traffic
TECHNOLOGY INTERNATIONAL

January 2014

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Articles on Inrix's XD Traffic, La Trobe's solution for safer level crossings, Singapore, electronic license plates and much, much more!

Visual effects
The real-world benefits of advanced signs and displays

Divided opinions
How operators are embracing ITS for safer bridge crossings

Ready or waiting?

Todd Litman and a panel of transportation experts separate hype from reality and contemplate the future impact of driverless cars on our roadways

PLUS

Paul Pisano, FHWA, RWMP
"There's research needed to develop the appropriate weather tools so that DOT folks can gain the confidence in them"

Behind the lens
Leaders in machine vision assess the success of smarter cameras in road traffic management

The light brigade
Saving the planet, enhancing safety and stretching your budgets with more intelligent streetlighting

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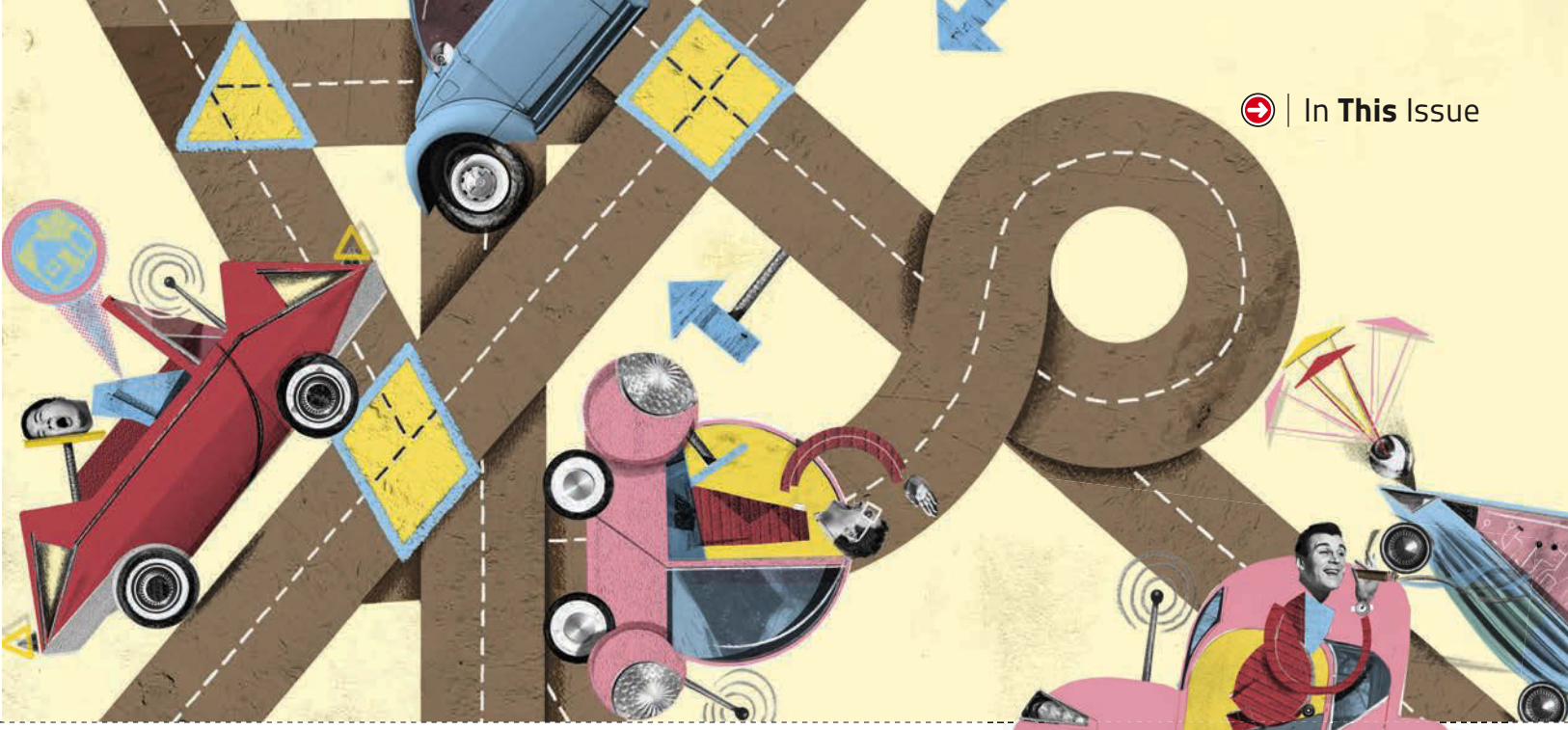


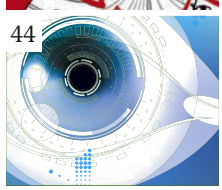
Cover story

36 Ready or waiting?

Why it could be decades before the benefits of the AV are felt

Todd Litman analyzes the potential costs, benefits and impact of the driverless car on transportation managers

Features



Interviews

Regulars

Technology Profiles

Foreword

Tokyo was all that I imagined it would be. By night I'd liken it to a scene from *Blade Runner*, minus the replicants. In rush-hour, it confirmed its reputation for being a crowded, claustrophobic metropolis. As we piled onto the Yanamote line at 7:30am – quite literally stuffing ourselves on board railcars like sardines into a can – conversely it all ran with a uniformed professionalism and an *esprit de corps* that I would argue puts the Swiss to shame.

Japan's capital city was also every bit as high-tech as I was led to believe – from taxi cabs replete with cameras to detect personal items left by occupants to its architecture, tourist information points, vending machines and, forgive me, even its WCs. The 'washlet' in my hotel room boasted a heated seat, remote control and an automatic bidet nozzle that washes 'users' with warm water before drying them with air (paper is optional). Rather embarrassingly, I did have to call room service to help me locate the flush.

As far as the 20th World Congress on ITS goes (my reason for being in Japan), there were gadgets galore on show. The theme of the 2013 event, 'Open ITS to the NEXT', I never quite grasped. But if it was meant to symbolize the next-gen systems on our ITS horizons, we're clearly in for an exciting ride. Organizers promised leading-edge science and didn't disappoint. My impression after four days at Tokyo Big Sight? People are really very serious about autonomous driving.

Given the number of demonstration vehicles exhibited – and sophistication of ADAS on show to usher in this driverless era – it's difficult not to get caught up in the current wave of 'Google' hysteria. Still, I couldn't resist devoting our cover story to that topic, with Todd Litman's article (p36) looking specifically at timelines for deployment, likely benefits and costs – and why the latter especially means traffic managers shouldn't be redesigning their roadways just yet. In all likelihood I'll be in my 90s before there's sufficient enough penetration for an autonomous fleet to have a widespread and discernible impact, by which time I might be teleporting myself everywhere anyway.

Nevertheless, I'm sure Litman's timeline for deployment won't curb the enthusiasm for autonomous vehicles among the mass media. And given the noises being made in officialdom, you can't really accuse them of sensationalism. As we put this January 2014 edition to bed, NHTSA appears to have given a cautious green light to the numerous ongoing autonomous driving projects of automakers and Tier 1s, with the caveat that they won't be hitting our roads "immediately".

More's the pity. Apart from the practical benefits, they could contribute US$1.3tn in annual savings to the US economy alone and US$5.6tn worldwide, if a recent Morgan Stanley study holds true. How? Declining costs for fuel and accidents, as well as US$507bn in annual productivity gains (the time currently spent driving could be spent working). While the thought of adding yet more hours to my working day is as appealing as a bidet nozzle hosing my nether regions, a healthier economy is good news for all. Enjoy the read!

Nick Bradley, Editor-in-chief

Traffic Technology International
UKIP Media & Events Ltd, Abinger House, Church Street, Dorking, Surrey RH4 1DF, UK
Tel: +44 1306 743744 • Fax: +44 1306 742525
Email: traffic@ukipme.com • www.ukipme.com

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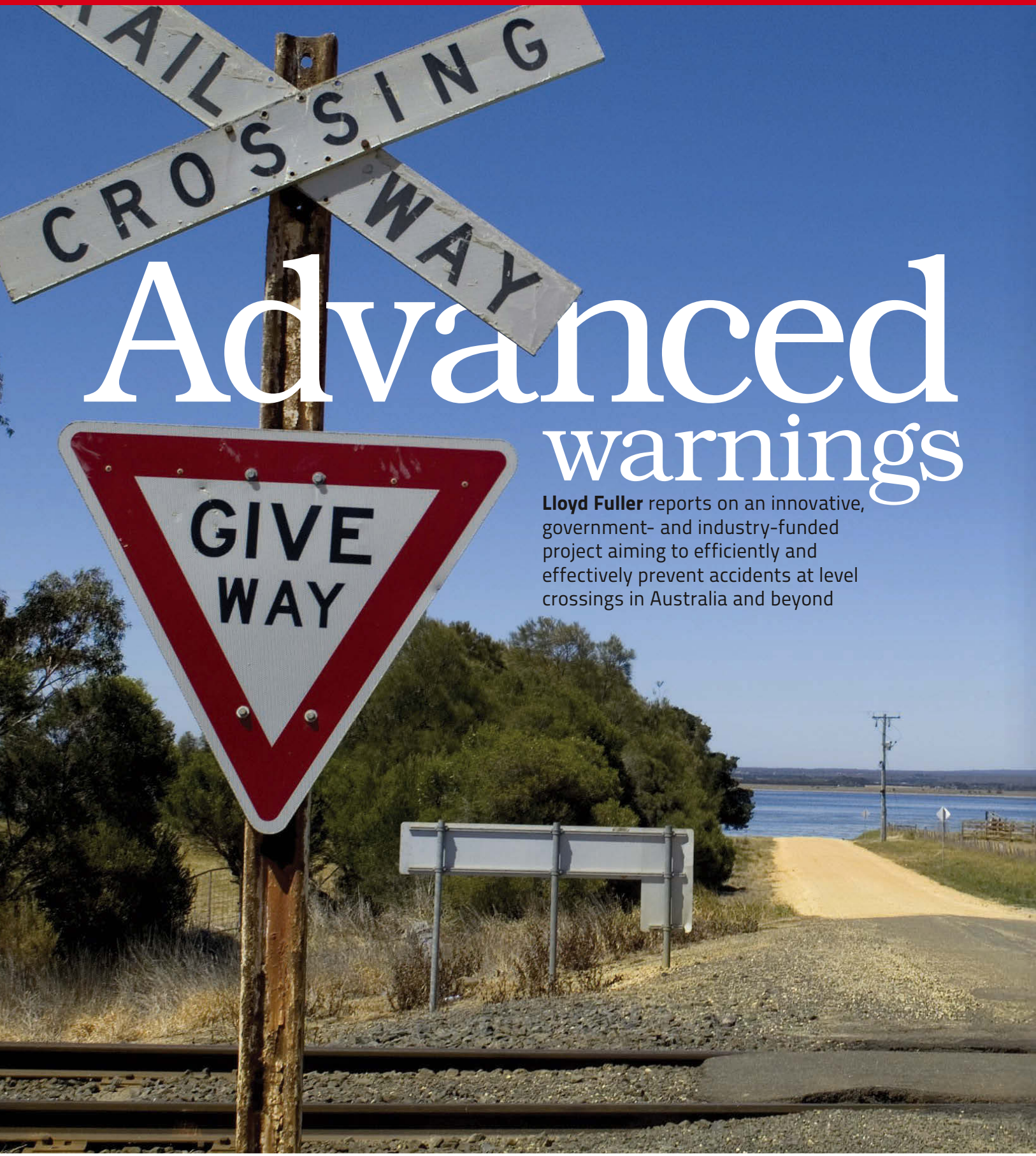


Advanced warnings

Lloyd Fuller reports on an innovative, government- and industry-funded project aiming to efficiently and effectively prevent accidents at level crossings in Australia and beyond

On June 5, 2007, a truck was hit by a passenger train on a level crossing near Karang in the Australian state of Victoria. Eleven people died and eight were seriously injured. Following a recent inquest into the tragedy, coroner Jane Hendtlass made 25 recommendations including changes to road signage, warning systems and emergency response procedures at these conflict points on the road network, stressing that transport and road authorities need to work together to provide better technology and infrastructure to improve safety.

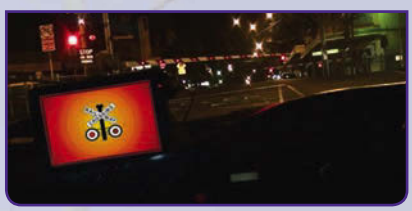
At the 19th session of the UNECE Committee on Environmental Policy in Geneva (October 2013), Jack Singh, director of the Centre for Technology Infusion (CTI) at Melbourne's La Trobe University, spoke about a current A$5.5m (US$5.1m) project that directly addresses Hendtlass's recommendations.

"We believe we can save lives at level crossings," Singh says. "Our technology enables vehicles to talk to each other. Through enhanced awareness, alerts and warnings, driver and passenger safety is increased."

The Intelligent Transport Systems to Improve Safety at Level Crossings project – developed by Singh and his colleagues at CTI – is built on GPS and DSRC technology. Using a dedicated wireless network, it exploits rapid vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication to warn road users of potential dangers.

"As a train approaches a level crossing, it sends information to other road users in the vicinity," reveals Singh. "Data includes information such as vehicle size and type, position and motion, as well as facets such as brake status, throttle and steering angle."

More than 630 collisions occurred on Australia's level crossings between 2001 and 2009. They are mainly attributed to driver error, poor communications, signaling difficulties or environmental conditions such as visibility. "Existing measures include passive and train-activated warning signs and signaling systems," says Singh. "Passive signs are an economical option, but their effectiveness is limited when it comes to visibility, human error or poor driver behavior. Yet active warning systems, such as boom gates, are expensive to install."



This data is interpreted by an application developed for the project that generates warning messages – advising motorists of approaching trains, expected delays, etc – inside nearby cars. "It enables warnings to be transmitted to drivers before the level-crossing interaction, so they're not suddenly overloaded with information in a high-risk situation," Singh says. "There are also different alert levels. Drivers have 360° awareness of their surroundings."

In June 2013, CTI received the Victorian iAward merit in the Research and Development category for its level crossing project

There are already numerous in-vehicle HMI (human-machine interface) solutions that use GPS to warn motorists about forward collisions and lane departure, but this is the first system dedicated to providing warnings at level crossings. CTI's technology features a dashboard-mounted touchscreen LCD device that incorporates a HUD (head-up display) developed in accordance with ISO guidelines for international use.

"Level crossing safety is not isolated to Australia – it's a global issue and this will have a global impact," says Singh. "We hope that when the 2016 World Congress on ITS occurs in Melbourne, delegates will come and see how this technology could be implemented all around the world."

Technical trials

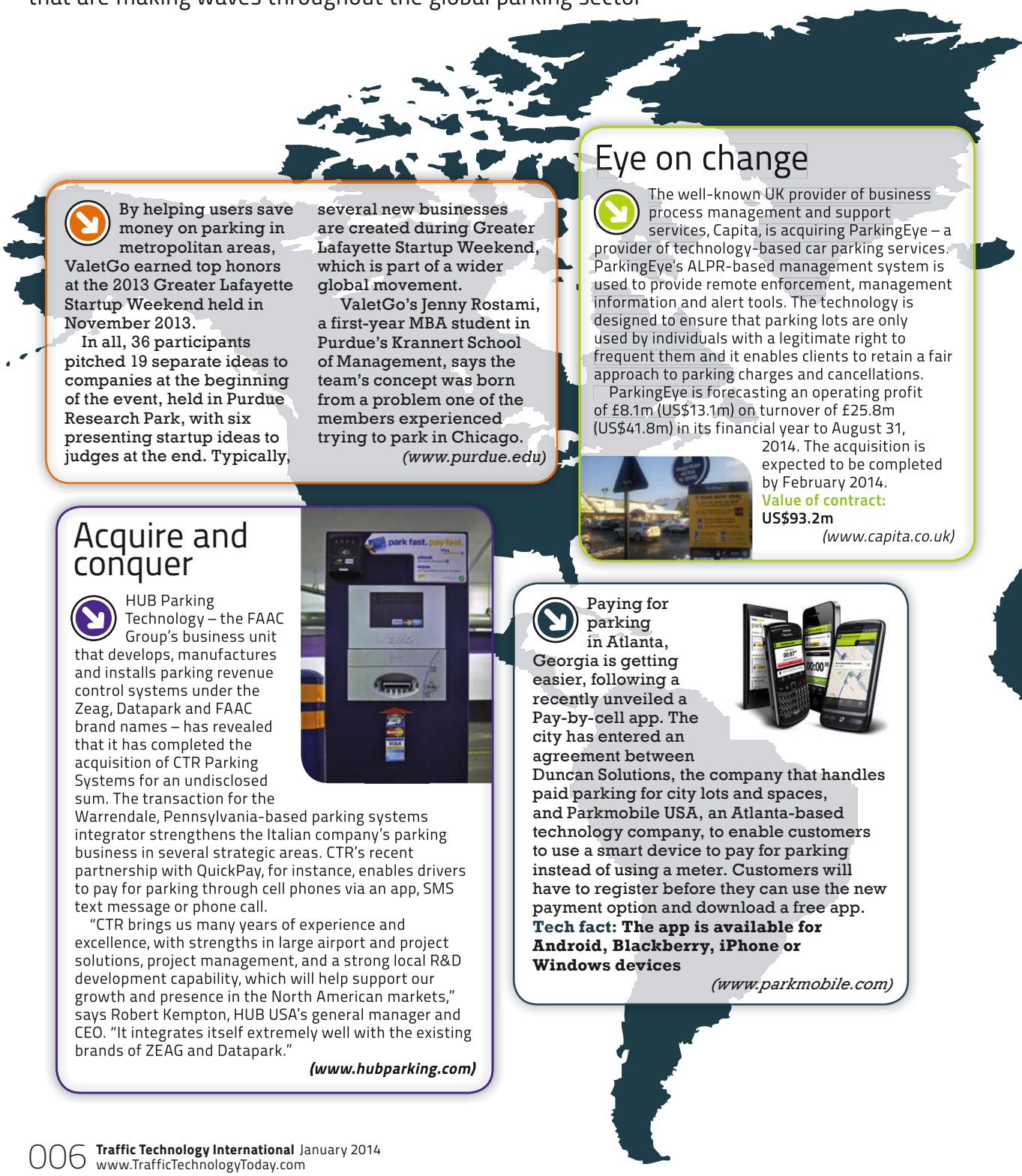
Several real-world trials involving large numbers of vehicles at level crossings in both urban and rural locations took place in Victoria in 2012. "These included orchestrated trials where drivers were given instructions about their driving routes and approach speeds, as well as a six-week longitudinal trial where 10 local drivers were asked to drive as they normally would while 16 radios were fitted to eight live trains that passed through the level crossing," says Jack Singh. "Participants in all of the field trials reported a high level of alert effectiveness. The most noticeable and intrusive alert received the highest ratings, while a low-level advisory notification received the lowest. This was in keeping with our objective – that alerts should be non-intrusive in non-threatening situations."

CTI's technology is currently being trialed by the Queensland Government as part of a A$2m (US$1.9m) initiative to address safety at railway level crossings.

> "Level crossing safety is not isolated to Australia – it's a global issue and this technology will have a global impact"
>
> *Jack Singh, director of the Centre for Technology Infusion at La Trobe University*

Parking matters

Parking management is often a neglected facet of the overall traffic management picture. To counter this, **Lloyd Fuller** reveals the new contracts, technologies and business deals that are making waves throughout the global parking sector



By helping users save money on parking in metropolitan areas, ValetGo earned top honors at the 2013 Greater Lafayette Startup Weekend held in November 2013.

In all, 36 participants pitched 19 separate ideas to companies at the beginning of the event, held in Purdue Research Park, with six presenting startup ideas to judges at the end. Typically, several new businesses are created during Greater Lafayette Startup Weekend, which is part of a wider global movement.

ValetGo's Jenny Rostami, a first-year MBA student in Purdue's Krannert School of Management, says the team's concept was born from a problem one of the members experienced trying to park in Chicago.

(www.purdue.edu)

Eye on change

The well-known UK provider of business process management and support services, Capita, is acquiring ParkingEye – a provider of technology-based car parking services. ParkingEye's ALPR-based management system is used to provide remote enforcement, management information and alert tools. The technology is designed to ensure that parking lots are only used by individuals with a legitimate right to frequent them and it enables clients to retain a fair approach to parking charges and cancellations.

ParkingEye is forecasting an operating profit of £8.1m (US$13.1m) on turnover of £25.8m (US$41.8m) in its financial year to August 31, 2014. The acquisition is expected to be completed by February 2014.

Value of contract:
US$93.2m

(www.capita.co.uk)

Acquire and conquer

HUB Parking Technology – the FAAC Group's business unit that develops, manufactures and installs parking revenue control systems under the Zeag, Datapark and FAAC brand names – has revealed that it has completed the acquisition of CTR Parking Systems for an undisclosed sum. The transaction for the Warrendale, Pennsylvania-based parking systems integrator strengthens the Italian company's parking business in several strategic areas. CTR's recent partnership with QuickPay, for instance, enables drivers to pay for parking through cell phones via an app, SMS text message or phone call.

"CTR brings us many years of experience and excellence, with strengths in large airport and project solutions, project management, and a strong local R&D development capability, which will help support our growth and presence in the North American markets," says Robert Kempton, HUB USA's general manager and CEO. "It integrates itself extremely well with the existing brands of ZEAG and Datapark."

(www.hubparking.com)

Paying for parking in Atlanta, Georgia is getting easier, following a recently unveiled a Pay-by-cell app. The city has entered an agreement between Duncan Solutions, the company that handles paid parking for city lots and spaces, and Parkmobile USA, an Atlanta-based technology company, to enable customers to use a smart device to pay for parking instead of using a meter. Customers will have to register before they can use the new payment option and download a free app.

Tech fact: The app is available for Android, Blackberry, iPhone or Windows devices

(www.parkmobile.com)

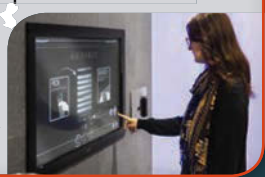
Lost and found

Finnpark's Find Your Car system has been recognized by Viscom – the international trade fair for visual communication, technology and design – as being the best guidance service in Europe. Viscom acknowledges the most efficient, creative and innovative projects with its Digital Signage Best Practice award. Each prominent new product was evaluated for its appeal as a complete package. According to the international jury of multidisciplinary experts, the Find Your Car service provides "a well-designed and practical solution to a common problem: how to find one's vehicle in a large parking lot".

The award-winning installation of the Find Your Car service is located in the P-Hämppi parking lot in the city center of Tampere, Finland. The service is available for use on large touchscreens at several customer service points in the parking lot. The desired vehicle is denoted by just swiping the parking ticket in the card reader. The service relies on real-time information on vehicle identities and locations inside the parking lot. The shortest route to the vehicle is drawn on the screen map. In addition to parked vehicles, the system can be used for finding surrounding city services such as shops, restaurants and public transport. Finnpark developed the service in co-operation with Palko Interactive.

Did you know? P-Hämppi is Finnpark's most modern parking lot in the city center of Tampere, Finland. It was awarded as the best new parking lot in 2013 by the European Parking Association

(www.finnpark.fi)



Austrian traffic technology group Swarco has formed a partnership with a Swiss designer and supplier of 'smart' onstreet parking systems called Tinynode. As a result, the latter's products will now be included in Swarco's portfolio of road safety and traffic management equipment and the technology will additionally be used in Swarco's own systems.

Tinynode designs and sells wireless vehicle detection systems for outdoor parking deployments, its products regularly being used as part of applications such as guidance, monitoring, enforcement, availability and reservation applications. The Lausanne-based manufacturer has so far equipped 40 sites in France, Germany, the UK, Switzerland, Sweden, Finland and the USA.

Swarco, in fact, has already deployed the Tinynode system at its headquarters in Wattens, where the 40 spaces for staff and visitor parking are currently being used as a test bed. What the deployment demonstrates is that wireless products can also be seamlessly integrated into indoor parking management systems.

Tech fact: Tinynode's range of wireless 'puck' sensors features low-power electronics and a self-configuring, multi-hop and self-healing mesh networking protocol

(www.swarco.com)

Mission accepted

ImPark from WPS Parking Systems, part of Royal Imtech, is a new approach to parking management systems that offers parking lot providers a broad spectrum of new possibilities and functionality to optimize revenues, reduce operating costs and improve customer experience. The system recently underwent – and passed – a rigorous testing process according to the exacting new parking systems standards of parking lot operator Q-Park.

"Rather than just adding more modules to traditional parking software – which has been the typical approach in the industry – we took the radical step of developing a completely new IP-based operating platform ideally suited to our interconnected, technology-driven world," explains Peter Peddemors, director of WPS Parking Systems: "The ImPark system is perfect for international roll-out, in support of our overall strategy to become a top three player in the parking technology industry."

Tech fact: The ImPark system is a combination of WPS's popular ParkAdvance hardware and ParkID software

(www.imtech.com)

Streetline and Cisco have deployed an advanced parking technology system in the busy Born Market area of Barcelona, as part of a demonstration project on display at the 'Internet of Things World Forum' held in the Spanish city. Using patent-pending wireless sensor technology embedded in the pavement, the system captures information regarding the occupancy of parking spaces – as well as parking patterns and trends – to not only help motorists more quickly find parking but help officials better manage parking facilities across the city. The smart parking project will also provide valuable information and data that will enable planners to improve the management of urban mobility. This is the first advanced parking project implemented jointly by Cisco and Streetline in Europe.

Did you know? Underscoring the potential impact this technology could have in cities such as Barcelona, an IBM study showed that parking is responsible for around 30% of traffic in cities across the globe, and the difficulty of parking deters 60% of people from participating city activities;

(www.streetline.com)

Island records

Having pioneered the concept of congestion pricing almost 40 years ago, **Singapore** is working on some new ideas to reduce congestion and deter law-breakers on this crowded island state

Infographics courtesy of Louise Adams

The **Land Transport Authority**, of which **Michael Lim Choo San** is chairman and **Chew Hock Young** is chief executive, is responsible for planning, operating and maintaining Singapore's land transport infrastructure and systems

Total population of

5,312,000

in 2012 (which has jumped by more than 1.1 million since mid-2004)

The number of people on the island – a third of the size of Luxembourg – may grow to 6.9 million by…

2030

$ Singapore is spending S$12bn on buses and highways to try to rein in its congestion and to enable future growth

Average speed on
Expressways = **63.1km/h**
Arterial roads = **28.6km/h**

Average daily traffic volume in the city is

292,000

Breakdown of people injured in road accidents (2012)

Total = 9,106
Pedestrian = 939
Cyclist = 391
Motorcyclist and pillion rider = 4,294

Congestion costs Asian economies an estimated

2-5%

of GDP a year due to lost time and higher transport costs

Traffic infrastructure

Number of flyovers = **119**
Number of vehicle bridges = **212**
Number of vehicle underpasses/tunnels = **29**
Number of traffic lights = **2,185**
Number of ERP gantries = **72**

2012 road accident casualties, according to Singapore's Department of Statistics

Fatalities **168**
Injuries **9,106**

Fatalities among two groups of vulnerable road users –motorcyclists and their pillion riders, and pedestrians – declined in 2012, from 99 to 76 and 49 to 44 respectively

There were

330,909

traffic violations detected by Singapore Police in 2012

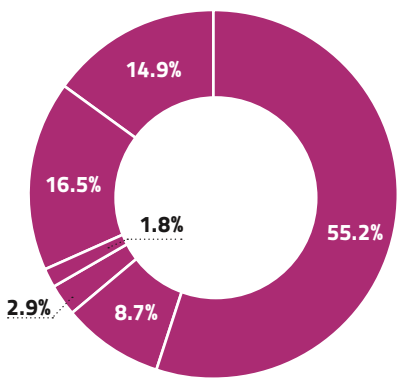
Speeding and red light-running offenses recorded in 2012

Speeding = **245,427**
Red light-running = **18,708**

Singapore implemented the Area License Scheme – road pricing – to address congestion in

June 1975

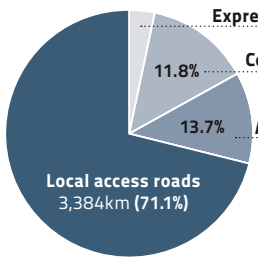
Singapore vehicle population as of 2012



All vehicles 969,910

Private cars 535,233 (55.2%)
Other cars 84,431 (8.7%)
Taxis 28,210 (2.9%)
Buses 17,162 (1.8%)
Motorcycles 144,110 (14.9%)
Goods and other vehicles 160,417 (16.5%)

Breakdown of roads by length…



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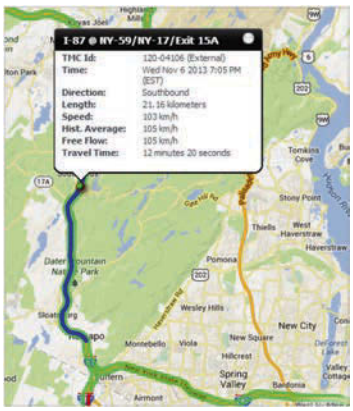
Kapsch TrafficCom provides traffic management solutions allowing road authorities and operators to manage, monitor and maintain their roadways while giving the road users intelligent information to ensure a convenient and save trip. We offer complete end-to-end traffic management solutions for highways comprising back office, roadside controllers, sensors, variable message signs, SOS emergency telephones, and CCTV with IDS functionality by partnering with leading vendors of such systems.

www.kapsch.net

always one step ahead



Far-reaching scope

Inrix XD Traffic has been designed with all of the ideas and audiences discussed in this article in mind. Far more than just another traffic data service, its aim is to fundamentally change the traffic data landscape, and open a world of traffic intelligence to the public and private sectors that previously didn't exist.

At the same time, it is connecting cars better, and makes our roads smarter – bringing communities one step closer to delivering on the promises of intelligent transportation systems.

Free flow and prosper

Justin Graham explains how breakthroughs in traffic science are set to deliver on the promises of intelligent transportation systems

Many of us have been there before, monitoring traffic operations during a normal Friday afternoon prior to our rush-hour commute. A glance at the real-time traffic conditions shows the local interstate as free-flow, the calm before the storm. All of a sudden, the phone rings with a report of an accident with a half-mile backup behind it. A second glance at the real-time traffic conditions still shows free-flow traffic. How can that be?

Currently, the standards that provide the framework for reporting traffic conditions on roadway networks are much like entering a tunnel. Everything may be fine on the entrance to and exit from the tunnel, but there may be something amiss in the middle that you can't see from the outside.

In all, 33 countries are currently receiving real-time traffic information via TomTom Traffic, which uses OpenLR location referencing

Traffic Message Channel (TMC) is the current traffic location standard, originally developed to provide a lower cost, efficient way of delivering traffic and travel information to the navigation systems in consumer and fleet vehicles. Other parts of this and other industries adopted the standard to perform analysis of roadway networks. Transportation agencies followed suit, as it was the best way at the time to move traffic management into a more digital age. The TMC standard was accomplished by dividing all roads into 'segments' and assigning them codes. The logic of the coding was to segment at decision points such as interchanges and intersections. In practice, this approach creates several challenges for transportation agencies and car navigation systems as it forces the traffic intelligence community to paint the entire segment one speed, regardless of its length (which can vary greatly from a half mile to several miles) or the differences in traffic speeds across the segment.

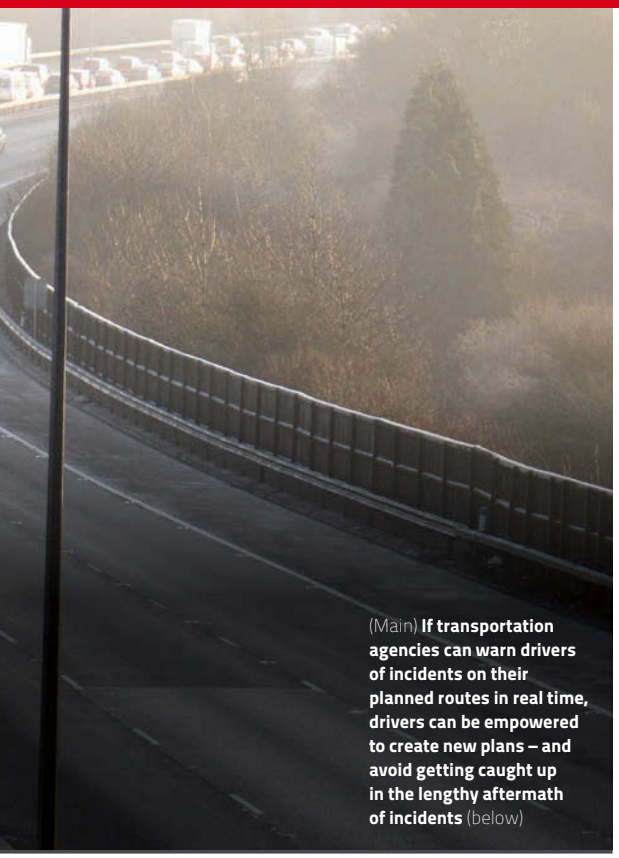
A prime example

One of many examples of this challenge to traffic operations and transportation agencies is I-87 in southern New York. In our real-world example (illustrated top left), an accident has occurred on a stretch of this highway just north of the New Jersey state line.

The TMC segment for this stretch of road is 13 miles long! Although traffic speeds can vary greatly across this length of roadway, until now traffic companies have been forced to average everything together into one speed and travel time reported for this segment.

What if that Friday afternoon accident happens five miles into this segment with heavy congestion starting at mile four and continuing to mile 5.5? The congestion will get averaged out and the segment will report free-flow conditions. Unless there are traffic cameras or roadway sensors on all of these long segments – many of which are in rural areas – DOTs can be blind to the actual conditions.

That example sounds like a very bad situation. Yet what if your state spent millions building a new highway to enhance transportation around a major urban area, but had no way to report traffic on that road? When a new road is built, two key actions must happen



(Main) **If transportation agencies can warn drivers of incidents on their planned routes in real time, drivers can be empowered to create new plans – and avoid getting caught up in the lengthy aftermath of incidents** (below)

in order to report traffic on that road (assuming there are no sensors installed). First, mapping companies must update their maps to reflect the new road. Second, the consortium that manages the TMC table must segment the road and assign TMC codes to the segments.

In some cases this can happen in a short time. However, in many cases it can take years. So how can transportation agencies manage their roads effectively when they are forced to work with limited, imprecise or sometimes non-existent data? The answer can be found in Inrix XD Traffic, a new real-time traffic information service that eliminates these issues and covers more roads, faster and with greater precision than many other services – even sensors. The new services offer improvements in three key areas: coverage, precision and content.

What do the improvements and benefits delivered by Inrix XD Traffic really mean for our roads and the vehicles on them? At the simplest level, they will make life considerably easier for road users, giving them more advance warning of impending congestion problems, more options for alternate routes and much higher levels of confidence in the navigation technology they use – confidence that is often lacking as a result of the uncertainty over the timeliness and reliability of the data. Journeys will get shorter, time spent in traffic will diminish and money will be saved, as the hours wasted in traffic are put to much better use.

But what happens next?

So far, so good. But this driver's good-luck story is just a small part of a much bigger picture in which car manufacturers become more competitive, transportation agencies operate their networks more safely and at less cost while spending more wisely as they invest in intelligent transportation systems, and technology companies spend less time solving repetitive problems. For governments and transport agencies, the promise of high-quality traffic data is entirely new. Tasked with reducing congestion and pollution in cities, reducing accidents on major commuting routes and improving the condition of their highways in the face of increasing traffic congestion, they need better tools with which to plan and manage their road networks. In this context, insight from traffic data is extremely valuable – not just for short-term management of incidents and road closures, but also for longer-term planning of road improvements, better understanding of commuting patterns and improved cooperation with other transport networks. For departments already struggling to achieve more with smaller budgets, even small incremental improvements make a big difference to the bottom line, freeing up money for real improvement and innovation rather than constant defensive maintenance.

And what of the technology companies that make all of this possible? Increasingly, high-quality traffic information and driver services are a critical part of the offerings from device manufacturers, mobile app developers and services-based organizations, enabling them to offer advanced products that provide not only information but also actionable insight. It's the difference between drawing lines on a map and informing a driver if he has enough time to travel from one sales call to another, knowing exactly which route is the best and still arrive in time should an accident occur on the planned route.

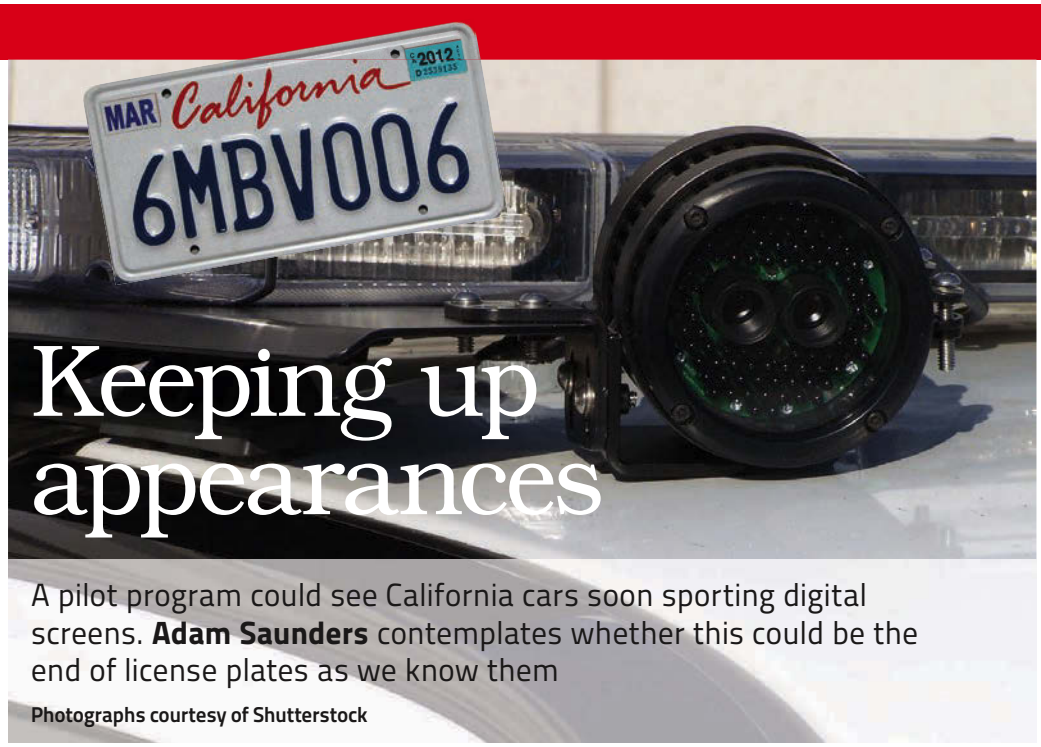
The potential of geo-based services to evolve in ways that generate substantial value has clearly not gone unnoticed by industry giants, who have been busy in their acquisitions of navigation and location-based specialists in recent years. Whether they compete or cooperate, smaller players need to take maximum advantage of available technologies if they are to prosper.

The magic number

There are three ways Inrix XD Traffic solves the issues outlined in this article: *Coverage*: The new service covers four million miles of road in 37 countries. This is compared with just under two million miles under the TMC scheme. This coverage includes more highways, freeways, ramps, interchanges and arterial roads, including ones recently constructed, such as the new Bay bridge between Oakland and San Francisco. *Precision*: Inrix XD Traffic calculates traffic conditions to a granularity of 10m. The Friday afternoon accident discussed in the main article would have been accurately reported and communicated to agencies, in news reports and directly to drivers via navigation apps in the car or on the phone. *Content*: The service provides more coverage of incidents and events than ever before. Incidents are reported faster and more accurately in terms of description and location on the road. This helps emergency responders get to the scene faster via earlier notification of incidents as well as better routes that understand exactly where backups start and end. It also helps law enforcement know exactly where the backs of queues are so that they can dispatch police ahead of these queues, in doing so giving drivers enough warning of approaching slowdowns.

Over 23 billion GPS probe points were received by Here Traffic, a Nokia Business, in August 2013 alone. Here expects this figure to grow rapidly over the next few years

> "Insight from traffic data is extremely valuable – not just for short-term management



Keeping up appearances

A pilot program could see California cars soon sporting digital screens. **Adam Saunders** contemplates whether this could be the end of license plates as we know them

Photographs courtesy of Shutterstock

Pilot pricing

It will cost less than US$50,000 for the DMV to administer the pilot program and complete the evaluation report, according to the Assembly Appropriations Committee.

The pilot is restricted to no more than 0.5% of registered vehicles for the purpose of road testing and evaluation, and limited to vehicle owners who have voluntarily chosen to participate.

The DMV will be responsible for sharing the results of the program with the California Legislature no later than July 1, 2018.

The report will include information about whether the devices evaluated in the pilot program have the ability to transmit and retain information relating to the movement, location or use of a vehicle. If a product does contain that ability feature, the report shall also note if the technology includes any security features to protect against unauthorized access to that information.

More than 10 million license plate renewals take place in California each year; no wonder, then, that the state is actively looking for cheaper ways to process these renewals

> "The technologies used will be based on the DMV request for proposal process
>
> *Senator Ben Hueso*

In October 2013, Senate Bill 806 was signed by California Governor Jerry Brown. This innocuous-sounding bill could actually prove to be somewhat revolutionary; it authorizes the state DMV to establish an electronic license plate pilot program. This could mean an end to license plates as we know them – well, in the Golden State at least.

The pilot needs to be established by January 1, 2017. And although the law does not include the requirement of an electronic solution, previous versions of the bill do mention ideas such as partnering with the private sector on electronic alternatives for payment and processing programs regarding vehicle registration and titling.

The idea to move over to electronic license plates is prompted in great part by financial analysis that suggests if such a system were rolled out, it would lower the cost of DMV vehicle registration services – especially with regard to processing and mailing expenditures. The pilot project will enable the DMV to test a digital electronic plate, and electronically issue the millions of updated stickers and registration cards that get sent out each year.

Senator Ben Hueso, the bill's author, was quoted at the time as saying that, "The DMV may choose to work with a product that already exists on the market." He added, "The technologies used will be based on the DMV request for proposal process. This process will allow the DMV to seek out any and all products in the marketplace that may generate efficiencies within the vehicle registration process."

One company with a somewhat vested – but totally understandable – interest in the pilot is Smart Plate Inc. The company has a patent on digital electronic license plates and has offered to make its product available to the DMV. The current system consists of a computer screen that takes on the appearance of a standard California license plate.

What kind of thing could the electronic license plates display?

The device will be limited to the data necessary to display evidence of registration compliance. However, it is within technological capability to post other text, such as Amber Alerts or 'stolen' if the vehicle has been illegally taken from its owner. As well as the registration number for the car, a wireless connection to a central server could update the screen to provide other relevant information, such as whether the plates are expired or if the car has been stolen. If this type of application makes it through to our roads, it could have a revolutionary effect on vehicular-related crime.

SB 806 contains parameters to ensure that personal information is protected and it outlines the following provisions: it specifies that the pilot is voluntary; it prohibits the DMV from receiving or retaining GPS data; and the DMV must report to the legislature on all tested products and their features, specifically those that include the ability for GPS tracking.

The report must also contain DMV recommendations for how any personal information will be managed and maintained.

It is perhaps unsurprising that following the announcement of the pilot program, civil liberties campaigners are already expressing concerns about privacy issues. As well as suggesting that computer hackers are likely to target the electronic license plates, campaigners are also urging caution when states are pitched ideas for new technologies such as this without fully acknowledging – and addressing – the security factor from the very start.

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There are challenges aplenty to ensure freight and travelers pass across our bridges safely and efficiently, hence **Timothy Compston** finds operators are increasingly embracing ITS to keep vehicles on these crucial links flowing smoothly

Illustration courtesy of Lee Hasler

Crossing points

The reality on any highly trafficked bridge is that should an incident occur – a breakdown, accident, routine maintenance or perhaps something more catastrophic – traffic managers are much more limited in terms of available options than they would be on other parts of their networks. Detours will quickly develop into a major source of congestion and disruption, which is far from ideal if you're a commuter on the way to or from work, or a truck driver with a time-sensitive delivery. Having effective strategies in place is therefore a must to minimize the impact on the wider region.

The PMH1 project is one of the largest design-build contracts ever in North America. The project's scope included design/construction of 37km of urban freeway, 17 interchanges and the new 10-lane cable-stay bridge across the Fraser River

Extreme and unexpected weather conditions such as fog and ice can also play havoc where bridges are concerned – a fact that was brought into sharp relief in September 2013 when around 100 vehicles were involved in a series of accidents during the morning rush-hour on the Sheppey Crossing in Kent, UK. It was a miracle there were no fatalities. But it's highly likely that in the aftermath of the Sheppey pileup, operators elsewhere would have been busy re-evaluating their own systems and policies – particularly how they detect irregularities and warn drivers of dangers ahead – and whether or not solutions specific to local conditions (such as visibility sensors in fog-prone regions) need to be factored into their thinking moving forward.

Great divide, much relief

Such considerations are not lost on TI Corp – the crown corporation set up by the Government of British Columbia to realize the Port Mann Bridge near Vancouver on Canada's west coast. The multibillion-dollar structure forms the striking centerpiece of the Port Mann/Highway 1 Improvement Project (PMH1 Project), which has seen 37km of highway widened from Vancouver to Langley. The objective of the project was to reduce travel times along the Lower Mainland's busiest highway. Eight lanes on the new bridge were opened to traffic in December 2012 and a further two are going live soon, in the process greatly expanding on the capacity offered by the older bridge (now demolished), which was increasingly struggling to cope with the monumental growth in traffic volumes in the region.

An unexpected challenge grabbed the headlines in the Port Mann Bridge's first few months of operation, when ice forming on – then falling from – the cables above the bridge led to reports of cars crossing the bridge being damaged. With concerns raised over safety, the Government of BC, TI Corp and design-build constructor


MPH
HQ
CAM 23
A
B
TECH DEPLOYMENT COMPLETE
ID

Ghost hunters

With the opening of the €2bn **Øresund Bridge** in 2000, Sweden became linked by road to mainland Europe for the first time. Traffic manager **Jopas Wulff** shows us the technologies that ensure travelers cross safely and efficiently

The Øresund Bridge – comprising bridge, artificial island and tunnel with a four-lane highway and rail line – is a vital link between Sweden and Denmark that stretches for 16km. A comprehensive ITS system is relied on for day-to-day operations.

One substantial capability that traffic manager Jopas Wulff feels is paying dividends is an intelligent video detection system. "It analyzes images captured by our cameras to determine if there is slow traffic, congestion, stopped vehicles, wrong-way drivers, dropped loads and even pedestrians where they shouldn't be."

Although the system is active all over the bridge, it was primarily adopted for the tunnel. "We don't have an escape lane in there so we need to be aware of any issues quickly," Wulff says. "Away from the tunnel, the detection system tells us if a car is reversing in the opposite direction to the flow of traffic; sometimes drivers go past the last exit

> "Stop barriers lower automatically so that we don't feed the tunnel with more traffic when the 'ghost driver' comes through

when they were supposed to travel to the airport and end up reversing back down the shoulder." Even more worrying, a small number of those drivers turn around and become what Wulff refers to as 'ghost drivers'. "Travelers coming in the right direction are shocked to see two headlights moving toward them at high speed. Will the 'ghost driver' stay in that lane or move to the other lane? It is all pretty frightening."

Asked how the ITS on the bridge can be deployed to respond to this scenario, Wulff says the signs above the roadway are used to display a double cross to warn the 'ghost driver', while other users are alerted to keep in the right-hand lane and informed that the left lane is blocked. "In almost every instance of ghost driving, the driver stays in their right lane, as if they were driving on a two-lane highway," he says. "Stop barriers in front of the tunnel lower automatically so that we don't feed the tunnel with more traffic, and when the 'ghost driver' comes back through the tunnel they're greeted by two steel barriers and our police officers."

Kiewit/Flatiron, responded decisively and ingeniously. Among the variety of options identified by engineers as a solution, one was to use a custom-designed sweeper fitted around each cable to remove snow and ice before it accumulated too much. Following successful tests, plans have since been announced to install the sweepers on all the bridge's 152 cables. Additionally, as added protection, engineers are testing water-repellent coatings and deicing sprays for possible application to the cables in the future.

Despite these initial teething problems, Martin Fyfe, project technician, Traffic and ITS for the PMH1 Project at TI Corp, is certain that the changes brought about by the addition of the new bridge will be for the better for Vancouverites. "With only five lanes and around 14 hours of congestion a day, the old Port Mann Bridge was one of the most congested corridors in Canada," he reveals. "Now that we have this huge increase in capacity provided by the new lanes, congestion has already been greatly alleviated."

> With only five lanes and around 14 hours of congestion a day, the old Port Mann Bridge was one of the most congested corridors in Canada

Martin Fyfe, project technician, Traffic and ITS , PMH1 Project at TI Corp, British Columbia, Canada

As to the ITS systems employed on the new bridge – and the wider corridor – Fyfe singles out the microwave radar vehicle detectors, specifically the Wavetronix SmartSensor 125 HD, as a gamechanging element. "Once complete, we will have 140 of these on the highway [including the bridge]," adds Fyfe. "They'll count traffic, measure speed and lane occupancy, and provide classifications. All of these features are invaluable for future traffic engineering purposes. We are going to have full highway coverage in both directions at approximately 500m spacing between the devices, which is quite high in resolution in terms of traffic detection." The Wavetronix solutions are already proving easier to install than more traditional alternatives such as loop detectors, and

When dealing with specific weather phenomena on the bridge, Wulff says a strange quirk is that conditions can vary enormously from one end to the other. Not surprisingly this variation can – and does – have a major impact on traffic and so needs to be monitored carefully, 24/7. Wulff says lessons have been learned along the way and the number of weather stations has been ramped up, from an initial three to five, closing some critical gaps in coverage.

"In the beginning we had a weather station positioned on land (by the toll booths), another on the high bridge and one on our artificial island; we didn't have any at all on the Danish side. There was a major accident back in December 2004 just outside the tunnel, due to ice on the roadway, so we had to think again and quickly brought in another RWIS there. We now know that the lowest point on the bridge tends to be the position where a slippery surface will start to develop and therefore needs to be paid greater attention."

(Far left) **The Øresund Bridge's four-lane road carries six million vehicles a year, while the two rail tracks carry another eight million people each year** (Above) **Traffic manager Jopas Wulff has tremendous faith in the automatic incident detection system installed in the tunnel as well as on the bridge**

looking ahead Fyfe is hoping for much less maintenance, too. "As they are shoulder-mounted, lane closures are not necessarily required to maintain them," he notes.

Ready for redecking

Across the other side of the country, in Nova Scotia, the Halifax Harbour Bridges (HHB) authority has the task of keeping two tolled suspension bridges – the A Murray MacKay and the Angus L Macdonald bridges – operating smoothly simultaneously. For Steve Snider, CEO of HHB, the major project on the horizon that will test his organization's ability to its very limits is the replacement of the suspended structure of the Macdonald Bridge in 2015/16. Given how vital both bridges are to mobility and economic vitality in the region – and the lack of alternatives – this is a process that is going to have to be carefully managed to avoid impacting negatively on commuter traffic. "We have about 34 million crossings a year, which by any standard is very high usage," Snider details. "Essentially these are commuter bridges, so we don't have the option of taking one of them out of service for any extended period of time."

To minimize the impact of the work, Snider plans to replicate the approach taken with the 1997-99 redecking of the approaches to the bridge, by concentrating activity in the evening away from the peak travel times and using VMS units to communicate information to drivers.

"The challenge this time around is that the magnitude of the project is much bigger," Snider explains. "For a sense of the scale you just need to look at similar work that was undertaken on the Lion's Gate – a twin of the Macdonald – that was completed about 10 years ago." As to the finer details of the task ahead, it will involve taking a 60ft section, disconnecting it and lowering it onto a waiting barge in the harbor, moving that out of the way, reconnecting another 60ft length and being ready to re-open for traffic at 5:30am. To help ensure things run according to plan, Snider reports that HHB is using the same design engineers that were involved in the Lion's Gate project. "It's like bringing in the same doctor to perform open-heart surgery on you after they have worked successfully on your twin brother," he laughs.

(Above) **Beginning in 2015, the bridge road deck, floor beams, stiffening trusses and suspender ropes will be replaced on the Angus L Macdonald Bridge** (Right) **Figures from 2009 show that Halifax's A Murray MacKay Bridge had an average of 52,000 vehicle crossings a day**

Regarding the technology that has helped to ease congestion on the bridges, Snider points out that the HHB is celebrating the 15th anniversary of the introduction of electronic toll collection. "In itself it has made a huge difference for us, with about 74% of all traffic now electronic," Snider reports. "What is perhaps of more interest is that commercial vehicles that use the MacKay Bridge represent only about 3% of the total traffic but around 95% of that sector uses ETC. In other words, they understand the benefits of avoiding congestion at the toll plazas."

(Far left) **A lane-control system is in operation on the Auckland Harbour Bridge** (Left) **Incident response on the bridge is part of a wider suite of ITS services, managed by Transdyne with DYNAC ES software**

Although the third lane that was added to the Macdonald in the late 1990s has also helped ease congestion, the 2010 president of the IBTTA emphasizes that the challenge now – as traffic volumes have risen from 28 to 34 million annually – is how HHB can embrace technology to make the best of what it has. "Our economy is starting to pick up and with it there tends to be more travel." To prepare for the expected extra demand, HHB is going to engage in a study over the next couple of months to better understand and evaluate the potential benefits of open-road tolling.

The answer for Auckland

Auckland, New Zealand's largest city, is home to the long-serving Auckland Harbour Bridge, which opened in May 1959. At the time, it had just 11,000 vehicles crossing daily – a figure that has now soared to 200,000, making it one of the most heavily trafficked bridges anywhere in the world. Intriguingly, there are three structures to the Auckland Harbor Bridge with the middle section, featuring the distinctive steep arches of the original four-lane 'truss' bridge, plus two clip-ons that were added in 1969 to provide two additional lanes on each side of the older structure. A moveable lane barrier was installed in 1990 to prevent head-on crashes as well as to improve rush-hour traffic flow.

Kathryn Musgrave, regional traffic operations manager at the NZ Transport Agency (NZTA), explains more about the system. "We have always operated the bridge in tidal flow, changing the way it is configured throughout the day," she says. "The moveable lane barrier machine is there to enable us to do that safely and mitigate the potential we once had for head-on collisions."

New Zealand was a real pioneer in this respect, being the first country to implement anything remotely like this system on a bridge. More recently, Musgrave says, when the Victoria Park tunnel on State Highway 1 opened in 2012 the length of the moveable barrier was increased and now extends right the way back to a major intersection in the city center.

To assist with the need to maintain a tidal-flow operation, Musgrave says there is also a fully operational lane-control system across the bridge. "This was introduced in the 1980s and has been supplemented over the years by VMS and camera coverage," she explains. "We also have wind detectors and loop detectors to provide additional data regarding any potential issues happening on the bridge itself.

> The commercial fleets – our tractor trailers – that use the MacKay Bridge represent about 3% of total traffic but around 95% of commercial traffic uses ETC
>
> **Steve Snider, CEO, Halifax Harbour Bridges, Nova Scotia, Canada**

"When you're talking about ITS provision, we've basically got everything that you could possibly imagine," continues Musgrave. "This is mainly due to the really high volumes of traffic using the bridge. There are actually only two crossings of the harbor. To keep things moving we really need the constant monitoring and management that ITS offers."

While there has been much talk of a third harbor crossing that would alleviate some of the pressure on the bridge – with a tunnel the most likely solution – Musgrave believes that, given the expense of such a solution, it is unlikely to happen any time soon.

The clip-on extension bridges are a slightly different structure from the main part of the bridge, so there are constraints in terms of weight. "This means we that need to actively manage heavy vehicles and over-dimension vehicles to use the truss structure – the center four lanes," Musgrave says. "Three years ago we implemented an ALPR system into our weigh-in-motion site so that we can actually pick up and advise overweight vehicles."

High-wind considerations

Operated and maintained by the Forth Estuary Transport Authority (FETA), the windswept Forth Road Bridge, north of

Replacement therapy

The current Forth Road Bridge, north of Edinburgh, is soon to be joined by another across the Firth of Forth. The Queensferry Crossing is scheduled to open toward the end of 2016. Discussing ITS plans, Allan Hall, network operations manager at Transport Scotland, stresses that it's very much a corridor-based approach rather than looking at things in isolation. "As far as ITS is concerned – overhead lane-control signals, camera coverage, traffic detection and journey-time information – we

are focusing on the whole 23km corridor from the M90 motorway at Halbeath right down to the M9 at Newbridge," he reveals. On the new bridge itself, the three towers will each sport gantries for overhead lane-control signals and VMS, while ramp metering will be in effect on the north and south approaches.

A major departure for the new bridge is the plan to adopt thermal imaging cameras on the main gantries. Hall says this is due to the decision not to have above-the-road lighting on the bridge, unlike the existing crossing. "We still need to see what's going on at night with the traffic," he says. As well as the thermal cameras – which come into their own during the hours of darkness – the Queensferry Crossing is also to feature standard motorway cameras on its towers to provide an overview of traffic during daylight hours.

Performance measured

The iPeMS analytics platform from ITS specialist Iteris provides comprehensive real-time and historical road performance data for transportation agencies. Using the software, the company was recently able to quickly compute analytics detailing where traffic went during the first full day of the San Francisco-Oakland Bay Bridge closure back in 2013, from August 28 to September 3.

Over the course of a typical weekday, around 120,000 vehicles travel into San Francisco over the Bay Bridge. On August 29, the bridge was closed to traffic for the switch to the new eastern span. The traffic wasn't a disaster everywhere though. Comparing the first full day of the closure with the average weekday in the summer, the iPeMS data shows substantial changes in inbound traffic patterns in response to the Bay Bridge closure: traffic

volumes over the San Mateo Bridge increased by around 62%; volumes through North Bay alternative routes, including the Richmond Bridge, SR 37, and Highway 101 increased by 27%; and traffic levels over the Dumbarton Bridge increased by 12%. However, the system showed that traffic volumes on the major Bay Bridge approaches in the East Bay dropped by 25%, including a 20% drop in traffic via SR 24W through the Caldecott Tunnel, and a 25% drop in traffic along I-80W between Albany and the MacArthur Maze. The Bay Area Rapid Transit system also noted increased ridership, achieving the third-highest levels ever recorded on a weekday.

Edinburgh, ranks as one of the most substantial long-span suspension bridges in the world. In fact, it was the longest outside the USA when it opened back in 1964 and stretches to an overall length of 2.5km. Nowadays 24.5 million vehicles cross the bridge annually.

John Russell, operations manager, says strong winds are a major consideration. "In such cases, our VMS signs and approach signs help to highlight which vehicles can and can't cross," he reveals. "High-sided vehicles are not allowed over once we get above 50mph. Not only do we put this up on our own ITS, we do so on the extended road network by tying into Traffic Scotland's sign infrastructure."

Russell feels the challenge of dealing with vehicles in windy conditions has become even more pronounced after tolling stopped completely on the bridge. "The tolls acted as a bit of a filter. When it wasn't safe we could simply stop traffic at the booths and then arrange for vehicles to turn around using our slip roads."

Given the importance of effectively communicating to motorists what they should and shouldn't be doing, Russell says FETA's investment in the best ITS has to offer has been worth it. "Things really came to a head in 2008 when a couple of vehicles were blown over, so since that time we've been working hard with hauliers and use the VMS displays to alert drivers of high-sided vehicles about closures due to wind speed." Meanwhile, the bridge's CCTV cameras monitor the traffic very closely, especially during high-wind events, to spot vehicles trying to cross when it is not safe to do so. "We're even using social media and uploading videos of CCTV footage to YouTube, showing vehicles being rocked about, to demonstrate to drivers what can happen if they ignore our warnings," Russell explains.

Ultimately, it matters not whether a structure is 50 years old or brand, shiny new. In the face of high traffic volumes and tighter budgets, smarter thinking and intelligent technology are a must in order to keep the wheels safely and efficiently in motion.

> **The tolls acted as a bit of a filter. When it wasn't safe we could simply stop traffic at the booths and then arrange for vehicles to turn around using our slip roads**
>
> **John Russell, operations manager, Forth Estuary Transport Authority, Scotland**

(Right) **Due to ITS systems in place for wind detection and motorist warning, in the past decade only a handful of vehicles out of a total of over 200 million have overturned on the Queensferry Forth Road Bridge** (right)

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Message makers

Four leading signage vendors discuss the latest trends in roadside displays with **Louise Smyth**, who is pleased to discover there's a great deal of news coming from all corners of the market

Illustration courtesy of Sean Gladwell

The signage sector is one of those facets of road traffic management where there's always something new to discuss. In a sector that's often decried as being woefully slow-moving (due to the usual suspects of politics, legislation and money), it's refreshing to discover progress is being made wherever you look in the world.

As part of a wider traffic management trend that's turning away from hard-handed enforcement technologies and instead embracing systems that enable traffic managers to offer drivers guidance rather than punishment, the sale of products such as vehicle-activated signs (VAS) is soaring. And although the long-term effects of such solutions on driver behavior is still very much up for debate, the strong sales would suggest roadway authorities are seeing the merits of a more proactive approach to guidance – and at a very democratic price point, too.

Growth opportunities?

Technology is, as ever, playing its own role in advancing the growth of the signs sector. Increasing numbers of vendors are moving toward matrix LED signs, rather than the older 'push-through' designs. This alone means VAS are now capable of acting as variable message signs, so arterial roads can start deploying the same style of systems we see on freeways and motorways. Other technical developments include the growing use of PV (enabling authorities to deploy signage in areas without mains supply), and more intelligent, adaptive methods of communicating with technologies in the field, which provides a greater degree of flexibility in terms of what is displayed and when. The knock-on effect of this growth is also prompting new applications for signage solutions.

Final proof of the traffic signs' burgeoning market can be seen in the number of new vendors joining the ranks – often coming from other fields, rather than a traditional traffic background. Over the following pages, you'll hear from a number of companies that we haven't featured before – some new, some well established – about why they think these solutions have a very bright future. >

Rapid response units

Mobile VMS is a popular option for those seeking fast installation at short notice...

> Zero incidents relating to standing traffic were recorded during the A1 refurbishment project

On the UK's roads, there are growing battalions of mobile VMS being deployed for various applications. Pat Musgrave, managing director of Mobile Visual Information Systems (MVIS), believes this popularity reflects the flexibility they provide users. "Mobile solutions are ideal for use in short-term projects, especially those requiring fast installation at short notice (for instance, due to highways accidents), and also those that require signs to be repositioned throughout their duration (such as evolving roadworks)," says Musgrave. "Our signs are solar powered, and so can be instantly operational without prerequisite civil engineering work," he says.

But Musgrave is quick to dismiss the notion that mobile signs offer a more 'anything-goes' strategy in terms of what can be displayed on them. "In the UK, portable VMS must adhere to the Highways Agency TR2518A specification for use on the trunk road network," he reveals. "Fixed VMS must comply with TR2516B. Both fixed and portable units must both conform with the Traffic Signs Regulations (TSRGD) with regard to the messages or pictograms that are displayed.

"We continue to work in partnership with major highways industry organizations to create innovative ITS solutions, such as our recently launched Solar-Powered Journey Time solution, to help the UK's road network operate with increasing efficiency," says Musgrave of a busy few months for the company. "MVIS also continues to listen and respond to our customers, developing new products such as the Solar 2012 Multi-Use Trailer Platform, which will enable them to provide a cost-effective service. We have recently undertaken major city-center projects for a number of metropolitan councils and police forces, and in the near future look forward to announcing details of several new highways deals currently in negotiation."

A notable recent MVIS success story was the A1 western bypass between Newcastle and Gateshead in northeast England, a project undertaken by A-one+ in 2013. Zero incidents relating to standing traffic were recorded during the refurbishment project, a result the company attributed to a VMS package from MVIS. The solution comprised 10 VMS-C units, each featuring a display that switched from speed roundels to three-color Chapter 8/MS4- style pictograms in the event of standing traffic due to lane closures.

"Not only did MVIS's VMS facilitate a rapid message change in response to the quickly changing traffic situation, but the high visibility of the three-color pictograms engendered an instant motorist reaction, promoting the safety of road workers, police and motorists alike," reveals A-one+ incident manager of operations Ian Lee.

Both portable and static VMS are often targeted with accusations of being a distraction to motorists. However, Musgrave says a lot of work is put into ensuring that MVIS signs display only concise, easy-to-digest information. "We advise customers to display the minimum information required to get the message across, ensuring that road users have adequate time to take in that information safely. Monitoring and changing the legends remotely ensures we have overall access to all messages being displayed on the network at all times, and can change these as the situation evolves. With roadway authorities showing an increased tendency to reduce the amount of signage and 'street clutter', a single sign with the flexibility to display variable messages fits the bill."

(Left) **Journey time information can be delivered accurately via portable signs** (Below) **Easy-to-digest pictograms can inform drivers of specific incidents or traffic conditions**

School of thought

A new player from the video display sector has set its sights on the urban market for VMS

> A combined sign enables users to do more with less infrastructure

Being a well-known name in the field of video displays, DisplayLED's Paul Langridge says the company's non-traffic background should be of little concern: "Our technology is well proven," he says. "It's used all over the world in very big applications, such as at stadiums. But we now see an opportunity to bring it to the highways sector. This is in part prompted by the move away from traditional push-through LED signage toward the sort of matrix displays that we produce. Matrix displays are already familiar sights on motorways but we're not going after the motorways business; instead we're looking to work closely with local authorities in urban environments and off-road applications."

Langridge highlights DisplayLED's technical credentials as one of its USPs: "User feedback is one element we're taking from our video products and bringing into the traffic signs market. We're designing our VAS so that clients can monitor each display remotely, either via SMS alerts or by checking the status on a web browser, to see whether any LEDs are out or if the power is down. Our digiLED ROAD system can detect a fault down to the individual pixel level and report automatically should any issues arise, using 3G or other data networks."

And then there's the old 'two for the price of one' offer – but with a twist: "The other thing we wanted to do was differentiate our VAS product by putting another sensor into it," explains Langridge. "There's the traditional speed sensor [from AGD Systems] but there is also one for the outside temperatures built in. So that when the temperature gets down to freezing it will automatically trigger the display to say 'Caution black ice' or something like that."

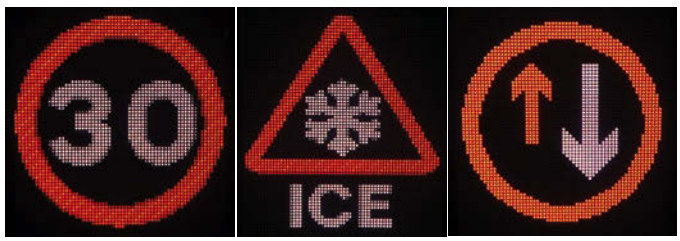
This effectively transforms VAS into VMS, says Langridge, as the signs will not only warn drivers who are going too fast, but will also alert drivers to dangerous conditions.

In particular, Langridge regards school zone applications as a primary market, noting the UK's push to implement 20mph zones outside schools. He says, "A matrix sign can be put to great use in those areas. Outside school hours the sign could show '30 limit: slow down' but between school hours, that sign can automatically change to display the 20mph limit and show the pictorial 'children crossing' sign – as well as the usual 'slow down' message to any drivers detected as speeding. Ultimately, it's doing what a VMS does but bringing that to trunk roads. It's also in line with councils wanting to reduce clutter caused by the plethora of static signs. A combined sign enables users to do more with less infrastructure."

Langridge also feels that VAS are popular among councils because they do have a positive effect on driver behavior. He explains, "Rather than speed cameras that fine you and alienate drivers, this is an advisory notice. It doesn't cost councils anything over and above the cost of the sign itself – whereas speed cameras do. And it is a dynamic sign so it's hard not to see it, whereas static signs can blend in with the background."

He also reveals that as well as school zone applications, DisplayLED may have even hit upon a completely new application of VAS technology.

"We're now wondering whether this technology could be used to deliver variable messages for cyclists. The signs could be in exactly the same position and height as they are for motorists because the radar would pick up cyclists as well – we'd just have to change the sensor to be more sensitive. Obviously the messages displayed would not be about warning cyclists not to speed; they would be more geared toward improving cyclist safety by warning them about potentially dangerous behavior. Councils want to do more to warn cyclists, and displaying messages such as 'Are your bike lights on?' or 'Are you wearing a helmet?' could go a long way to making councils more proactive when it comes to cycling safety."



(Below left) **DisplayLED is using matrix displays rather than push-through LEDs** (Below) **VAS can display information on road conditions as well as speed warnings** (Bottom) **A flexible, intelligent approach enables VAS to act as VMS**

Thanks for the memories

A bespoke new tourist gateway sign has been delivered by UK materials specialist Rennicks

> The idea is to display an 'iconic' image on a tourist sign that gives visitors to the city a lasting memory

Rennicks UK and sister company MTS are well-known names in the UK traffic sign sector. The former specializes in materials for static signs, such as its Nikkalite and Hi-S Cal retroreflective and non-reflective materials. Meanwhile, MTS's portable VMS can be found on roads throughout the UK. "MTS has a range of pVMS and these, combined with our ANPR, CCTV or Smartsensor HD, can offer real-time queue detection, journey time management, data collection and security systems," explains Rennicks' David Skinner.

All the company's signs also conform to the UK Highways Agency rules regarding use of color: "Our pVMS are fully compliant and only show the color LEDs that are legal on the highways," says Skinner. "In contrast, we think full-color pVMS signs encourage people to put on displays of non-compliant messages and this can lead to confusion to drivers."

Rennicks has recently been involved with a project so bespoke that it's one-of-a-kind thus far. It doesn't involve pVMS or indeed an ITS application of sign technology. Instead, Rennicks' material was used to create a new sign displaying what the company has dubbed an "iconic, full-color, digitally printed image".

The end result is a set of Tourist Gateway signs recently deployed in the city of Plymouth. "The idea is to display an 'iconic' image that gives visitors a lasting memory," says Skinner. Clearly there's a balance between achieving that result and distracting drivers. Rennicks collaborated closely with the DfT and Nordis Signs (the manufacturer) to avoid the latter, and achieved DfT authorization for 'non-prescribed traffic signs and special directions'. "The DfT initiated this project. Wayne Duerden from the DfT is a huge fan of what has been achieved and is keen to roll it out elsewhere," says Skinner. "This may open the door for other brown signs, such as directional venue signage and maybe even other things entirely – such as blue cycling signs. We are also now working with Transport Scotland, as sign regulations differ in Scotland from England and Wales."

Standard response

A lack of standards harmonization for US signs helps keep vendors on their toes

> The signs feature feedback on surge and airflow as well as real-time WYSWYG Message Verification

If you think that UK signage standards and legislation is tricky, the US market offers a whole different set of challenges. With no sign of any industry-wide harmonization any time soon, successful vendors are required to continuously create bespoke, flexible solutions.

James Barnhart, technical product manager for Skyline Products, explains how tough this market is: "Each agency has its own set of rules to follow, so it varies by agency. Regulations include the size of sign, number of characters per line, number of lines, messages displayed at all times/only at certain times, etc."

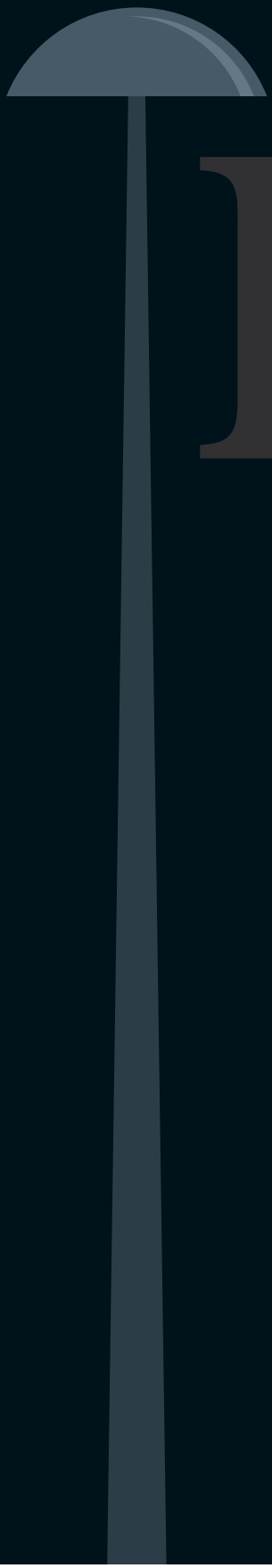
Despite the challenges, Skyline is seeing huge demand for its ITS-grade DMS, rotary drum and scrolling film electronic sign technologies. "Our biggest customers include Colorado DOT, Texas DOT, OOCEA, Oregon DOT, New Jersey Turnpike Authority and many city/port agencies," says Barnhart. "Our signs have never been easier to use or more accurate than they are today. They're also extremely long-lasting. The other advantage is in the sheer level of feedback we give users. The signs feature feedback on surge and airflow as well as real-time WYSWYG True Message Verification Display."

The company also offers a multisign controller system that's proving popular. "This is based on industry demand to have multiple signs on a single structure," explains Barnhart. "The multisign controller allows one controller to be built into the sign cabinet to control up to eight signs by enabling each sign to have its own IP address."

Barnhart sees a trend toward using full-color DMS in ATMS to replicate the pictograms/messages found on static, standard signs: "This approach offers motorists a more familiar message with recognizable symbols, colors and shapes from standard traffic signs."

Skyline sells full-color DMS, and Barnhart explains that it is the supplier of "one of the largest in the USA" in Colorado on I-70.

The City of Colorado Springs also recently awarded Skyline a contract to supply 35 full-color DMS to display traffic conditions for public rights-of-way. The signs are the first to be built on a design that uses a KYNAR 500-coated aluminum mask over polycarbonate glazing for a 20mm pixel pitch. "This design fully protects the LEDs from the environment, which is an industry first," states Barnhart.



Dark matters

Timothy Compston discovers that there's a bright future for the above-the-road lighting market, with predictions of more intelligent solutions to deliver enhanced efficiencies and light when – and where – it's needed

Illustration courtesy of Patrick George

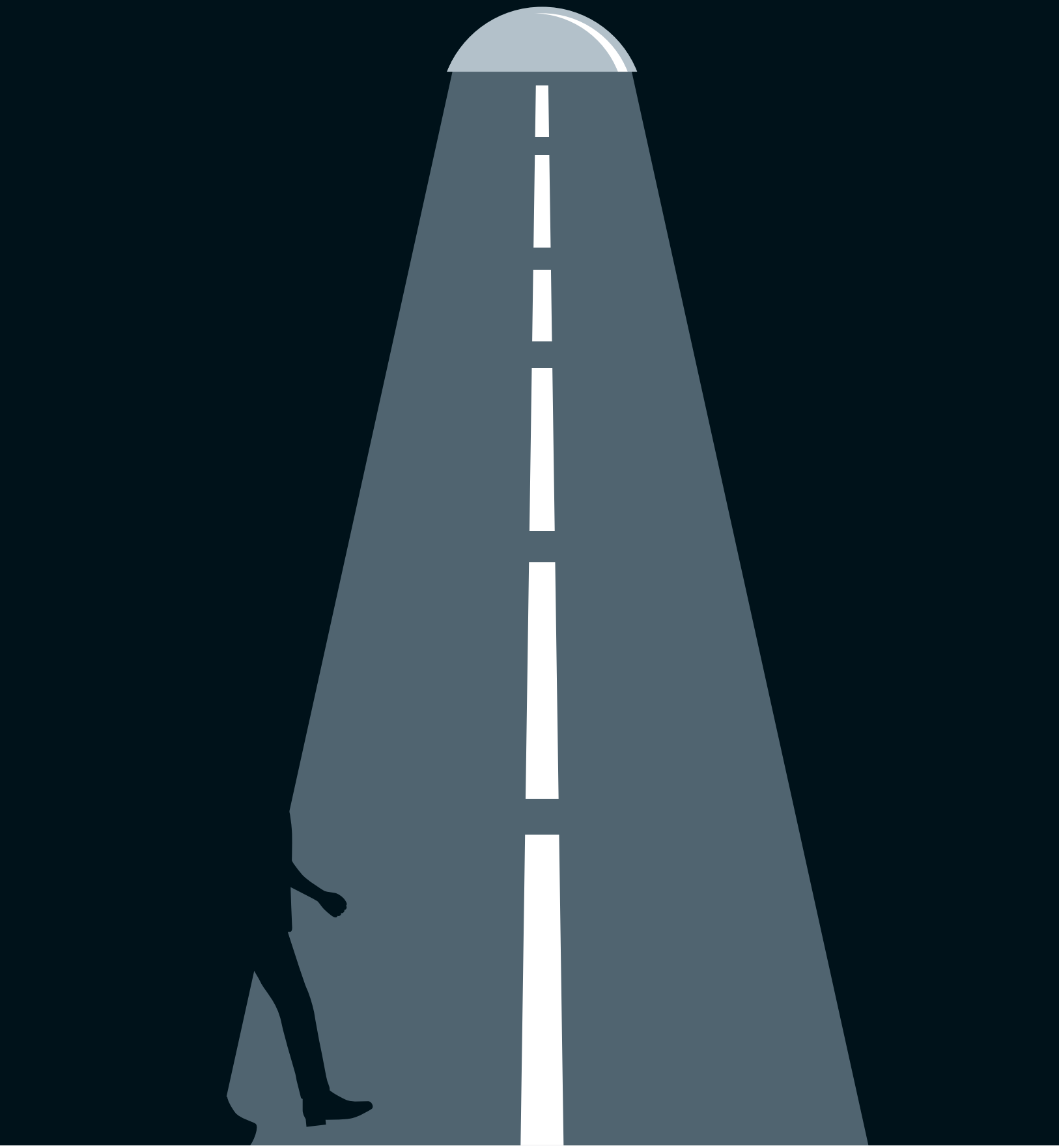
Not all that long ago streetlights were the forgotten assets of roadway infrastructure, given scant regard until a bulb gave up the ghost. Now, with a clear focus among DOTs and municipalities on making their budgets stretch further and minimizing wastage wherever possible, solutions with greater levels of control are sought – more proactive, smarter and green. But it's not about deploying for deployment's sake – in some cases we're questioning whether certain installations are needed at all.

Changing requirements

In the UK, for example, the Highways Agency is trailblazing numerous measures in a streetlighting program to reduce carbon emissions and light pollution from its motorways, all while maintaining critical road safety standards. "Our original lighting policy was developed in the 1970s," reveals the HA's Stuart Thompson. "So in 2007 we started reviewing our practices and our requirements for when to install and operate lighting."

Putting the need for such a review into context, 40 years ago it was believed roadway lighting could reduce night-time incidents by around a third. But when the HA carried out a more up-to-date investigation – thanks to advances in areas such as vehicle lighting and general car safety – there was now, on average, no more than a 10% safety benefit from the existence of roadway lighting.

One of the practical outcomes of the review was for the HA to start switching off lighting at six sites across the UK between the hours of midnight and 5:00am, which was expanded to 15 locations by September 2012. As to how the sites were selected, a number of criteria were factored in as part of a strict safety analysis by the HA. "This ranged from the number of incidents, the type of road and the recorded traffic volumes," reports Thompson, adding that, to date, there haven't been any adverse effects on road safety, traffic volumes or speed at any of the sites in the big switch-off.



Seeing is believing

Mark Rea, director of **Rensselaer**'s **Lighting Research Center**, explains how a better understanding of how our retina and fovea help humans perceive roadways could usher in a new generation of street lighting systems

Highlighting the human element in the whole roadway lighting equation is Mark Rea, a professor in cognitive science as well as director of the Lighting Research Center at Rensselaer Polytechnic Institute in New York. "Most people think of driving as a monolithic task where you're looking at something and identifying hazards," he explains. "Although that is certainly important, from a visual perspective there are really dual systems working in parallel where 98% of your retina – which we call 'off-axis' or 'peripheral vision' – is for remote sensing, so any change in context, movement or color is picked up and then you automatically move your fovea to see whether it's a hazard or something to be ignored."

Having extensively researched the causes of traffic accidents, Rea reveals they often occur through misjudging what the fovea tells the driver. "What we have come to believe is that illumination from streetlights is really important for 'figure-ground'. Is something moving toward or away from me?" This doesn't mean that peripheral vision isn't important, too, Rea stresses – it's just that they result in two qualitatively different types of accidents. "One is a failure to detect and the other a failure to judge speed and direction. Once you know this, you can design the most effective lighting systems."

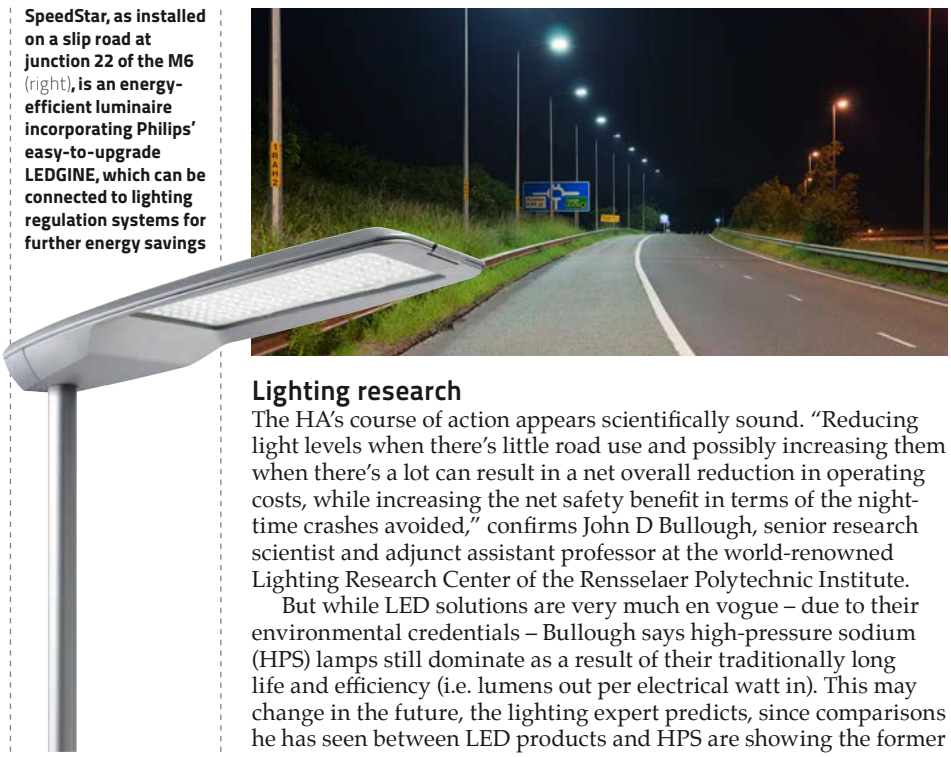
> "What we have come to believe is that illumination from streetlights is really important for 'figure-ground'. Is something moving toward or away from me?

A critical point raised by Rea is that key lighting standards have been based upon the assumption that roadway lighting needs

Following these findings, the HA decided to switch off lights permanently at a number of carefully selected locations. One of these was a stretch of the M6 motorway between junctions 15 and 16 near Stoke-on-Trent, a move that it is estimated will reduce annual carbon emissions by 148 metric tons.

Of course, there was a media frenzy concerning the potential safety impact, although at the time of the announcement the HA stressed this section of the M6 had boasted a good safety record overall and that the change was only sanctioned once it was deemed it wouldn't increase the risks to the driving public. In actual fact, had the roads been newly built under the design and appraisal standards for lighting on motorways and major A roads – published in August 2007[1] – none of the switch-off sites would have featured lights anyway.

Of course in critical locations it's a different story. Further north on an M6 slip road at junction 22, the HA has deployed Speedstar LED luminaires incorporating LEDGINE technology for connection to a lighting regulation system. In this case, the HA worked alongside service provider A-one+ and lighting manufacturer Philips.



SpeedStar, as installed on a slip road at junction 22 of the M6 (right)**, is an energy-efficient luminaire incorporating Philips' easy-to-upgrade LEDGINE, which can be connected to lighting regulation systems for further energy savings**

Lighting research

The HA's course of action appears scientifically sound. "Reducing light levels when there's little road use and possibly increasing them when there's a lot can result in a net overall reduction in operating costs, while increasing the net safety benefit in terms of the night-time crashes avoided," confirms John D Bullough, senior research scientist and adjunct assistant professor at the world-renowned Lighting Research Center of the Rensselaer Polytechnic Institute.

But while LED solutions are very much en vogue – due to their environmental credentials – Bullough says high-pressure sodium (HPS) lamps still dominate as a result of their traditionally long life and efficiency (i.e. lumens out per electrical watt in). This may change in the future, the lighting expert predicts, since comparisons he has seen between LED products and HPS are showing the former

(Far left) **As roadway lighting becomes more sophisticated, so, too, does our understanding of its impacts beyond simply providing visibility** (Left) **Mark Rea says that although the finding that safety benefits from roadway lighting are highly related to the visibility improvements lighting provides is not novel nor unexpected, evidence for this direct link has been scarce in the literature**

only to provide information to the fovea by illuminating the roadway itself. "Lighting the edge of the road where the peripheral retina is used to detect potential hazards moving onto the roadway is also important to consider in lighting standards," he says. "In fact, many studies have shown the fovea and the peripheral retina respond best to different light spectra (i.e. colors of illumination). For example, at the same measured light level, a 3,000K light source will be equally effective for illuminating the road for the fovea but the 3,000K source will be less effective than a 6,500K source for detecting hazards by the peripheral retina."

has the potential to outperform the latter as far as efficiency goes, with modest energy savings, and possibly in terms of life as well. "That noted, LED solutions haven't really been around long enough yet to verify their designed lifetimes," Bullough cautions.

Lighting's impact on overall safety is an area of expertise for this Rensselaer scientist. One of his latest investigations shows that although the latest overhead lighting is useful at providing 'figure-ground' information to reduce vehicle-to-vehicle crashes – the most frequent crash types at intersections – it's less effective at making pedestrians stand out for drivers. "It tends to illuminate the ground rather than vertical surfaces such as pedestrians," says Bullough.

As a result of this 'lighting gap', the Lighting Research Center has been looking into bollard-level lighting to maximize the contrast between pedestrians in crosswalks and surrounding environments. "We've conducted several demonstrations – including a recent test in Aspen, Colorado, in conjunction with 3M and Intrigue Lighting, which developed the test fixtures," Bullough adds.

(Left and right) **A novel bollard-based approach was adopted in tests by the Lighting Research Center as an economical and viable way to increase crosswalk safety and visibility**

Pittsburgh pioneers

No discussion of LED streetlighting would be complete without mentioning the much-publicized strides made in Pittsburgh, Pennsylvania. Councilman Bill Peduto, who until being elected mayor of Pittsburgh at the end of November represented

> LED solutions haven't really been around long enough yet to verify their designed lifetimes
>
> **John D Bullough, Lighting Research Center, Rensselaer Polytechnic Institute, USA**

Pittsburgh City Council District 8, is a strong advocate of LED. So much so, he founded the Pittsburgh Climate Action Plan back in 2005. "Although important, the initial push wasn't so much financial – it came from the climate action plan to reduce the city's carbon footprint by 20%," he says. "Streetlighting was seen as one of the better ways we could achieve that since, even then, LED lights were about 60-70% more efficient than other solutions."

By 2008, the Pittsburgh LED Streetlight Project had been born, with a trial in the neighborhood of Shadyside that saw half of the HPS streetlights replaced by energy-efficient LED models. "There was an immediate response to the quality of the light and when we told the community that it would cost less to use the lights, we pretty much had automatic buy-in."

Thereafter, research was conducted to provide, in Peduto's words, "a 360° profile" of all the options of streetlighting and the first Lighting Code for the City of Pittsburgh. "We wanted to ensure we had the right lighting in place – it wasn't simply

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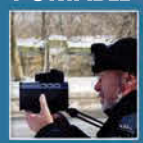

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Photograph courtesy of GE Lighting

a question of changing 'bulbs'." So far there have been 5,000 transfers to LED covering every business district in the city center and Peduto reveals that an impressive 53 different models of lights have been submitted for testing along the way.

As to the financial considerations, he acknowledges the upfront cost with LED but Peduto is adamant that in the longer run it makes sense to use "guaranteed energy-saving programs" where you can allocate the money saved in energy costs and maintenance.

Roadside assistance

Donald Carter, director of the Remaking Cities Institute at Carnegie Mellon University explains the institute's involvement in Pittsburgh's LED initiative. "The city didn't know which technology to use, which color spectrum to put in the specification, how far apart the lights should be and how they should be shielded," he says. Out of a request for assistance, the institute's research team drew up various recommendations, including how warm or cold white the lighting should be [on the Kelvin scale] to better reflect the daylight spectrum. "We also looked at the heights of the poles as well as how to work with the existing infrastructure. Essentially, they ended up replacing all of the 'cobra heads' (the streetlights that arch out over the street) and the 'acorns' with LED."

Since LEDs are highly directional, one aspect Carter's team was concerned about was glare. "One of our experts is very tuned into the issues of the elderly, whose eyes don't adjust well at night from bright to dark, whether they're on foot or behind the wheel," Carter says. A remedy to this was screening with 45° cut-offs. "What was interesting with these cut-offs was that, when driving down the street, you now only see the LEDs that are within 300ft (91m) of your position – the actual light source – yet down the road beyond that distance, you just notice that the street is illuminated, not the actual lights themselves."

> The city [Pittsburgh] didn't know which technology to use, which color spectrum to put in the specification, how far apart the lights should be and how they should be shielded
>
> **Donald Carter, director of the Remaking Cities Institute, Carnegie Mellon University, USA**

(Above left) **The US Department of Energy estimates the installed base of street and highway lights in the USA alone is around 52 million, of which only 1% is LED**

One element Carter was keen to put in place for the future was the capability to control every streetlight with its own IP address so, should funding become available, the groundwork's in place to enable a central monitoring and control of the lights through wireless technology.

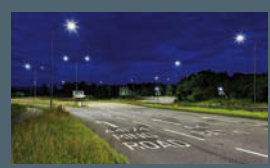
Northern Lights

Responsible for overseeing the city of Edmonton's signals, streetlighting and infrastructure rehabilitation, Vlado Cicovski says North America's northernmost metropolitan region has already switched 15,000 streetlights to LED, with many more in the pipeline. "We previously conducted some successful pilots with LED, so starting in 2013 our new standard is to have the technology for all new fitments on our

A drive for better lighting efficiency

Mike Simpson likes to emphasize the operational advantages of LED. "Today LED is ahead of some traditional light sources in terms of efficiency," reports the technical and design director at Philips in the UK. "You are also getting a better quality of light and as they are physically small light sources, there is good light control. Whereas in the past you would seek to control the edge of the beam – but always have a fade-off – with LED there is a really precise cut-off, meaning that more of the light you produce is cast onto the road."

Simpson thinks that every 12 months or so, there's a 10% uplift in LED efficiency – a trend that shows no sign of abating. "You can play that whatever way you want," he says. "You can either opt for more light output, or you extend the life of the LED or maybe even go for a better color. Basically the cooler a light source looks, the more efficient it will be."



Although the Philips man says HPS and LEDs are around the same in terms of efficiency, at about 140 lm/W, he says the big difference is when you're trying to get this light out of the lighting system. "A typical road lantern will lose maybe 20% through the optics – including the reflector – whereas with an LED you might lose about 4-5% because, in a sense, it is its own optics system.

"You need to compare apples with apples and think about the light on the road in relation to the energy that goes into the system in the first place."

Driving control

Expanding upon how roadway lighting can be operated – and maintained – in a smarter way, John Charles traces such moves all the way back to the mid-1990s when the first iteration of Harvard Engineering's LeafNut was brought to market.

Charles, business development manager at the company, says that LeafNut can be fitted retrospectively to existing lanterns or via the OEM route. It has a fairly simple communication architecture using GPRS from an asset management center to the apparatus in the field, the so-called BranchNode main controller unit. According to Charles, such a solution

(Above) **John Charles from Harvard Engineering** (Right) **The LeafNut node**

greatly enhances maintenance procedures and practices. "The contractor can see lamp mortality or LED mortality data through the system," he says. "This enables much more effective planning of the plant and labor aspects of a contract. There's a lot of money to be saved on traffic management from this aspect alone."

A 'live' UK motorway scheme with LeafNut is currently entering its second phase. In this case the motorway lighting interface system tells the LeafNut system when to dim or ramp up the associated luminaires based on what's happening in the road. "The original trial was very successful," Charles reports. "We were dimming the system from 100 to 75 and then 50% depending on the conditions. Of course in the event of a road traffic accident, we can override the system and bring the lights up to 100%."

For the next phase of the project, Charles is excited by the prospect of a more granular dimming capability that is planned to enable changes in increments of only 1%. "It becomes much more dynamic and the client was keen to match as closely as possible the latest British standard."

streets," says the city's acting director in Transportation Services.

A few aspects in particular were especially pivotal, says Cicovski when explaining the rationale. "We are trying to limit light pollution and reduce greenhouse gas emissions," he says. "We have a very aggressive target to meet so streetlights are a key part of that; alone they account for around 21% of the city's power consumption and we are trying to reduce this by 40 to 50%, which is actually a major challenge."

The first LED trials in Edmonton were on residential streets rather than main roads: "This was mainly to gauge the maintenance element as well as to garner feedback from residents," Cicovski adds. "We have a 10-year warranty on the LEDs at this point in time and we anticipate they should last around 20 years, which – apart from all the energy and GHG savings and reduced light pollution – is a hugely important factor to the city's coffers."

A pilot test is under way and two more are in the works with different vendors in Edmonton to establish how to 'talk' or communicate with LEDs. "The whole city will eventually have controllable lights or lights that we can monitor based on actual road conditions," Cicovski says.

Lessons have already been learned and acted upon based on Edmonton's LED experience. "Where most of the light was focused on the road, there were some concerns that drivers wouldn't be able to detect pedestrians, so we've now changed the distribution of the luminaires so it's wider and casts light onto the sidewalks too. Pedestrians can now be seen more easily than with the first luminaires we deployed."

> Streetlights alone account for around 21% of the city's power consumption and we are trying to reduce this by 40 to 50%, which is actually a major challenge
>
> **Vlado Cicovski, acting director in Transportation Services, City of Edmonton, Canada**

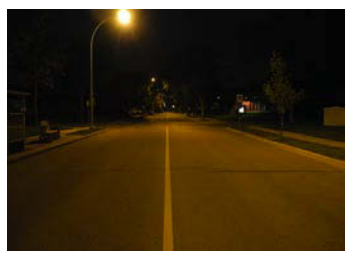
Looking ahead, Edmonton is keen to accelerate the conversion process, so rather than being limited to the current 4,000 or 5,000 lights a year – which might take 20 years to complete – a request has now been put out for proposals that would enable the city to achieve the goal in five years instead. Bright ideas are sought.

Lighting the way

As we have seen, strong cases are being made in cities such as Edmonton and Pittsburgh for lighting systems that more accurately reflect what's happening on our roads, sidewalks included, with illumination levels fluctuating accordingly based on traffic volumes or specific incidents. Sure, HPS still has a place – for the moment – but the big winner from this renewed drive toward smarter and more economical systems will undoubtedly be LED. If not quite yet the solution of choice, LEDs are very much in the driving seat.

References

[1] *www.standardsforhighways.co.uk*



Solid-state lighting solutions (far right) **offer significant energy savings over HPS by both eliminating light spill and delivering more effective and uniform lighting with lower overall lumen output**

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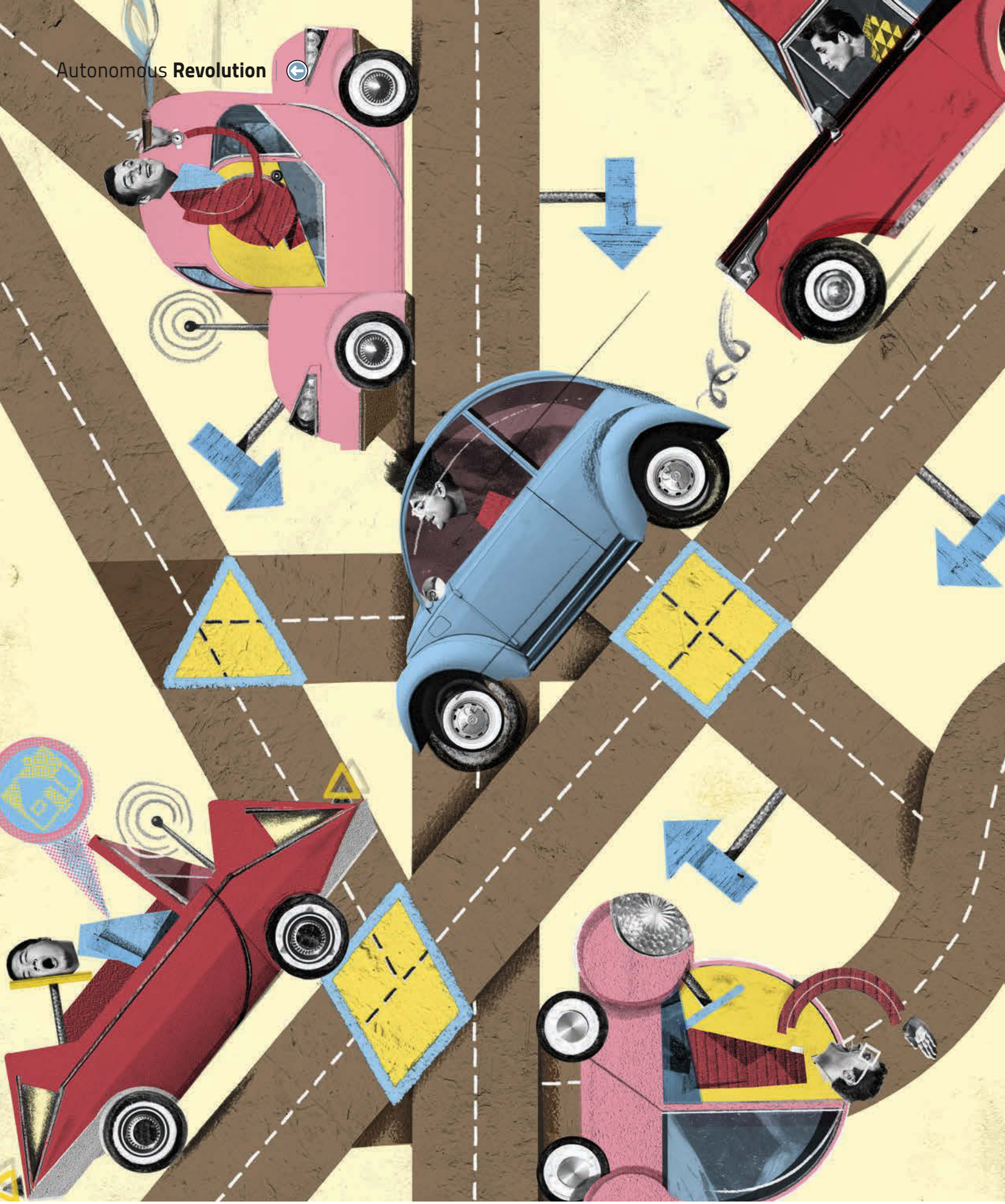


Ready or waiting?

Autonomous, self-driving vehicles are likely to develop and be deployed during the next few decades. But, asks **Todd Litman**, how will they affect transport planning decisions such as road and parking supply, as well as public transit demand?

Illustration courtesy of Arthur Chiverton

Motor vehicle technologies including communications and control systems have – and are – rapidly advancing. Many vehicles now come equipped with GPS navigation and collision avoidance systems. Automatic parallel parking and lane-assist capability, the latter keeping the car in the center of the lane, are beginning to penetrate more widely. As a result of these semi-autonomous functions, some experts predict that fully autonomous (aka self-driving, driverless or robotic) vehicles – which eliminate the need for a driver altogether – will soon become commonplace.[1] Advocates predict these will quickly revolutionize our transportation systems, making them safer, more efficient and easier to use.[2]

But it's premature to fire your chauffeur just yet. Even the most optimistic projections indicate it will be many years before a typical household can purchase a fully autonomous (level four) vehicle, and decades before they are common enough to substantially affect the need for roads, parking facilities or public transit services.[3] And even when they do reach market

Levels of autonomous vehicles[4]

Level 1 – Function-Specific Automation: Automation of specific control functions, such as cruise control, lane guidance and automated parallel parking. Drivers are fully engaged and responsible for overall vehicle control.

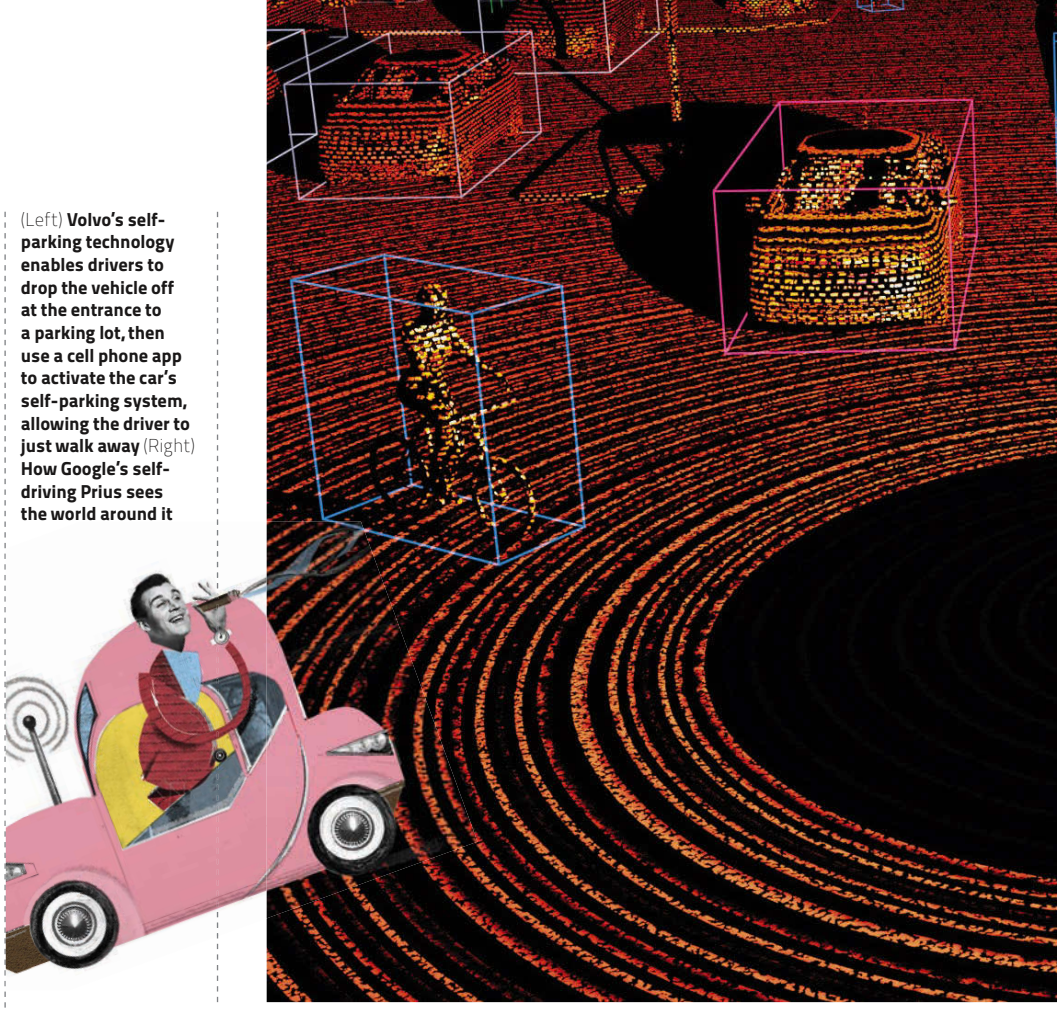
Level 2 – Combined Function Automation: Automation of multiple and integrated control functions, such as ACC with lane centering. Drivers are responsible for monitoring the roadway and expected to be available for control at all times, but under certain conditions can be disengaged from vehicle operation.

Level 3 – Limited Self-Driving Automation: Drivers can cede all safety-critical functions under certain conditions and rely on the vehicle to monitor for changes in those conditions that will require transition back to driver control. Drivers are not expected to constantly monitor the roadway.

Level 4 – Full Self-Driving Automation: Vehicles can perform all driving functions and monitor roadway conditions for an entire trip, and so may operate with occupants who cannot drive and without human occupants.

Image courtesy of Volvo Cars

(Left) **Volvo's self-parking technology enables drivers to drop the vehicle off at the entrance to a parking lot, then use a cell phone app to activate the car's self-parking system, allowing the driver to just walk away** (Right) **How Google's self-driving Prius sees the world around it**



saturation, it's entirely feasible that many motorists will prefer to continue driving their own cars unless the use of autonomous technologies becomes mandated.

Benefits and costs

So what are the potential benefits and costs of autonomous vehicles? Is it possible to look at previous vehicle technology development and deployment patterns for clues and – based on this information – predict any timelines for autonomous vehicle implementation? And how are these vehicles likely to affect transport planning in future decades? Let's take a look…

Potentially, autonomous vehicles could significantly reduce stress levels and offer us the capability to rest – or work – while traveling. Driverless cars could also provide independent mobility for non-drivers, increase road capacity and reduce traffic congestion. They could additionally reduce parking costs, accidents, offer energy conservation, emissions reductions as well as more scope for vehicle sharing.

Some of these impacts, such as reduced driver stress and increased urban roadway capacity, may occur under level 2 or 3 implementation, which provides limited self-driving capability, but most benefits such as significant reductions in congestion and accidents will only occur after level 4 autonomous vehicles are affordable and become a major portion of vehicle traffic.

The ultimate incremental costs of autonomous vehicles is uncertain. Other, simpler technologies add many hundreds of dollars to vehicle retail prices. Optional rearview cameras, GPS and telecommunications systems, and automatic transmissions, for example, each typically cost US$500 to US$2,000 extra, while navigation and security services have US$200 to US$350 annual subscription fees. Autonomous vehicles require these plus other equipment and services.

Subscriptions to special navigation and mapping services may be required for autonomous vehicle operation. This suggests that – even when their technology and markets are mature – self-driving capability will probably add US$5,000 to US$20,000 to vehicle prices, plus a few

> Despite progress, significant technical improvement is needed to progress from restricted level 3 to unrestricted level 4 operation
>
> **Jack Opiola** D'Artagnan Consulting

We have to separate hype from reality. Truly autonomous vehicles that drive themselves on both interstates and urban congested centers of our cities are a lifetime away. I know all the announcements are playing to the hype, but the programming and computing power to produce a fully autonomous vehicle that can master the complications of urban driving without human assist isn't going to happen in our lifetimes. Full stop!

Assisted driving and semi-autonomous operations of a car are already occurring to some degree. Cars can parallel park themselves, or platoon together with a lead vehicle driven by a human, or navigate in a highway environment with a human in there to take over if the autonomy is exceeded or in an unforeseen circumstance. In short, how far does the human have to be away from the controls? In autopilot,

> "Truly autonomous vehicles that drive themselves on both interstates and urban congested centers of our cities are a lifetime away"

the aircraft's captain is still there to take over the controls if need be. I think a similar thing will happen with cars. But the idea that the car will totally drive itself through an urban environment – with pedestrians and other road activity such as buses and roadworks while the driver is turned away reading a newspaper – just isn't going to happen in our lifetimes.

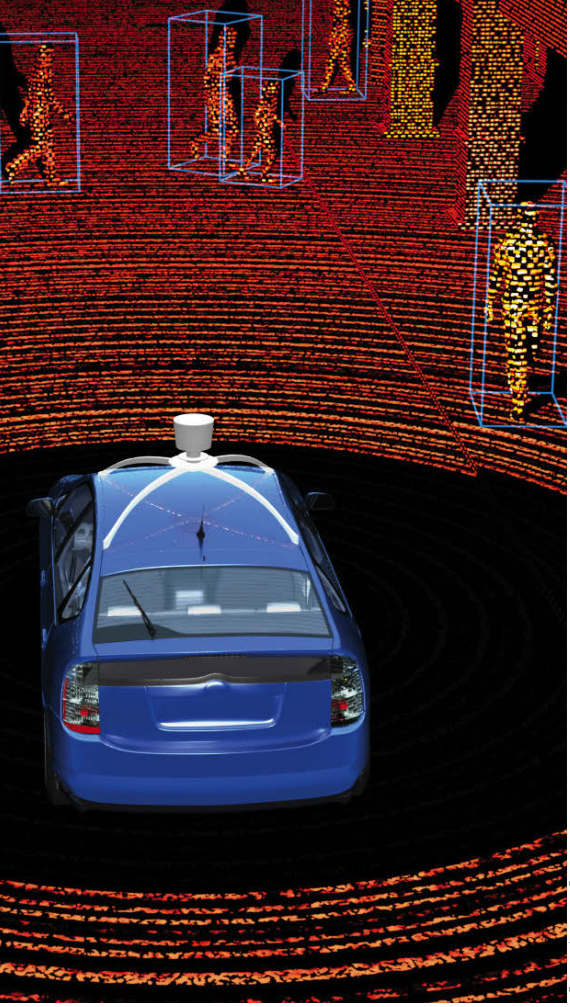


Image courtesy of Google

Paul Sorensen RAND Corporation

Despite impressive progress, there remains uncertainty surrounding the timeline for developing and deploying vehicle technologies with increasing degrees of automation. In addition to technical hurdles, there are also important issues related to regulation and liability to be resolved. The aggregate effects of automated vehicles on travel behavior are also unknown. For suburban or exurban dwellers, automated vehicle technology could allow drivers to sleep or work while traveling, reducing much of the disincentive for longer commutes and fostering sprawl and greater total vehicle travel. Within urban areas, in contrast, the technology could enable an affordable 'driverless taxi' service that results over time in denser development patterns with much lower auto ownership and less need for parking supply.

The prospects for automated vehicles, however, represent only one of many uncertainties that long-range transportation planners must contend with; others include the effects of improved telecommunications on travel, shifts in attitudes toward mobility among younger generations, and potential shifts in fuel sources and vehicle propulsion technologies. It simply isn't possible to point toward a particular envisioned future for which planners should be preparing. Instead, planners should adopt analysis methods that explicitly account for uncertainty and allow for the development of adaptive plans that should perform at least reasonably well however the future unfolds.

> "In addition to technical hurdles, there are also important issues related to regulation and liability that must be resolved"

hundred dollars in annual maintenance and service costs, increasing annualized costs by US$1,000 to US$3,000 per vehicle. These incremental costs may be partly offset by fuel and insurance savings. Motorists, for instance, spend on average approximately US$2,000 for fuel and US$1,000 for insurance. If autonomous vehicles reduce fuel consumption by 10% and insurance costs by 30% the total annual savings will average US$500, probably less than their incremental annual costs.

Currently, many new vehicles have some level 1 automation features such as automated cruise control, stability control, obstacle warning and parallel parking. Starting in 2014 or 2015, some OEMs plan to offer vehicles with level 2 features, such as autonomous lane guidance, accident avoidance and fatigue detection. Coordinated platooning is currently technically feasible but requires dedicated lanes, so isn't yet operational. Google level 3 test vehicles have reportedly driven hundreds of thousands of miles under restricted conditions: specially mapped routes, fair weather, and a human driver who can intervene when needed.[5] Some OEMs aspire to sell level 4 automation vehicles in a few years, although details are uncertain.

Despite progress, significant technical improvement is needed to progress from restricted level 3 to unrestricted level 4 operation. Such vehicles must anticipate all possible conditions and risks, with fail-safe responses. As a failure could be deadly to occupants and other road users, automated driving has high performance requirements. Sensors, computers and software must be robust, redundant and resistant to abuse. As such, several more years of development and testing could be required before regulators and potential users gain confidence that level 4 vehicles can operate as expected under all conditions.

Auto supplier Bosch believes continued improvement of autonomous systems over the coming years to make them work at faster speeds and in more complex driving situations will eventually lead to the availability of fully autonomous vehicles

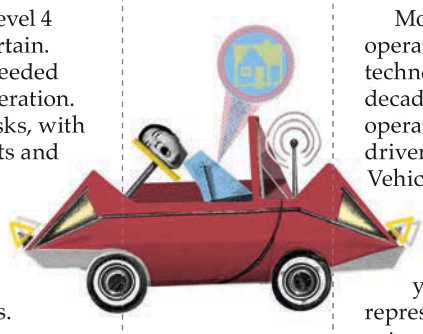


Image courtesy of Bosch

Implementation projections

Autonomous vehicle implementation can be predicted based on the pattern of previous vehicle technologies and vehicle fleet turnover rates. Most new technologies initially have high costs and poor performance, resulting in small market shares. They generally require two to five decades from commercial availability to market saturation, and without any government mandates coming into force will not be universal.

Modern vehicles are durable and can operate for decades. As a result, new vehicle technologies normally require about three decades to be implemented in 90% of operating vehicles.[7] Vehicles tend to be driven fewer annual miles as they age. Vehicles built in 2001, for example, averaged approximately 15,000 miles in their first year, 10,000 miles by year 10 and possibly only 5,000 miles by year 15, so vehicles older than 10 years represent about 50% of the vehicle fleet yet only about 20% of total mileage.[8]

For argument's sake, let's assume that fully autonomous vehicles will be available for sale and legal to drive on public roads around 2020. As with previous vehicle

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technologies, they are initially costly (tens of thousands of dollars price premiums) and imperfect (poor reliability and performance, and difficult to operate) hence represent a small portion of total vehicle sales. Market shares increase in subsequent decades as their prices decline, performance improves, and their benefits are demonstrated, so they grow as a portion of the total vehicle fleet. Over time they will increase as a share of total vehicle fleets. As newer vehicles are driven more than average annual miles, their share of vehicle travel is proportionately large.

With autonomous vehicle technology likely to add thousands of dollars to vehicle purchase prices, it may only provide large benefits to some users (high-income non-drivers, long-distance automobile commuters, and commercial drivers). It is therefore unclear what portion of motorists will consider the benefits worth the additional costs. It might, for instance, follow the pattern of automatic transmissions, which took nearly five decades to reach market saturation and still a portion of motorists continue to choose manual transmissions.

The implementation of driverless cars could be even slower and less complete than optimistic predictions. Technical challenges may be more difficult to solve than expected, so fully self-driving vehicles may not be commercially available until the 2030s or 2040s. They may have higher than expected production costs and retail prices, their benefits may be smaller or problems greater than predicted, while technical constraints, privacy concerns or personal preference may reduce consumer acceptance, resulting in a significant portion of vehicle travel remaining human-driven even after market saturation, indicated in Figure 1 by dashed lines.

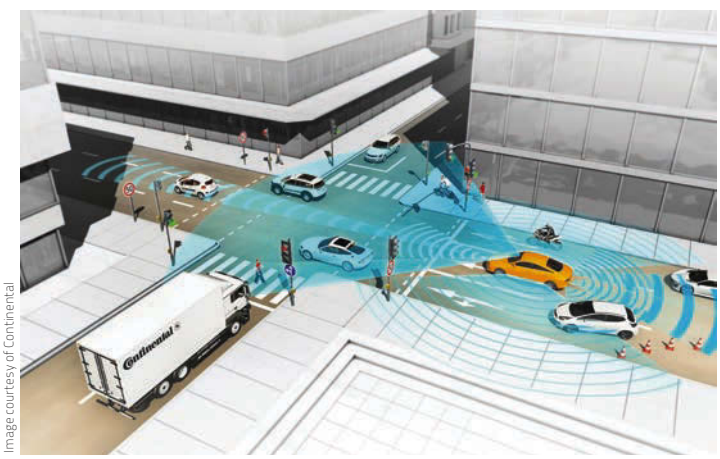
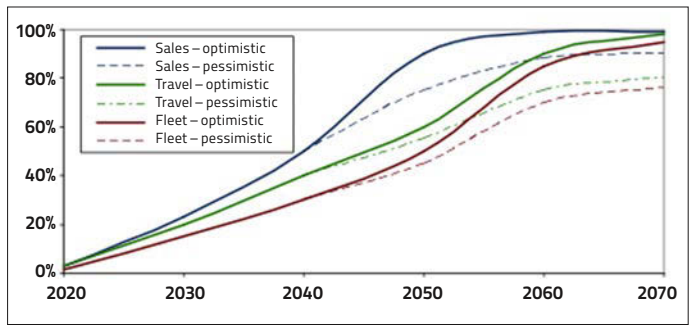


Image courtesy of Continental

> Technical challenges may be more difficult to solve than expected, so fully self-driving vehicles may not be commercially available until the 2030s or 2040s



(Figure 1, above) **Projected autonomous vehicle sales, fleet and travel. The dashed lines indicate pessimistic projections of saturation levels**
(Left) **Germany's Continental says the first production-model self-driving cars will likely hit the roads around 2016**

Significantly faster implementation would require much faster development and deployment than previous vehicle technologies. For example, for the majority of vehicle travel to be autonomous by 2035, most new vehicles purchased after 2025 would need to be autonomous, and new vehicle purchase rates would need to triple, so the fleet turnover process that normally takes three decades can occur in one. This would require most low- and middle-income motorists who normally purchase cheaper basic or used vehicles to spend two to four times more to purchase a new autonomous vehicle, and many otherwise functional vehicles are scrapped just because they lack self-driving capability.

If autonomous vehicle implementation follows the patterns of previous vehicle technologies, it will take one to three decades to dominate vehicle sales, plus one or two more to dominate vehicle travel. And even at market saturation, it is possible a portion of vehicles and vehicle travel will still be self-driven. (Dashed lines indicate pessimistic projections of saturation levels.)

Figure 1 above illustrates projected deployment rates. If accurate, in the 2040s autonomous vehicles are likely to represent approximately 50% of new vehicle sales, 30% of the total vehicle fleet, and 40% of total vehicle travel. Only in the 2050s would most vehicles be capable of self-driving. The dashed lines indicate the possibility that, at saturation, a portion of motorists will choose to continue driving their own vehicles.

Bob Poole Reason Foundation

I am very skeptical of the Sunday supplement hype about AVs within a decade or two enabling a doubling of highway capacity, shifting vehicles from individually owned to an on-demand service, etc. Those might be very long-term possibilities, but until a great deal more work is done to resolve numerous liability issues, figure out how to make AV technology readily affordable for the mass market, and resolve AV safety issues enough to no longer require a human driver in place ready to take over in the event the automation fails or cannot cope with an emergency, it is very premature to be planning for a radically different highway system. One new report, from the Eno Foundation, even suggests reasons why large-scale use of AVs may increase VMT. I do think transportation planners should be more open to the idea of specialized lanes (urban freeway managed lanes, long-haul truck-only lanes on interstates), since some future AV transition strategies may restrict AVs to non-general-purpose lanes.

Transportation planning implications

So what of the functional requirements and planning implications of various autonomous vehicle impacts, and their expected time period? During the 2020s and 2030s, transport professionals will primarily be concerned with defining autonomous vehicle performance, testing and reporting requirements for operation on public roadways. If several years of testing demonstrate autonomous vehicle benefits, transport professionals may support policies that encourage or require self-driving capability in new vehicles.

When autonomous vehicles become a major share of total vehicle travel, they may significantly reduce traffic risk, traffic congestion, parking problems, and provide some energy savings and emission reductions. If these benefits are as large as proponents predict, transportation professionals will be involved in technical analyses and policy debates concerning whether public policies should encourage or require autonomous vehicles.

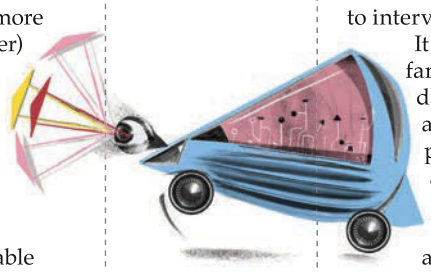
These impacts may vary geographically, with more rapid implementation in areas that are more affluent (residents can more quickly afford autonomous vehicles), more congested (potential benefits are greater) and have more public support.

Conclusions

Recent announcements that major manufacturers aspire to sell autonomous vehicles within a few years have raised expectations the technology will soon be widely available and solve transportation problems such as traffic congestion and accidents. But more critical analysis suggests that such vehicles will have only modest impacts during the foreseeable future.

There is considerable uncertainty concerning actual costs, benefits and deployment speed of autonomous vehicles. If they follow the patterns of previous technologies, early autonomous vehicles are highly likely to be costly and imperfect.

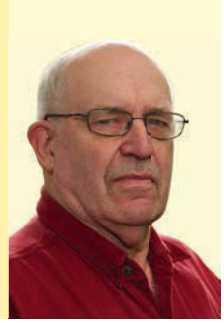
Image courtesy of Mobileye



Mobileye is aiming to get most of the functionality of autonomous driving into cars for much less, with fewer cameras and computer equipment costing hundreds – not thousands – of dollars

Peter Samuel *www.tollroadsnews.com*

Sizing roadways, bridge decks and tunnels rigidly for 3.6m or 12ft lanes and current mixes of vehicles looking to traffic forecasts of 2030 or 2040 is absurd. By 2020 we should be able to have – to cite just one example – many of our roads' vehicle systems steered so accurately they can run at higher speeds, with higher throughput, and in much narrower lanes – cars at least, maybe not trucks. Especially on major highways, we'll be looking to find ways to narrow specialized lanes for cars, and maybe provide for segregated roadways within the highway cars/trucks, autonomous/manual drive, etc. We need to be building our highways for flexibility and adaptation or repurposing as vehicle autonomy develops and spreads.



> More critical analysis suggests that such vehicles will have only modest impacts during the foreseeable future

So in the 2020s and perhaps the 2030s, autonomous vehicles are likely to be expensive novelties that can operate under limited conditions, with a licensed driver at the wheel ready to intervene if and when required.

It will probably be the 2040s or 2050s before middle-income families can purchase vehicles that can safely chauffeur non-drivers, and longer before lower-income households can afford them. It is also entirely feasible that a significant portion of motorists will still prefer to drive their vehicles anyway, so the traffic make-up will be mixed, which in itself will create new roadway management problems.

A critical issue is the degree that these benefits can be achieved when only a portion of vehicles are autonomous. Some potential benefits, such as improved mobility for affluent non-drivers and more convenient taxi and car-sharing services, may occur when autonomous vehicles are relatively costly and uncommon. But most benefits require that most or all vehicles on a road are autonomous. It therefore seems unlikely that traffic densities can significantly increase, parking requirements be significantly reduced, traffic lanes be narrowed or traffic signals be eliminated until most traffic on the affected roads is automated.

• *Todd Litman is founder and executive director of the Victoria Transport Policy Institute, an independent research organization dedicated to developing innovative solutions to transport problems*

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[8] *ORNL (2012), Table 3.8*
[9] *Litman, 2013*

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CCD or CMOS? Analog or digital? Performance or price? Machine vision continues to throw up plenty of questions, but **Max Glaskin** tracks down the experts with the right answers

Illustration courtesy of Artcalin

Human beings are good at lots of things but technology can often outperform us when it comes to excelling at specific tasks. That's what's happening with machine vision for traffic applications. The camera and analysis systems are quicker, cheaper, more accurate, more resilient and less distractible than a person sat at the roadside with a clipboard and a stopwatch. The result? Safer roads and more free-flowing traffic.

The most significant trends are behind the lens. Cameras have been around for a long time in public spaces, but never before have they boasted the intelligence levels to be so potentially useful. "There are more than half a million video cameras in London alone," says Robert Loce of the Xerox Research Center near Rochester, New York. "We have all that raw data and a lot of it hasn't been mined before." The reason? Humans aren't up to the task unless there's a huge number of them, shackled to monitors and constantly attentive. Xerox and others are creating systems that free people from such fates.

"We're bringing all the power of computer vision techniques – including image classification, anomaly detection and trajectory analysis – to this vast resource of wild data," confirms Loce.

Fuel for thought

The need for appropriate machine vision for ITS is made clear with a few simple facts. "In San Francisco about half of the fuel used by vehicles is consumed while the driver is looking for a parking spot. It's almost as crazy in Brooklyn," says Loce. "So managing parking with camera technology can have a huge impact on air quality and noise pollution, let alone savings in fuel costs." More widely appreciated is its application to traffic management, emergency management and enforcement.

Whichever application, success depends on capturing the right images and analyzing them sufficiently quickly for effective management of the situation, such as when a life may be at risk. "New statistical techniques can go through lots of video in seconds," adds Loce's Xerox Research Center colleague, Aaron M. Burry, principal scientist. "For an amber alert when a child is missing the data can be mined to look for a vehicle and its license plate. This has been enabled by the increase in computing power and the deployment of an increasing number of cameras," says Burry.

A visionary toolbox

With a product line to meet the ruggedized, critical performance requirements of transport and security, the GigE-based Genie TS range has proved to be a perfect fit for ITS since launching onto the market, reveals **Teledyne Dalsa**'s **Manny Romero**

Teledyne Dalsa makes cameras for a vast range of machine vision applications, with its Genie TS series aimed at traffic. "We're pushing area-scan GigE vision products that have a certain level of functionality on the camera," reveals Manny Romero, product manager for Genie TS cameras. "Roughly 60% of the machine vision market has accepted GigE as the main interface and the majority of players in traffic are moving forward with it."

Image courtesy of Teledyne Dalsa

> If you perform image compression, it cuts your bandwidth fivefold – you'll still have amazing quality and you won't need the faster medium

The technology is advancing because, being based on Ethernet, it has a level of scalability. Having been set in 2006 with the usual bandwidth of 1Gb, products operating at 10Gb have started to appear, which would be excessive for most traffic applications. "There's plenty that you can do to avoid needing more than 1Gb, should you even be reaching that threshold," says Romero. "If you perform image compression, for instance, it cuts your bandwidth fivefold and you'll still have amazing quality and you won't need the faster medium."

Teledyne Dalsa describes its cameras as components for a complete traffic vision system. "From a personal point of view, I'd like to do the whole system but it's much cooler to work with all the various players that do different things," Romero notes. "No one is doing the job the same – they've all got their nuances. With our range, I place special emphasis on ensuring the products are flexible, like a toolbox, so customers can do a lot of things. They don't need to use it all at the same time, but it offers flexibility for the different combinations or scenarios that the customers intend using it for."

Romero saw this variation himself on a recent expedition to Europe. "In three separate countries, three different customers

Fortunately, most events that require responses by TMCs and emergency services are more mundane but, according to Michael Gibbons, director of sales and marketing at Point Grey, customers have become more knowledgeable as the technology has developed. "In Europe there is an ongoing transition from analog to digital," he says. "As an imaging component provider, we often deal with integrators, many of whom have built their systems around lower-resolution analog cameras. These integrators are now facing demands from their customers for high-definition 720p or 1080p video. They want the added detail in the image, but they also want images that are formatted and look good on a monitor. And the fact is that most of today's HD-capable cameras use a digital interface – either IP, GigE or USB 2.0."

Markets can also be driven by government decisions. "In China they have gone straight to digital and higher-megapixel resolutions, typically 2 and 5MP. There is also a big emphasis on image compression – historically on the PC but increasingly on the camera – to reduce data and bandwidth requirements."

> We're bringing all the power of computer vision techniques – including image classification, anomaly detection and trajectory analysis – to this vast resource of wild data

Robert Loce, research fellow and technical manager, Xerox Research Center Webster, USA

Sensor launch

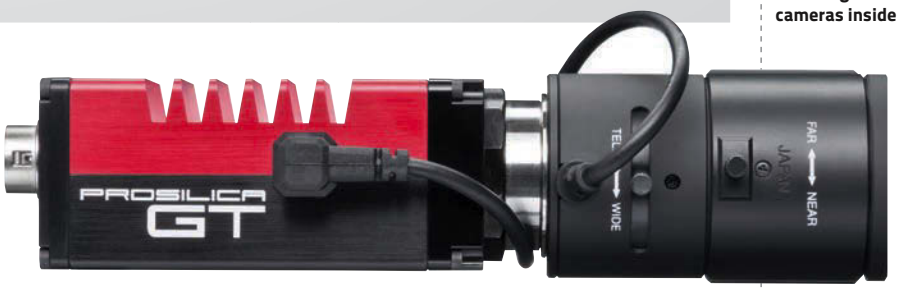
There is currently a sense of anticipation among the machine vision players that have traffic applications because Sony, a huge player in the manufacture of image sensors, is expected to unveil a brand-new product in the near future. "It's exciting because we think this new sensor, the IMX174, will be ideally suited to traffic applications," continues Gibbons. "It'll be the first global shutter CMOS from Sony and brings a lot of advantages to the table: exceptional imaging performance and dynamic range; 1080p resolution at very fast frame rates; no smear (a characteristic inherent to CMOS technology); and global shutter, which is important to capture distortion-free motion images."

The need for better sensors is highlighted by Dr Robert Tietz, director of corporate development at Allied Vision Technologies. "Traffic applications for machine vision are much more demanding

were using the exact same interface for the same application but using the product in three completely different ways," he reports. "Different sensors, size, speed, ways of triggering the sensors, techniques to get different outcomes from the sensors. It was quite amazing to realize they're competing with one another, doing the same type of application but they were using the parts so differently."

Romero characterizes the market as very competitive, but Teledyne Dalsa finds it easier to operate in Europe than in the USA, partly down to more consistent legislation. "In the USA, individual states operate independently with laws that are state-specific," he says. "It makes building more generic ITS systems even more complicated from a system integrator point of view. Generally speaking, traffic cameras are more accepted in Europe than in North America."

(Above) **Genie TS provides remarkable dynamic range to ensure optimized image capture from sun-to-shade** (Far left) **The Genie platform has been engineered to meet the critical performance and environmental requirements of challenging applications such as ITS**



than in industrial applications, where you can control everything – event timing, speed, lighting and exposure," he states. "With traffic you don't always know when something will happen – the objects' speed, and the lighting is uncontrolled, and that's before you factor in the environmental conditions. It's challenging for a camera."

Traffic management centers used to accept these shortcomings – but no longer. "Customers are very demanding, very well educated, they know what they're looking for, with a good idea of what they want to achieve as well as how to get there," notes Tietz, speaking from experience. "We guide them through the process and hope we know how our cameras work better than they do. We build a lot of firmware features into our products, although each customer will use only a set of them."

Allied Vision Technologies has invested a huge amount of development in extending the temperature ranges of its Prosilica GT range and while this will help many customers, there

> In Europe there is a transition ongoing from analog to digital. China has leapfrogged that by going straight to digital
>
> **Michael Gibbons, director of sales and marketing, Point Grey, Canada**

(Below) **The Prosilica GT cameras feature the latest CCD sensors** (Bottom) **Point Grey's Blackfly line combines PoE and highly sensitive sensors** (Bottom, right) **An ALPR system featuring Point Grey cameras inside**

are always a handful that want the unobtainable. "Some, for instance, would love to have a high dynamic range to see the driver's face while their high beam is shining in the camera," says Tietz. "In low light it would be nice to get rid of the flashlight. Color fidelity is an issue in some countries – the color of the sky changes the shades of vehicles so you just have to have good color calibration. Customization is a really good way to give customer satisfaction."

Weather proof

And some customers install systems in places that are almost as tough for cameras as they are for humans. "In a perfect world some would like to turn off the weather because it creates big challenges," Tietz laughs. "The snow, soft mud and drizzle vehicles encounter in a day in Nordic countries, for instance, all change plate reflectivity so the camera must cope. But then you get one car in a hundred that will be clean and the license plate will then be really reflective!"

There's little doubt that the machine vision market for traffic applications is growing. Demand by the tolling market, for instance, is growing by up to 20% annually and in the enforcement sector by up to 25%. Jeff Bernstein, president of the American Imaging Association (AIA), is clearly happy with the opportunity this expansion represents for his 320 member companies. "The ITS market is growing in importance for machine vision companies," he concurs. "We're seeing a lot of activity, particularly in Europe with ALPR and with speed enforcement in China," Bernstein says.

More than half of the business for AIA members now comes from outside the industrial sector. "There are a lot of players out there – a lot making cameras and going after traffic applications," he reports. So does that mean that customers are in the driving seat to make good deals? The AIA president is circumspect in his reply. "I don't know about that," he demurs.

Which is best?

Basler is a machine vision component supplier with interests in many markets. "We provide the eye and the traffic solution developers combine it with processors and software to generate a product (e.g. ALPR modules) for their clients," explains Enzio Schneider, Basler's ITS product manager. "So we're involved with CCD and CMOS image sensors, and with IP, GigE and USB3.0 interfaces among others."

For Schneider, the differences among the ITS market are narrow. "The red light, speed and bus lane enforcement market isn't as price-sensitive as others because they're revenue generators," Schneider says. "But the solutions for these applications are pretty wide. They can use digital consumer cameras or very high-resolution industrial cameras with CCD or regular security cameras. So the competition is widespread," he says. Most customers are moving on from CCD sensors to CMOS as a result of the lack of smearing, lower price and good sensitivity. "Our Ace camera line, for example, is our first with the USB3.0 interface. It puts a very low load on the processor in the ALPR box, so you can have a lower-grade CPU or the CPU can take care of the really important analytics. But if you need long cable lengths, go for GigE," says Schneider.

This is typical of any technology as it gets more sophisticated – no longer is there a one-size-fits-all solution. "What we learned is that sophisticated processing moves more and more to the edge – i.e. embedded on the camera," says Dr Marco Sinnema, product manager at Q-Free. "We therefore launched an embedded version of ALPR earlier this year."

As ever, it's a trade-off between cost and quality. "Is it really necessary to capture each and every vehicle for a travel-time measurement application, for instance?" Sinnema asks. "And where to put the emphasis – is it yield, correctness or a combination of both? Every increase in quality will come with a price. Our VRE690 imaging system, for instance, delivers high yield, high automation and extreme reliability. Therefore you will find its application mostly in road user charging and enforcement applications, where image quality has a direct impact on the financial processes."

Rather handily, Sinnema offers an eight-point checklist for comparing cameras for a specific purposes: contrast; sharpness; resolution; effective angle; trigger performance; manual readability level; automation rate; and correct identification rate. "It's important to keep in mind one question throughout, however. What exactly do I want to evaluate and the underlying rationale – i.e. what is the impact on my business?"

Coming soon…

Lumenera is sampling a new camera with a high-speed USB3.0 interface. The Lt365 has a Sony ICX674 ExView HAD II 2MP CCD sensor with low noise and good sensitivity and NIR response. It's capable of 70fps at full HD and 53fps at the higher, full resolution. "It delivers strong signals, even from the most minute amount of light entering the sensor," says the company's Claudia Dunphy. "So it's for traffic applications that record fast-moving vehicles and it optimizes images in ambient light conditions without an external flash."

The Lt365 is promised soon and will extend the company's range of USB3.0 cameras. Its other models use CMOSIS CMV2000 and 4000 Rev3 CMOS sensors. They have frame rates of up to 170fps and resolutions of 2 and 4MP and are particularly useful for automated tolling applications, says Lumenera.

Lumenera's compact, high-performance Lt365 is designed for high-speed video and image capture

> What we learned is that sophisticated processing moves more and more to the edge – i.e. embedded on the camera
>
> **Dr Marco Sinnema, product manager, Q-Free, Netherlands**

(Above left) **High-resolution machine vision cameras are increasingly popular for enforcement** (Below) **Q-Free's single-gantry, congestion-charging system in Gothenburg**

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Course of action

Timothy Compston maps out the path that authorities are taking to enhance road safety research and analysis using geospatial information tools

Images courtesy of City of Edmonton, ESRI & Purdue University

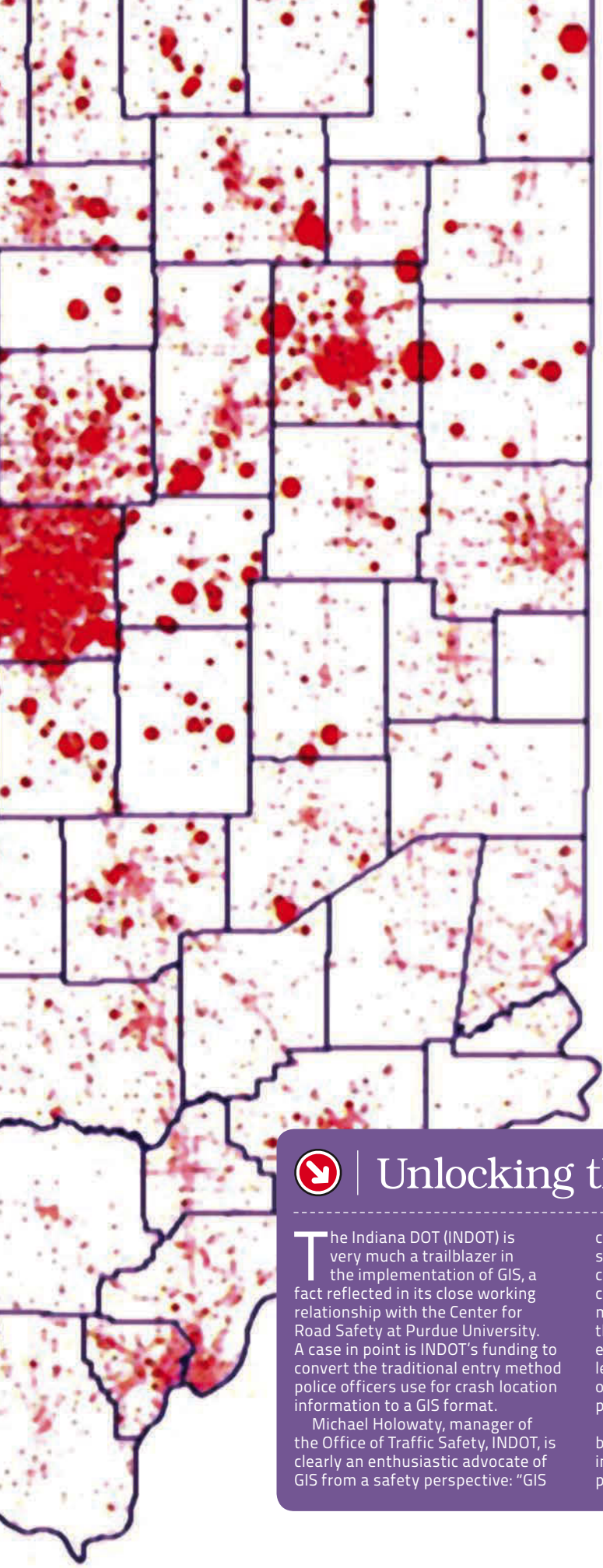
There is little doubt that the increasing sophistication and application of geographic information systems (GIS) is revolutionizing road safety. With the click of a mouse, transportation departments, municipalities and research bodies can place road safety into a wider geospatial context and, when required, drill down for additional detail on areas of interest. It's a world away from putting pins on a map! Today, the location of specific events such as vehicle accidents can be plotted through GIS software packages with a high degree of accuracy, and hot spots of concern can be identified as a result of the widespread availability of GPS in the field.

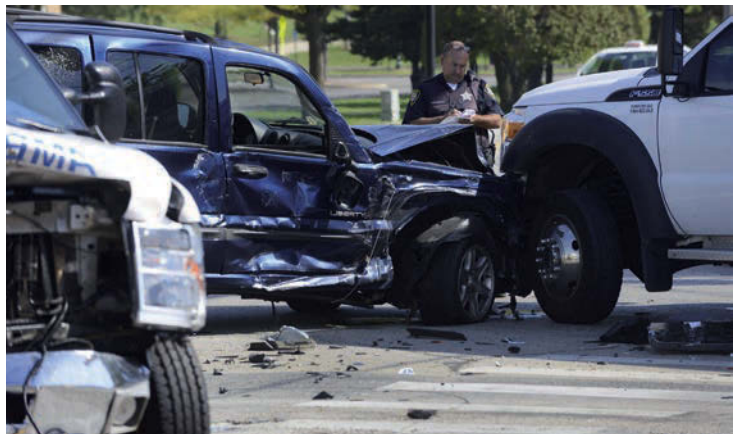
Value proposition

The Center for Road Safety (CRS) – which is affiliated to the School of Civil Engineering at Purdue University in Lafayette, Indiana – has established a reputation for leading-edge research in the area of road safety. "GIS is extremely useful because it improves both the quality and the integration of data," reflects Professor Andrew P Tarko, director of CRS, on the impact of GIS. "The reality is that you can't do research and analysis very well without data."

One project with a GIS component that has certainly attracted a great deal of

(Far right) **GIS can identify areas of the road network that need particular attention, enabling a more efficient prioritization process**





attention is Indiana CODES (Crash Outcome Data Evaluation System), which is funded by the National Highway Traffic Safety Administration (NHTSA) and the Indiana Department of Homeland Security (IDHS). "With CODES – which links crash, EMS and hospital outpatient and discharge data to vehicle, crash and human characteristics – we are finding out more information about the nature and severity of people's injuries," says Tarko. "Based on that, we are better able to estimate the social impact of crashes – the high-risk users and communities with the greatest safety needs – and the economic impact of crashes – the average cost of crashes for different roads."

Unlocking the power of GIS

The Indiana DOT (INDOT) is very much a trailblazer in the implementation of GIS, a fact reflected in its close working relationship with the Center for Road Safety at Purdue University. A case in point is INDOT's funding to convert the traditional entry method police officers use for crash location information to a GIS format.

Michael Holowaty, manager of the Office of Traffic Safety, INDOT, is clearly an enthusiastic advocate of GIS from a safety perspective: "GIS crash analysis has moved traffic safety engineering into the 21st century," he feels. "Instead of chasing black spots around a map, patterns of crashes and how they may relate to the roadway environment can be identified, leading to systematic treatment of roadway environments with the potential for safety improvements."

For Holowaty it is all about being proactive in implementing improved measures for crash prevention or mitigation.

In terms of practical examples, INDOT uses GIS to screen and prioritize projects for several safety countermeasures. Holowaty singles out the installation of cable barrier systems in the medians of Interstate highways as a successful application. "GIS has aided INDOT not only in determining where cable barriers are most effective, but also, importantly, determining which segments have crash histories that demonstrate the greatest need. This enables efficient prioritization for deployment."

Crash clustering

Massachusetts DOT (MassDOT) in northeastern USA is reporting the benefits of GIS in relation to mapping crashes and enhancing safety. "We use GIS to identify high-crash locations throughout the Commonwealth," reveals Jennifer Inzana, GIS specialist/safety analyst with the Highway Division, Traffic Engineering Section, MassDOT.

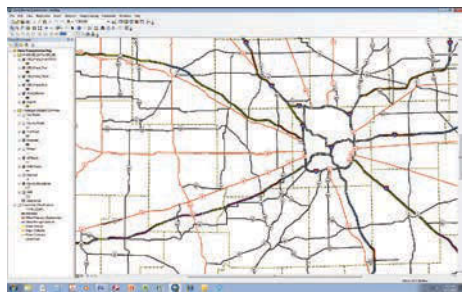
Inzana and her colleagues apply crash location information obtained from the MassDOT Registry of Motor Vehicles Division to 'geocode' individual crashes on both state and local roads: "Our latest year of data is for crashes that occurred in 2010 and we have been able to geocode 92% of those."

Inzana says the beauty of GIS is that it enables the clustering of individual crashes to identify at-grade intersection locations with the highest frequency and severity of crashes: "Roadway safety projects are now selected using data-driven methods that were simply not as practical before the adoption of GIS."

To put the impact of GIS into perspective, Inzana confirms that more than 50 locations have been redesigned or are under construction for safety improvements since the DOT began identifying high numbers of crashes there five years ago.

She says, "We have applied GIS to identify roadways with a higher incidence of lane-departure crashes as well as cross-referencing stop-controlled intersections with crash data to identify locations for low-cost safety improvements."

(Below) **GIS enables traffic managers to analyze safety in a geospatial context and prioritize areas of action**



(Left) **Cable barrier systems have been proven to help prevent accidents where vehicles cross the median and into other lanes of traffic. GIS helps determine suitable locations for their usage**

Tarko feels that access to hospital information in particular gives a more detailed picture than that obtained briefly at the scene by paramedics and police officers. Naturally, not every person is going to be hospitalized so this data represents only a subset of injured people.

As a result of privacy regulations, only basic information tends to be collected from hospitals – for instance, the names of patients are not included. "As a result we have undertaken a lot of probabilistic linking so that the different fields – hospital and crash data – concur with each other, hence there is a good likelihood of a link," Tarko continues. "From the hospital data we might have base information such as the gender, age, details of injuries and date of admission, and on the other hand we have information about a crash from the police such as the time and who was hurt."

Identification parade

Interestingly, despite the high profile of CODES, Tarko feels that there are several other noteworthy safety-related projects that rely on GIS even more heavily. One of these, he says, is funded by Indiana DOT (INDOT) through the Joint Transportation Research Program. "We refer to it as SNIP (Safety Needs Identification Program) and it is basically a tool for safety managers and others who want to analyze safety in a geospatial context," Tarko reveals. "It includes road network information, the speed limit, the number of lanes, traffic volumes and crash data, and the users of the software can then decide what parameters to look at. If they want to focus on crashes involving high-speed collisions they can be found in the database and attached to small pieces of road. Displaying the results on a GIS map will show, for instance, which parts of the road feature a large number of speed-related crashes. This information can then be used by the police to help focus their enforcement efforts."

> We have undertaken a lot of probabilistic linking so that the different fields concur with each other, hence there is a good likelihood of a link
>
> **Andrew P Tarko, professor of civil engineering and director of CRS, Purdue University, USA**

SNIP was employed successfully in an INDOT project to develop reports submitted to the FHWA on the 5% of Indiana's roads with the highest number of crashes and severe crashes: "SNIP helped to find all the roads that had more crashes," Tarko says.

"With this system we were getting information on locations where crashes were a systematic problem, not just a random occurrence."

A new version of SNIP is in the pipeline and will bring a catalog of safety-related road improvements into the mix: "Locations can now have attached the type of road improvements and countermeasures most relevant for the road and the type of crashes. There is even an optimizer that can take Indiana's road budget and see how it can be used in the most efficient way possible."

Essential selections

In Edmonton, Canada, Gerry Shimko, executive director of the Office of Traffic Safety, reports that since 2009 GIS has become an essential tool and forms the foundation for most of his office's data integration in an area which, on average, sees 25,000 traffic collisions every year. "When we started we employed a fairly manual process in terms of our collision-detection data," he states. "We are now progressing toward what we call situational awareness using data integration. We are about halfway there in terms of having a pretty good idea on trends and patterns."

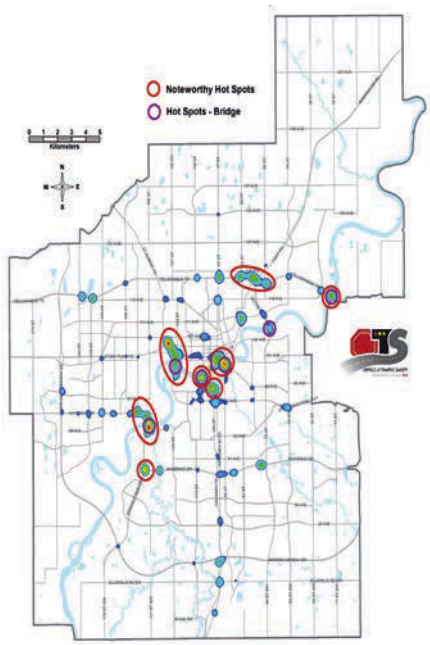
Shimko says he eventually wants to go beyond predictive analytics, where things are based on historical data, to a near-real-time approach: "That is the direction that we are going in and GIS is one of the tools we can use to help integrate our collision data with volume and speed data for better traffic safety management."

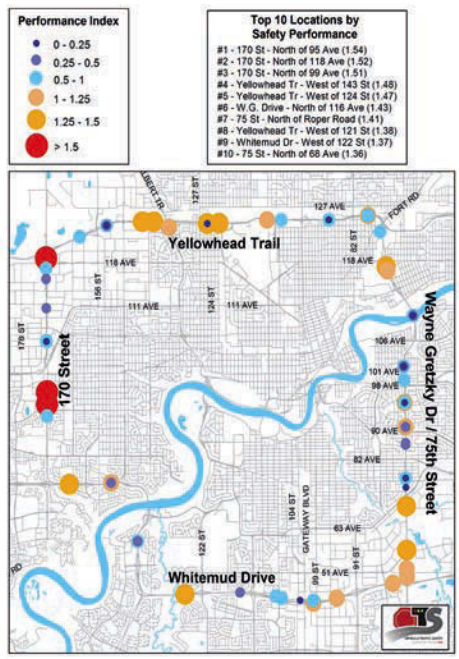
Asked about specific details regarding the impact of GIS in Edmonton, Shimko highlights the technology's central role: "We apply GIS mapping to identify all our enforcement sites, and then we can look at where we have fixed or mobile enforcement and can also call up all our injury, collision-location and risk-analysis data." One of the newer things that is happening in Edmonton now is using GIS for automated enforcement intelligence to try to help identify the point of origin of violators.

According to Shimko, GIS is also helping to flag up certain types of collisions from so-called 'run off road' to 'follow too close'. "These are more indicative of locations where there is a weather influence, so the objective here is to predict the hot spots where they are over-represented and then use an ITS message system to try to educate drivers about the risks."

> GIS is one of the tools we can use to help integrate our collision data with volume and speed data for better traffic safety management
>
> **Gerry Shimko, executive director of the Office of Traffic Safety, Edmonton, Canada**

GIS is now very much an essential element in the intelligent management and analysis of road safety. The ability to identify trends and patterns, and cross-reference with other data such as vehicle, road and junction type, speed and traffic volume, driver characteristics and severity of injuries, is helping to inform future decisions on highway engineering and ITS deployments, including where remedial safety measures are most urgently required.





(Left) **MassDOT uses data from the state's DMV to pinpoint high-crash intersection locations** (Right) **Crash clusters have enabled MassDOT to begin safety improvement work on more than 50 dangerous locations**

(Above) **Edmonton has applied GIS mapping to identify run-off-road collision hot spots** (left) **as well as mid-block collisions** (right)

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The FHWA's **Paul Pisano** – our go-to guy for all things road weather – discusses RWMP initiatives, connected vehicles and team ethics

Interviewed by Max Glaskin

> We have a really strong working relationship with other countries that goes way back to the very beginning of the work under SHRP

Dangerous weather can bring people together. So it's no surprise that someone striving to reduce weather-related road risks stresses the importance of collaboration. Paul Pisano often uses words such as 'community', 'stakeholders' and 'sharing' when he describes his work as team leader of the FHWA's Road Weather Management Program (RWMP). His remit is to improve road safety and mobility by mitigating the effects of weather on road transportation. And his team punches far above its annual US$4m budget as he, his two full-time and three part-time colleagues leverage their efforts by cooperating and partnering with DOTs, researchers and transport operators.

Genesis of the RWMP

"The RWMP team was officially stood-up in 1999, and it was also during the latter half of the 1990s that weather and the winter maintenance work under the Strategic Highway Research Program (SHRP) joined up with the world of ITS," Pisano begins. "Since then, it's really been driven by the ITS program and the funding coming from it."

Pisano has been with the FHWA for 28 years, starting off in traffic safety before moving into rural ITS. Although he's taken courses in meteorology, most of what he now knows has been learned on the job. "And I've learned a lot," he admits. "I had a great mentor [in Andy Stern] on weather and he supported us with technology. That support was very instructive – about the physics behind weather, how modeling works and how the weather community functions."

The RWMP exists because, every year in the USA, more than 1.4 million accidents occur under adverse weather conditions and the number of fatalities is 10 times that of people dying in hurricanes, tornadoes, heatwaves, lightning strikes and floods combined. Connected vehicles are widely seen as offering a great opportunity to reduce these tragic statistics.

"Fixed sensors are costly and they don't provide a sufficiently dense network," Pisano feels. "In contrast, connected vehicles offer a highly granular picture, generating good quality data to inform traffic managers, maintenance managers, emergency managers and travelers."

Mobile solutions

A vital step on this connected pathway has been the Vehicle Data Translator (VDT) software developed for the RWMP by the National Center for Atmospheric Research (NCAR) in Boulder, Colorado. "It extracts data from vehicles [air and road surface temperatures, humidity, precipitation, etc], quality-checks it and merges it with data from other external sources to present a view of weather conditions on a particular road segment at a specific time," Pisano says. "It can be used in any number of applications and we're testing and

> I'd say the USA has caught up and we're now in a position to be transferring some of our own ideas, particularly the MDSS, to other countries

evaluating a couple this winter. We develop the software, make it available through NCAR with a free license for application developers and they use it to provide better products." Ultimately, it should help to narrow the gap between weather information and road weather information.

As ever, once an expert is asked about their work, the information flows rapidly. "We've got a great ongoing project called Integrating Mobile Observations," Pisano reveals. "We're working with NCAR alongside DOTs in Minnesota, Michigan and Nevada to obtain data from their state fleets, which is then run through the VDT and into two applications. One is an enhanced maintenance decision support system (MDSS) and the other is a motorist advisory and warning system.

"At this point, it's feeding back into the state DOTs' systems so they can better manage their networks, whether for maintenance, traffic management or traveler information," Pisano continues. (The applications were expected to be up and running by January 1, 2014.) "The data is extracted from the vehicles' CANbus sensors as well as external probes, such as infrared pavement temperature sensors, then we're combining it with similar data from snowplows and other light-duty vehicles."

Such projects are clearly leading edge but Pisano reports it hasn't always been like this for road weather management in the USA. "We have a really strong working relationship with other countries that goes back to the very beginning of the winter maintenance work under SHRP," he says. "A group of state DOT and federal highway folks went out into the world to investigate how others were dealing with snow and ice control and discovered how far behind we were, especially compared to countries such as Sweden and Finland – in terms of road weather information systems (RWIS) and anti-icing based on pavement temperature modeling, etc.

"The benefits were plain to see and we eventually learned a great deal from Scandinavia and Japan, and we've since made great strides of our own," Pisano continues. "In fact, I'd say the USA has caught up and we're now in a position to be transferring some of our own ideas, particularly the MDSS, to other countries.

In an ideal world…

Omnipotence is the privilege of deities. We mortals have to get by on restricted budgets and goodwill. Yet we can have a vision of an ideal world. "What I'd like to see is that we really have full integration of traffic and weather models so that – before I take any transportation-based action – I can get a perfect or near-perfect picture of what I'm going to be facing, and be able to make sure I do what's safest and most efficient for me," says Pisano of his vision for the road weather management plan.

There is some way to go to that vision becoming a reality. "Current systems tell you what's happening right now, which is fine if I'm going to be traveling in one area. But it doesn't tell me what the weather's going to be or what I can expect in the next couple of hours. Painting a really good picture of what I'm going to be facing in weather and road conditions is where I want us to be."

"We continue to work with countries elsewhere through the World Road Association (PIARC), which sponsors the Winter Road Congress every four years and which is a great opportunity for us to share best practices, ideas, etc."

Research and rescue

Digitization has generally provided unprecedented opportunities to gather, distribute and analyze data, so what's the biggest barrier to making such RWMP solutions ubiquitous? For Pisano, changing culture is near the top of the list. "There's a very skilled traffic management community who may not have had the opportunity to try out new ways of dealing with weather," he says. "There's research needed to develop the appropriate tools so that DOT professionals can gain confidence in them. We need to get the road managers to the table so they can say, 'Yeah, I'm willing to try that!' We're making a lot of progress on both fronts but there's more work to do."

Among the many approaches that Pisano's team has identified for culture change is for state DOTs to test prototype systems in the real world. "Utah DOT recently tested a system enabling citizens to report road weather conditions, feeding that into the traffic management center so it could then provide better traveler information," he reveals. "We're also working with Utah on a weather-sensitive signal-timing study; with Oregon DOT to test Active Traffic Management tools, such as variable speed limits and lane control; and we're also kicking off projects with South Dakota, Wyoming and Michigan DOTs to test various other strategies. DOTs need to see proof for themselves that these systems work. They're not forced to adopt them but, if our research shows the costs are outweighed by benefits, the expectation is that the states will then deploy them."

The DOTs are at the sharp end of RMWP outcomes but a great deal also depends on input from meteorologists. To some extent, Pisano has to make sure the two work smoothly together. "At our stakeholder meetings we bring in representatives from all of these fields," he says. "I'm not saying everybody always sees things the same way but we find a way to continue to focus on making the roads safer and more efficient in adverse weather conditions."

Sounds like a job akin to secretary general of the UN, motivating and keeping everyone on board? "The pleasure is working with a lot of great people to work out the systems that are going to make things better," Pisano says. "It's working with people, to realize the potential we have between the technology and weather and roads and bringing all three together. It's not like basketball with a high every minute. It's continual gradual reward."

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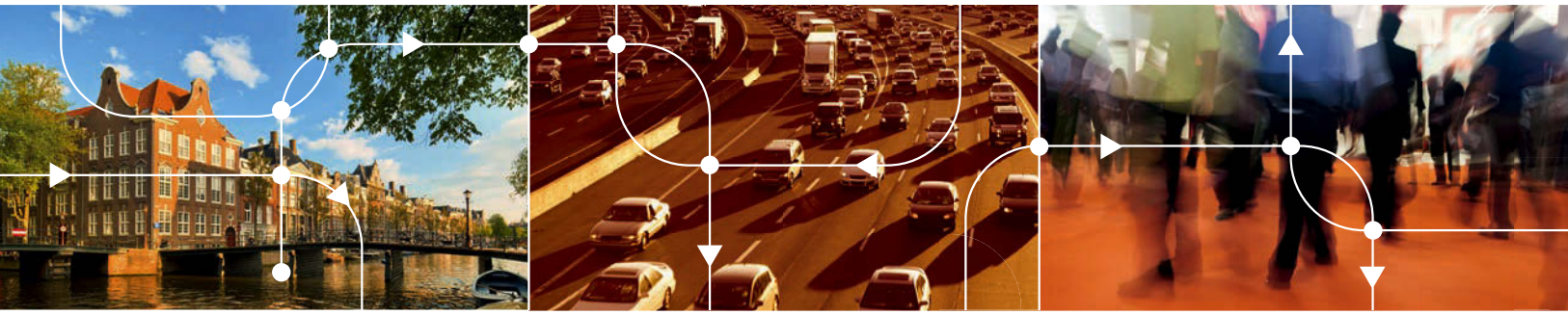

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The new secretary general of the International Transport Forum, **José Manuel Viegas**, talks think-tanks, data delivery and ITS's role in the bigger picture

Interviewed by Saul Wordsworth

> Technology should always be part of a package including measures on funding and taxation as well as regulation and social aspects

Prior to taking over as secretary general of the International Transport Forum (ITF) at the Organisation for Economic Co-operation and Development (OECD), José Manuel Viegas enjoyed a distinguished academic career. While Professor of Transport in Lisbon, he founded TRANSPORTNET, a collection of eight European University Research Groups in Transport Systems. In parallel, as chairman of TIS.pt consultants, he advised governments and international institutions on high-profile transport projects. So is this new role the pinnacle of his profession?

"The ITF is a wonderful organization and I'm really proud to be a part of it," Viegas admits. The ITF is the successor of the ECMT (European Conference of Ministers of Transport) and was founded 60 years ago. "It was the ECMT that first delivered policy recommendations on wearing seatbelts, drunk driving and the standardization of road signaling," Viegas reveals. "In one form or another this group has been a breeding ground for a lot of the things that we now take for granted."

Today the ITF uses what Viegas calls its "soft powers" – or influence, despite its lack of regulatory clout – to help set the transportation agenda in an attempt to ensure it contributes in areas such as economic growth, environmental protection and the preservation of human life.

"We are a think-tank that conducts collaborative research and policy analysis for the governments of our 54 nation-state members," he reveals. "We not only research but manage a major effort in road safety statistics and analysis in the form of the IRTAD (International Traffic Safety Data and Analysis Group), which includes countries beyond the ITF membership."

Safety in numbers

IRTAD, a permanent working group within the ITF, currently boasts members from 70 organizations from 34 countries. Its principal objective is to aid international cooperation on safety data and its analysis, although it also shares information about

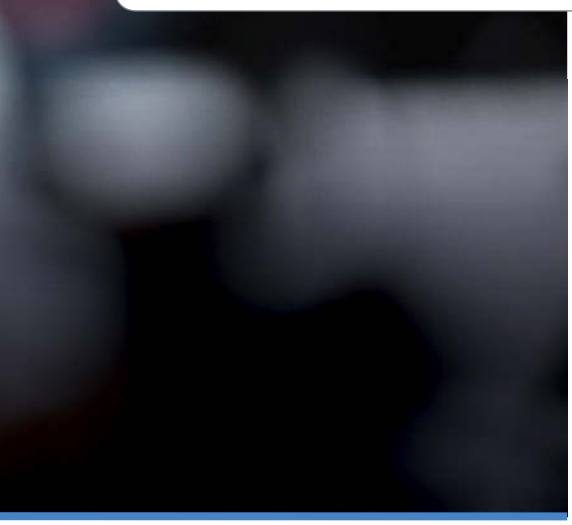
The days of his life…

Although no two days are the same, José Manuel Viegas's work does follow a distinct pattern. "Generally speaking, I will pass one third of my days away from the office, meeting with governments but also at international conferences that we are invited to. The other two thirds in the office are given over to my main concern of strategic development of the organization," the Portuguese says.

"I have a very good team and I'm someone who likes to delegate," he continues. "I will often participate in meetings organized by the unit, in which they'll ask me to be present because they want there to be some kind of check on what they're developing. Is it, for instance, compatible with the strategic vision I have for the ITF? Then I, myself, will be doing a lot of work on a revision of how we should be organizing ourselves and addressing the whole issue of the value proposition.

"Currently our funding model is in discussion with the countries and I have to work hard on that, along

with plenty of to-and-fro communication. It's really very lively – a great variety – but I understand my major responsibility here is for the strategic conduct of the organization. The tactical developments in each of the units are largely delegated to the respected heads."



trends in road safety policies. IRTAD maintains a high-quality database of road safety information known as the International Road Traffic and Accident Database, through which numbers can be sourced about injuries, fatalities and the hospitalized in relation to population, vehicle, road network length and seatbelt-wearing rates. These statistics stretch all the way back to 1970.

"We recently concluded an agreement that covered nearly all of Latin America and the Caribbean, and involving 20 other countries," Viegas adds. "We have a leading organizational role in this to ensure that data-collection procedures are brought up to the highest international standards so the data becomes internationally comparable. Then we manage groups of experts when it comes to analysis of the data and determining what we can do to improve its value in supporting the design of policies to reduce deaths and serious injuries. Wherever member countries have an interest in working together to improve their capacity for handling data, we respond, calling in external experts where and when necessary."

Man with a mission

When Viegas ran for secretary general of the ITF in 2012 his mantra was 'value for members'. True to his word, since his appointment he has done his best to instill this culture throughout the organization.

"My mission is a basic reshaping of the ITF in such a way that national ministers will hopefully always feel it's worth paying their contribution because they're getting excellent value for money," he says. "We don't have to exist. We have to justify our existence by what we deliver. I have been fine-tuning our processes here and as a result have added two major innovations to our portfolio."

The first of these has been to bring in a structured approach to collaboration with the corporate sector. Viegas has found that often, when working with academia and government officials, the resulting recommendations are not always easily applicable because the realities of life in the field have not truly been considered, or have been misunderstood. As a result he has proposed – and member countries have approved – something called the Corporate Partnership Board, in which around 50 international companies from fields such as finance, energy and IT will be working with the ITF to improve their perspectives on policy issues, thereby enabling better value in the advice ITF is able to dispense.

Viegas's second innovation is what he refers to as Short Cycle Projects. "We will be complementing our action on research projects, which typically have an average duration of two years, with something shorter as per a member country's request. If a government is having to handle a tough policy issue and feels there's some value in receiving international, independent and competent advice, we can now very quickly assemble a team of experts and people from administrations in other countries, in doing so providing the country in question with firm evidence of what is being done, what has worked well in the past, what our view is on what should be theoretically sound, what is practicable, etc. This is a line of development that we started midway through 2012 but the feedback has proved very positive and we already have around five requests for Short Cycle Projects."

Forward technology

One of the ITF's great successes has been its annual summit. The May 2014 event will be held in Leipzig, Germany under the theme 'Transport for a Changing World'.

"The event will have considerable focus on traffic management," Viegas alludes. "We've been working on and following a lot of issues related to ITS. We believe a lot more could be done to improve transport if ITS was more traveler-centered and not based only around the vehicle. I see a bias that should be corrected. If you focus on the traveler, you will more naturally look at the whole field of transport choices the traveler has, not only when he's sitting in his car."

But on that note, Viegas has high hopes for autonomous driving, particularly in the realm of freight movements – an area close to the ITF's heart. Freight platooning, the ITF secretary general feels, will be an area that will have a faster uptake than the passenger car, especially on long-distance motorways.

"This would be relatively easy to introduce," he believes. "It would be a natural uptake and the first step of introduction, with the first and last miles into and out of the cities performed with a human driver and possibly smaller trucks. Such technology could help address the current problems in recruiting long-haul drivers in Europe and act as a stimulus.

"I am very excited about the future of ITS in helping to shape and improve transportation for our citizens, but it should never be taken on its own. Technology should always be part of a package that includes measures on funding and taxation as well as regulation and social aspects – for instance how you communicate the message and what value it has for its citizens. Technology must never exist in isolation."

Reducing energy consumption with traffic-adaptive streetlighting

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Over the past few years, a substantial effort has been made to increase the energy efficiency of streetlighting. One of the reasons is that the European Commission issued the so-called 20/20/20 targets, setting three key objectives for 2020: a 20% reduction in EU greenhouse gas emissions from 1990 levels; raising the share of EU energy consumption produced from renewable resources to 20%; and a 20% improvement in the EU's energy efficiency. Additionally, rising energy costs are motivating operators of streetlight infrastructure to improve the energy efficiency of their streetlights.

A promising method of contributing to the targets and reducing energy consumption is the deployment of LED-based luminaires, because luminous efficiency (lumen per Watt) has reached a critical value where it makes sense to use them from both a technical and economical point of view. A next step is the integration of intelligent functionality in today's LED streetlights. Since the level of luminosity is adjustable almost instantaneously and a wide dimming range is possible, a highly dynamic control of the level of luminosity depending on sensor inputs can be realized. Consequently, predefined time-based scheduling can be replaced with a schedule depending on events such as the current traffic volume.

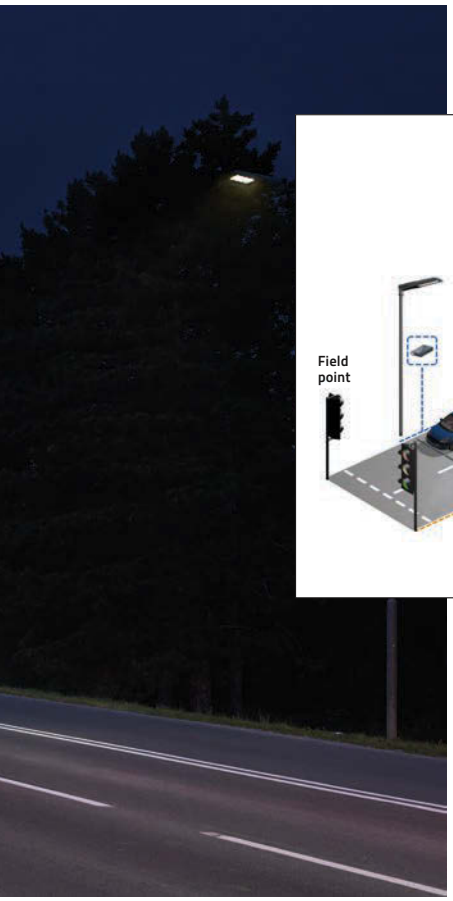
The idea to adjust the level of brightness depending on traffic volume is being called 'traffic-adaptive streetlight control'. Instead of realizing a closed streetlight system with its own dedicated sensors, data from a traffic management system (TMS) is used because it already stores sensor data to get a picture of the current traffic and environmental situation. As a further step, intelligent streetlighting is included as an application within a TMS and is set up with an integrated streetlight system to enable overall traffic and streetlight control strategies.

Ernst Luckner, head of the R&D department at Swarco Futurit, says the benefit of this approach is "that energy consumption is reduced without endangering road safety". Further advantages are no additional deployment of sensors for streetlight control, and reduced installation and maintenance costs.

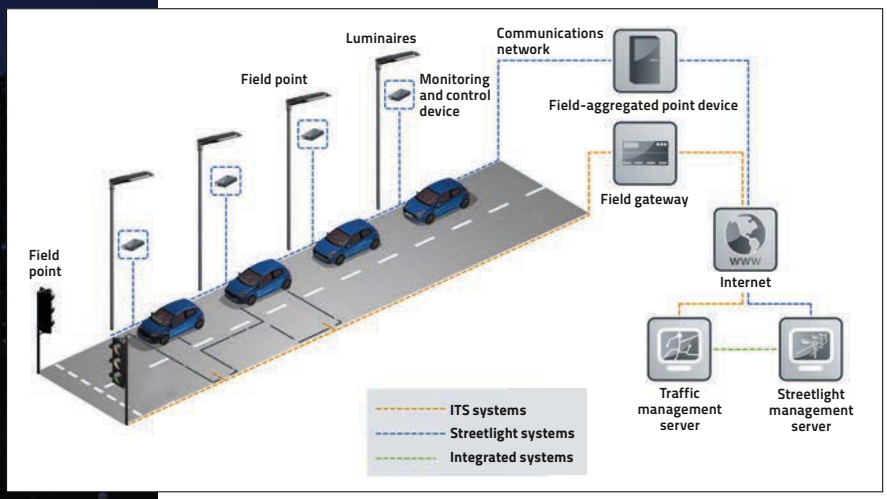
System architecture

In general, the integrated streetlight system architecture consists of three major components. The diagram opposite gives an overview of the system architecture. Although the architecture strongly depends on existing installations and legacy systems, typically, the following three components are necessary. *Intelligent streetlight* is the luminaire at a field level. It includes a monitoring and control device module (CDM) to manage the luminaire. It can read status information or change the brightness of a luminaire. The device interfaces to the gateway.

Field aggregated point device (gateway) is the field device used to collect information from individual controllers and to interface with the streetlight management. The gateway acts as a bridge between the local communication network used to reach the CDM and the wide area communication network to the streetlight management. *Streetlight management* runs the application software, graphical user interface and web services. It interfaces with the gateways through the wide area communication network and exchanges information with the traffic management components in the TMS.



(Left) **Intelligent control means lighting can be adjusted depending on traffic volumes**
(Below) **Overview of the traffic-adaptive streetlight management architecture**



The integrated streetlight management also includes communication networks to exchange data among the various devices. The link between management server and gateways is typically based on wired Ethernet/IP connections. Data exchange from the gateways to streetlights can be realized by UMTS/TCP links for long-distance coverage, short-distance technology such as ZigBee (wireless) or Powerline (wired).

As depicted in the diagram, the integration between the traffic and the lighting components is realized at the system level. The reason is that existing traffic and lighting infrastructure is tremendously heterogeneous. Experience from meetings with stakeholders shows that a huge effort is required to use existing field equipment for traffic (for example, a roadside controller at an intersection controlling traffic lights) as well as lighting applications. The advantage of integration in the field, however, is that less equipment is required, resulting in a reduction of costs and an even more efficient system.

Need to know?

A new, intelligent approach to help authorities reduce the energy consumption of their streetlights

- The new solution is known as traffic-adaptive streetlight control
- In general terms, what this approach means is that the brightness of streetlighting can be either increased or reduced depending on traffic flows
- A test site in Austria provided the means to showcase the solution

Use case

In three cities in the east of Austria, a traffic-adaptive streetlight management system was deployed throughout 2013. Around 50 luminaires from Swarco Futurit were equipped with a ZigBee-based communication module at each test site. The traffic-related information comes from radar sensors. Its input is processed and the brightness of streetlights set according to a predefined control strategy in the streetlight management application.

The control strategy is based on the traffic volume on the dedicated stretch of the road. Four categories of traffic volume are identified in a qualitative manner: no traffic; single traffic; heavy traffic and inactive (that is, no change of category). Depending on the category, two different control commands can be sent to the luminaires (increase brightness or reduce brightness).

Increase brightness is applied when the traffic situation changes from low to high and vehicles pass the radar sensor. The sensor informs the streetlight management that vehicles are detected. The traffic volume is assessed. Based on the available system information, the control strategy identifies a category. The appropriate streetlights are selected and a control command generated. This command is forwarded via the gateway to the streetlights. Reduce brightness becomes relevant when the traffic situation changes from high to low. Finally, if the category is not altered, the brightness remains the same.

During the operation of the traffic-adaptive streetlight management in a real-world scenario, the energy consumption of the intelligent streetlights is continuously monitored. It is compared with the consumption of the traditional installation to identify the amount of savings. "Such an approach means we can quantify the benefits and proven results to relevant stakeholders," says Michael Schuch, member of the executive board at Swarco.

Contact

Swarco Futurit
+43 1 8957924
office.futurit@swarco.com
www.swarcofuturit.com

Keeping traffic and wealth flowing

READER ENQUIRY NO. 502

Throughout history the world's great cities have relied upon strong transport links to generate wealth. This is still the case today and the capability of merchants, traders, tourists and residents to access the city governs the success of the local economy and in some cases, has been the cause of a city's downfall.

Although city authorities are under intense pressure to cut the amount of traffic on the roads, they must keep in mind that if you cut off the traffic, you cut off the wealth. It is a delicate balance because when there is too much traffic on the roads, the noise, pollution and health issues can cause citizens to move out of the city and into the surrounding areas. But for them to carry on working they have to travel back in to the city, which in turn causes even greater levels of traffic.

Therefore it is important to find a way of controlling access to the most congested areas of a city and encourage reductions in usage through other means than just implementing a blanket ban. The harsh reality of most modern cities is that it simply isn't possible to increase road capacity and infrastructure due to the lack of space available for development. Instead the existing infrastructure needs to be used more intelligently. Politicians often try and deal with these issues by reassigning existing infrastructure for a different use, for example creating a bus lane. Although this may benefit bus passengers using those particular sections of road, for passengers overall it makes things worse. If roads are already congested, taking away capacity for use by specific modes of transport has the effect of squeezing the other traffic onto an even smaller amount of infrastructure, which leads to ever greater congestion.

Need to know?

Urban access control systems can improve traffic flow without impacting the economy

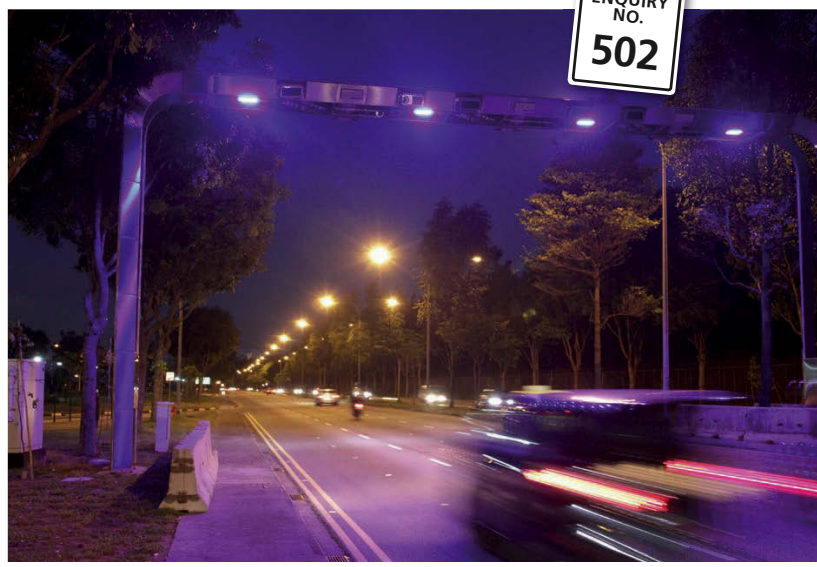
- It's not feasible to keep building new traffic infrastructure, so cities have to devise smarter solutions to cater for the increasing demand for their transport networks
- Access management systems enable cities to control who is driving in them – and when

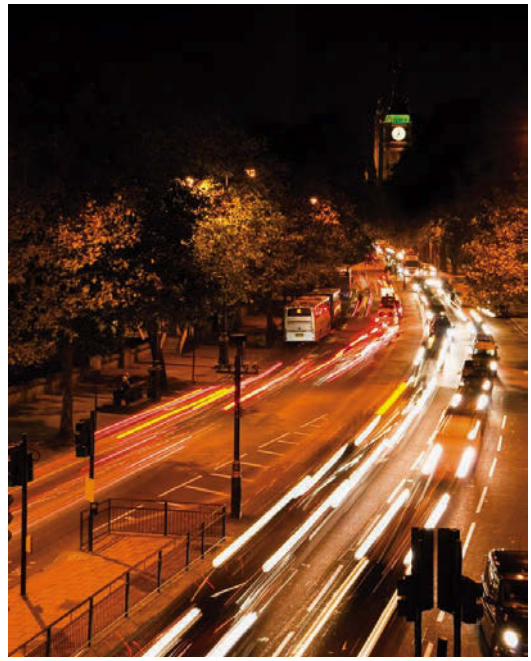
Access control

A better way of dealing with congestion is to control (or restrict) access to the city according to the type of vehicles and usage that city authorities would like. Automated access control systems provide many benefits, but the three most obvious are that they are cheaper to run than a manual system, including the processing of payments and violations; they allow authorities to change the access rights of different vehicle types throughout the day, depending on demand; and most importantly, they significantly improve traffic flow. Where traditional traffic management would use a red light to stop everyone, newer access solutions enable operators to deny access to selected vehicle types while letting others continue about their business.

The oldest example of city access management in Europe is the city of London, which implemented a congestion charge in 2003. The charge – which is paid by certain vehicle types entering the most congested areas of the city – has led to a 30% reduction in traffic during the regulated times of day. The London congestion zone is an example of selective targeting. Low-emission vehicles are exempt and the charge does not apply before 7:00am and after 6:00pm on weekdays and is lifted for all vehicles at weekends. It has been used by city authorities as a tool to shape what type of traffic they want to have within the city confines.

Utilizing access management solutions to shape the traffic using a city's infrastructure doesn't just have to be about time of day or vehicle emission class. It can also be used to charge vehicle owners based





(Above) **Access restriction, such as deployed in Singapore, is a traffic management tool typically used where it is necessary to grant or deny access to a limited number of vehicles**
(Left) **Congestion-charging systems, such as in London, can be based on an ALPR system and/or DSRC using onboard units and transceivers to automatically control access**

on their earnings or job role, as well as encouraging certain positive behaviors, such as obeying speed limits.

It isn't just London that has seen success with city access management. Sweden, Italy and Norway are all developing similar schemes. In the Netherlands, authorities have chosen to focus more on emissions and have set up 16 low emission zones. Non-compliant vehicles are banned from entering the zones; however they can buy access if required, although the charge is very high so as to put people off.

For the historical cities of Italy, congestion on tight and narrow streets is a particular issue, one of the reasons that there are now more than 100 access zones in operation with outright bans on non-compliant vehicles. The city of Bologna has implemented a ban on all vehicles in its city center, but does sell a set number of access passes on a daily basis, priced at €5. Another example is Milan, where there is 100% compliance for charging based on vehicle emissions, meaning all vehicle users pay for access, unless they are using an EV or hybrid car.

The EC is currently working toward two main goals when it comes to city traffic. The first is to halve conventional combustion engine car traffic in cities by 2030; the second for there to be no combustion engine car traffic in cities at all by 2050. The only way either of these goals can be achieved is through the use of city access solutions. The trick will be to maintain the wealth while keeping the traffic flowing. ○

Contact

Kapsch
+43 50811 0
petra.hamm-fierthner@kapsch.net
www.kapsch.net

Sam Schwartz

sschwartz@samschwartz.com

In 1973, *MAD* magazine did a spoof article, *MAD'S Traffic Commissioner of the Year*. The commissioner looked unsurprisingly like my old boss, NYC's traffic commissioner Theodore Karagheuzoff. A few frames were shown of the traffic department sign shop where workers were competing for most confusing sign of the month. Candidates included a one-way arrow with two arrowheads, a No Parking sign from 8:00am to 6:00pm and 8:00pm to 8:00am, and others I don't remember. If *MAD* were to do a 2013 version, they'd have fun with our VMS signs, traffic alerts and Twitter messages. Too many of us do not write for the user – i.e. the driver. He or she may not know north from west or not know that Main Street is also County Route 55. Saying '10 minutes to I-60' on a VMS means nothing to the driver who doesn't use the route regularly.

When it comes to VMS, I'm sure all the traffic engineers reading this have seen a sign flashing two or three lines of words on two panels about 100 characters long, saying something like, 'George Washington Carver Expressway Northbound/Traffic Moving Freely to Abraham Lincoln Parkway'. The Carver Expressway was moving freely ahead but traffic was jammed from the VMS south for a mile as drivers slowed to read the two panels of the message.

Over time we did get to be more concise in our word messages because we know that drivers want the info fast and to get on with their driving. We also know shorter messages are safer. Drivers slowing down to read a message increase the crash potential. So in this day of Twitter, Facebook, texting and radio alerts, we must be frugal with our words yet get the message out clearly. We need Messaging 101 for the Traffic Engineer at operations and management centers.

Creating effective traffic advisories and alerts is not dissimilar to the principles used in advertising. Headline writers at American Writers & Artists highlight the 'Four Us' when it comes to grabbing the reader's attention. The headlines should be 'Useful', provide a sense of 'Urgency', convey a 'Unique' idea, and be 'Ultra-specific'. In terms of traffic advisories, this means the message should precisely state the affected routes, how they're affected and how the driver's trip changes.

Another aspect of traffic advisories that can be improved is the notion of directionality. Many drivers are directionally challenged. NYCDOT's transportation commissioner Jeanette Sadik-Khan recently highlighted a study that showed one out of three New Yorkers didn't know which way was north.

To address this issue, it is better to say 'Manhattan bound' rather than 'eastbound', or 'Bayonne Bridge to New Jersey' rather than 'northbound'. This way, everybody understands which direction is impacted.

In ad speak, 'grab words' are words that grab the target audience's attention. This concept is very useful on Twitter. These words work because they change the dynamic of the content. Phrases such as 'Gridlock Alert' and 'Emergency Closure' immediately provide drivers a sense of how they will be affected. So although words such as 'Construction' and 'Major Rehabilitation' are good descriptors of the event, they are less important to the driver affected by it. When limited by the amount of space and available time to convey a traffic advisory, it's critical to communicate at the outset how drivers will be affected. Any secondary information should be omitted entirely.

So I urge all readers, 'Save Words for Safe Roads'. Become Mad Men of Traffic – not fodder for *MAD* magazine.

> So I urge all readers, 'Save Words for Safe Roads." Become Mad Men of Traffic not fodder for *MAD* Magazine
>
> **Sam Schwartz, Sam Schwartz Engineering, USA**

The lens: a forgotten element in image recognition

READER ENQUIRY NO. 503

The picture on the left has been taken with Tamron megapixel lens while the one on the right with a cheap equivalent. Both were mounted on the same camera with the same settings and under the same conditions. What this clearly shows is that the camera isn't always the reason for lost or unavailable picture information

The demand for better image quality in the ITS market has been rising steadily for several years. In the domain of license plate recognition, for example, there's an abundance of specialized cameras, recording and monitoring systems – but how many times have you heard a mention of the lens? It's often the forgotten part of the whole image-recognition process.

Once you understand its function, however, you will undoubtedly appreciate how critical a good quality lens can be. Selecting a low-quality lens for an application simply means that the first element in the image-capture chain will impact and decrease the performance of the system as a whole – and that's lost information that cannot be retrieved or compensated for at a later stage.

So when contemplating the role of the lens in ITS, remember that a higher quality input has a direct correlation on overall accuracy. In the case of speed or red light enforcement, that means more successful prosecutions while in all-electronic tolling, it's integral to minimizing revenue leakage.

Lens considerations

So what are the major considerations for ITS applications, particularly in relation to multi-megapixel equipment? To achieve optimum picture quality, the lens needs to be able to take the image through dark to bright light conditions. Does it have sufficient resolution and contrast in order to capture the correct numbers and/or letters contained within a license plate?

Many lens manufacturers define the resolution of lenses with a certain number of megapixels. To some extent, this can help you assess quality but the information isn't sufficient when describing the actual lens resolution. Other than the number of pixels on the sensor, the resolution of lenses cannot be measured exactly, since resolution depends on too many factors. What, for instance, is the light condition? What is the object distance? Which aperture has been used? Under ideal conditions, the necessary resolution may easily have been achieved in the center of the image, but what happens at the peripheral areas? In fact, this is precisely where you can see the real difference, as lens resolution decreases at image corners, hence it is especially important to check for this when using multi-megapixel cameras. If you don't, you're essentially not taking full advantage of megapixel technology. Tamron is conservative in this respect in that it rates the resolution of its lenses according to the real resolution at the image edges. In the center itself, the resolution is higher.

Another critical aspect to consider with lenses is the sensitivity of megapixel cameras and the importance to use a bright f-stop lens to collect more light onto the camera sensor itself. As a result of the large pixel quantity, the individual pixel size of megapixel cameras decreases, in doing so leading to lower sensitivity. Because of that, megapixel cameras have less depth-of-field than normal cameras, so users should also think carefully to adjust focus precisely.

Developed for ITS

Sensitivity is a crucial factor in the ITS market and is one of the reasons that larger sensors sizes as 1/2", 1/1.8" and even 1" have recently become increasingly popular. Lenses with fast aperture are necessary to recognize anything in bad lighting situations.

For traffic surveillance applications, most of the lenses are used in the telephoto side of the focal length. Users should

Need to know?

Tamron aims to boost its share of the traffic market with a new 3MP Integrated Zoom Lens

- Compact size enables it to fit into a PTZ dome
- Precise remote control is possible by the adoption of stepping motors, which drastically reduces installation time
- High-demand focal range of 15-50mm. Suitable for LPR, identification of people or vehicles, etc
- Color smear is eliminated by reduced chromatic aberration
- Precise, high-quality construction maximizes performance

therefore bear in mind that when the focal length lengthens, the f-number becomes bigger. If you peruse a lens datasheet, the stated f-stop usually refers only to the widest angle – i.e. shortest focal length.

But there's additional information that cannot be found on datasheets. For example, special coating technologies and advanced optical design is needed to eliminate ghost and flare.

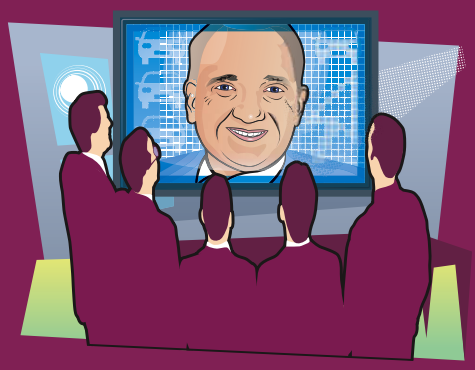
Tamron recently launched its 3MP Integrated Zoom Lens incorporating a hall sensor, which enables exact control over the aperture – a critical point for backlight conditions typical in traffic surveillance applications.

The combination of an FA camera and a fixed-focal lens is mainstream in the current ITS market. But as the lenses used have a fixed focal length, adjustment during installation is limited and multiple lenses must be prepared. Also, because the lens and camera are separate, the superior functions of an integrated camera cannot be utilized.

Tamron's 3MP Integrated Zoom Lens has a focal range of 15-50mm to meet the most demanding ranges in the traffic surveillance market, while its durable and compact design makes it a seamless replacement for any existing solution. It can be integrated into the camera, and makes the installation simple as there is no need to adjust back focus.

Contact

Tamron Europe – OEM Business Development
+49 221 97 03 25 75
v.zhekova@tamron.de
www.tamron.de



james.eden@aecom.com

Governance within interoperable groups isn't anything new. It's been an issue for more than 20 years – ever since thoughts of electronic toll collection were first introduced. Back then, there were no deployed systems or business rules. Although there were large financial and political risks, they were not nearly as great as they are today.

I always felt that the hardest part of a project was starting it and wrapping it up. Despite great progress recently, there are many issues left to resolve in order to have national tolling interoperability in the USA. Today we all are struggling with many technical, political and business issues that must be overcome in order to offer customers a seamless user-fee transportation system. It seems that every time there's a disagreement about something, another group is created.

We now have so many groups that you can probably spend half your week just attending conference calls. Even after initial decisions are made, changes in technology, business rules and operational issues require re-evaluation by everyone involved. These negotiations and the ultimate resolution will need to be by consensus and not by a dozen independent organizations. This is not an easy problem to solve.

Remember, more than 10 years ago, the IBTTA tried to take the reins and pick a long-term RFID technology that everyone could eventually adopt. There were committees and many discussions, but despite eventual board approval, not one agency adopted 5.9GHz. How could that happen? The same people who were at the table made the decisions for their agencies. Maybe it was at least partially caused by the fact that despite all of these independent businesses belonging to the same group, they must all make decisions based on what is best for their agency.

Someone recently told me that in order for this to work, everyone has to come into the room and leave their egos and wallets at the door because – in the end – everyone's going to have to compromise and it's going to cost everyone something.

Remember that agencies will eventually become interoperable – not only with each other but potentially other entities (transit, parking, etc). How will private or commercial entities work with government organizations? Will agencies contract out the management of interoperability? What will happen to the groups that are managing states or regions now? Will they merge into one or disband? And the big question: who is going to govern this now combined multibillion-dollar inter-regional or national consortium – not just now but in the future? How will that governance work? How will decisions be made? Will this group be capable of forcing decisions on an agency? Who will get a vote? How will equity work between large and small agencies?

Today there are many examples of governance that work: E-ZPass, IBTTA, ATI, AAMVA and AASHTO, for instance, have succeeded in their missions. Florida, Texas and California have succeeded within their states. But the potential of this group to grow into a Goliath is real, and setting up and administrating this organization won't be easy.

It's not an easy problem and it's not going to go away either. We are achieving interoperability regionally and advancing toward national compliance. But soon, we'll have to come together and formulate a plan on what structure we use to manage.

> These negotiations and the ultimate resolution will need to be by consensus and not by a dozen independent organizations
>
> **James Eden, director of tolling, Aecom, USA**

While traffic stands still, technology moves fast

READER ENQUIRY NO. 504

How do you implement solutions such as video, vehicle and roadway sensors, and other advanced traffic communication tools when legacy infrastructure doesn't seem to support it?

This can create a headache for traffic engineers and city planners who want to keep a city moving. It happened in Peoria, Arizona a few years ago.

During the economic boom, Peoria experienced significant growth. Its once-efficient congestion management system suddenly felt obsolete, unable to handle the influx of new residents and increased traffic.

Back in 2005, Peoria had over 100 signalized intersections that were equipped with NEMA TS-2 cabinets and traffic controllers that employed time-based coordination. To tackle congestion, the city performed regular count studies and figured out timing plans that were manually added to each controller.

(Far left) **Signals can now be directly linked up to TMCs** (Left) **Intelligent communications systems can easily handle video streaming** (Below) **Traffic may be stuck but technology is moving quickly**

Need to know?

Cities are enjoying the benefits of improved communications technology

- A hybrid communications network featuring wireless and fiber optics can help a city develop intelligent transportation systems in a cost-efficient way
- Wireless technology has evolved greatly in recent years and WiMAX-based products are at the heart of this evolution
- Ruggedcom offers a range of WiMAX-based solutions to help cities improve traffic management

Unfortunately, the existing system didn't allow Peoria's Traffic Management Center (TMC) to communicate directly with the controllers, so traffic engineers had to make frequent trips out to the field. And with increased congestion, keeping up was a daunting task.

In need of a solution, the growing city sought help to minimize congestion, reduce travel times for motorists, provide accurate information to everyone on the road, and avoid having to send personnel to the field.

Siemens worked with the city to create a hybrid communications network featuring a high-speed fiber backbone. Most importantly, the company implemented technology that could withstand the extreme Arizona desert heat – and stand the test of time.

Today, Peoria boasts one of the most advanced traffic management systems, with gigabit connectivity to all of the city's CCTV cameras, message signs and traffic signal controllers. The system utilizes a combination of fiber optics and 45Mbps, 5.8 GHz radios for locations without fiber.

Lower costs, better control

Traffic signal connectivity improvements, which were once expensive to deploy, are now well within budget.

And it's not just small, downtown urban centers that are benefiting. Reliable network solutions let engineers anticipate problems before they happen and manage headaches when they arise – all over a span of hundreds of miles.

Getting traffic flowing the right way doesn't necessarily mean a complete overhaul of infrastructure. The best solution is often a mix of technology that works with legacy traffic signal infrastructure and an advanced wireless technology such as WiMAX 4G broadband private radio, used in Siemens' Ruggedcom WIN products.

Because intelligent transportation systems don't rely on one specific piece of communication technology, leading technology companies are able to tailor solutions for cities that want to modernize their traffic flow.

With Ethernet over VDSL, existing copper cable can be transformed into a conduit for modernizing traffic signals in major metropolitan centers around the world. Ethernet over VDSL provides the type of bandwidth traffic systems require to handle adaptive algorithms and streaming video. By connecting modern hardware to legacy infrastructure, engineers and city planners are getting a new lease on their older equipment without having to dig up the old copper and lay down new fiber optics.

While getting an instant upgrade to the outdated technology beneath the street surface is valuable for so many cities around the world struggling with outdated transportation technology, it's what's happening in the air that's really interesting.

According to Lee Lipes, product management director at Siemens, the future of

intelligent transportation is with wireless technologies such as WiMAX and secure wi-fi.

"Wireless technology has come an incredibly long way," explains Lipes. "We recognize that some traffic management departments are concerned about security, but we're at the point now where wireless communication is as secure as wired technology – and a lot less costly to deploy."

Lipes says WiMAX offers the kind of advanced security that intelligent traffic management demands, including device authentication and over-the-air hardware-based AES-128 encryption. WiMAX systems authenticate every single device on the network using X.509 certificates installed on the system end points.

WiMAX is designed to work outdoors and cover much greater distances than wi-fi. In fact, WiMAX, is built to cover up to 40km at bandwidths of up to 40Mbps. Ruggedcom WIN WiMAX-based products can withstand the harshest of weather conditions. That's important when building out networks in cities where snow, sleet, wind and hail are the norm.

What's more, because WiMAX is based on the 802.16 family of IEEE standards, it is possible to leverage a bigger ecosystem of suppliers and ensure longer technology lifecycle. That's important now, and it'll be important when cities upgrade their systems or add new pieces of equipment.

Contact

Siemens Canada
+1 416 856 5288
ruggedinfo@ruggedcom.com
www.siemens.com/ruggedcom

Larry Yermack

lyermack@gmail.com

I've been musing lately about E-ZPass on the occasion of its 20th anniversary and – because I think they still have relevance today – I wanted to share a few of the early 'war stories'.

For starters how do seven agencies buy the same thing? They can't have a single, seven-agency procurement, and they may not all have the legal ability to buy against each other's contract. We needed to invent a procurement approach, so we created the 'irrevocable offer'. One agency conducted the procurement under its rules, and all seven agencies participated in the selection process. The lead agency issued a contract but as a part of that contract the technology provider agreed to make an irrevocable offer to all current and future E-ZPass agencies.

The offer contained some interesting clauses. E-ZPass would determine who was a member and able to use the contract. The provider had to offer E-ZPass its best price and if they subsequently offered lower prices to a new customer anywhere, they had to make those prices available to E-ZPass. They needed to provide a guaranteed second source to avoid monopoly pricing, a clause that was negotiated away after I left (and I still think it was a bad idea to do so). The irrevocable offer pointed the way for ATI to procure a video hub and is a way today for agencies to work together.

Another big debate at the time was between read-only versus read-write technology. Read-only tags would just identify a vehicle with calculation of toll rates to occur at the back-end. Read-write tags would be able to capture entry and exit data on toll roads and allow the patron to see their toll when leaving a tolled highway, but they were more expensive.

I never believed that read-write was necessary but since I saw my role as managing the process and not necessarily getting my own way, I deferred to read-write. However the trend over these past years has been for the processing to move from the lanes to the back-office and so today all tags, even though they are read-write, function as read-only devices.

The broader issue is that 20 years ago the focus in toll systems was on the point of sale – the token or cash. If all you were collecting was cash or cash equivalents, such as tokens, then all you needed to do was count the quarters or tokens that you collected in the coin machine. Check the counter against what the employee handed in and you were done. The accounting system was an afterthought.

Today the point-of-sale terminal can accept RFID tags or license plate reads, or even phone calls. No longer is counting the tolls simple. We should be putting our focus on the back-end financial transaction processing, a subject about which I'll be writing in the New Year.

> Twenty years ago, the focus was on the point of sale. If all you were collecting was cash or cash equivalents, such as tokens, then all you needed to do was count the quarters or tokens that you collected
>
> **Larry Yermack, Wendover Consult, USA**

Arizona's DUST monitoring and warning system for I-10

READER ENQUIRY NO. 505

The Arizona Department of Transportation (ADOT) has recently been testing a new warning system on I-10 between Bowie and San Simon in the southeast of the state. The technology is designed to alert drivers to the dangers of impending dust storms – or 'haboobs' – which are a major hazard in certain parts of Arizona. This was in evidence as recently as October 29, 2013, when three people died in a 19-car pileup after a dust storm popped up without warning.

Forecasting exactly where and how dense dust will be is extremely challenging, so ADOT's Dual Use Safety Technology (DUST) Warning System has been developed to help improve matters on dust-prone stretches of freeway.

"Providing a safe, efficient and reliable highway system is our primary goal," suggests Reza Karimvand, assistant state engineer and transportation technology manager. "This recently installed dust-warning system was an upgrade to an existing weather monitoring system that was installed several years ago. That original system and the upgrade were funded by an FHWA Rural Innovative Technology grant. "The upgrade also includes some weather monitoring equipment in Texas Canyon, which is the highest point on I-10 in Arizona," says Karimvand. "The northern systems were associated with monitoring winter conditions and the two in the Safford District in southeastern Arizona were installed to monitor dust storm conditions, although they were found to be very useful during the winter as well."

Inclement weather impacts our road networks in many different ways – and results in something in the region of 1.5 million traffic accidents a year in the USA alone – but few DOTs will have to cope with events such as haboobs.

Different kinds of storms

"The Safford District has a wide range of topographies," Karimvand explains. "I-10 in southeast Arizona ranges from about 3,500-4,900ft in elevation. The normally dry climate, ubiquitous wind, desert land forms and sparse vegetation make dust storms a common event in this part of the world. There are different kinds of dust storms just as there are different kinds of precipitation."

(Above) **Drivers are advised to tune in for guidance** (Left) **Visibility is drastically compromised during a dust storm**

Need to know?

A warning system to reduce the number of dust- and weather-related KSIs

- Designed to detect weather parameters above the agreed set point, signaling the likelihood of dust cloud formation or other low-visibility conditions
- System warns motorists of winter and dust hazards using remotely activated solar-powered flashing beacons, DMS and HAR
- Alerts ADOT to adverse weather in the area

(Top) **DMS are programed to display weather-related warnings** (Above) **The warning system detects where – and how dense – dust is likely to be**

Although dust-storm accidents make up a small percentage of Arizona's traffic fatalities, they tend to be large and dramatic. Between 2000 and 2011, blowing dust was responsible for 1,207 collisions, 40 fatalities and 1,136 injuries, according to DOT figures.

The DUST warning system is ADOT's response. "I would say the project is innovative in that the weather conditions trigger phased messages to the driver based on wind speed (phase 1) and visibility (phase 2)," Karimvand continues. "Amber flashers are mounted on static warning signs and information signs at the eastbound and westbound gateways to the instrumented segments. Meanwhile, low-power AM radio transmitters (Highway Advisory Radio) broadcast variable messages regarding driver awareness and actions that are needed to remain safe in the event." (The phase 1 and phase 2 messages are different.)

The overhead signs are interconnected electronically to the weather sensors and automatically display different

messages in each phase. "These can be overridden by the operations center, if required, but the weather event display is automatic," Karimvand notes.

"When we hear from the National Weather Service that blowing dust is possible – or that it is occurring – we will work through our traffic operations center to get the DMS activated as soon as possible," adds ADOT's Doug Nintzel. "Although DUST could help provide better warnings, the technology does have its challenges. If you have a narrow channel of dust going across a highway, the position of the monitoring station may be miles away from where that's happening, and it does you no good. These dust 'channels' can be relatively thin. That makes for quite a challenge in terms of what you can do to advise drivers that something has happened, because we may not know about it right away."

So how has the system been received so far? "Anecdotally, it has been reported that drivers slow down when the messages are displayed or the beacons flash. It is still early to gauge the effectiveness of this pilot technology. Like all weather events, dust storms tend to be random, their presence not always easy to detect, their footprints vary, and their durations are relatively short. The monitoring equipment now in place senses spot conditions within a fairly large area that can contain great, yet undetected, variation."

Contact

Arizona DOT
+1 602 712 7355
rkarimvand@azdot.gov
www.azdot.gov

jmisener@gmail.com

I have the pleasure of going to many meetings – some quite interesting and others, well, not so interesting. In the past month, I've attended three automated or self-driving car get-togethers, which in content and in sociological or cultural differences absolutely fit the former category.

It occurs to me that these meetings represent three separate forces of change – a veritable three-headed hydra. If we are to make an automated vehicle-highway system a reality, these forces should be combined. One distinct head – or perhaps a triumvirate – would make these three camps into a powerful single entity. Going different ways, they only succeed in pulling against each other.

The first gathering was a 'meet up' at the Nissan Silicon Valley Research Center, where Anthony Levandowski of Google regaled a virtually cheering crowd of what I will call Silicon Valley enthusiasts. We heard a Google Vision that embraces autonomous cars by 2020.

The second meeting was invitation-only and convened in Harrisburg, Pennsylvania, hosted by the Pennsylvania State DOT and Carnegie Melon University. It featured a logical and very linear preliminary plan by the USDOT that envisions a government role in shepherding research that might enable and would demonstrate a cooperative vehicle-road system. PennDOT was particularly interested in infrastructure planning and investment, not necessarily for an autonomous car, but for an automated, connected vehicle-highway system that, by 2040, could yield tremendous safety and productivity benefits, to include a transformation in goods movement.

The third was Richard Bishop's 18th International Task Force of Vehicle Highway Automation in Tokyo, Japan. The figure 18 says enough: these are the vehicle-highway automation stalwarts who've persisted through thick and thin and are – finally – riding the pendulum back toward the mainstream. The perspective is mature (as are the folks, at least chronologically), and there is a strong dose of realism – bordering on resignation – that there are still a great many implementation challenges, and that solid and large-scale studies of technologies, reliability and social and institutional changes are needed to ascertain both the near- and long-term claims of benefits.

My question, therefore, is how does one reconcile these three meritorious points of view with their distinct and important brands of stakeholders? I posit that a seamless melding is important, and if any one of these vectors go the wrong way, then we lose magnitude and potentially diffuse. Now it is easy enough to proclaim that these three parties should meet and combine but it is more difficult to make it happen. Certainly, judicious investment in public money would be important. Also important is the emerging tri-lateral (USDOT, European Commission, Japan) cooperation and joint workplan. But where are state DOTs? Where are university researchers? And, importantly, where are those wide-eyed entrepreneurs and developers? Finally, while some vehicle manufacturers and suppliers are in several of these venues, how exactly do they play?

Certainly universal definitions, compatible R&D thrusts, a dose of healthy competition, some government funding and standards will 'glue' all necessary – if not manual – inputs to craft what will be a decidedly non-manual output: ubiquitous, beneficial and desirable automated/self-driving vehicles on our roads.

> One distinct head – or perhaps a triumvirate – would make these three camps a powerful single entity. Going different ways, they pull against each other
>
> **Jim Misener, transportation and technology consultant, USA**

In the USA, will a vehicle miles traveled (VMT) tax or road-use charging eventually replace tolling as we know it?

Answer the Burning Question via our LinkedIn group page at www.traffictechnologytoday.com

"VMT, RUC or MBUF? No matter how you say it – or how many times you change the name – the end result is the same. Our nation can't sustain the funding required for our transportation infrastructure solely through motor fuel taxes. It's no secret alternative fuel and electric vehicles, and traditional vehicles with much higher fuel economies, have had a dramatic impact on gas tax receipts, and it's not going to get any better. With no political will to raise fuel taxes – and thereby increasing revenues to fund all of our needs – we need to find other means of getting the job done. VMT, RUC and MBUFs are getting lots of attention, with pilot programs underway. These play to the issue of fairness – users of the system pay a fee for doing so, instead of requiring tax money from the population at large. We're familiar with that as it's the premise under which toll agencies operate. So why the apparent angst about VMT/RUC/MBUF replacing traditional tolling? To many of us, it's a new concept and we tend to be wary of things we don't understand. But as these concepts mature and grow in acceptance, we'll see that instead of replacing tolling, they'll complement traditional toll operations."

PJ Wilkins
executive director, E-ZPass, USA

"My most likely future scenario envisions mileage-based user fees being implemented in different ways for different portions of the roadway system. For limited-access highways (interstates, freeways, etc), the simplest and probably most politically feasible is to use state-of-the-art all-electronic tolling, based on transponders and license plate imaging. This already permits congestion pricing where needed, and does so without 'Big Brother' privacy concerns that the public and politicians are so worried about. For all other roads, where the cost of roadside equipment would be vastly too expensive, several low-tech options are available, as evidenced by pilot programs in Oregon, tests in Texas, and reports from RAND and others. These range from a flat annual fee to annual odometer readings to a gadget inserted into the vehicle's diagnostic port to record total mileage in-state and out-of-state, based on cell tower locations. Thus, the limited-access system's MBUFs would be per-mile electronic tolling, while the mileage charges on the rest of the roadway system would be something like a monthly or annual road-use bill."

Robert W. Poole, Jr
director of transportation policy, Reason Foundation, USA

"It will be a decision for the various governments and they are subject to many different ideas and interests. There may be places where tolls are submerged in systems of generalized charges for travel on all roads – which really is tolling-writ-large, even universal tolling. VMT or road-use charges (I prefer the word 'use' to 'user' because a fuel tax or vehicle registration is technically a user charge) are generally being pressed in the USA as a supplement – or even a replacement – to the fuel tax to support traditional modes of having the states deliver road service in the traditional way. State DOTs and their lobbyists are the big promoters of the VMT or mileage fees as their strength is being sapped by their dependence on the ailing fuel tax. Personally, I think generalized VMT or mileage fees are a horrible idea, that will perpetuate and aggravate many of the worst features of central planning and crony capitalism that currently plague us in the USA and elsewhere. The traditional agencies of government are recklessly incurring debt they cannot possibly service, and are financially unsustainable. We shouldn't be giving them new ways to get into our pockets to bailout and preserve their obsolete monopolies. We should be opening the way for new kinds of entrepreneurial and self-financing entities to own, develop, operate and manage our roads to serve the people, not politicians and special interests the way state DOTs do."

Peter Samuel
chief correspondent, www.tollroadsnews.com, USA

"VMT or road user charging is meant to replace the gas tax as a way to raise revenue for entire jurisdictional transportation networks, which would still then be allocated, probably through some policy-driven legislative process. VMT/RUC doesn't replace tolls; it employs AET in one form or another for another purpose. 'Tolling' is not the technology – it's the business of providing a user-fee-funded premium facility, financed by outside resources in response to market demand for the premium facility. The tolls industry – fueled and driven by intense financial and public policy pressure – has gone through 20 years of innovation by trial-and-error (largely without research funding) to develop the customer service-oriented product called 'electronic tolls'. This endeavor and product has proven extremely worthwhile and popular beyond most people's imaginations."

JJ Eden
director of tolling, AECOM, USA

Readers are invited to answer the Burning Question for the February/March 2014 issue:

How can DOTs and road authorities work with technology providers to advance intelligent transportation systems in a mobile world?

email answers to:
louise.smyth@ukipme.com

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