; a GNSS/GSM OBU is mandatory for all trucks.

The Slovakian system claims to be the first based only on GNSS, for all major roads, and was relatively cost-effective to implement, taking only 11 months to build up the 2,400km toll network. Updates of the "geomodel" of the road and zone network are performed over the air using secure GPRS data communication, allowing new roads and other infrastructure to be incorporated quickly and easily. The ease of extending a GNSS/CN scheme is likely to influence other potential adopters and upgraders.

2. Eddington, 2006 - transport report for the British Government

6 Public Transport

Public transport works well in high-density urban environments, but less so in rural or suburban environments. Nonetheless, public transport is crucially important, especially in urban and suburban areas as the world-wide trend is towards increasing urbanisation.

Public bodies are making transport data available for app developers, increasing transport efficiency. Benefits of smart-phone Near Field Communication (NFC) include passenger convenience, lower sales and distribution costs, more flexibility, personalised communication with passengers and promotion of public transport. For the consumer, mobile technology allows travel time to be used productively and mobile ticketing will triple between 2013 and 2018.

A journey may include more than one mode of transport. Research identifies four areas that can make public transport easier and more convenient (DfT 2014):

- **Improving the quality and availability of information;**
- **Smart and integrated ticketing;**
- **Improved and reliable connections in multi-modal journeys;**
- **Safe, comfortable and easily accessible transport facilities, meeting the needs of passengers.**
- **An important part of this is making data available for app and other developers; see www.data.gov.uk**

Car-pooling and dynamic ride-sharing, encouraged by mobile technology, reduce congestion and pollution, and commuter costs. Zipcar (Avis) claims to be the world's leading car sharing club, based in North America and Europe. DriveNow (BMW/ Sixt) operates in Europe and San Francisco. Some companies, including Uber (Google) and Lyft, have turned dynamic ride-sharing into a successful business. Car-pooling, car clubs and dynamic ridesharing rely on mobile technology, and their use will increase.

Cycling is increasingly used for short journeys in cities. Customers of cycle-hire schemes use smart-phones to check availability, locate, pay for and unlock bikes, . The Dutch VANMOOF company has GPS connectivity and Vodafone M2M SIMs in its e-bike to combat theft and to map commuter routes.

7 Travel information and Traffic management

Traffic and traveler information play an increasingly part in traffic management, and empower passengers. Car drivers will switch to transit if they can manage their commutes through smartphone apps with real-time information on schedules and delays.

Apps are cheaper than electronic displays at bus-stops. So mobile technology and social media can improve the passenger experience and benefit the transport operator and the MNO. The annual "App Quest" competition of New York State's Metropolitan Transportation Authority (MTA) uses real-time data sets and APIs, with $50,000 prize money from AT&T.

Road traffic information supplied by mobile technology: The Singapore Land Transport Authority use drivers' smart-phones as traffic sensors and to deliver personalised real-time traffic information. The Waze (Google) app generates traffic, mapping and other road data in back-ground mode, and reports on traffic disruptions or fuel prices. Social media, especially Twitter and crowd-sourcing, are important sources of transport information and control. 90% of US States use Twitter and Facebook to publicise traffic incidents, construction projects and safety initiatives; 50% offer mobile apps and 73% have mobile-friendly web sites.

7.1 Social Media in Transport

In 2013 there were 680 million active monthly mobile users of Facebook, 120million users of Twitter and 46 million users of LinkedIn (GSMA 2013b). These and other social media, especially twitter and crowd-sourcing, have become an increasingly important source of transport information and even of control. People may learn about a road traffic accident or transport problems through twitter before they hear about it from their traffic information service; for example, Transport for London asks people to follow @TfLTrafficNews to get live travel news and avoid disruption. Car-sharing has been found to be more acceptable with "Facebook Friends" than it is with strangers.

Social media allow transport users to communicate and share intelligence with each other as distinct from the traditional relationship of communication between transport system providers and end users, as we have seen above.

8 Conclusions

ITS is a complex subject, but the transportation solutions being developed under this banner have the ability to transform our daily lives.

From the effective and profitable running of a transport operators business or the efficient operation of a city right the way through to an enhanced customer experience or the increased safety of an individual citizen.

ITS solutions clearly offer many benefits, but establishing the correct ecosystem to deliver these solutions is critical. In many cases Policy makers will play a large role in defining not only how services are delivered but how interoperable and collaborative these services are. In order to create transformational ITS solutions and inform supportive policy choices it is important that the ecosystem partners start to collaborate. The GSMA believe that mobile operators have an important role to play in the generation of ITS and would encourage the ITS ecosystem to engage with their local mobile operators.

9 Further Reading

Relevant GSMA publications

GSMA (2015), Intelligent Transportation Systems Report for Mobile, April 2015.

GSMA (2012), White Paper: "Mobile NFC in Transport", September 2012. Amended April 2013.

GSMA (2013a) "Guide to Smart Cities: The Opportunity for Mobile Operators", February 2013.

GSMA (2013b), "The Mobile Economy 2013".

GSMA (2013c), "Connected Car Forecast: Global Connected Car Market to Grow Threefold Within Five Years", February 2013.
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GSMA (2014a), White Paper: "The Value of Mobile Commerce in Transport". February 2014.
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GSMA (2014b), "The Mobile Economy 2014".

GSMA (2014c), "Smartphones &Mobile money: The Next Generation of Digital Financial Inclusion", GSMA July 2014.

GSMA (2014d), "Smoother, Smarter Transport in the UAE", January 2014.

Other publications

Automotive Council UK. (2014), "Connected and cooperative transport: for a safe, efficient and sustainable transport system". Technology Roadmaps. Sept. 2014. https://www.transportinnovation.se/system/files_force/dokument/roadmap_for_connected_and_cooperative_transport.docx?download=1

Beecham Research (2014), "Benefits analysis of GSMA Embedded SIM specification on the Mobile Enabled M2M Industry". Beecham Research Ltd and GSMA, September 2014.
http://www.gsma.com/newsroom/wp-content/uploads/BRL-Benefits-Analysis-GSMA-Embedded-SIM-Specification-2014.pdf

Begg, D. (2014), "A 2050 vision for London: what are the implications of driverless transport". (Commissioned by Clear Channel).

Berthelsen, E, (2015) "Movement analytics delivers an untapped revenue opportunity for mobile operators", Machina Research White Paper for INRIX, February, 2015.
https://machinaresearch.com, www.INRIX.com

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USDoT (2015a) "2015 Pocket Guide to Transportation", US Department of Transportation, Bureau of Transportation Statistics.
http://www.bts.gov/publications/pocket_guide_to_transportation/2015/

USDoT (2015b) "Beyond Traffic: Trends and Choices 2045", Draft, US DoT, February 3, 2015. www.dot.gov/beyondtraffic.

Walport, M, (2014) "The Internet of Things: making the most of the Second Digital Revolution". A report by the UK Government Chief Scientific Adviser. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/389315/14-1230-internet-of-things-review.pdf

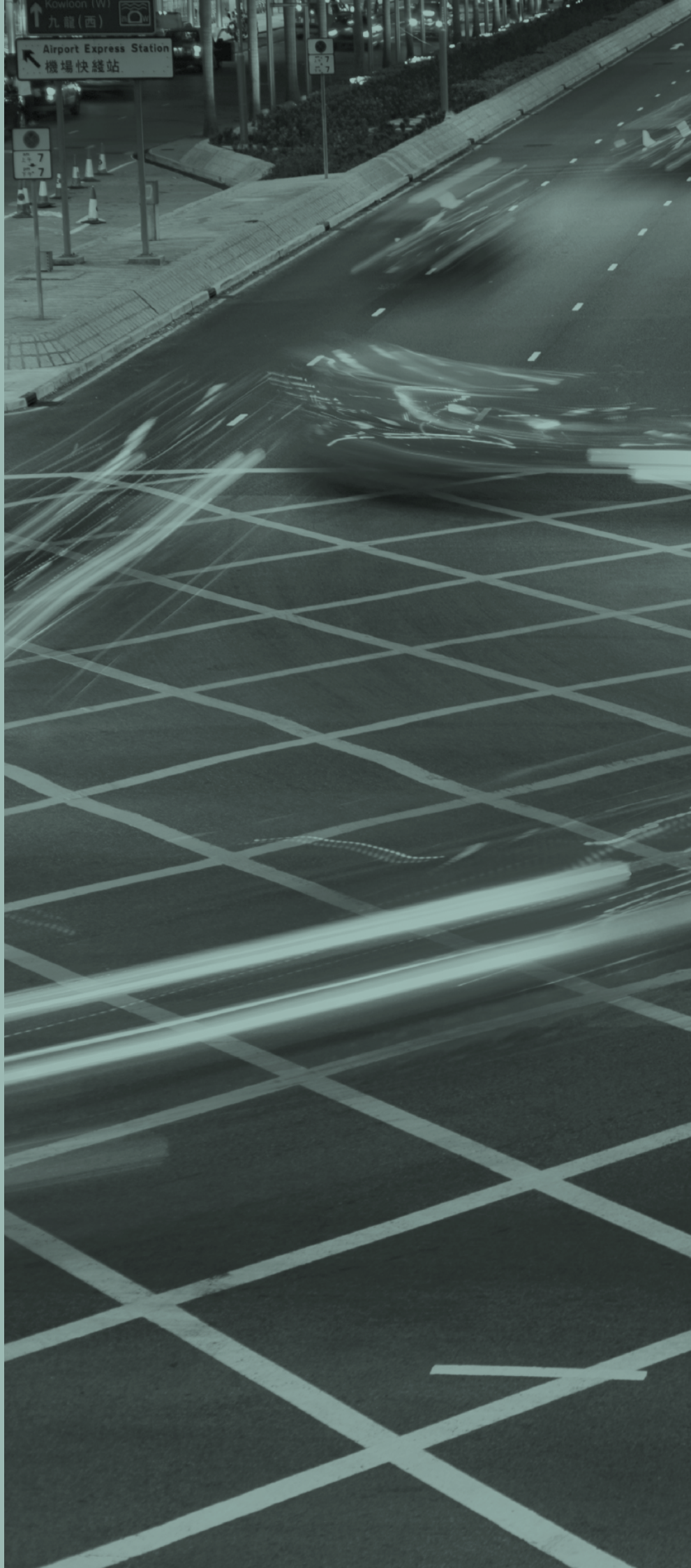
Useful websites

All the national ITS associations, including, ITS America, ERTICO and ITS Japan, have useful websites, and in some case newsletters that can be subscribed to.

13th ITS Asia Pacific Forum, Auckland, New Zealand, 28-30 April 2014
http://www.itsasiapacificforum2014.co.nz/final-papers/

C-ITS web sites:
http://its-standards.info
http://its-standards.info/Feeds/cits.rss
http://release1.its-standards.eu/
http://calm.its-standards.info
http://coopsys.its-standards.info
http://pt1601.its-standards.info
http://stf455.its-testing.org

Telematics: http://analysis.tu-auto.com/



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