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Answers for infrastructure and cities.

Cover story

42 Utopian streets

Creating a balanced transportation environment

How can the Shared Space concept increase efficiency, safety and sustainability? By Timothy Compston

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Foreword

It's probably just as well that I was born when I was, in 1975, because had I popped out 20 or so years before, you can bet your bottom dollar I would've been sucked in to one of the cultural fads of the '60s – flower power, hippy, moptop or paisley (or perhaps all at the same time!). But I do own a lava lamp and am not averse to shaking a twist on a wedding dancefloor, although admittedly I didn't start listening to The Beatles until around 2004 – before which time I referred to them as 'pre-Wings McCartney'.

Considering the psychedelic tones of our cover, though, I wouldn't blame anyone for thinking my seven Nespressos a day had been laced with some form of hallucinogenic fungus. The peace, love and unity inspiration is of course our take on Shared Space – most likely a counterintuitive prospect for the majority of traffic engineers as it involves removing traffic lights, signs, pavement markings and curbs from our streets in order to effect a positive change on driver actions and behavior. "As soon as the brain's engaged, the speed drops," says Ben Hamilton-Baillie, a Shared Space proponent who picked up the mantle of the Dutch traffic engineer who initially pioneered the approach (see page 42).

We first featured the work of Shared Space guru Hans Monderman in our June/July 2007 edition, and sadly he passed away before we had the chance to quiz him about his ideas. The airing a few years back of a BBC Radio 4 documentary, *Thinking Streets*, though, reminded me to revisit the subject again some day – and here we are.

Thinking Streets put Shared Space into the UK spotlight, and some notable projects have since had time to bed in and – just as in Poynton (Cheshire), Ashford (Kent) and even in Monderman's home town of Drachten in the Netherlands – there are some interesting results for traditionalists to ponder.

One newspaper columnist I follow is a fan of the concept and suggests it "treats citizens as adults" and "treats cyclists and jaywalkers – the motorists' demons – as the streets' most effective policemen". But detractors (including the BBC's *Top Gear* presenter, Jeremy Clarkson) think they're potentially deathtraps, labeling those responsible for the scheme in Ashford in particular as "shared space idiots". To date, there have been no traffic fatalities and very few people have been injured on Ashford's scheme. Almost all street furniture has been removed and neither vehicles, cyclists nor pedestrians have priority. Perfect harmony.

No doubt Clarkson would be equally as disparaging about autonomous vehicles, which feature in our article by Stanford Law School's Bryant Walker Smith (page 4), who feels driverless cars and trucks have the potential to revolutionize society as much as the horseless carriages that preceded them. For editorial purposes, though, nothing beats talkin' 'bout a revolution – and our feature about the emerging technologies that may supersede ALPR considers just that (page 28).

I'm not sure how John, Paul, George and Ringo would have viewed the 'freedom' implications of driverless cars and ALPR, but I reckon they would have embraced the concept of Shared Space and visionaries such as Monderman wanting to change the world. Enjoy the read – peace, man…!

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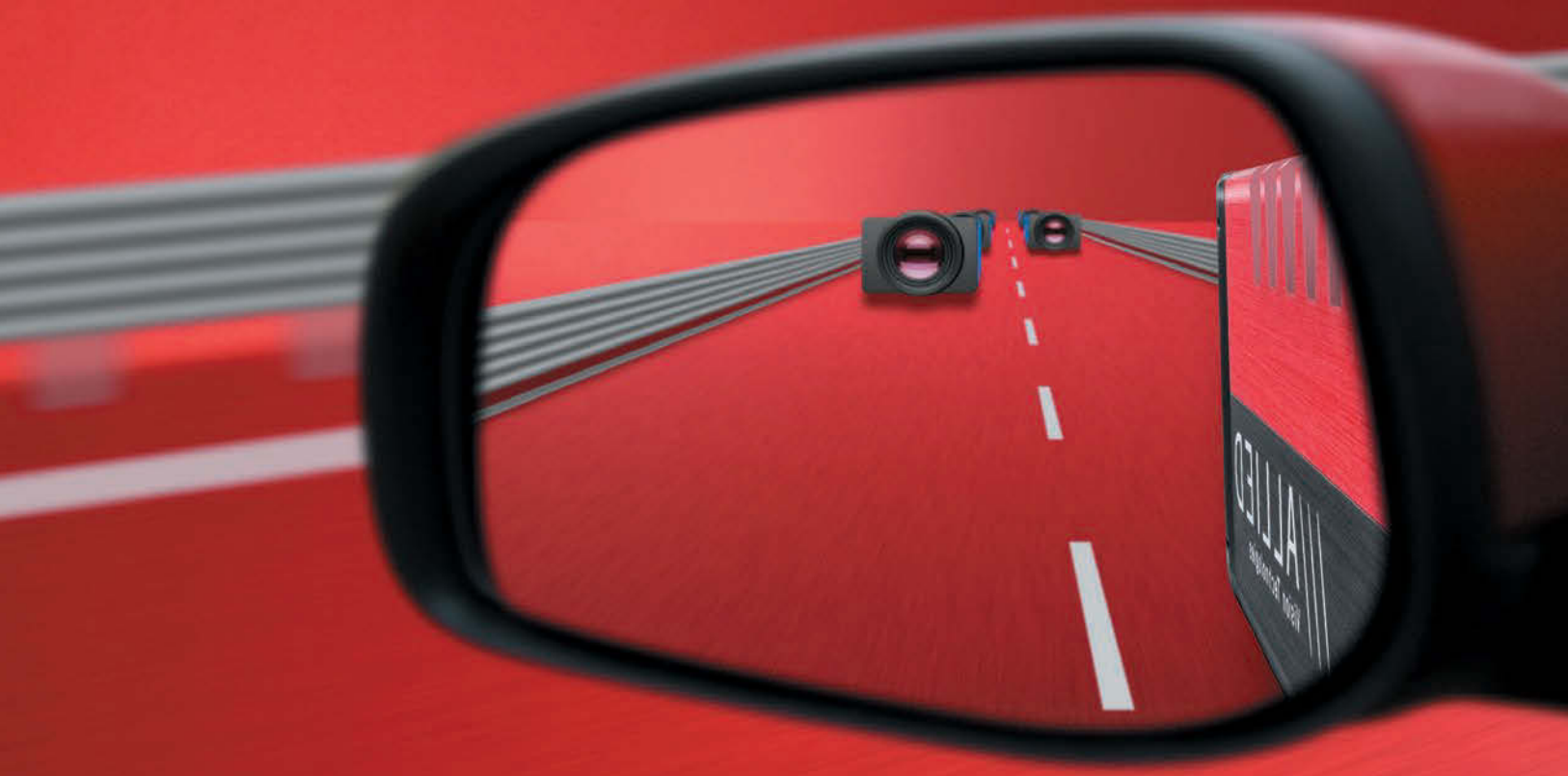

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SEEING IS BELIEVING

Tomorrow's world

Autonomous driving, writes **Bryant Walker Smith**, could significantly increase motor vehicle travel, in doing so having important consequences for the physical and legal infrastructures in which tomorrow's vehicles will operate. How will you prepare for this new dawn?

Following the lead of Florida, California and Nevada – US states that have all developed regulations paving the way for autonomous driving – the Southwest Research Institute (SwRI) and TÜV Rheinland's Mobility group are now collaborating to establish standards and performance metrics that will enable the three leading US states (and others that follow) to evaluate and regulate the effectiveness of automated driving. The announcement came just a few months after Volvo's senior vice president of R&D, Peter Mertens, urged Washington to avoid a patchwork approach to regulating driverless cars. "It's important that the US government underlines that regulation of motor vehicle safety systems and components is their jurisdiction. NHTSA research on the issues associated with autonomous vehicles could be the first step toward adoption of performance ratings on technology for autonomous driving," he said. "It is also crucial that state legislation doesn't restrict the use of active safety and support systems. They should be explicitly excluded from the definition of autonomous driving."

Photograph courtesy of Volvo Cars

Autonomous driving could have a dramatic, albeit gradual effect on traffic engineering concepts such as VMT, capacity, demand and time-cost of travel. Even without considering other phenomena, the total cost of motor vehicle travel is likely to decrease while demand for that travel is likely to increase faster than corresponding capacity.

Autonomous driving is likely to have far-reaching effects on travel. Many people believe, for instance, that self-driving cars that do not need human drivers or monitors could substantially increase mobility for those who cannot (legally) drive themselves as a result of youth, age, disability or incapacitation. Around 9% of adults identify as blind or report "trouble seeing, even when wearing glasses or contact lenses". Nearly 11% of Americans are between 10-17 years old and nearly 13% are 65 or older. Meanwhile, more than 31% of the total population (and 13% of those 16 or older) does not have a driver's license. (Nonetheless, poverty may remain a barrier to many would-be drivers.)

Truly self-driving cars will not even need human occupants. In announcing its self-driving car project, Google alluded to an earlier research vehicle "that delivered pizza without a person inside". Of the nearly 400 billion person-trips undertaken by US drivers in 2008, almost 43% were for personal and family-related purposes (such as shopping trips and trips for medical care). The frequency, duration and timing of shopping, refueling and chauffeuring trips may therefore change as people find they can simply dispatch cars from the convenience of their home or office. In other words, as the time-cost of these trips approaches zero, demand for them is likely to increase. Drivers, on average, appear to value their time even more than their gas: a 30-minute, 20-mile trip that costs US$8 with one human occupant (the driver) would cost less than half that without human occupants.

> "In the long term, the widespread or universal adoption of autonomous driving could actually increase system capacity

3 trillion
miles were traveled by motor vehicles in the USA in 2006. Broadly speaking, VMT has roughly doubled since 1980 and could reach 5 trillion by 2037

Cost-effective chauffeuring

Moreover, the price of travel could also drop substantially for the occupants of an autonomous vehicle. Any per-mile fuel savings achieved by automation through smoother and less frequent throttling and braking, for example, would reduce the vehicle's operating costs – even if the purchase price is greater.

A vehicle that parks and fuels itself would also reduce total trip time. And if the (well-connected) car provides an environment that is as enjoyable or productive as the home or office, the time-cost of motor vehicle travel could also drop substantially. Each American currently spends an average of one hour a day in a vehicle (as either a driver or a passenger), which is equivalent to twice the minimum time that an adult should spend exercising, 15 days a year, or US$5,950 per person per year (assuming average cost of time of US$16.30 per person per hour).

Capacity gains

According to a paper written by UC Berkeley's Steven Shladover, currently vehicles moving at freeflow speeds on a freeway use only "11% of the length of the lane, while the remaining 89% of the lane length represents the gaps that the drivers need to maintain behind other vehicles in order to feel safe and comfortable in their vehicle". More precise throttling and

braking could facilitate lower vehicle headways and even accommodate closely spaced vehicle platoons, both of which could significantly increase lane capacity. Likewise, the typical highway lane width in the USA is 11-12ft, but even large passenger cars, vans or SUVs rarely exceed 5.9ft in width. The remaining lane width is needed to accommodate steering imprecision by light-duty vehicle drivers, as well as to allow for use by heavy trucks and buses, which can be as wide as 9ft. More precise steering might permit an increase in total lanes through a reduction in the width of some of the lanes.

In the near term, automation may reduce the typical motor vehicle capacity of roadways and intersections. An autonomous vehicle that stubbornly maintains a headway of three seconds, for instance, could reduce the roadway space available to other vehicles. Similarly, an autonomous vehicle that proceeds tentatively after stopping or that yields to a pedestrian will delay the vehicles behind it. Importantly, these behaviors may well be desirable. Longer headways, for example, can reduce crash frequency and severity, and drivers are legally required to yield to or stop for pedestrians in marked and unmarked crosswalks.

In the long term, though, the widespread or universal adoption of autonomous driving could actually increase system capacity. Three potential aspects of automation could drive this increase, which in turn could accommodate and ultimately foster more demand.

First, automation – particularly cooperative technology that facilitates rapid communication among vehicles (C2C) – could increase the amount of usable road space in the longitudinal and lateral dimensions (see *Capacity gains*, left). Second, automation could increase total functional capacity along corridors that include several parallel highways (and that therefore offer more than one potential route). Better real-time travel information could be used to route some vehicles to comparatively underutilized highways.

Third, automation could reduce the number of small disruptions to vehicle flows (such as unexpected braking, lane changing, hesitating, jockeying and rubbernecking) and the rate of crashes and other incidents. The combination of smoother flow and more useful travel information could also increase the predictability and reliability of trips, a key element of driver comfort.

In other words, autonomous driving could ultimately have the same effects as adding that third, fourth or fifth lane to the freeway. And such a capacity expansion could lower the internal price of a motor vehicle trip, which in turn could increase both near- and long-term demand. This is the potential paradox of autonomous driving. Highways may carry significantly more vehicles, but average delay during the peak period may not decrease appreciably. Similarly, emissions per vehicle mile traveled may decrease, but total emissions

Photograph courtesy of Volvo Cars

(throughout the day) may actually increase. The denominator matters to these claims, and both the costs and benefits of autonomous driving must be considered on a systemic basis as well as on a per-mile basis.

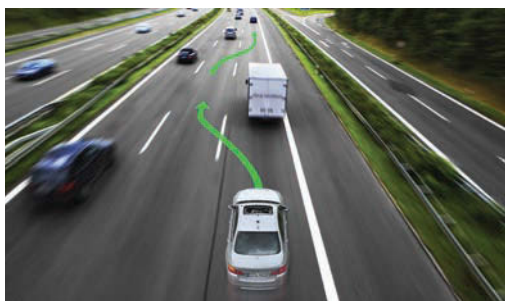
How law could respond to changing travel patterns

A significant increase in motor vehicle travel could pose myriad challenges for policymakers, including changes in rural and urban land use, shifts in congestion, increases in certain emissions, decreases in mass-transit ridership and increases in maintenance costs for roads and bridges. Internalizing the costs of travel, limiting suburban sprawl and optimizing urban circulation are three broad approaches to managing autonomous transportation demand and thus the effects thereof:

Internalize the costs of travel: The previously mentioned 30-minute, 20-mile trip imposes time-costs of about US$4.15 and operating costs of about US$4.00. The driver pays these variable costs (plus certain variable costs from crashes), which together make up approximately half the total cost of motor vehicle use. The driver also pays the fixed costs of owning the vehicle

Photograph courtesy of BMW

Highly Automated Driving is an ongoing project between Continental and BMW and is seeing several prototype vehicles fitted with automated driving equipment



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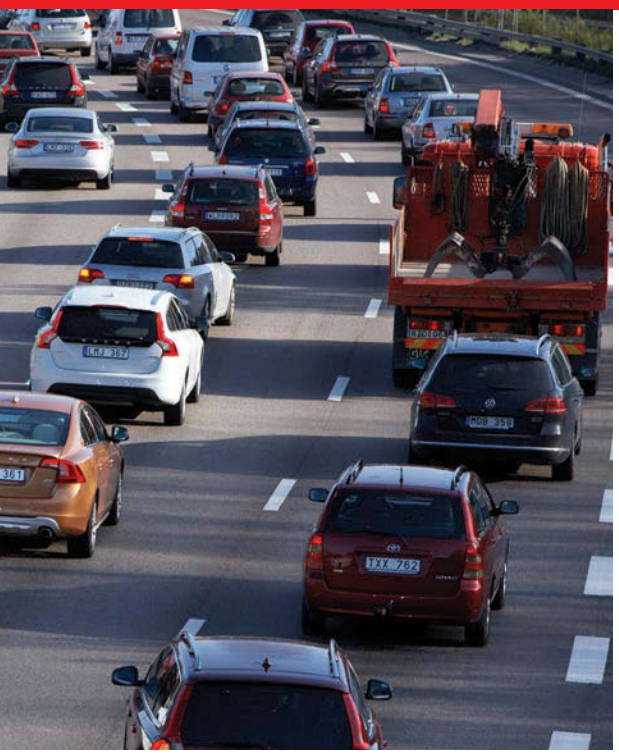


(Main) **In the Volvo-fronted SARTRE project, vehicle platoons drove at 52.8mph, with a gap between each vehicle of just 19.7ft** (Below and below left) **Google's self-driving cars are able to sense their surroundings, pedestrians and even stoplights. To date, the vehicles have completed more than 400,000 miles of autonomous driving**

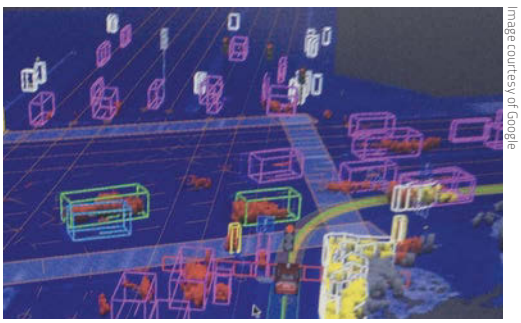


Image courtesy of Google

> "Autonomous driving could ultimately have the same effects as adding that third, fourth, or fifth lane to the freeway

Photograph courtesy of Google

(including certain fixed costs from crashes), which make up about one-quarter of the total cost of motor vehicle use. The remaining quarter are costs imposed on society generally, albeit unevenly, through off-street parking, additional crash damages, congestion, pollution and other environmental damage, the loss of land to roadways, fuel costs not borne by the driver, and traffic services.

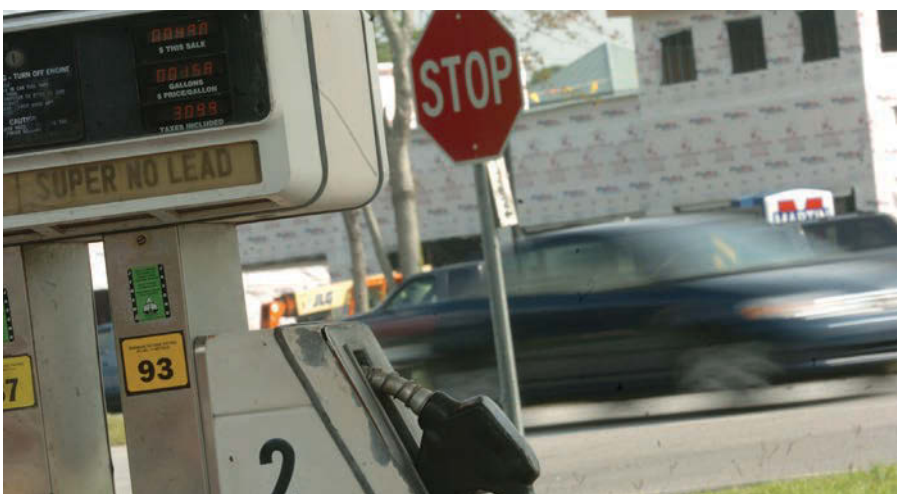
This analysis is necessarily imprecise, exclusive of the costs and benefits of the sprawl that fosters and depends on motor vehicle travel and subject to changes in automation and propulsion. But it illustrates that drivers tend to underprice their trips – a problem that could be exacerbated by the lower cost of an autonomous vehicle trip.

As the National Surface Transportation Infrastructure Financing Commission recognized, underpricing can also mean underpaying. The Commission was established by Congress to "assess the [transportation] funding crisis and make recommendations to address the growing transportation infrastructure investment deficit".

Its final report, entitled *Paying Our Way*, stressed that: "The funding and finance framework should cause users and direct beneficiaries to bear the full cost of using the transportation system to the greatest extent possible (including for impacts such as congestion, air pollution, pavement damage and other direct and indirect impacts) in order to promote more efficient use of the system. This will not be possible in all instances, and when it is not, any cross-subsidization must be intentional, fully transparent and designed to meet network goals, equity goals, or other compelling purposes."

Federal and state gas taxes – or, more precisely 'excise taxes imposed on the consumption of gasoline, diesel and special

25%
of police-reported crashes are down to distracted driving, NHTSA says, which blames it for 16% of traffic fatalities and US$230 billion societal cost



Autonomous driving technology could cut down on vehicles' weight – and therefore improve fuel efficiency. But what impact will that have on federal tax dollars?

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fuels' – internalize some of the cost of motor vehicle travel. Today's state and federal taxes increase the cost of a gallon of gasoline by an average of 48.8 cents, ranging from 26.4 cents in Alaska to 67 cents in California. Assuming 27.5mpg, this average tax rate amounts to just 35.5 cents for a 20-mile trip.

In 2025, however, that 20-mile trip might cost only 18 cents – or the equivalent of 13 cents after inflation. There are three reasons for this potentially dramatic decrease. First, in the half-century that federal fuel taxes have been used as a dedicated source of transportation funding, their rates have increased sporadically, with the last such increase occurring in 1993. Second, federal fuel taxes are not pegged to inflation; as a result, the actual purchasing power of the [federal] gasoline tax has declined 33% since 1993. Third, the CAFE standard for 2025 will be 54.5mpg. This last point is crucial. More fuel-efficient vehicles incur less per mile in motor fuel taxes – and fully electric vehicles incur none.

Many solutions to this looming crisis in transportation funding have been considered, including tolling, VMT fees and carbon taxes. Electric vehicles may ultimately force – and autonomous vehicles may facilitate – greater adoption of these solutions at both state and national levels.

In addition to raising revenue, these approaches also offer the potential to internalize more of the costs of driving, including impacts such as congestion, air pollution and pavement damage, and other direct and indirect effects.

Photograph courtesy of GM

This would place driving as a whole on more equal terms with other forms of mobility, access and activity – a wide spectrum that includes not only other modes of travel but also substitutes for travel. However, as a result of the likely difference in time-cost, autonomous driving would still have a significant (and justifiable) price advantage over conventional driving – an advantage that could help speed its adoption.

Limit suburban sprawl: Because of this lower time-cost, autonomous driving may nonetheless encourage suburban sprawl by increasing the acceptable commuting distance. In 2009, workers took an average of 25.1 minutes to get to work. Indeed, whether the setting is an African village or a US city, the daily round-trip commute clocks in at about 1.1 hours, as it has for some time. But if workers could sleep or work in their cars, they may be willing to live further from their jobs. Mass-transit riders, for example, take significantly longer to reach work but are able to spend at least part of their travel time on tasks other than driving. Autonomous driving would offer a similar advantage but – unlike mass transit – would not necessarily foster clustered development. Moreover, in the long term, a dramatic expansion in functional roadway capacity that increased commuting distances without, at least initially, increasing commuting times could also open additional areas to development; much as Robert Moses' New York parkways, expressways and bridges contributed to the rapid suburbanization of central Long Island.

While Long Island-style sprawl is hardly a new phenomenon, efforts to promote 'smart growth' have often met more unending controversy than unqualified success. States (or, more likely, the municipalities or regions to which planning, zoning and land-use control are generally delegated) will face two key challenges with respect to the private farmland and forestland that autonomous driving could render susceptible to suburbanization. First, what areas or corridors should be preserved

> "More broadly, autonomous driving raises questions in disciplines ranging from sociology and psychology to medicine and economics

At peak
capacity, US highways are only 6-8% occupied with vehicles, yet filled with autonomous vehicles could accommodate 2 to 3 times as many automobiles

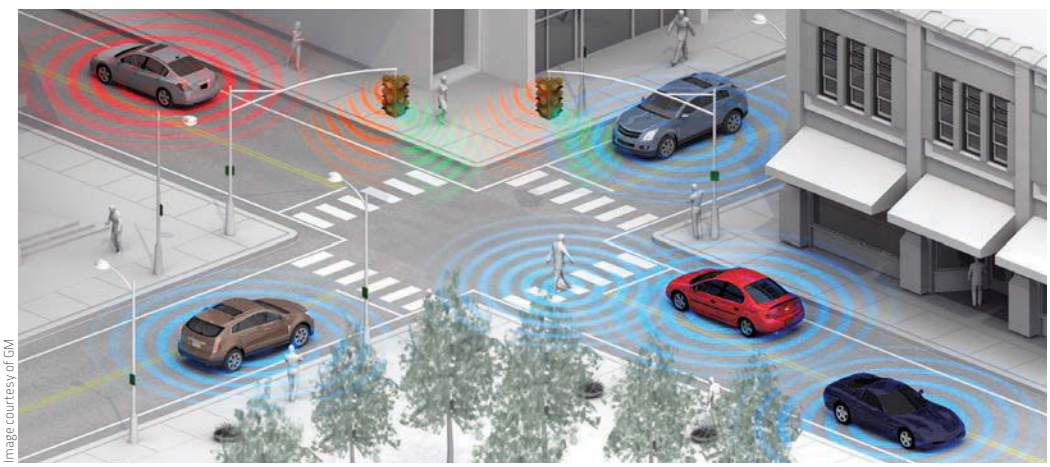

Image courtesy of GM

(Left) **Autonomous cars will be able to better utilize road space. With a road full of driverless vehicles, cars can safely drive closer together – using less space and reducing traffic and travel times** (Above left) **Super Cruise, a suite of GM technologies that lets a car drive itself on some roads, could be ready by the middle of the decade, the car maker says**

Urban context

Although the focus of this article has been on freeways, motor vehicle trips almost always begin and end elsewhere. Urban streetscapes are complex environments that serve many types of pedestrians, bicyclists, motorists and other users, whether mobile or stationary. Lanes may be narrow, and vehicle flows are interrupted by pedestrian crossings, stop signs and traffic signals. Because each movement at a traffic signal receives only a portion of the total 'green time' each cycle, the capacity of a single lane is at most 1,500 vehicles an hour and often much less. Queued vehicles can also occupy large portions of a physical roadway during peak periods.

Such is the environment that autonomous vehicles might encounter upon leaving a freeway. Cities, if so empowered, might use tolling or parking fees to manage any increased demand generated by these vehicles. But autonomous driving may also create new circulation patterns within the city that require innovative design or policy measures. On the one hand, vehicle volumes in some neighborhoods could conceivably decrease if drivers no longer need to scout for parking. On the other, autonomous vehicles – particularly those that are privately owned – would need to drop off and pick up their passengers and, in the meantime, queue, park or circulate – the autonomous equivalent of idling.

Photograph courtesy of Google

(Left) **A challenge in the USA could be getting self-driving cars such as Google's approved for use on all public highways, not just in the states that currently allow them** (Below) **Once driverless cars penetrate sufficiently, car makers such as Volvo predict accidents due to driver error will decline sharply, occurring only under extreme or unusual circumstances**

(and how)? Second, in those areas that should not or cannot be preserved, how and when should development occur?

Optimize urban circulation: A variation of that second question – how should a city function – applies with equal force, and even urgency, to existing communities. In the USA, the median lifetime of commercial buildings is 70-75 years, and the average bridge was constructed in 1963. Parks and homes are politically difficult to remove. Cities do shrink, and corridors do disappear, but urban infrastructure is generally a long-term investment. How, then, should communities anticipate the arrival of autonomous vehicles on their streets?

Preliminary recommendations

With respect to demand, capacity and time-cost, autonomous driving may require revisions to reference books such as the *Highway Capacity Manual* and *Trip Generation*; to regional models for forecasting land use, travel demand and emissions; and to project documents such as environmental impact statements, traffic impact assessments, concession agreements and economic analyses of proposed agency rules. More broadly, autonomous driving raises questions in disciplines ranging from sociology and psychology to medicine and economics.

Policymakers should also seek to maximize the share of motor vehicle travel costs that are internal and variable as opposed to external or fixed. Although this strategy might ultimately involve some form of the VMT-based user fee, in the near term it could include variable tolling, management of on-street parking and renewed efforts to index state or federal fuel taxes to inflation. Measures that do not directly affect the price of a particular motor vehicle trip might nonetheless reduce the price of an alternative.

In his paper 'Win-win transportation solutions: mobility management strategies that provide economic social and environmental benefits', Todd Litman identified some 20 "cost-effective, technically feasible market reforms that help solve transportation problems by increasing consumer options and removing market distortions that encourage inefficient travel behavior". However, as with autonomous driving itself, any of these reforms may have unintended consequences.

Photograph courtesy of Volvo Cars

Finally, public and private actors should develop strategies for data protection and collection. Just as autonomous driving will require a huge amount of information, effectively managing the transportation demand that this driving creates will require a careful understanding of the who, what, where, when, why and how of travel. The use of individual data for modeling, traffic enforcement or variable tolling, for example, may raise privacy and security concerns that are best addressed proactively.

As autonomous and even semi-autonomous technologies become more feasible, governments – and especially their planners, engineers, and lawyers – should not be idle. Autonomous driving has the potential for tremendous benefits. In the near or long term, however, some of these benefits – such as a lower time-cost of travel and a higher vehicle capacity on some highways – may actually increase certain costs associated with congestion, emissions and sprawl. Maximizing the net benefit of autonomous driving will require researching, modeling, planning and regulating – cooperatively, not autonomously.

• *Bryant Walker Smith is a fellow at the Center for Internet and Society at Stanford Law School and the Center for Automotive Research at Stanford (CARS), whose current research focuses on the law and policy of self-driving vehicles. Special thanks in this instance go to the* Santa Clara Law Review *for its kind permission to publish extracts from* Managing Autonomous Transportation Demand. *The full version of the paper can be perused online by logging on to http://digitalcommons.law.scu.edu/lawreview/vol52/iss4/8*

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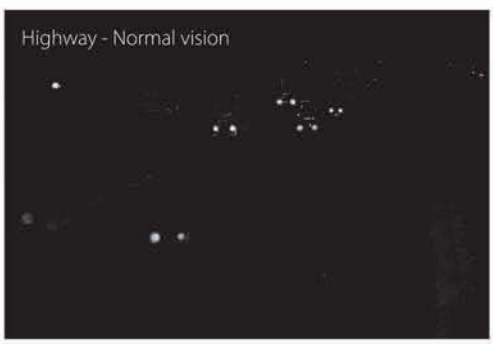

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Continental shifts

Turkey's largest city, **Istanbul**, is also one of Europe's busiest – second only to Moscow according to TomTom's *2012 European Congestion Index*. But they're not the only figures that are a consternation to traffic authorities...

Infographic courtesy of Andrew Locke

The Istanbul Metropolitan Municipality's (IBB) Traffic Directorate – run by Mehmet Necip Ertas (see page 34) – is responsible for keeping traffic running smoothly and safely

1.3 MILLION
daily trips between Asia and Europe by private car

CO_2 emissions from road transport in Istanbul are estimated to have increased by 37% between 1990 and 2007, from 6.5 million to 8.9 million metric tons

13.6m
The population of Istanbul as of January 2012 was 13,624,240 – equivalent to 18.2% of Turkey's total population

In 2012, there were 222 fatalities and 21,326 injuries resulting from 48,775 accidents in Istanbul

134 crashes a day

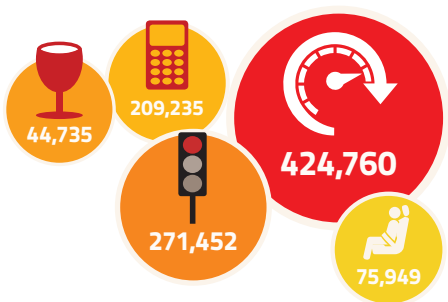
55%
Congestion level in Istanbul, based on the recent TomTom *European Congestion Index Annual Report 2012*

Delay per hour driving in peak period

64 min

The total annual delay from a 30-minute daily commute in Istanbul is 118 hours

118



In terms of traffic law enforcement in 2012, 424,760 citations were issued for speeding, 44,735 drink-driving offenses were recorded, 271,452 red light runners, 209,235 were fined for driving while using cell phones, and 75,949 citations were issued for non-use of seatbelts

25,000km
of roads are under the control of IBB, kept in check by approximately 400 traffic cameras, 1,900 signalized intersections, 350 RTMS road sensors, 35 RWIS sensors, 22 variable message signs, 35 semi-dynamic traffic signs, and 150 EDS enforcement cameras

29%
of vehicles on Istanbul's roads are automobiles and taxis, and 63% public and service buses. Just 7% use rail systems and sea transportation. Cycling makes up 0.05% of trips a day – practically non-existent – while walking is 16% lower than in other comparable metropolitan cities

35% of the city's residents live on the Asian side (Anatolia), with the remainder on the European side (Thrace)

US$2.7bn
Traffic congestion costs Istanbul more than 5bn Turkish liras (US$2.7bn) a year due to loss of labor and excess fuel consumption

Plan for success

The Strategic Transportation Plan for the Olympic Games was key to the candidacy of the city of Rio de Janeiro. The plan has the ambitious objective of deploying a set of mitigation measures that would prioritize Olympic Family travel yet allow the resident population to continue their daily activities. CET-Rio traffic engineering company commissioned Modelle Logistics and Engineering (Tectran Group) to analyze the deployment of measures to prioritize Olympic Family circulation during the event as part of the Strategic Transportation Plan.

As this project required multi-tier modeling, Modelle ensured maximum consistency by using the Aimsun traffic modeling software with its integrated macroscopic, mesoscopic, microscopic and hybrid micro-meso levels in a single platform.

Sharing is caring

As the preparations for the 2016 Olympic and Paralympic Games in Rio de Janeiro ramp up, **Eduardo Coelho** and **André Libânio** describe how modeling is helping to shape innovative lane-sharing strategies for transporting the Olympic Family

The 2016 Olympic and Paralympic Games will bring major mobility challenges to the host city of Rio de Janeiro. In fact, it's hard to imagine a greater storm of simultaneous large-scale events, with thousands of vehicles and pedestrians including international visitors, athletes and VIPs, many of them trying to travel along the same routes at exactly the same time. As well as the need to prioritize Games traffic, local traffic must also be given careful consideration.

6,500
fines totaling £845,000 (US$1.3m) were issued to motorists driving in any of the 30 miles of dedicated Games Lanes in London during the 2012 Games

Modelle Logistics and Engineering's initial analysis at the macroscopic level showed that Rio simply did not have the capacity to absorb the general vehicle traffic diverted from the lanes that would be reassigned exclusively to Olympic traffic, as outlined in the proposal. Even after reducing the number of non-Olympic trips with the imposition of staggered travel and other measures to contain demand, there would be a drastic deterioration in the level of service in some key links, causing the system to collapse.

A more detailed mesoscopic analysis showed that problems were particularly acute where the South Zone – a densely populated tourist area including the neighborhoods of Copacabana, Ipanema and Leblon – connects with Barra da Tijuca. Barra is the main venue hub of the Games and although Rio has invested in a new metro line linking Barra to the existing metro network, this alone will not be sufficient to eliminate the congestion. A major change of plan was in order.

A perfect match?

A key observation in devising an alternative strategy to meet that challenge was that the Olympic route network almost perfectly matches Rio's (current and future) Bus Rapid Transit (BRT) network. Olympic venues are spread over the areas of Barra da Tijuca, Copacabana, Deodoro and Maracanã; the city's hotels, Olympic Family residences and other key facilities are widely dispersed.

The next step was to analyze the rather bold possibility of sharing the Olympic reserved lanes with the BRT and other public transport vehicles. This is not a solution that has been attempted before and was met with considerable skepticism. But Rio is a special city calling for special measures.

Besides the microsimulation of the base scenario, used to confirm the model calibration, Modelle simulated various other scenarios: first the projected demand during the Games with

(Main image) **3D microscopic simulation of** (left) **the intersection at Avenue Visconde de Albuquerque**

Olympic transport using exclusive lanes and not the BRT network; then the projected demand with Olympic transport sharing the BRT network. These simulations showed that sharing the BRT exclusive tracks with the Olympic transport reduced the impact on the general traffic considerably, without penalizing the BRT system. Even so, the capacity of the system was not enough to absorb all the Olympic transport. Therefore a projected demand with a 20% reduction in traffic volume, because of the imposition of staggered travel and other measures to contain demand, was tested. Even then the separate, non-BRT Olympic lanes continued to penalize the general traffic. However the capacity of the BRT reserved lanes, where those existed, proved to be more than sufficient for both Olympic and BRT demand when running together.

Doing the math

Usually, the maximum number of buses assigned to a BRT system is limited by the service capacity of its passenger terminals, where a standard operation with four passengers requires a minimum headway of 20 seconds between the buses: 12 seconds to maneuver the vehicle (stop, open and close the doors, and accelerate) and two seconds for each passenger to board. Across two terminals (as in the standard set-up) this gives an average capacity of only 360 vehicles per hour. BRT tracks generally have a free lane or a stopping bay at the passenger terminals. That free lane has its capacity substantially reduced by the limited green time at signalized intersections. If green time is set to 60%, this gives a total capacity of 1,080 buses per hour (3,600 secs ÷ 4 secs per vehicle x 60% for two lanes).

It is therefore clear that the road capacity (1,080 buses/hour) far exceeds the number of buses operating on the BRT system (360 buses/hour), leaving plenty of space to absorb the Olympic Family vehicles, which are predicted to reach 200 vehicles per hour on the most loaded link, with more than 50% being cars.

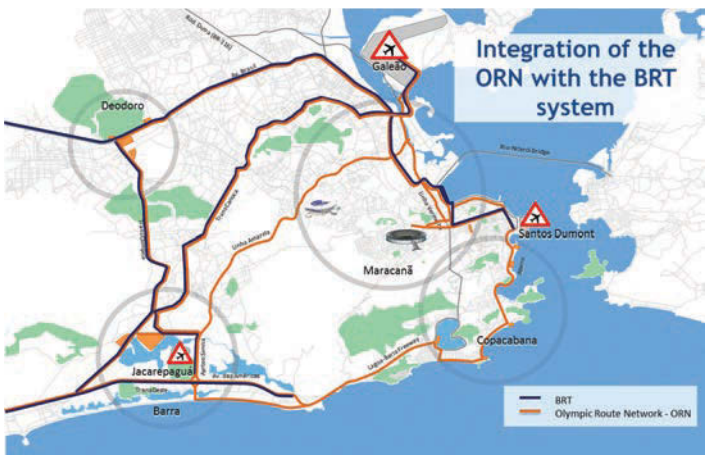
The solution of sharing the BRT lanes means minimal incremental investment and rapid implementation, in addition to easy maintenance of the exclusive lanes, and simple measures, such as modular concrete lane dividers, to stop the general traffic from entering the reserved lanes.

CET-Rio is currently analyzing the results of the studies and the next stages of the project will be redirected according to its findings. ○

> “The next step was to analyze the bold possibility of sharing the Olympic lanes with the BRT

126
smart road sensors were deployed for bus priority (for both Games traffic and regular public transport) at intersections during China's Beijing Summer Olympics in 2009

• Eduardo Coelho is from Tectran Group and André Libânio is from Modelle Logistics and Engineering



Visualizing how the Olympic Route Network could be integrated with the Bus Rapid Transit System

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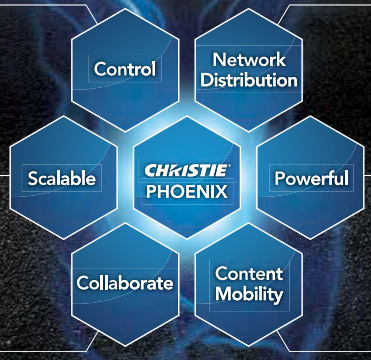

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Police state

A forum at the recent 16th European Police Congress tackled the issue of progress within road traffic safety work in Europe. **Wolfgang Blindenbacher** reveals the highlights of the presentations and their applicability to German roads

The theme of the specialist forum known as VIII and held on February 19 as part of the 16th European Police Congress in Berlin was 'Police traffic safety work in Europe – accident prevention, traffic surveillance and technology'. The role of the police is one that we in the ITS sector tend not to focus on too much as we are so caught up in technology. Yet as the presentations at the forum made clear, it is the police who actually shape a significant part of our industry – and indeed, the technology that is used on a daily basis. Their viewpoint is not to be ignored. As such, the following are highlights from some of the most compelling presentations.

From the top

To kick off the event, as head of the VIII specialist forum, German MP Kirsten Lühmann, a member of the committee for traffic at the German Federal Parliament, welcomed representatives from science, academia and the police, as well as firms that produce traffic surveillance equipment. In her introduction, she maintained that the challenges we face today are as great as ever. Globally, more than 1.2 million people die in road traffic accidents every year, with approximately 30,000 in Europe and more than 3,500 in Germany. These figures ought to give cause for ongoing focused concern about the subject of traffic safety.

In his electronic greeting, Dr Dieter-Lebrecht Koch, MEP, pointed out the significance of the Vision Zero safety concept for road traffic in Europe, which, in view of the immense consequences of traffic accidents, seems to be the only viable strategy. In addition to this, Koch emphasized the value of the European 'Target 2020', which, as an interim step toward Vision Zero, has the objective of halving the number of road fatalities in Europe (from 2011).

As the first speaker at the event, Professor André Bresges from the University of Cologne provoked much interest as he explained how humans learn in road traffic and how they retrieve what has been learned but sometimes also "allow it to lie idle", which leads to restricted human information processing when driving a motor vehicle. The ensuing recommendations for traffic accident prevention (the use of traffic safety software that clearly demonstrates the consequences of poor behavior) and for traffic surveillance (speed measurement with vehicle stopping and subsequent traffic education talk) were convincing.

Ways of improving traffic safety

Professor Dieter Müller from the Institute for Traffic Law and Traffic Behaviour in Bautzen discussed specific methods of improving traffic safety. Starting from the assumption that 'Traffic safety is not of an optional nature', he outlined the necessity of engaging competent staff,

77%

fewer KSIs (killed and seriously injured) could result from deploying the SPECS average speed control system, according to the vendor that produces it

TISPOL's view

TISPOL (Traffic Information System Police) president Koen Ricour, who traveled to the 16th European Police Congress from Belgium, presented his organization's traffic safety philosophy. Starting from its basic approach oriented toward preventing traffic accidents, TISPOL's focus is primarily on traffic surveillance, especially with regard to the so-called 'three killers': excessive speed, alcohol- or drug-affected driving; and the non-wearing of seatbelts. Besides this traditional road safety orientation, the 'road security' approach is currently taking on greater importance because criminals use the roads for their activities too: in some cases, crimes are committed on the roads.

What the event is all about

Unlike most of the events featured in these pages, the European Police Congress is not simply a traffic show. Instead, it is an annual international information platform for police and decision makers from security authorities and industries. The intention is to strengthen the dialog between these authorities and enable the participants to establish new contacts from all over Europe. Every year critical discussions on up-to-date issues are held and the latest developments in technologies for the professional use in the security sector are presented by the speakers of the various specialist forums. The European Police Congress is the largest conference for internal security in the EU.

Measuring average speed is widely agreed to be the fairest way of conducting speed enforcement

0.25mg/l
is the legal breath alcohol content limit in Germany and the blood alcohol limit is 0.5mg/g – which are fairly standard figures for most European countries

Section speed control is operating well in Switzerland but privacy issues have hindered its deployment in Germany

and followed up with the understandable remark that people are "the most valuable asset in successful traffic surveillance". Suitable equipment and the need for the main causes of accidents to be properly monitored were his next points. He also called for "fair – and hence accepted – standards", and within this context introduced the notion of section speed control. Müller declared this to be the fairest form of speed monitoring because average speed is measured over a marked section of road – as opposed to spot-speed enforcement, which only captures speed at one point. On top of this, he said the time had come to introduce the 'owner liability' rule in Germany, which is recognized as an effective traffic safety measure in many other European countries.

Section control in Switzerland

Uwe Urban of Jenoptik Traffic Solutions and Volker Fröse from the Swiss Federal Roads Authority explained all about the successful section control model that has been running for some time in Switzerland. This speed measurement over a marked section of road is used mainly in tunnels, at roadworks and at accident black-spots. The illustration of precautions relating to data protection was very convincing. For instance, so long as the vehicle does not travel at too high an average speed in the measured zone, neither the vehicle occupants nor the vehicle's registration number are saved or can be traced back. A frontal photo of the driver and the vehicle's registration plate is only taken if the average speed exceeds the limit. This procedure appears to have not yet been sufficiently well

communicated in Germany, where there is still no section control system in place – with reservations about data protection legislation often cited as the reason for this.

Legal issues with breath alcohol analysis

Daniel Budde of Dräger Medical also had interesting news to report on the subject of 'Legally admissible breath alcohol analysis in the road traffic offenses field'. This measuring method is now being used with legal recognition by numerous European countries, including the Netherlands, France, Italy, Sweden and Norway. What is surprising though, is that the German-manufactured breath testing devices have received Type Approval from the country's Physikalisch-Technische Bundesanstalt since as far back as 1998. The question that therefore arises is why it has been such a struggle to put this legally admissible technology to use in Germany. Political interests may be at play.

• *Wolfgang Blindenbacher is chief of the German Police Union Road Traffic Commission*

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The new black

The ERF and the Spanish Road Association recently announced some positive news about a usually negative topic. **David Hall** reports on the findings of the WhiteRoads project

Image courtesy of Shutterstock

On March 20, the European Union Road Federation (ERF) and the Spanish Road Association (AEC) presented the final results of their three-year WhiteRoads project. The philosophy behind the initiative was to create a positive approach to road safety and focus on zero-fatality roads, as opposed to the traditional, somewhat negative practice of focusing on accident black spots.

A European White Spot (EUWS) is defined as a section of road that's at least 15km long where no fatality accidents have happened during the previous five-year period considered during the study. After analyzing 85,418km of roads and 248,158 accidents in the EU, 982 EUWSs have been identified, representing 40% of the total Trans-European Transport Network (TEN-T) road network.

The data collection challenge

The main challenge for the consortium was the collection and analysis of data and statistics from 27 member states, information that would become the basis to develop the entire project. Throughout the research, the ERF and AEC maintained regular contact with more than 100 experts in road safety from national road agencies, ministries of transport, home affairs, traffic police and national statistics bodies.

The need for concrete information about accidents represented a significant challenge because some countries were not allowed to provide any data due to strict privacy regulations. Such a lack of statistics or the existence of incomplete information has always had a very negative impact on road safety. José Díez from the ERF described the difficulties and challenges faced by the consortium and stressed that "if we want to achieve a goal and improve road safety, we need to have good data at our disposal".

During the results event, Elena de la Peña, deputy general of the AEC, presented the WhiteRoads checklist, which can be used to complement existing guidelines for the design, maintenance and management of safer roads as laid down by the Directive on Road Infrastructure Safety Management. "WhiteRoads aims to contribute to the creation of safer roads but, ultimately, an integral approach between users, vehicle, infrastructure, enforcement and governments is needed," she said.

A white spot features a 100% presence of road markings

MEP Inés Ayala Sender opened the event. She stressed the project's positive vision and the need for inter-institutional cooperation to reduce accidents, especially those involving vulnerable users.

Other highlights of the event

Various panelists including Sangjin Han (OECD/ITF) and George Yannis (DaCoTA project), focused on the necessity of improving data collection and methodology, with a particular focus on serious injuries. Lars Ekman from the Swedish Transport Administration explained the Vision Zero experience in Sweden and its continuous improvement in road safety.

The panel was concluded by Szabolcs Schmidt, head of the EC's Road Safety Unit, who described the policy tools used at EU level to halve the number of fatalities by 2020 and congratulated the member states for the 9% reduction in fatalities in 2012 in the EU.

The rationale

WhiteRoads is an ERF and AEC project that ran from April 2010 to March 2013 and was co-financed by the EC (DG MOVE). It set out to achieve the first positive approach to improving road safety from the infrastructure perspective.

The initial definition of white spots – which was sections of road more than 25km with no fatalities in five or more years – came from research in Spain by the AEC and Mapfre Foundation.

Although there's no failsafe method to achieve white spots (apart from removing traffic from roads entirely!), what the Spanish research showed was that there are a number of different variables that are seen time and time again on these stretches of White Roads. As such, the project team was able to create a 'project rationale' that incorporates these various features.

Firstly, white spots have a design speed of 80-90km/h. They have average daily traffic of less than 3,200 vehicles and just a small proportion of those are heavy vehicles.

In terms of safety at the design level, white spots need to have traffic signs with the maximum reflectance level. They require the presence of traffic guidance equipment. And they also need to have a 100% presence of road markings with the maximum level of reflectance.

>30,000
people died on EU roads in 2011 alone – about theequivalent of a medium-sized town – showing how white spots are urgently needed

> "Ultimately, an integral approach between all stakeholders is needed

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Grid unlocked

A downside to the golden promise of C2X communications and interconnected traffic infrastructure is the potential for hacking. **Saul Wordsworth** logs on to find out what's being done to combat this faceless threat

Illustration courtesy of Tim Ellis

Many years ago, before the dawn of civilization (in other words, pre-internet), vehicles and infrastructure existed independently. Cars were driven around, blissfully disconnected from the outside world. Drivers used maps, and when lost, pestered locals for directions. Traffic lights were standalone structures, programmed to change at set intervals. Then Tim Berners-Lee came along and linked us all up. Today, everything is online. Today, everything is hackable.

"The vehicles of 2013 have dozens of electronic control units, but security is a comparatively new topic for auto makers," believes Frank Kargl, professor for distributed systems at Germany's University of Ulm and coordinator of the European PRESERVE project for car-to-car security. "The problem we now face is that vehicles have communication interfaces everywhere. This opens doors for a potential attack. Once inside a vehicle, the assailant finds little resistance and can do many evil things."

In 2011, a cross-university research project entitled 'Comprehensive Experimental Analyses of Automotive Attack Surfaces' was undertaken in the USA. It showed clearly how an ordinary sedan could be compromised remotely via a doctored CD, Bluetooth or cellular radio, and how wireless communication could assist in a theft, vehicle tracking or long-distance vehicle control. A hacker could theoretically disengage the brakes or bug the vehicle via a hands-free Bluetooth connection. All this and the age of car-to-car communications (C2X) is not yet upon us.

Communication breakdown

By 2017, though, C2X using short-range communications technology will likely come as standard for new vehicles, in doing so posing a whole new set of questions in terms of safety and security. Imagine, for

Protected drive

Olaf Henniger explains how EVITA's hardware security module ensures that vehicle data remains secure and the networks tamper-proof from would-be hackers

Should recent predictions from ABI Research hold true, by 2027, 61.8% of vehicles could be equipped with some form of Car-to-X (C2X) technology, hence the current urgency to iron out security concerns. It seems like a long time away, but in vehicle development terms, 14 years is just around the corner.

The integrity of C2X has been a focal point of research since the concept of talking cars first surfaced. Indeed, it's a primary area of investigation in the trials currently nearing completion in Michigan (USDOT Model Deployment) and in Germany (Project sim[TD]).

Other projects have looked at the issue, too, notably SeVeCom (Secure Vehicular Communication) and more recently EVITA (E-Safety Vehicle Intrusion Protected Applications), which concluded in December 2011. "We investigated the security of the communication networks within the vehicle," reveals Olaf Henniger, EVITA

> "EVITA's onboard network security would be a cornerstone for all the other vehicle-networking projects out there" *Olaf Henniger*

project coordinator from the Fraunhofer Institute for Secure Information Technology, "but we were always thinking about parallel C2X networks under development. EVITA's onboard network security would be a cornerstone for all the other vehicle-networking projects out there."

After extensive evaluation and analysis, Henniger and his EVITA team – comprising BMW Group Research and Technology, Tier 1 suppliers such as Bosch and Continental, security experts including Fraunhofer SIT and EURECOM, software experts such as Fujitsu, and hardware experts Escrypt and Infineon – decided the vehicle networks required hard-wired cryptography. "The scrambling and decoding of data would take place within a physical microchip – called a hardware security module – rather than via software," he explains.

One of the main benefits of the HSM is its speed – it can encrypt data packets almost instantaneously, whereas software often involves a slight lag. Any processing delay cannot be tolerated in a vehicle traveling at more than 100km/h (62mph) – where even a tenth of a second could be the difference between life and death. "We investigated all the requirements and carried out a thorough risk analysis for all types of data transfer and connectivity," Henniger continues, "and we specified

Emerging cyber threats are increasingly being used against critical infrastructure systems such as vehicle and traffic management systems

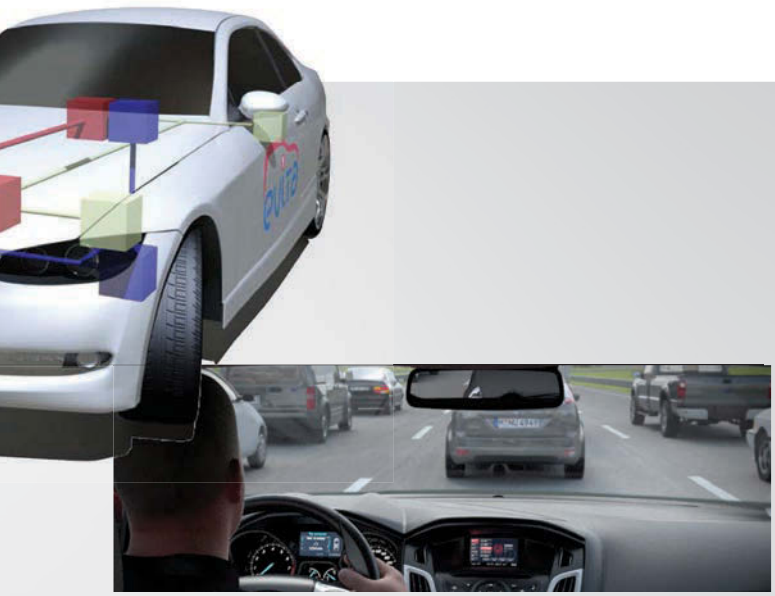
instance, a C2X convoy of 20 vehicles on a fast road, the speed of which is set by a lead vehicle based on the conditions. The gap between the vehicles is set automatically. If the controlling software is deliberately undermined, carnage could ensue. "Whether anyone would be motivated to do this is another question, but the potential to do damage exists," insists Dr Ireri Ibarra, functional safety consultant at MIRA, an advanced automotive consultancy. "With C2X there is greater risk because there are more open points of communication."

Tony Bull is managing director of consultancy Notitia Salu and a thought leader in traffic security. He, too, is concerned over the introduction of C2X technology: "The automatically driven cars will not be a 'big bang' launch," he predicts. "Beginning with automatic parking, motorway lane driving and driving in urban traffic, it is a slippery slope down to fully autonomous vehicles. I am unaware of any current work on the security of these systems. Car manufacturers have a great heritage in safety, but nothing is safe unless it is secure and it is very difficult to do both. Safe and secure no longer go hand in hand."

Issues of communication go well beyond security. Privacy also plays an important role. When cars communicate with other systems, from back-end systems and satnavs to smartphones, broader issues emerge. "Pay-as-you-drive insurance schemes and navigation devices create privacy concerns as they offer the potential to track drivers," says Kargl. "If a car repeatedly reports its position to an insurance company or to a navigation provider, it is parting with personal identifying data, even if theoretically it does so anonymously."

Infrastructure under assault

The car is not the sole concern. Variable message signs, traffic lights and other interconnected infrastructure are all areas of potential vulnerability. Two years ago, a Polish teenager discovered that the



the HSM to incorporate countermeasures to reduce these risks.

"The automobile sector is very price-sensitive, so we had to design our HSM with costs in mind," Henniger adds. "We identified three levels of security: EVITA Lite, Medium and Full. The Lite version is used to transfer data from a small sensor to a central processing unit, involving fairly innocuous data that people are unlikely to access and it doesn't need the highest level of protection. At the other extreme, EVITA Full offers asymmetric cryptography, which is used to ensure the integrity and authenticity of messages whenever the car connects to outside networks."

(Inset) **EVITA has developed a unified approach to security and safety risk analysis for automotive onboard networks** (Above) **EVITA provides a basis for the secure deployment of electronic safety applications based on C2X communication**

control of his local tram system was infrared, the same protocol supported by his TV remote control, and before being found out enjoyed an afternoon of mischievous fun. "Across all traffic management control systems, old bespoke hardware is being replaced by controllers with generic protocols and generic information systems at the back-end," Bull continues. "This means Windows servers – or Linux if you're lucky. Traffic lights that were installed in the late 1980s are today being replaced by systems that are highly vulnerable. Windows, IP and HTTP protocols have all

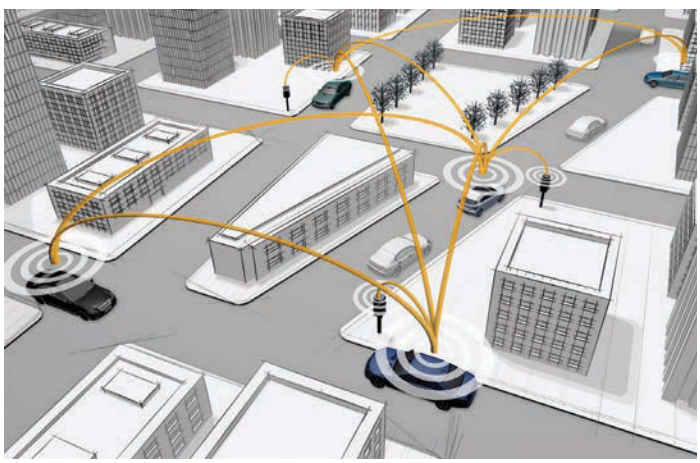
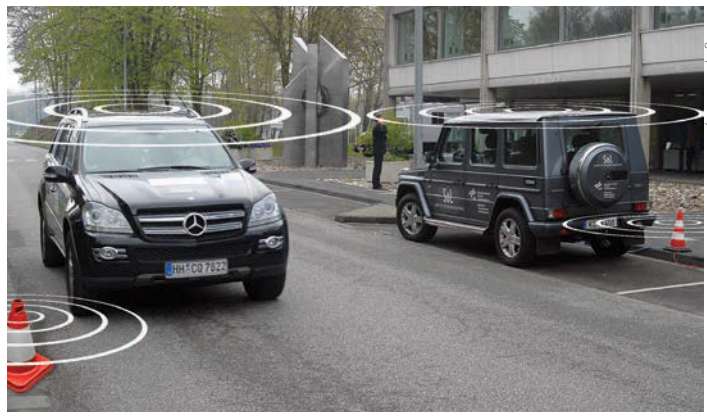


Image courtesy of Daimler

Allowing the physical world to interact with the in-vehicle network introduces a number of security risks, including cyber attacks targeting vehicle functionality and maneuverability



Photograph courtesy of Fraunhofer ESK

Wireless C2X systems can warn of of potential hazards but they must also be watertight to potential hacking threats

been shown to be hackable at will. The old paradigms just don't apply when developing a safety system.

A traffic light system is a safety system. You put a Windows controller box on the back and test it to death. Then the deploying organization will say it wants data – for instance how many cars pass through – so you connect it up to the internet under the assumption that it's safe. Yet you've got to put the right governance in place. Although it's been tested endlessly and expensively, you will still find it's not secure."

> Car manufacturers have a great heritage in safety, but nothing is safe unless it is secure and it is very difficult to do both
>
> **Tony Bull, managing director, Notitia Salu, UK**

Alberto Garcia refers to himself as an ethical hacker or 'penetration tester', essentially somebody who tests company systems for weak spots and flags up vulnerabilities. Last year he became a minor celebrity when he hacked into Spain's transport network then offered to fix the problems for free. "Everyone is concerned about physical security because it is visible," Garcia suggests. "This inspires trust. But it is not complete security. Recently I have been investigating how to disable a car in just a couple of seconds. If you break the IT system, it won't start."

"We have found it a challenge to get people to understand the risks because for so many years these were closed systems," explains Peter Wood, managing director of UK ethical hacking firm, First Base Technologies. "The massive shift toward connecting everything via IP has meant a lot of the security by obscurity that these systems depended on historically is no longer valid. All real-time systems

No joke

GNSS spoofing is the use of a GPS jammer to block satellite signals. Jammers can be bought for as little as US$20, while more expensive models may cost 20 times as much but can replicate signals and provide false locations. In some cases, jammers can deny GPS reception over a large area. They can be used by drivers wanting to cover their tracks when working out of hours or moonlighting. GPS jammers can also be used when stealing a high-value vehicle with built-in tracking.

A UK study into GNSS spoofing was launched in 2012 following concern that jammers could interfere with critical systems that rely on GPS – and with good reason. In 2009, Newark Liberty International Airport in the USA found some of its GPS-

based systems were suffering interference. The problem was traced back to a truck driver using a jammer.

It is difficult to intercept GNSS spoofing, since the system has no authentication mechanism implemented. The best way to constrain potential attacks is by having sophisticated plausibility checks using other position systems such as Russia's GLONASS in parallel, or by completing double checks with trusted vehicles or traffic infrastructures.

are areas of great vulnerability and remote administration is often inadequately secured. The systems that were adequate 15 years ago haven't changed that much. This is our big worry."

Evidence of hacking

Just because it is hackable doesn't mean it will be hacked. The National Highway Traffic Safety Administration (NHTSA) in the USA says it is "aware of the potential for hackers … but is not aware of any real-world cyber-security issues in vehicles". The truth is that assaults on traffic and vehicular security are limited to isolated incidents, such as the disgruntled employee of a Texan car dealership who in 2010 remotely deactivated the ignition systems of customers' vehicles. Beyond that, there is anecdotal evidence of extortion in other sectors, for instance rumors that money is being demanded to prevent ships running into BP oil rigs following the Deepwater Horizon debacle, via means of GNSS spoofing (see *No joke* sidebar, above).

Photograph courtesy of BMW

Photograph courtesy of Fraunhofer ESK

"Although several research groups have proved that manipulation of cars is theoretically possible, we do not consider these attacks a serious threat," stresses Thomas Wollinger, managing director of ESCRYPT, a specialist in embedded security. "The requirements for successful attacks are still too high. Moreover, the IT infrastructure of cars is still very heterogeneous, so generally applicable patterns cannot be developed. I am not aware of any real-world attacks."

But this doesn't mean attacks couldn't happen in the future. History suggests there will always be a minority of people who gain satisfaction from hacking into a system simply because it's there, or as a badge of honor. "I don't know that people have especially considered telematics as an area for attack but it is right to highlight it as risk area, especially in the context of C2X communications," says Duncan Matheson, director of government practice at PA Consulting. "Any computer system is vulnerable and unless appropriate design steps are taken at the beginning, the risk remains. It would seem a prudent approach for new system designs to incorporate the latest thinking in security features and try to ensure that data is encrypted in some form, as with CCTV, where imagery is encrypted to reduce the chance of interception."

> It would seem a prudent approach for new system designs to incorporate the latest thinking in security features and try to ensure that data is encrypted in some form
>
> **Duncan Matheson, director of government practice at PA Consulting, UK**

(Left) **Leading car makers such as BMW are taking C2X security and integrity extremely seriously in their R&D efforts** (Top right) **C2X technology from the Fraunhofer Institute that incorporates WLAN and GPS for vehicles**

Last word

The image of the hacker as a disenfranchised young man sitting alone in a basement with a slice of pizza endures, but the reality might be quite different. "Our threat analysis indicates many potential sources," concludes Wood. "It's everything from nation-state attacks to criminal groups with a mixed agenda, right down to the disenfranchised lone wolf."

Some overplay the danger, others underplay it. Solutions such as Symantec Critical System Protection, Industrial Defender and Cryptzone SE46 Application Whitelisting all recognize the various needs of modern systems. Groups such as PRESERVE keep the profile high. What we surely know is that where there is money to be made or mayhem to ensue, security is paramount. For now the industry as a whole seems intent on waiting to see the threat realized before it does anything about it.

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Coming soon?

Cars featuring barcodes rather than traditional license plates may for the moment be the stuff of Hollywood movies, yet **Louise Smyth** discovers the vehicle recognition sector still has a few blockbusting developments up its sleeve

Main illustration courtesy of Vasyl Yakobchuk

When a handful of ALPR experts were asked to predict where they thought license plate and vehicle recognition technology might go in the future, one of the more interesting responses was the issue of what to do when ALPR is no longer sufficient. Marco Sinnema, Q-Free's video and ALPR product manager, was the man who raised this question and is currently focused on answering it. "In today's market, some form of OCR is increasingly becoming a key part of systems," he begins. "Toll systems, as an example, have evolved so that the ALPR that was once used solely as the enforcement component is now used for electronic or video tolling; hence you need to recognize more to pull in your revenues."

Essentially, when you're using ALPR for enforcement, it's just part of an overall system, but when you're using it for video tolling, it *is* the system – it has to identify every single plate. Elaborating, Sinnema adds, "Let's assume you use ALPR for video tolling and it recognizes only 90% with sufficiently reliability. All the other images get passed to operations to be identified manually, which is just pure cost. So if you increase the percentage you can automate, you reduce operational costs. Increasing that yield is informing our R&D efforts today."

Obscuring the issue

Even with the best LPR software in the world using images from the best cameras, it's never going to be possible to get a 100% read-rate using ALPR, with obscured plates remaining just one common obstacle. But with 'vehicle fingerprinting', plates can still be read even when they're partially obscured by a tow bar or other LPR-foiling items such as a frame surrounding the plate. "With fingerprinting you don't try to recognize all the individual characters on the plate," Sinnema continues. "Instead, you make a fingerprint of the area of the plate and around it, which uniquely identifies a specific vehicle. Independent of whether there's a tow bar in front or a frame around it, you just take those other aspects into consideration while making the fingerprint.

"Of course, if you can't read it with ALPR then you have to recognize it manually anyway – and that's OK. But if you reactively update your database and store a fingerprint of the car with the result that's been identified manually, the next time you see the car and that ALPR didn't work, you now have a fingerprint you can match, so you can handle it automatically anyway."

The appeal of such a solution for toll roads (which have many regular users) is clear – hence this is where Q-Free is noticing the most demand for its fingerprinting technology. A major US Turnpike is one notable customer, with Sinnema reporting good results from this recent deployment. "Not everything at this Turnpike is being read by fingerprinting because if you can process it by ALPR, it's not needed," he says.

A dual technology approach

In Virginia, USA, the Department of Motor Vehicles (DMV) and Virginia State Police have been asked to study how to track license plates using two kinds of technology – RFID and barcodes. The two Republican law-makers who made the request say that it would cut costs and increase revenue for the Commonwealth.

Delegate Joe May and State Senator Stephen Newman want to replace current license plates with a barcode to save costs associated with plates and their decals. Their aim is to eliminate plate decals and improve the readability of license plates while saving the Commonwealth money.

If the barcoded plates were deployed, they would be readable by law enforcement officers, who would then be able to track vehicles more efficiently.

Needless to say, concerns have already been raised about the privacy issues associated with barcoded plates. The American Civil Liberties Union (ACLU) is adamant that the potential cost-cutting measure raises significant concerns. "These kinds of technologies are real threats to our privacy," said Claire Gastanaga, the executive director of the ACLU.

The RFID component of the proposal would simply enable law enforcement officers to scan license plates.

But Gastanaga insists, "It won't stop with law enforcement. It just essentially allows government to follow you wherever you go in your car."

Even putting privacy concerns aside, it seems unlikely the state will overhaul its license plate technology just yet.

"But of the images that couldn't be read by ALPR, we can still process a further 50% by identifying them with fingerprinting."

Section speed enforcement is another ideal application of fingerprinting and there is currently a scheme in the Netherlands using Q-Free technology. An interesting point about this particular application, though, is that even countries in which ALPR cannot be widely used for legal reasons can still deploy section speed control. "Some legislation prescribes that you can only identify people who are actually violators. With section control you take a photo at one point and another elsewhere and work out the time between the points. If you're using ALPR then you are actually identifying the vehicle, regardless of whether it's speeding or not. But with fingerprinting you just take an anonymous fingerprint, find the same fingerprint later in the trajectory, calculate the difference in time and assess if it's speeding. If it is, you can use ALPR legally."

Statistical success

JAI is another vendor looking at fingerprinting to complement ALPR, with tolling again proving to be where the demand for such advances is greatest. "The 'poster child' for this approach has been the 407 Express Toll Route in Toronto," reveals JAI's Rich Dickerson. "They implemented a combination of our ALPR and Matcher software in 2006 and have received multiple awards for it since. By combining OCR results and pattern matching into a library of what are called Vehicle Data Tags, they're able to identify a higher percentage of vehicles automatically."

So what do seven years of results show? "The deployment has resulted in a 20% decrease in manual verification, a 37% reduction in head count and a 17% improvement in readability of plates," Dickerson explains. "And the resulting increased accuracy of billing leads to more customer satisfaction."

> "Of the images that couldn't be read by ALPR, we can still process 50% by identifying them with fingerprinting"
>
> **Marco Sinnema, video and ALPR product manager, Q-Free, Norway**

(Left) **Toronto's 407 ETR** (Below) **Q-Free's Intrada ALPR software**

A section speed control system in the Netherlands is also using JAI fingerprinting technology, as is a parking facility in Japan. Dickerson hints other developments – in terms of both projects and vehicle recognition technologies – are due to be revealed soon.

It is worth noting, however, that ALPR itself is unlikely to be completely replaced by fingerprinting (or anything else) any time soon. And suppliers such as Q-Free and JAI are still very much promoting their conventional ALPR products. Like these players, Genetec also offers a range of license plate and vehicle recognition products. But as Stephan Kaiser, general manager of Genetec's ALPR business unit, reveals, the company takes a different stance to many in the sector. "A lot of ALPR vendors only address the license plate aspect of tracking and identifying a vehicle," he says. "We integrate LPR with video surveillance and access control on a single security platform.

"We combine and address multiple variables and situational analytics – for

(Above) **Genetec's software is widely used in law enforcement**

instance, how a vehicle enters and exits parking lots or rental car facilities, the vehicle's state and condition before and after use, how it operates in traffic, or where it is in a parking lot. In short, we unify the multiple variables associated with identifying, fingerprinting and matching a vehicle."

Make and model identification

Genetec clearly feels there is a lot more to be done with recognition technology and Kaiser cites a number of trends its R&D team is currently investigating. "We're working on velocity measurement, where one of our AutoVu Sharp camera systems will be able to approximate a vehicle's velocity based on the license plate image," he says. "Automotive make, model and brand/logo signature data is the other big trend. We're working to offer an accurate way to match not only car-tag placement, but also recognize the make and model of most vehicles, based on tail-light orientation, the specific shapes of car rear-ends, edges and bumper location."

Such a feature could obviously have significant appeal for traffic law enforcement – if any vendor can actually bring an accurate system to market. So how can such identification be conducted reliably? "The R&D effort is still ongoing and we haven't concluded exactly how vehicle make and model will be determined," Kaiser explains. "The challenges are numerous, but as an example, to be able to recognize an exact make and model you need to compare an image of a vehicle against a database of images. Such a database would be huge – models vary from continent to continent, people modify their cars and models change yearly.

"The capability to provide law enforcement officers with an accurate vehicle identification is key. You certainly don't want to wrongly identify a model and make in an emergency situation. Another target for this type of development is parking security and ensuring that the same license plate enters and exits an area with the same type of car. This will identify cars that have had their plates swapped while in the parking lot. An ideal solution would be to have some form of vehicle identifier that isn't completely dependent on a huge database of images."

The future of vehicle recognition

Looking even further ahead, Kaiser agrees with Sinnema and Dickerson that LPR has a "very promising" future and is unlikely to be replaced by any of the more unconventional concepts for vehicle recognition out there. "LPR is complementary to approaches that use RFID or Electronic Vehicle Recognition, for instance. As long as the identifier for vehicles on the road is a license plate, you will need LPR to validate if the vehicle is legal, has paid its registration, and so on. We do agree that there is value in combining an RFID read with a license plate read, as it can be used to confirm that the plate is on the correct vehicle, etc. But the downside of RFID is that to be able to identify a vehicle you need some form of reader that can capture RFID signals. A license plate is universal to the human eye and can be recognized without any additional equipment. This is why we believe that having the ability to recognize a vehicle without any form of transponder and dematerializing vehicle recognition has its advantages and is not ready to be replaced yet."

For now at least, Q-Free's Sinnema says LPR will continue to dominate the industry. "Fingerprinting is being used for tolling as a back-up if the ALPR doesn't work, but advances in ALPR itself make it increasingly reliable and less in need of a back-up.

"I don't see a move to full fingerprinting in the next five years, at the minimum. ALPR and video in general are becoming more important – cameras are becoming better, cheaper and more widely deployed. And while there are developments in terms of people investigating alternatives to traditional license plates, I don't think the current landscape will change greatly. While every car still has a license plate, video will continue to be used – even if it is just as a back-up."

> We're working to offer an accurate way to match not only car-tag placement, but also recognize the make and model of most vehicles
>
> **Stephan Kaiser, general manager, Genetec, Canada**

Track for the future

Although various companies are investigating the use of barcodes to replace traditional license plates, they seem unlikely to be used in the near future for a very simple reason that has nothing to do with technology. Regular license plates form an inherent part of the visual identification of a vehicle. If an accident – or indeed a crime – is reported, then the emergency services often request the license plate number to help identify the vehicle and/or its owner. The use of barcodes could possibly encourage greater vehicle crime – and criminals would certainly have an easier getaway, assuming no barcode readers are in the immediate area where they've committed their crime. In short, human eyes cannot read barcodes, so vehicles would lose an integral identifier.

Another idea for the potential use of barcodes is that they may not function as actual barcodes to be read directly, but as transponders or tracking devices. Relevant information could be stored on them, allowing for longer range vehicular scanners on law enforcement vehicles to track vehicles at a distance without having to scan the plate.

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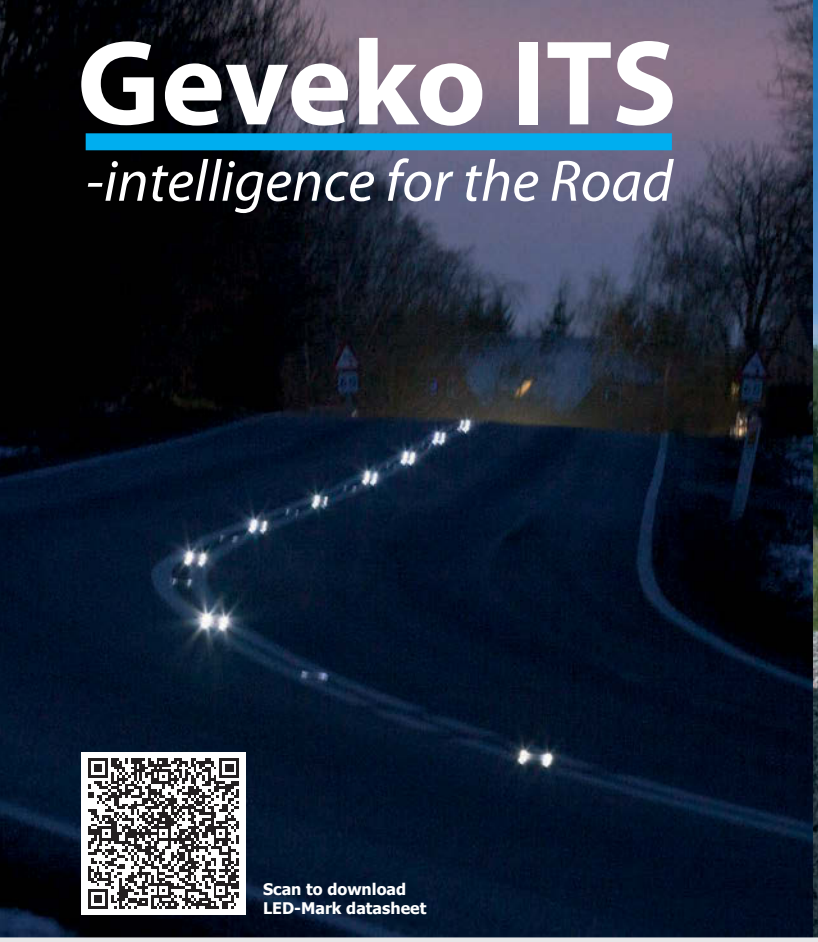

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LED-Mark datasheet

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LED-Guide concepts

Use solar road studs to improve road safety, guide traffic and collect traffic information

LED-Mark

is typically used for

- Dangerous curves
- Blackspots
- Roundabouts
- Cycle paths
- Pedestrian crossings
- Railway crossings
- Harbours
- Spots of road prone to frost

Key features

Visibility up to 2 km ahead
Ultra-thin and stand-alone
CO_2 neutral operation
2000 hours of operation without sun
Snow plough safe

LED-Guide

is typically used for

- Intelligent traffic counting
- Intelligent roundabout light
- Intelligent pedestrian crossing
- Ghost driver warning
- Cyclist counting
- Right turning lorries warning
- T-junctions / curve warning
- Wrong-way driver warning

Key features

Visibility up to 2 km ahead
Ultra-thin and stand-alone
CO_2 neutral operation
2000 hours of operation without sun
Snow plough safe

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City of schemes

There can't be too many traffic managers around willing to swap jobs with Mehmet Necip Ertas. But having achieved so much – and with the drive to achieve so much more – he tells **Nick Bradley** it's a job he wouldn't dream of swapping anyway

Photographs courtesy of EMBARQ Turkey and Istanbul Metropolitan Municipality

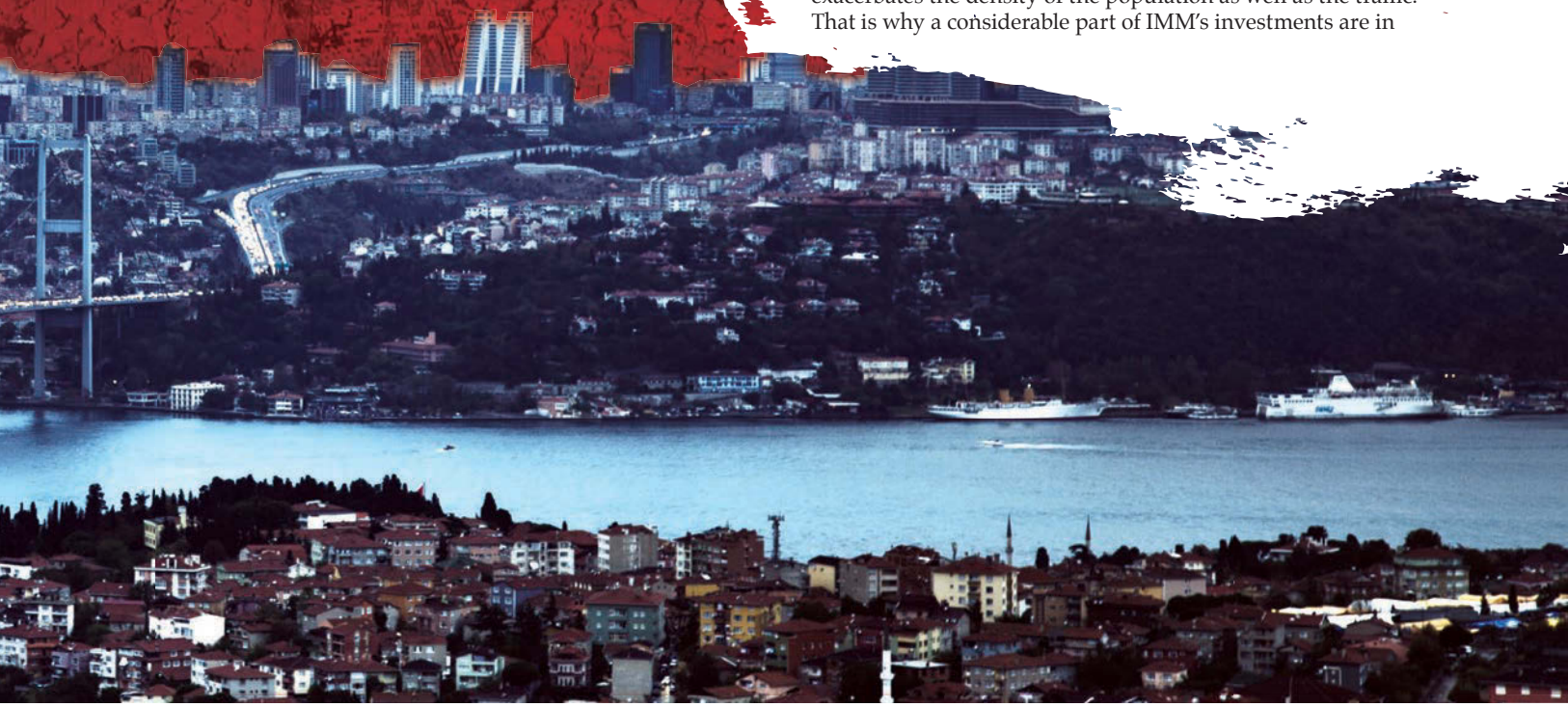
Highlighting the extent to which Istanbul's traffic scene has transformed over the past two decades, in 1995 officials were attempting to regulate the city's vehicle population with a mere 300 intersection signals. And in 1997 there were just 10 traffic cameras. Today there are more than 1,900 signal-controlled intersections and 700 traffic cameras, 195 of which are in the city's four tunnels. Just for the record, there are also in the region of 800 traffic detectors, 22 variable message signs, 35 semi-dynamic traffic signs, 200 EDS traffic-monitoring cameras and 35 meteorological sensors.

Of course, there are now many more vehicles on the roads of this 8,000-year-old city than there were in 1995 – approximately 2.7 million, with 500 or so more adding to the problem every 24 hours – but in more ways than one the Istanbul of today is night and day to the Istanbul of a little under two decades ago.

Man on a mission

And that is just as well for Mehmet Necip Ertas, traffic director at the Istanbul Metropolitan Municipality (IMM), as it is his task to ensure everything runs smoothly, safely and efficiently – with technology increasingly lending a hand. So is this the most challenging job in traffic management worldwide? It is according to figures from TomTom's *2012 Congestion Index* (see *A city in gridlock*, page 39), with those commuters traveling 30 minutes a day suffering 118 hours of delay a year. Yet Ertas exudes nothing but positivity as he speaks to us from his recently completed state-of-the-art Traffic Control Center (TCC).

"Istanbul is one of the world's largest metropolises, and if you count those who come into the city every day it has a daytime population of nearly 15 million," says the 47-year-old mechanical engineer, who joined IMM in 1995. "It is a large population for a relatively confined area. The city's industrial, commercial and cultural centers are all in specific areas, which not only makes it a very mobile city but exacerbates the density of the population as well as the traffic. That is why a considerable part of IMM's investments are in



Safety and sustainability

Turkey clearly has severe problems with safety. Yet as EMBARQ's Arzu Tekir tells **Louise Smyth**, any improvements to be made go hand-in-hand with sustainable mobility – which is a win-win-win situation for everyone

Burgeoning car ownership is the root of Turkey's current congestion problems, according to Arzu Tekir, who was appointed director of EMBARQ Turkey in December 2011. "Each day more than 500 cars are joining the traffic in Istanbul," she reveals. "The average traffic speed is now 20km/h. We cannot move as a result of rising car ownership and urbanization."

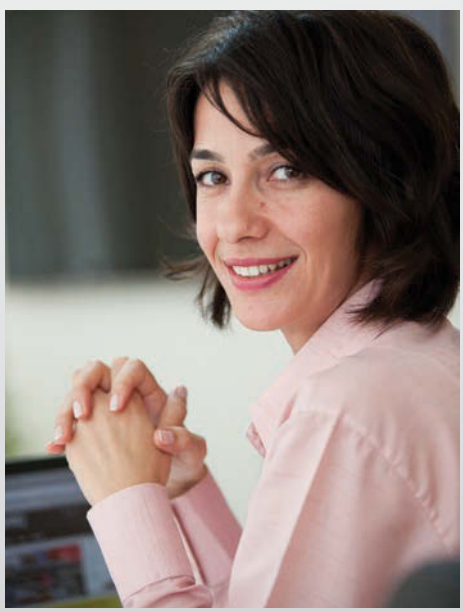
Yet while keeping Turkey on the move is important, ensuring it does so sustainably and safely is also a huge motivation for Tekir, who feels the latter issue should top any agenda. Statistics about Turkey from the World Health Organization, for instance, evidence approximately 10,000 lives being lost due to traffic accidents every year, with almost 200,000 people seriously injured.

However, as Tekir explains, it's nigh on impossible to devise solutions when you don't know the full extent of the problem: "The statistics show the amount of people who die on the roads each year, but we don't count those who die later in hospital as a result of road accidents.

"Our main challenge is actually data collection. We just don't do enough calculations and gathering of statistics. We don't even know how many cyclists are involved in accidents each year.

"Turkey needs to develop a proper traffic accident data collection system and do it as soon as possible. In meetings with transport ministers, I always explain that data collection is the most crucial part of risk mitigation and the prevention of crashes, serious injuries and deaths. Without it, we don't know which part of the safety problem to prioritize."

> "Our main challenge [in Turkey] is actually data collection. We just don't do enough calculations and gathering of accident statistics. We don't even know how many cyclists are involved in accidents each year



However, safety is moving up the local agenda as a result of a recent collaborative project. Tekir continues, "Turkey is one of the countries included in the Road Safety in Ten Countries Project (RS10), implemented since December 2010 and set to be conducted over a five-year period by a consortium of six international partners [EMBARQ Turkey is one of the partners representing Turkey]. The project focuses initially on the cities Afyonkarahisar and Ankara – by building capacity, raising awareness, developing model programs and implementing effective interventions. Speeding and seatbelt use are two main risk factors where action is being undertaken."

Turkey is also part of the Decade of Action for Road Safety. As part of this, the Decade of Action Road Safety Plan aims to reduce traffic fatalities by 50% by 2020. However, despite the rising number of road accidents, it was announced at the National Road Traffic Safety Symposium and Exhibition in 2012 that there had been an 8% drop in fatalities over the past three years. "This gives us hope," Tekir says.

When it comes to more high-tech solutions, she believes that deploying more ITS would be "very helpful" in improving road safety. "GIS-based accident information systems, for example, help to identify the major accident locations, the frequency of these accidents and their type. Based on the analysis of this data, transportation planners can mitigate the accident risks."

And there is a financial motivation for deploying ITS, too. "Compared with 'hard infrastructure' investments, ITS schemes are less expensive but at the same time can deliver results more quickly in terms of transport efficiency," Tekir adds.

The role of ITS in fostering sustainable mobility in cities shouldn't be forgotten either. "Such goals will be achieved notably through the deployment of core ITS applications in urban areas, covering traffic management and urban logistics, travel information and smart ticketing. By improving the efficiency of door-to-door

transport, city-level solutions will also contribute to the European Union's energy and climate objectives."

Safety ultimately plays a key role in any long-term vision related to sustainable transport: by its very nature, for something to be sustainable, it has to be safe – or at least a lot safer than it is today! And Tekir is the first to acknowledge safety's role in the bigger 'sustainable' picture. "As more cars enter city roads [due to a rising middle class] and more people move to urban areas, we need to rethink the way we move in cities.

"Sustainable transport is a win-win-win scenario, where one may reap benefits across multiple areas without spending millions in just one area. Sustainable urban transport and development saves lives and improves quality of life; it has clear economic, environmental and quality of life benefits."

(Far left) **Safety of pedestrians will feature heavily as part of Turkey's Decade of Action for Road Safety** (Left, middle) **Arzu Tekir initially joined EMBARQ in January 2011 as operations manager** (Above) **Following the opening of the fourth phase in 2012, Istanbul's BRT line now extends 51.3km** (Below) **Istanbul has undergone a tumultuous transition from an ancient metropolis to sprawling megacity**

Mehmet Necip Ertas (center) **and his team monitor and control Istanbul's traffic in real-time from the TCC, which has become an indispensable part of the solutions to the transportation problems in the city**

transport. Although we are planning new infrastructure, priorities are traffic management and control to ensure we use what we have effectively."

Ertas, who ascended to the top of IMM's traffic directorate in 2002, reveals that there are a number of departments beneath the overall IMM umbrella, employing 14,000 staff, contracted officers and workers. Additionally, there are 24 companies operating under the municipality, including the general directorate of IETT (Istanbul's electric tramway and tunnel operations) and the general directorate of ISKI (the city's water and sewage administration). "With this structure and through these companies, Istanbul is not only serving its citizens but also delivering world-class projects," Ertas says.

> Istanbul deserves the best … but we're cognizant of introducing new solutions without having to bin existing ones

ITS: the best this man can get

Ertas's domain, though, is the TCC and the major roads of Istanbul, which cover an area of 5,389km^2 and a road network of approximately 25,000km. "Istanbul deserves the best, hence why we monitor closely developments in technology and practices, but we're cognizant of introducing new solutions and having to bin existing ones.

"In the area of traffic signalization we're operating a variety of intersections, from the simplest pedestrian button-operated crossings to complex systems that synchronize intersections along all our arterial routes. We're also now deploying energy-efficient LED traffic lights, which are much brighter."

A city in gridlock

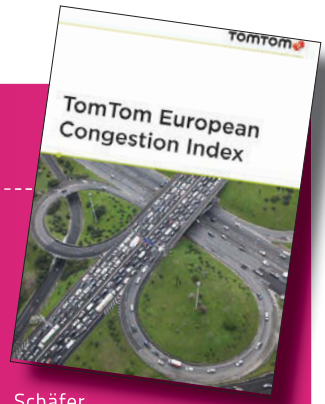
TomTom's *2012 Congestion Index* covered 58 European cities and showed Istanbul to be the most congested city of the lot. Average journey times, for instance, are 57% longer than when traffic in the city is flowing freely, and 84% longer during the morning rush-hour.

Based on real-time travel data captured by vehicles driving the entire road network, the *Congestion Index* is one the world's most accurate barometers of congestion in urban areas. TomTom's traffic database contains more than six trillion data measurements and is growing by five billion measurements every day.

The overall congestion level for all the European cities analyzed between April and June 2012 was 23% – a drop of 4% compared to the same period in 2011.

The top 10 most congested European cities, ranked by overall congestion level between April and June 2012, were Istanbul (57%); Warsaw (45%); Marseille (42%); Palermo (40%); Rome (34%); Paris (34%); Stuttgart (33%); Brussels (33%); Hamburg (32%); and Stockholm (30%).

"This *Congestion Index* gives the general public, businesses, industry and policy-makers accurate and unbiased information about congestion levels in urban areas," says Ralf-Peter Schäfer, head of Traffic at TomTom. "Because TomTom's traffic information is so precise, we can pinpoint congestion trouble spots more effectively. When combined with real-time traffic information and routing technology, traffic starts to be routed away from these congested areas, helping to ease congestion in cities and urban areas."



When it comes to incident detection, Ertas's colleagues at the TCC monitor Istanbul's traffic 24/7 so that immediate and appropriate responses to traffic incidents can be implemented whenever they occur. The four tunnels in his jurisdiction, however, combine automatic incident detection systems with specific cameras used for tunnel management. "We call on a wide variety of sources to collect traffic data," Ertas continues. "We're using radar and image processing-based sensors, but we also employ Bluetooth and RFID to calculate journey times. Additionally, we receive traffic data from our EDS monitoring system and through our IMM MobileTraffic application. When all the data from these various sources is combined and assessed, it is used either instantaneously in real-time traffic management or for statistical purposes."

Istanbul's head of traffic isn't ruling out data from C2X sources in the future, either. "In cities around the world, including Istanbul, you will see applications that permit vehicles to talk to one another as well as with the roadside infrastructure," Ertas predicts. "We are watching developments in C2X and are excited by the benefits. And here in Istanbul we've already started R&D work to ensure that we're ready when these technologies eventually reach a deployable reality for our roads. We're certainly gearing up our signalization and signage systems to be compatible with these next-generation communications technologies."

A city like no other

Although widely traveled and ever keen to evaluate practices from other ITS-rich cities, Ertas is keen to stress that Istanbul is like no other metropolis in the world, so what works in London, Sydney or New York may not necessarily succeed for him and his colleagues. "A number of traffic control techniques used elsewhere are simply ineffective for this city as a result of its geographical makeup, not to mention the driving habits of our citizens," he says. "We either have to adapt technologies for our environment or – as in the case of a project coming online soon that we've worked on with ISBAK [IMM's technology wing] – completely new technologies have to be developed from scratch."

> A number of traffic control techniques used elsewhere are simply ineffective for the city of Istanbul
>
> **Mehmet Necip Ertas, traffic director, Istanbul Metropolitan Municipality**

Among the most successful of the projects to have come on-stream during Ertas's decade-long watch has been the Electronic Detection System (EDS) – Istanbul's combined traffic safety and monitoring system. "This was designed and implemented to regulate driver behavior and reduce violations of traffic laws by introducing some kind of order to the traffic," Ertas explains. "In many cities around the world, enforcement simply means that red light and speed infringements are monitored automatically, but we've developed a system that monitors parking, safety lanes, one-way-street violations, as well as incursions into bus lanes, tram lanes and pedestrian crossings."

In Turkey the responsibility for traffic enforcement lies with IMM's security directorate at the Istanbul Police HQ,

(Left) **Traffic management has become a critical issue in Istanbul as its population and vehicle ownership has exploded** (Top right) **The city's EDS system is designed to monitor speed and red light violations, hard shoulder and bus lane encroachments, parking infringements, and much more**

Traffic prediction

Turkey is fast becoming a focal point for leading-edge developments that are transforming the way vehicle data is gathered and analyzed. A case in point is a major IMM initiative seeking to direct drivers and pedestrians to their destinations via the best possible routes.

"We don't just want to disseminate information about the current traffic situation," insists Esma Dilek, a computer engineer at ISBAK (pictured right). "The potential traffic situation in the near future is much more important

so that people can actually make informed decisions about how they are going to travel. So by using the latest forecasting methods we are becoming much more informative."

A recent agreement between ISBAK and Turkish GSM operator AVEA is opening the potential for the IMM to obtain even greater volumes of data: "AVEA has access to a huge amount of network movement data that is really critical when you want to make decisions on traffic in the near future."

Dilek sees the rapid take-up of smartphones as a major opportunity to improve forecasting – a fact that (in addition to the AVEA initiative) is reflected in the number of people using its app for online traffic information. "Mobile phone data gathered from volunteer users gives us the chance to collect traffic data without having to pay for infrastructure such as static sensors," says Dilek.

In terms of the algorithms that Dilek and her colleagues are implementing to predict traffic, she explains that these are mainly based on speed analysis and speed forecasting rather than traffic density: "Traffic speed information is collected from a number of data sources such as stationary sensors, with mobile phones compensating for any missing values," she says. Nihat Kocyigit, a computer engineer who works with Dilek, feels the practical benefit of this work is that the average time people need to spend in traffic will decrease: "They can make decisions on their routes and – if there's heavy traffic – delay their travel or make another decision based on our forecasts."

co-located with Ertas's traffic directorate in the TCC. "We developed and operate the EDS with the police, and its success – i.e. significant reductions in traffic violations and accidents – resulted in a change to city regulations that was eventually rolled out nationwide," Ertas states with pride. "We collaborate with the police in compiling accident statistics, identifying accident blackspots, and developing specific solutions for such troublesome areas. The ambulance service is also with us in the TCC, so if there are any serious incidents on our roads we can all sit around the table and respond effectively."

As far as solutions to assist end users go, IMM MobileTraffic is the perfect showcase as it offers traffic information via numerous mobile platforms and is, as far as Ertas is aware, the first of its kind worldwide. "Drivers can access traffic data and announcements from any location, plan their journeys, and reduce the time they spend in traffic. With more than a million users, it's Turkey's most widely used app."

> The most satisfying part of my job is when we implement a solution and you start to see the benefits. That gives you further motivation to do more

There are more than one million individual users of IMM's MobileTraffic application in Istanbul

A long, long road ahead

"All of our projects are aimed at making life more comfortable and safer for the people of Istanbul," continues Ertas, who clearly has a passion for his city. But he is realistic about the challenges in front of him. "The 15 million or so people coming into the city make 21 million daily journeys," he says, reinforcing the fact that there are no silver bullets when it comes to traffic management. "We have 1.3 million journeys made each day between Europe and Asia alone. The average journey time between the two continents is 72 minutes, while the average length of other journeys is 49 minutes. And despite the fact that Istanbul is situated on two continents and divided by the sea, 88.6% of transport is by road. These are the realities. Istanbul isn't only a major city on its own account; it's a bridge between Europe and Asia, a location that places a huge transit/transport burden on the city."

It's enough to make any traffic manager wince. "Our worst days are when we see casualties or the loss of a life," Ertas laments. "And from a traffic management viewpoint, these tragedies affect traffic throughout the whole of the city, causing hours of congestion."

But Ertas and his colleagues have achieved so much in such a short time that you can't help feeling the city is in the very best of hands. "For me, what is important is the sense of having been able to contribute something to Istanbul. The most satisfying part of my job is when we implement a solution and you start to see the benefits," he concludes. "That gives you motivation to do more. If we can get through a day without any serious traffic accidents and keep traffic on the move, it's a good day as far as we're concerned."

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Utopian streets

Moving away from the constraints of traditional highway demarcations and traffic regulations, Shared Space aims for a more balanced and vibrant environment in which motorists, pedestrians and even cyclists coexist in perfect harmony. **Timothy Compston** investigates

Illustration courtesy of Ben White

Shared Space is about transforming the way that we think about, use and share our streets and urban spaces – whether you're a motorist, pedestrian or cyclist. In the Shared Space world, it makes sense to plan for an environment that supports rather than hinders social conventions and informal negotiations. So, the theory goes, with some forethought and clever design, you rely on the intelligence and adaptability of the users of a specific space to reach their own consensus. Falling back on tighter regulation or highway tools such as signs, curbs and road markings is, apparently, not the done thing in this more open scenario.

Ben Hamilton-Baillie, an urban design and traffic consultant from the UK's Bristol-based Hamilton-Baillie Associates, coined the term 'Shared Space' a decade ago, but reports the origins of the concept – or at least a derivation of the term – go back further.

Perhaps the greatest influence on what was to ultimately become Shared Space as we know it today was Hans Monderman, the Dutch traffic engineer who in the 1980s headed up road safety for Friesland in the north of the Netherlands. Hamilton-Baillie first met Monderman in 2000 and believes his contribution up until his death in 2008 cannot be overstated. "He was an extremely innovative, broad-thinking researcher and engineer, as well as a driving instructor," Hamilton-Baillie reveals. "This gave him the combination of a great understanding of the psychology of road users as well as the actual engineering itself."

The Ashford scheme in Kent challenged conventional ways of building highways by reclaiming significant areas of public realms once dominated by heavy traffic

History lessons

The city of Savannah in Georgia, USA, has a distinctive grid layout that is centuries old but that is scaled for the pedestrian and supports fluidity for traffic – contributing a more human feel and providing inspiration for Project DeRenne

As far as urban design and balancing the use of space go, the city of Savannah, Georgia, has a headstart on many communities, being known the world over for its distinctive grid pattern and 22 park-like squares, developed by the city's founder James Oglethorpe. The so-called Oglethorpe Plan from the 18th century has served the historic district of the city well over the centuries – including in the age of the automobile – and contributes a more human feel to the environment.

According to Sean Brandon, director of the Management Services Bureau (also responsible for mobility and parking), the existing squares dictate how traffic, pedestrians and alternative transportation such as bicycles move throughout the historic downtown. "We don't actually have to provide a whole lot of traffic signals or demarcation here in terms of movement," Brandon says. "There's no need as everything moves so slowly through the streets that have the squares, typically no faster than 25mph. There's nothing that indicates, for instance, a bicycle has to be in a certain area – it works itself out. At low speeds, cars and bicycles interact easier."

> "It works for pedestrians, it works for vehicles. It is humane and scaled for the pedestrian, but supports fluidity for traffic

Brandon points to some changes with regards to how the original street layouts are used today. Those not featuring squares, for example, now operate only as one-way routes. Some have even been reduced to just a single lane for vehicle traffic in order to reduce speed, to cater for more parking and, crucially, to provide more space for bicycles – a rapidly growing feature of the city. He also highlights the largest public works project in recent times downtown, which involved the restoration of Ellis Square. Here, a conscious decision was made to revitalize the area, and avoid clutter, by putting 2,000 valuable parking spaces out of sight underground.

Susan Broker, director of the citizen office for the City of Savannah (picture above), trained as an urban planner and is also enthusiastic about the legacy left by Oglethorpe. "The layout is centuries old and it works," she says. "It works for pedestrians, it works for vehicles. It is humane and scaled for the pedestrian, but supports fluidity for traffic." She encourages citizen participation in key projects, with much of her effort now firmly focused on the ambitious Project DeRenne. Started in 2008, this is targeting the critical DeRenne Avenue corridor with the aim of carefully balancing the interests of transportation and the community. The chosen concept is called the 'Boulevard Option', which has now entered an environmental review process.

"DeRenne Avenue is actually south of the historic district and where the edge of the

Monderman adopted a groundbreaking approach to integrating traffic into towns, by moving away from signals, controls, barriers, signs and other traditional facets of traffic management. "His idea was to 'treat people as intelligent, rather than authorities doing the driver's thinking for them'," says Hamilton-Baillie . He began writing about Monderman's largely unsung work in the UK and it was eventually picked up by *The New York Times* – turning the Dutch pioneer into a globally recognized figure in the field.

"If drivers are left to rely on their own senses, they're likely to have a more heightened awareness of the dangers around them than if the state is telling them what's obvious," Hamilton-Baillie continues.

Monderman began to reconfigure a number of villages and squares, exploring how he could influence the speed and awareness of drivers in ways other than through regulation or legislation. "That's at the heart of what Shared Space is all about," Hamilton-Baillie stresses. "The focus should be on integrating the whole design process – not just the traffic engineering but the urban design and landscaping, to tell the right story to drivers which then, consequently, governs how they will actually behave."

Very early on, though, Hamilton-Baillie realized there wasn't any vocabulary or a term to describe this unorthodox approach to street design and 'place making' in towns. "It needed to define a broad set of principles – something that would help debate and research," he recalls. "That's when Shared Space was born."

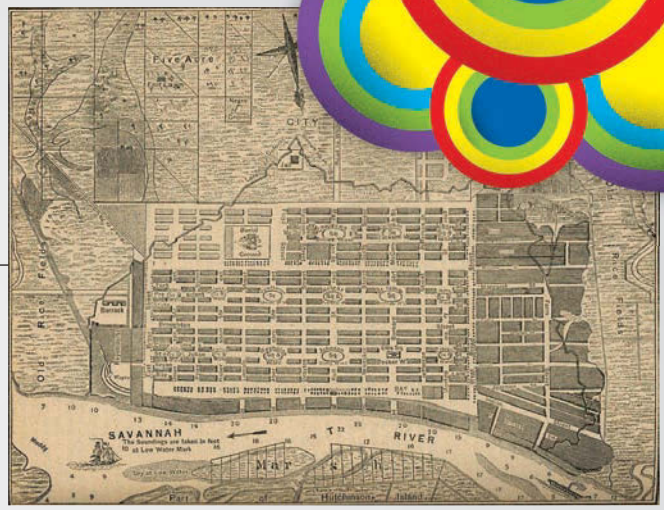
Location matters

"Clearly, Shared Space isn't really for motorways [freeways] or trunk roads, but rather for streets or spaces where multiple activities occur," Hamilton-Baillie goes on to say. In this context, he highlights a diagram that Monderman drew on a napkin the first day they met that has influenced the British designer's Shared Space thinking ever since. "Drawing on the napkin, he showed me that the qualities that make for successful highways are diametrically opposed to the qualities that make public space work well," Hamilton-Baillie recalls.

"For highways we need consistency, predictability, standardization, acceptance of state rules and controls, and a simple language of signs and markings. It tends to be a single-purpose space. For public spaces, Monderman's theory was that it works better if the opposite applies, being much more multipurpose; flexible, unpredictable and where people use a much wider range of human communication rather than just signs and markings." Hamilton-Baillie feels this helped to clarify in people's minds that a problem occurs when the characteristics of the highway leech into civic space.

Focusing on some of the practical measures that typify Shared Space, Hamilton-Baillie cites traffic signals being taken out to cut approach speeds, the removal of center-line markings, reducing the visual width of carriageways, changes in materials and lighting, and taking away guard rails, street furniture and signs.

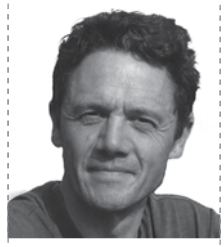
As for success stories, he singles out one of the last major projects that Monderman worked on, in his home town of Drachten: "For a large junction with 22,000 vehicles a day, he removed the traffic signals and created a space in which cars could move



Savannah is an incredibly innovative city on the merits of its urban plan, which goes back to the 1730s

city was in the 1950s," Broker reveals. "This means that it is very car-centric. Like a lot of cities in North America, over time roads have been built to accommodate commuter traffic. Out here, the street cars died out and our road systems weren't built to engage with the community. This contrasts with the systems downtown that connect with the pedestrians and the architecture of the buildings adjacent to them, making the space more livable."

Broker says the aim with Project DeRenne is to bring a "community feel" back by creating a mid-city main street that moves away from what is there at the moment, which is more akin to a highway than a neighborhood street.



> Monderman's idea was to 'treat people as intelligent, rather than authorities doing the driver's thinking for them'
>
> **Ben Hamilton-Baillie, founder, Hamilton-Baillie Associates, UK**

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Single-surface solution

London's much publicized Exhibition Road scheme runs all the way from the city's South Kensington to Hyde Park, home to some of the most important cultural and educational institutions in the UK, with three world-class museums, Imperial College London and the Royal Albert Hall.

Sometimes cited as an example of Shared Space, Mahmood Siddiqi, bi-borough director for transport and highways at the Royal Borough of Kensington and Chelsea (and the adjoining London Borough of Hammersmith and Fulham), stresses that in his view, Exhibition Road should more accurately be described as a 'single-surface project'.

Siddiqi (pictured right) says the definition of Shared Space tends to be pretty broad: "Even Kensington High Street – where all we did was remove meters and meters of guard railings and provide an island down the middle of the road so pedestrians might cross the road in two stages – could conceivably be termed Shared Space and then, at the other end of the scale, we have Exhibition Road, where we sunk the curbs into the road and provided a single paved surface that has the same pattern in the footway area and the carriageway.

"The problem with the term Shared Space is that it conjures up images of motorists plowing through a sea of pedestrians, which is clearly not going to be the case in any road scheme designed to improve pedestrian movement," Siddiqi insists.

The real distinction between a true Shared Space project and Exhibition Road is that there are still distinct zones. "We have always argued that it's conventional in this sense," Siddiqi says. "You have an area that is wholly for pedestrians, another area that is predominantly for motor vehicles and although it's now possible to cross the road indiscriminately – so the traffic zone will be used to get from one side of the road to the other – it's not that different to other roads in urban areas.

"With Exhibition Road, we have successfully achieved our objective to deliver an improved pedestrian environment without turning it into a fully fledged pedestrian zone.

"There has been a 30% reduction in traffic with – as planned – about a third of traffic being displaced onto a more suitable parallel route."

smoothly in combination with bicycles and pedestrians. Within a day or so people adjusted to the new layout, confirming that people do adapt with remarkable speed if given the right cues."

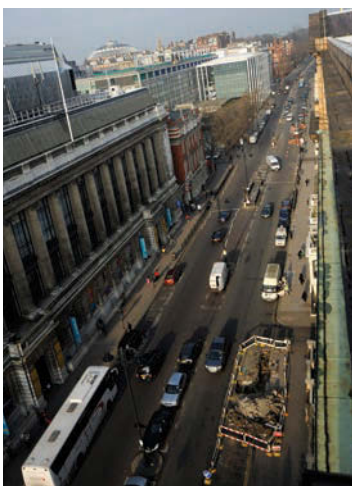
With regard to how Monderman's concept has evolved and been embraced elsewhere, Hamilton-Baillie points to the rebuilding of the New Road in Brighton, UK, which serves a couple of theaters: "It now has a completely different character; there's no formal delineation between the world of the pedestrian and that of traffic. Drivers just have to negotiate their way through a linear space." And on a much grander scale, he notes the landmark projects on Exhibition Road in London (see *Single-surface solution*, above), as well as the Ashford Ring Road in Kent, which has drawn attention from as far afield as Japan.

Breaking down the barriers

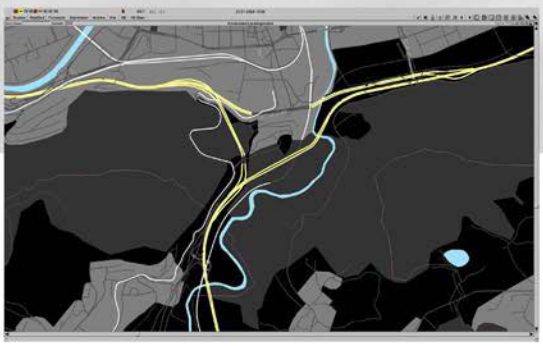
The latter scheme was agreed through consultation for the Greater Ashford Development Framework (GADF) initiative and was envisaged as a four-stage process. The first saw the conversion of the one-way ring road to two-way use in July 2007 and the second – of most interest here – led to the transformation of the Church Road-to-New Street area as Shared Space by the end of 2008. Two further stages have still to be implemented. The Shared Space portion of the road has a speed limit of 20mph, with 30mph enforced on the rest of the route.

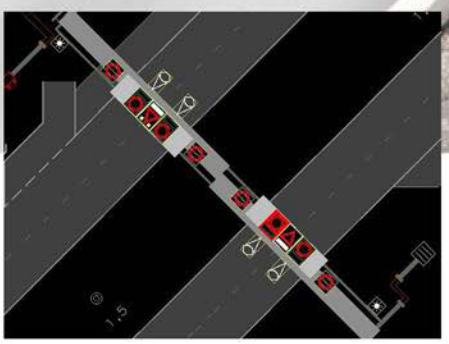
> There are no center markings or obvious crossing markings at Elwick Square, so drivers are required to find their way without some of the normal indicators
>
> **Bob White, development planning manager, Kent County Council, UK**

For Bob White, development planning manager, Kent County Council highways and transportation, the changes to the ring road were driven chiefly by Ashford being a growth area in the strategic development of the county. "It was a one-way ring road with two, three and even four lanes in place, so in effect a 'concrete collar' around the center of the town," he reveals. "Pedestrians and cyclists wanting to go into the center of town were confronted with a virtual barrier, which – despite them being able to cross via signalized control-led crossings – wasn't particularly inviting."



(Far left) **London's Exhibition Road as it was in January 2010, before the refurbishment** (Left) **The new Exhibition Road, in South Kensington, home to many of Britain's great museums, has proved a triumph for the Shared Space movement**





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White's initial focus was on the fact that the ring road was wide and fast. "It felt unsafe and was unattractive so our first step was to opt for two-way travel on the whole stretch, reducing speed and ensuring people had reduced distance to travel on specific routes. It was also vital to ensure there was sufficient capacity within the network, so any adjustment from introducing Shared Space on roughly a third of the stretch was soaked up by the remainder."

In White's view, the Elwick Square part of the scheme is the sort of environment where Shared Space works best as no one party dominates. "Drivers here proceed with extra caution compared to a more regulated road," he says. "There are no center markings or obvious crossing markings, so effectively they're required to find their way through without some of the normal indicators." The Shared Space area is a 20mph zone that is largely being adhered to, White reports, especially on the Elwick Square approach.

When quizzed about the volume of traffic flowing through the Elwick Square area, White says the changes have resulted in a reduction of around 50%, from a 12-hour figure of 20,000 vehicles in 2002 to around 10,000 vehicles now. "This was predicted and is thought to be a reasonable level for the proper operation of the Shared Space," he states. "It hasn't caused undue congestion on the rest of the ring road or an increase in safety problems."

In fact, White says it has been a worthwhile endeavor from a traffic management perspective, and one that other authorities could potentially follow. Indeed, he references a report presented in May 2012 that focused on three years of two-way operation that also evidenced a reduction in traffic-related accidents. "Based on three years of before-and-after personal injury crashes for the Shared Space part of the scheme, there was an impressive fall of 50% – seven compared with 14 – and a 41% reduction over the ring road as a whole. There was also only one incident involving a pedestrian post-Shared Space, compared with six beforehand."

Auckland open for business

While Kent is a mere stone's throw away from Monderman's home town, his visionary thinking has been embraced much further afield. In Auckland, New Zealand, for instance, Shared Space efforts are focused primarily on a number of side streets in the city's bustling CBD. "I was the manager delivering the first such scheme within the CBD in Darby Street [April 2011], and then subsequently completed Elliott Street next door and another one further up the road," reveals Auckland Transport's Eric van Essen, infrastructure development engineer (CBD Streetscapes), who has been working on Shared Space in the North Island city since early 2009.

(Above) **Auckland motorists are adapting well to 'sharing' space with pedestrians on inner-city streets including Darby Street, which no longer has the traditional road and footpath delineation** (Right) **How Darby Street looked before its Shared Space makeover** (Bottom left) **No other town had, until Ashford, Kent, attempted to tackle the divisive nature of a busy ring road as effectively**

Improving pedestrian priority and creating more usable space in the road corridor have been among the objectives, as well as adding amenity and producing a flexible, uncluttered area while still maintaining vehicle access and movement. "It was also about creating a destination," continues van Essen, "even supporting temporary events within the road corridor and outdoor dining. Not all Shared Space has these objectives immediately in mind."

At a practical level, van Essen's colleague Mitch Tse, a principal traffic systems engineer within the road corridor operations unit of Auckland Transport, says this has been delivered with minimal use of traditional traffic engineering measures: "Wherever possible, we tried to avoid applying raised speed tables, side islands, road markings, signs or traffic signals."

The reduced traffic speeds and volumes in Auckland are paying dividends by helping to give more prominence to pedestrians. "We're making it appear more like a pedestrian mall so when a vehicle enters the area, the driver recognizes from the outset that they're probably not as welcome as they might be in a conventional street. And as a result, traffic levels have dropped. We also no longer have parking in our Shared Space, so folks aren't coming

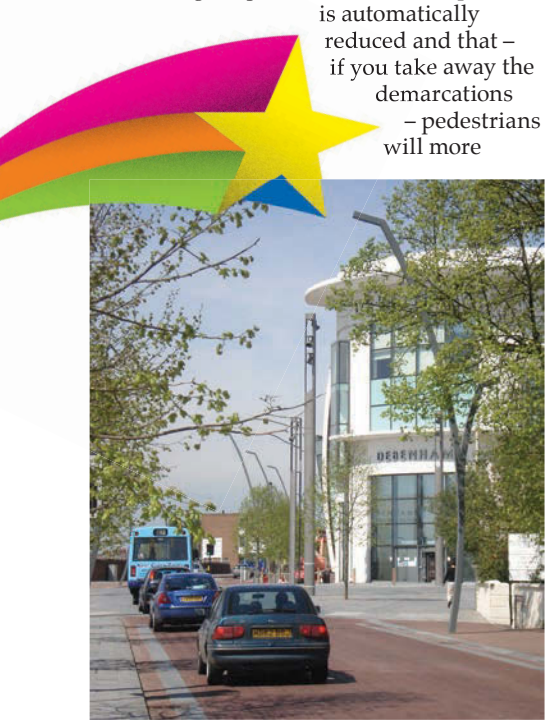
into the area just to look for spaces. Better on-street parking has been provided nearby and there is plenty of off-street parking capacity in the CBD, which is a move that falls into our public transport strategy."

Ultimately, Shared Space has been a perfect fit for this part of Auckland's CBD. "It has allowed us to maintain vehicle access to properties – albeit in a five-hour window for HGVs – while giving pedestrians more priority," Tse says. This was preferable to severing the road network by completely pedestrianizing the space, and is something that other municipalities in a similar position may want to consider.

Wishful thinking?

But Shared Space does have its critics. Dr Steve Melia, for instance, is a senior lecturer in transport and planning at the University of the West of England in Bristol and believes sometimes there is an element of wishful thinking, especially when phrases such as 'increasing social capital in cities' are thrown into the mix. "In the paper that I wrote with Simon Moody [*Shared Space – Research, Policy and Problems*], we were quite critical of some aspects of the long-running research undertaken by MVA Consultancy for the DfT into 10 specific schemes," says Melia – 10 schemes that supported the writing of the local transport note on the concept. He concedes, "There was, of course, some useful stuff in there as well, as with any research."

According to Melia, though, there is some controversy relating to the claims that the sharing of space means vehicle speed is automatically reduced and that – if you take away the demarcations – pedestrians will more readily share that space. "That element of their research was, in our view, highly flawed," Melia claims.



(Right) **Ashford's scheme cost £16.5m (US$25.5m) to build and is still one of the most extensive in the UK** (Bottom left) **The scheme that transformed Ashford's ring road into streets where drivers and pedestrians have equal priority has been in place since November 2008**

> **We were quite critical of some aspects of the long-running research undertaken by MVA for the [UK's] Department for Transport into 10 schemes**
>
> **Dr Steve Melia, senior lecturer in transport and planning, University of the West of England, UK**

To illustrate his point, Melia provides an extreme case of a historic city where space is shared with a high number of pedestrians walking all over the road. "Clearly, under those circumstances, speed must reduce because it would be physically impossible for cars to drive through at any great pace. But if you take a conventional road that has a relatively high traffic flow and lower pedestrian flow and just say, 'Right, we're taking away any demarcation', that's not necessarily going to reduce speed."

However, Melia does concur with the MVA research about the definition of Shared Space, where it was found that – practically speaking – there is no one feature that could be pinpointed to say that something actually constitutes Shared Space. "MVA did create a Shared Space rating, ranking the activity of the 10 schemes from the most to the least shared," Melia says. "This is probably quite a good way of looking at it given all the different elements that can make up what can represent Shared Space. There's the issue of a level surface, whether there are road markings, signage, separate features such as cycle paths, whether there are curbs or an area marked out by color for pedestrians."

When Shared Space solutions are implemented, Melia emphasizes, the removal of demarcation is rarely the only change: "There's typically a whole bunch of other alterations made at the same time. The reality is that some of those are often much more important than the Shared Space element itself. This would certainly be how I would see the Ashford Ring Road project, where they reduced the carriageway width leading up to Elwick Square and reduced the speed limit and – with that and some other changes – caused traffic flow to significantly reduce so that, unsurprisingly, the number of accidents went down too."

Shared Space will clearly always have its doubters, yet the concept built upon the work of Hans Monderman and trailblazers such as Ben Hamilton-Baillie nevertheless continues to transform the way many towns and cities operate key urban roadways to the benefit of drivers and, crucially, vulnerable pedestrians.

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The Maine event

After opening the state's first open-road toll lanes two months ahead of schedule and US$2m under budget, Maine Turnpike Authority's **Dan Morin** and HNTB's **Roland Lavallee** and **Walter Fagerlund** share their best practice secrets from the launch

Photography courtesy of Maine Turnpike Authority

The Maine Turnpike Authority (MTA) has become the latest US toll operator to introduce open-road tolling (ORT), marking a first for the Pine Tree State and reflecting a nationwide trend. Twenty-nine states are currently using ORT and electronic tolling systems, including New Hampshire, California, Texas, Florida, Pennsylvania and New York.

The MTA opened its newly converted US$4.4m facility on I-95's New Gloucester mainline toll plaza on April 1, 2013. The new lanes allow drivers with E-ZPass transponders to complete their toll transactions at 65mph without slowing down or searching for change to hand to a toll collector. All of the MTA's cash toll collection equipment is also being brought up to speed, paving the way for a system-wide upgrade and making the New Gloucester plaza entirely state-of-the-art.

The project will result in one ORT lane and three mixed toll lanes (cash and E-ZPass) in each direction at the New Gloucester toll plaza

Four traditional, slow-speed toll lanes were removed from the center of the mainline plaza to make way for the two ORT lanes – one in each direction. These new highway-speed lanes are a welcome addition for E-ZPass customers who for safety reasons were previously required to slow to 10mph as they drove through the plaza. The ORT lanes are separated first by striping, then by approximately 700ft of concrete barrier immediately north and south of the toll plaza. On the other side of the barriers, customers continue to have choices to stop and pay cash or drive through traditional lanes with E-ZPass.

ORT advances multiple goals

Since its inception in 1947, the MTA has continually demonstrated leadership in relation to the way it is financed, maintained and consistently improved. These new ORT lanes are merely the next chapter in its overall success story. For customers, ORT offers safety, convenience and shorter travel times. For the MTA, though, the new facility helps it to accomplish multiple objectives.

First it enhances customer service for all drivers who use the toll plaza. More than half of the plaza's transactions involve E-ZPass, users who no longer have to stop, while the remainder no longer

Turnpike officials say the system will add convenience for motorists, cut operating costs and reduce vehicle emissions

have to share toll lanes with them. It also increases operational efficiency. An ORT lane in Maine, for example, is projected to handle as many as 1,800 vehicles an hour – nearly twice the number of a traditional slow-speed, E-ZPass lane. Overall safety has also been improved. During the first weeks of operation, for example, the ORT lanes averaged 11,000 transactions a day, which significantly reduces volumes in the existing mixed lanes and thus reduces exposure to non-stop traffic for toll collectors and cash customers alike. In terms of maintenance cost reductions, the new ORT lanes will also save the MTA a fair chunk in maintenance as they boast lower annual costs than the lanes they're replacing. And finally, it helps to create a more sustainable facility. ORT lanes are 'greener' than conventional toll lanes as they require no stops and starts, so they reduce E-ZPass user fuel consumption and emissions.

The famous five best practices

The timing was right for MTA to add ORT. Aging cash toll system technology presented an opportunity that it seized, in doing so procuring next-generation technology for both the ORT lanes and new cash equipment for the existing mixed lanes.

HNTB, the general engineering consultant, worked closely with Doug Davidson, the MTA's chief financial officer, to provide project management, traffic planning, civil engineering design, toll system procurement, oversight and construction services. Rounding out the project team were TransCore, the system integrator for the ORT and cash toll systems, and Wyman & Simpson, the civil construction contractor.

The team delivered the ORT conversion project two months ahead of schedule and nearly US$2m under budget by adhering to five specific best practices: *Take an incremental approach*: New Gloucester, one of four mainline toll plazas on the 109-mile turnpike, represented the best

Equipped for success

For the New Gloucester ORT system, the MTA required E-ZPass-compliant Kapsch automatic vehicle identification equipment, in-pavement smart loop automatic vehicle classification equipment, and the latest in violation enforcement cameras.

The mixed-mode (cash) lane treadle-based AVC technology was also replaced with smart loops to lower maintenance costs. Meanwhile, a video audit system added to all new lanes increases MTA auditability, transparency and accountability.

Two ORT lanes have double the capacity of the four cash lanes they're replacing

To complete the new functionalities, the new cash lane technology includes violation enforcement cameras and advanced, color touchscreens for toll collectors. The newly deployed systems will be the basis for the rest of the turnpike's revenue collection equipment upgrade, which is part of a scheduled lifecycle replacement.

candidate for the MTA's first ORT lanes. Located in the northern section of the turnpike, the 10-lane mainline barrier plaza experienced lighter amounts of traffic than its sister plazas. Consequently problems – if encountered – would be smaller than if the MTA had launched ORT at one of the busier plazas. Using a segmental approach to ORT implementation as opposed to a system-wide rollout enables the MTA to learn from its first installation, lessons that can be applied to its other toll plazas, resulting in greater efficiencies.

Seek innovative funding sources: As part of the toll system procurement services, the MTA and HNTB negotiated with the MTA's existing toll system provider and maintainer, TransCore, to provide the entire toll system for the converted plaza free in exchange for an extension of its system-wide maintenance contract at an overall reduced cost. This agreement saved an estimated US$2m in capital costs for the recently installed toll system at New Gloucester.

Solicit stakeholder involvement: Involving toll collectors early in the design process helped smooth the transition to the new cash system in the mixed lanes. Fare collection management was brought in early during the design phase to provide input. Subsequently, long before the system went live, toll collectors received training on the new cash lane technology, so that their comfort levels would be high, and customers' experiences would be positive.

> The ORT and newly equipped cash lanes have been operational for only a few weeks, yet customers are already expressing their satisfaction

(Top left) **The ORT lanes process up to 3,000 vehicles an hour; cash lanes just 375** (Main) **Nightshifts minimized disruption from construction work** (Far right) **This first conversion is a testbed for Maine**

Collaborate to avoid obstacles: Delivering the project late was not an option, as it was timed to be completed in advance of the 2013 tourism season when peak traffic increases by as much as 25%. Combined, Maine's heavy summer tourism and harsh winter weather restricted construction windows. Having served as the turnpike's GEC for more than 60 years, HNTB was well aware of those challenges and got in front of them early.

Partnering sessions with all parties involved, an aggressive construction schedule with built-in incentives and penalties, and dedicated toll system integrator oversight were keys to overcoming the challenge and delivering the project two months earlier than its scheduled completion date. Civil construction began in spring 2012 and was completed by December, just in time to install the toll system before the snow began to fall.

On the toll system side, efforts began much earlier. Toll system implementation carries more unknowns and risk so HNTB worked closely with the MTA and TransCore to ensure the system was fully tested and ready to go well in advance of the projected opening.

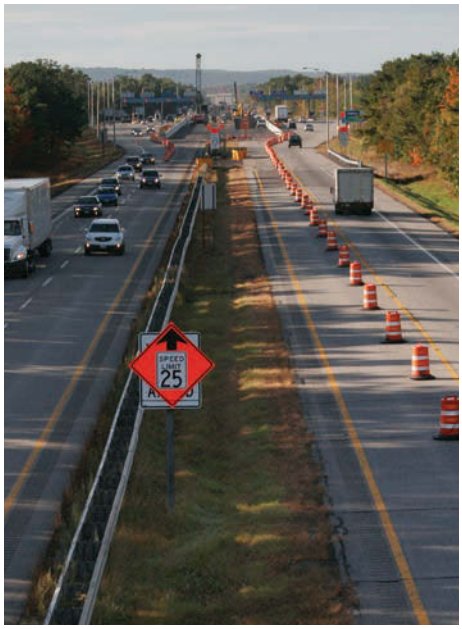
Leverage external expertise: Despite the project being important, it was just one of many active MTA initiatives, including a major corridor feasibility study, a replacement study for its flagship gateway mainline toll plaza, and a plan to convert an interchange to Maine's first single-point design. In addition, the MTA also operates its own toll system back-office, as well as its customer service and violation processing center (an uncommon practice in the USA).

With available resources already allocated to other priorities, the MTA's Davidson requested specific HNTB staff members who were experienced with previous MTA toll system work to lead the ORT conversion program both internally and externally. HNTB

All in the loop

Treadles were a thorn in the maintenance budget's side. Sensors embedded in the pavement, treadles detect vehicle wheels through contact pressure which in turn allows them to indicate to the toll system the number of axles on a vehicle. Because they are susceptible to damage during harsh environments and winter weather activities, however, treadle components often need to be replaced. In researching options, the MTA discovered an alternative in smart loops.

Smart loops, used in ORT lanes, consist of wound loops of wire embedded in the pavement. They are less susceptible to winter damage and perform similar functions as treadles. Once all lanes have been upgraded, the innovative application of smart loops will save the MTA the significant cost of having to replace the treadle strips after winter storms.



coordinated multiple agency departments and reported directly to Davidson – direct integration that served to be an important part of delivering the project successfully.

An open road to the future

At the time of writing, the ORT and newly equipped cash lanes have been operational for only a few weeks, yet customers are already expressing their satisfaction with the new system and the MTA is projecting a saving in maintenance costs with fewer treadles to maintain (see *All in the loop* sidebar). All in all, the successful launch at the New Gloucester toll plaza presents a compelling argument for similar conversions throughout the system.

In addition, the MTA has the option to readily expand the New Gloucester toll plaza to two ORT lanes in each direction when capacity warrants. To facilitate this, a space frame gantry in each direction spans the highway-speed lane and adjacent mixed lane.

The MTA decided to install only one ORT lane in each direction to reduce conversion costs and maintain the plaza's overall footprint; two ORT lanes added in each direction would have required the MTA to install an additional cash lane in each direction to meet MTA customer service objectives. In the future, as E-ZPass grows and cash declines (i.e. when two cash lanes are sufficient or E-ZPass volumes grow significantly), the MTA can readily expand the number of ORT lanes to match the number of mainline lanes.

Today, many MTA customers still prefer to use cash, and with Maine's high volume of summertime, out-of-state tourists, offering cash lanes still makes good business sense. The introduction of an ORT toll system, though, provides a foundation and operational experience that could one day provide a path to all-electronic tolling – but only on a schedule that makes the most business and financial sense for the MTA, its customers and its bondholders.

For now, the MTA is enjoying its elevated image as it joins agencies across the USA that have implemented the next generation of toll technology and, in doing so, are providing a higher level of customer service and operating more efficiently and effectively. ○

• *Dan Morin is public relations manager and legislative liaison for the Maine Turnpike Authority. Roland Lavallee is a vice president with HNTB Corporation. Walter Fagerlund, senior technical adviser also with HNTB, was the project manager for the conversion*

The IRU's secretary general **Martin Marmy** explains why it's critical for road transport to be facilitated at a governmental level

Interviewed by Louise Smyth

> While everybody complains about heavy road traffic when they are in it, they tend to forget that they are not just stuck in traffic – they are traffic

When you speak with Martin Marmy, secretary general of the International Road Transport Union (IRU), the passion he feels for his industry is evident from the off. And his explanation as to why road transport is so important is striking. "It's no longer a simple mode of transport," he states. "Due to the globalization of the economy, road transport has become a vital production tool that's indispensable to ensuring the competitiveness of the real economy."

Ever aware of that point, Marmy steers the IRU in the direction of two key priorities: road transport facilitation and sustainable development. To achieve these goals the IRU works hand-in-hand with all of its national member associations and their governments. "The aim of this cooperation – undertaken in true public-private partnerships – is to further expand and effectively implement the key UN multilateral trade and transport facilitation instruments," Marmy says. These include the Harmonization, TIR and CMR Conventions, and numerous UN multilateral agreements such as ADR and ATP, which enable road transport to provide better and even more efficient services.

Indeed, road transport – which is subject to national, regional and international regulations concerning not only the driver, goods and passengers but also the vehicle itself – remains the most regulated of all transport modes. "This is why, in order to fully benefit from the high-quality, flexible, door-to-door services provided by road transport, it needs to be further promoted and facilitated everywhere," Marmy says.

What's obvious to the IRU chief, however, is not always evident to other decision-makers in this sector. "The 65 years of IRU experience clearly demonstrate that the best way for governments to achieve this goal is to effectively implement all UN transport facilitation instruments that have allowed, for the past years, the removal of non-physical barriers to trade by international road transport. In this framework, it should be highlighted that decision-makers should never forget that any penalty on road transport is an even greater penalty on the economy as a whole.

"Experience unfortunately demonstrates that resulting from the inappropriate implementation of UN facilitation instruments, too many non-harmonized, outdated border-crossing procedures are still dramatically penalizing road transport – and thereby also economic development," Marmy says despairingly.

But this is a man who won't simply sit back and complain: Marmy's insistence on action is admirable. Five years ago he led the IRU as it launched the New Eurasian Land Transport Initiative (NELTI) to scientifically analyze the impediments to international transport

Model behavior

The IRU Model Highway Initiative (MHI) was developed to provide governments with an effective response to the dramatic scientific results of the four IRU NELTI projects. Marmy says: "Indeed, the IRU MHI aims to design and build, in public-private partnership, exemplary road sections with all the necessary ancillary infrastructure, such as secure parking areas, hotels and fuel stations, along with harmonized, appropriate border-crossing procedures.

"The objective of the MHI is to promote and further facilitate trade and international road transport across the Eurasian continent, by implementing the appropriate border-crossing procedures through the use of modern IT technologies, and by ensuring the coherent development of the required complementary infrastructure, both of which are necessary to improve procedures, drivers' working conditions, transit security and efficiency along all main trade arteries, including the modern Silk Road routes."

across the Eurasian continent. The four NELTI projects analyzed 200,000 border-crossing procedures on the Eurasian landmass, notably covering the BSEC, ECO and LAS countries. And the findings were shocking: "The results are clear: 40% of the total transport time is lost at borders and more than 38% of transport costs result from 'unofficial payments' at borders."

Marmy also looked at geographical statistics and noted some interesting figures. "The share of intra-regional trade in the BSEC region is 18% over the total foreign trade of all BSEC member states," he explains. "This share drops to only 10% in the Arab world and even worse, is only 5-7% in the ECO region. However, the same statistics confirm that – where governments have been working closely with the IRU and its members to implement the multilateral trade and international road transport facilitation instruments – intra-regional trade currently represents more than 70%."

For Marmy, this clearly indicates that to ensure economic growth, governments must facilitate road transport, notably by promoting intra-regional trade in true PPPs with IRU national member associations. And it is for this reason that the IRU developed the Model Highway Initiative (see *Model behavior* sidebar).

For all Marmy's advocacy of the economic benefits of improved road transport, he always keeps the goal of improving life for all road users at the top of his agenda. "While everybody complains about heavy road traffic when they are in it, they tend to forget that they are not just stuck in traffic – they are traffic," he continues. "This is partly why we initiated the Smart Move campaign in 2009, with the objective of doubling the use of buses and coaches worldwide within a decade.

"Smart Move provides an optimal response to the current and future mobility challenges of all governments and road users. Bus and coach transport is not only the greenest but also the safest, most efficient and most user-friendly mode of passenger transport, available at a very low cost for society. Doubling the use of bus and coach transport would considerably reduce congestion and pollution, while creating millions of sustainable jobs." The IRU was naturally very pleased when its Smart Move campaign was recently turned into an EU policy instrument.

ITS and road transport

As well as employing standards, cooperations and legislation, Marmy is also keen to use technology to rejuvenate the transport sector. In tandem with the development of the UN International Convention on the Harmonization of Frontier Controls of Goods, the IRU developed a free-of-charge TIR Electronic Pre-Declaration (IRU TIR-EPD) and a TIR-EPD Green Lanes concept.

"Thanks to the electronic transmission of cargo data prior to a truck's arrival, customs officials can undertake all the required risk assessment before trucks even arrive at the border," Marmy details. "Therefore, to fully benefit from the requirements of the Harmonization Convention and from this IT technology, it is the duty of each customs authority to give the large majority of trucks the 'green light' once the advance assessment has been successfully performed, and to undertake the appropriate checks for the few suspicious trucks the assessment reveals."

And to further reduce time wasted at borders, the IRU has also developed the Border Waiting Time Observatory, which Marmy says "allows customs to easily report waiting times at their borders and fleet operators to easily access this information, notably so that they can optimally plan their transport and charge the corresponding waiting times to their clients.

"Let me repeat that taking into account the unacceptable waiting times at borders, and the possibility offered by the private sector, it is high time for the governments concerned to improve their cooperation with trade operators and IRU national members associations."

The IRU's '3 I' strategy

The road transport sector has an obvious – and important – role to play in sustainable transport as a whole. "The IRU and its members are committed to implementing the IRU '3 I' strategy, based on Innovation, Incentives and Infrastructure, as it is the most cost-effective way to achieve sustainable development," Marmy comments. "It is precisely by implementing this strategy that the IRU has fully supported the EURO norm, whereby the new EURO 6 trucks have an environmental footprint reduced by more than 99% since the introduction of this norm in the 1990s. Trucks today have the lowest carbon footprint, for equivalent door-to-door transport service, of all transport modes."

With Dublin hosting the 9th European ITS Congress this June, **David O'Keeffe** has a busy summer ahead

Interviewed by Saul Wordsworth

> Despite the hardship this country has faced, funding for ITS is rising because it is seen as a more effective way of delivering on various policies

According to David O'Keeffe, Ireland is a country known for delivering high-quality IT solutions but until recently hadn't really focused on the transportation sector. "We're in the midst of fostering that environment and turning it around," suggests O'Keeffe, practice leader for Arup's Smarter Mobility practice across Europe and chairman of ITS Ireland. "We are quick adapters!"

This June the 9th European ITS Congress heads to historic Dublin and its spanking new state-of-the-art conference center, something that fills O'Keeffe with pride as he and ITS Ireland were integral in the successful bid to host the auspicious event. So in addition to the odd pint of Guinness, attendees can expect to find a country making interesting forays into the ITS arena.

"We had a deficit in our road infrastructure, so over the past decade we have been focusing on building motorways and upgrading roads," O'Keeffe reveals. "The focus has now shifted toward operations and getting more efficiency out of our existing networks. And we're now well placed as a testbed for piloting interesting and innovative ITS schemes. Despite the hardship this country has faced over the past few years, funding for ITS is rising because it is seen as a more effective way of delivering on various policies. This is reflected in our title for the conference: Real Solutions for Real Needs."

Project showcase

The M50 ring road around Dublin recently became one of the first motorways in the European Union to introduce barrier-free multi-lane free flow (MLFF) tolling for all vehicle classes. Prior to this, traffic was stacking up and causing severe congestion around the toll plaza.

"The new system uses 5.9GHz CEN Standard DSRC and video tolling as payment methods," O'Keeffe continues. "It improves speeds, reduces journey times and congestion and lessens pollution."

National interoperability is a critical feature of the Irish motorway network today, which is facilitated by a central transaction clearing hub (known as the Interoperability Management Services Provider – IMSP), which was procured by the National Roads Authority and is run on its behalf by a private operator. There is an increasing proportion of electronic transactions across the network (currently estimated at 50%) along with approximately 400,000 vehicles equipped with OBUs. In 2011 the financial value of the interoperable tolling transactions processed via the Information Exchange was in the region of €90 million.

Another recent project has been the outsourcing of Ireland's random location speed enforcement to the private sector, the only country in Europe to do so. Since 2010 the GoSafe Consortium has operated a network of 50 speed camera vans, each clearly marked as an enforcement vehicle, at more than 750 priority segments on the road network. The fleet of vehicles is GPS-managed to ensure maximum efficiency. This is part of the country's strategy to reduce road traffic accidents and fatalities and has been extremely effective. Conference delegates will have an

opportunity to study the project, which by then will have entered its third year.

A final initiative by the National Transport Authority, in conjunction with Dublin City Council, has seen the rollout of a national public transport passenger information scheme. The delivery of real-time bus arrival information through roadway signage and smartphone applications is in itself arguably not an example of innovation. However the central delivery and management of the scheme on a national basis is an example of best practice from a deployment perspective and demonstrates how efficiencies can be achieved in the deployment of ITS through multi-jurisdictional cooperation.

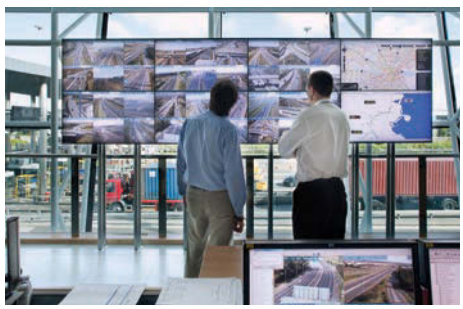
"The Congress is a chance for Dublin to showcase how ITS has helped advance the delivery of smarter travel through the implementation of barrier-free tolling, privatized speed enforcement, EVs and real-time information," O'Keeffe explains.

ITS Ireland's considerable progress since its inception in 2010 can be attributed in part to O'Keeffe's tenacity and influence as chairman. Membership of this public-private partnership is drawn from academia, suppliers, contractors, government, local authorities and public transport operators. The ITS Ireland Governing Board comprises eight members elected by the membership, meaning its profile is representative of the industry. All board members are volunteers.

"Our prime objective at ITS Ireland is to raise the bar for traffic technology and highlight the benefits it can bring to transport systems specifically in supporting government policy," O'Keeffe says. "I think we have done a good job in a relatively short time. We are not lobbyists – we see ourselves as simple advocates for ITS. We continually have groups visiting from abroad who introduce us to alternative, innovative and interesting solutions. We also run an annual conference, networking events and bi-monthly technical seminars. ITS Ireland is active in Government Working Groups, assisting in providing expertise in taking forward and implementing Directives such as the ITS and EETS Directives. Prior to ITS Ireland there was no forum for such discussion, nowhere for people to share ideas and expertise. It's a win-win for the industry."

Start-up brilliance

An ingenious Irish start-up company called CleverMiles recently won the Microsoft-sponsored challenge, the Imagine Cup, set up to encourage safer driving. The company developed a device that plugs into the car's electronics system to monitor the driver's performance. The idea – which was initially devised at the Sligo Institute of Technology – attempts to incentivize the young to drive more carefully through a concept known as 'gamification'. CleverMiles assesses driver behavior using metrics such as swerving, sharp braking, harsh acceleration and speed. Drivers are educated based on their own driving history. People can also compete against other drivers to improve their safety scores. Via its three-pronged strategy of monitoring, educating and incentivizing, it hopes to improve driving among the recently qualified.



Advanced ITS technologies are abundant in the operation and management of the Dublin Port Tunnel

Home-grown talent

In Data Display, Ireland boasts a leader in the manufacture of LED products, setting the standard for high-quality electronic message-display systems since 1979. Clients for the company's VMS include the New York Transit Authority, Transport for London and the Irish road network. "Data Display is a real success story, although it remains one of the few examples of indigenous manufacturing in the ITS industry," O'Keeffe continues. "For now Ireland's expertise lies more in the arena of IT and software (see the *Start-up brilliance* sidebar). What we don't have is the raw manufacturing in the ITS industry. This we would like to change."

In terms of research into ITS, Trinity College Dublin, University College Dublin and the Dublin Institute of Technology are very active within the European research framework and INTERREG programs, and are involved in carrying out research into vehicle probes, electric vehicles, traffic signal adaptive software, open data and a number of other projects. Additionally global giant IBM, in close collaboration with Dublin City Council, is carrying out extensive research in open data and ITS, which will lead to a better understanding of how to manage the city's transport infrastructure (see the *Welcome to the European ITS Congress* sidebar).

Last words

O'Keeffe believes the staging of this event in Dublin will help raise awareness of ITS in Ireland and provide opportunities for Irish companies to raise their profile with a wider audience. "I would characterize ITS in Ireland as developing," he says. "We've done a lot of good stuff and I think we could do a lot more. There are some enablers that will change the way we do ITS. One example is mandating vehicles to provide network operators with appropriate data. This could be used to foster the development of a number of wide-ranging products and services such as predictive signal control, real-time on-street parking availability, road pricing and pay-as-you-go insurance and road tax."

So if you're planning on journeying to Ireland this June, O'Keeffe says you can expect an exciting itinerary as well as something else that Dublin is world-famous for: the *craic*. "The Irish Night at the Guinness Storehouse should provide a real insight into what makes Ireland unique!"

Welcome to the European ITS Congress

There will be three opportunities to attend Technical Tours showcasing ITS in the Dublin area at the Congress in June.

The IBM Technology Campus is a lab featuring researchers from some of the finest seats in the world including Massachusetts Institute of Technology (MIT), Cambridge University and Trinity College Dublin. Its focus is everything from transportation and high-performance computing to the environment. A visit to the Dublin TMC is a further option, which boasts a number of unusual features including dedicated radio providing six hours of traffic updates every day. Perhaps the jewel in the crown, though, is the Tunnel Operations Control Centre and National Roads Traffic Control Centre. The Dublin Port Tunnel opened in 2006 and is a dedicated route for HGVs, removing all large trucks from the city and onto the national road network.

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Easy, electronic and efficient

READER ENQUIRY NO. 501

Mike Proudfoot, the CEO of TI Corp in Vancouver, British Columbia, can afford a smile as he looks out of the window of the Coquitlam Regional TMC toward the newly built Port Mann Bridge. With eight lanes of traffic now open and two more due by the end of 2014 when demolition of the old structure is completed – totaling three lanes of through-traffic in each direction plus two separated for travelers going back and forth across the Fraser River – the Port Mann Bridge is a much needed shot in the arm to cure many years of crippling congestion in the area.

Congestion relief

There's more to the Port Mann Bridge than meets the eye, though, as it is also one of the most advanced examples of ETC in the world. Indeed, the high-tech systems, back-office setup and customer service deserve more than their fair share of the plaudits. Hence Serge Le Yannou, program director at Sanef ITS, and Christian Copin, head of operations, customer care and implementation, TC Flow, are smiling alongside Proudfoot. Everything is running like clockwork – just as planned.

For the TReO toll system, integrator Sanef ITS deployed its FastFlow AET roadside and FastToll ERP back-office technology. Meanwhile, TC Flow, a consortium of Sanef and its French counterpart Egis, is responsible for tolling operations and maintenance through to June 2015. "Customer service and accuracy were key objectives for the tolling system," reveals Proudfoot. "We're a public agency and don't get away with anything but positive customer service."

In the case of Vancouver – which has witnessed (and will continue to witness) massive population growth and a huge surge in immigration – this means exemplary customer service in languages including English, French, Punjabi, Cantonese, Mandarin and Korean. How many authorities can match that? Operatives are in place to help users set up accounts, fluently answer questions about payment options and advise about which programs would be best for them, while helping with billing and accepting payments in person, by phone and online.

More than 750,000 drivers have now registered with TReO, reports Proudfoot's TI Corp communications director Max Logan. "This is equivalent to 50% of vehicles in the greater Vancouver area," he notes. "In fact, more than 85% of regular Port Mann Bridge drivers have registered with TReO, while traffic volumes to date are similar to those we saw in 2012 – around three million users a month."

(Main and below) **Drivers are now experiencing significant time savings thanks to the improvements investment has allowed** (Bottom) **Eight lanes on the new bridge opened to traffic December 1, 2012**

Need to know?

Optimizing toll collection and reducing operating costs with an advanced ETC solution

- Two configuration types (double or single frame) include tag reading and classification through the use of lasers, loops, ALPR and OCR
- The back-office software was created especially for the tolling industry to manage transactions and customer accounts
- The multi-protocol reader allows local interoperability of toll systems
- Its architecture is modular and flexible to adapt to the business rules of each operator

Billing accuracy

"We issued around 370,000 statements to registered customers and 250,000 invoices to unregistered customers in late January, and based on what we know of schemes launched elsewhere, that's usually when the phone starts ringing with queries about inaccurate bills," Proudfoot says. "But the phone has been silent, which is a great reflection on system integrity."

"So far the system has been working according to our expectations," concurs Le Yannou. Logan adds, "The excellent take-up with account registration and sticker tag use has made a big contribution to operational efficiency, including system performance and accuracy. We have 97% accuracy for vehicle class – and have achieved better than 99% – and 99.9% vehicle detection, 99% of transactions capture a readable plate image, plus we have 99.95% decal read accuracy."

Peter Wilkinson, site manager for Sanef ITS, says, "We have a 4D classification system – height, width, length and axles – using front and rear lasers and induction loops. The system includes a redundant triggering system, in that we can trigger cameras by lasers, from OSI, or loops, from Idris. The gantry controller determines which trigger to use, and also uses measurements taken from each sensor to determine a more accurate three-dimensional representation of the vehicle. This gives accurate performance in wet and foggy weather, in which lasers typically struggle."

The system also captures two front and back infrared images specifically for plate reads, and one color overview shot of each vehicle to aid in the classification process. "The LPR includes dual OCR engines – four results per vehicle – which gives improved accuracy and automatic postings," Wilkinson says.

"We associate decals to vehicles based on readings taken at the lane, rather than when we distribute at the back-office," Logan continues. "The AVI system uses three protocol readers; 18000-6C, Title 21, for interoperability with Golden Ears Bridge, and ASTMv6, for interoperability with the Weigh2Go-BC truck program."

Still gazing at the bridge, Proudfoot says, "The attitude toward customer services from TC Flow and the supreme accuracy and reliability of the system thanks to Sanef ITS have been crucial to everything we're achieving. From a reputation standpoint, it's more than we could have dreamed of!"

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Thirty-one years ago I was appointed traffic commissioner of New York City and had a dream to become the man who solved NYC's traffic problem. But at least half my time was spent not on ways to move traffic faster but on what to do with the traffic once it stopped – more precisely, how to park all those cars.

I had more than 60,000 parking meters – essentially more modern versions of the 'newfangled nuisances' that were met with scorn when introduced in Oklahoma City 47 years before. I soon learned that nearly everyone – parking maintainers, street collectors and coin counters – was taking their 'cut'. So when muni-meters appeared by the end of the decade, I bought in. But they are far from perfect.

The night before writing this, I had to walk two blocks to find a working meter – the nearest ones were all broken. This prompted me to imagine a future without street meters, where everyone pays for parking in some virtual cloud somewhere. Well that day is just about here…

Several cities have begun testing a new form of meterless parking. Smartphone use has grown tremendously in the past decade and it's no surprise that an on-street parking payment system was developed with smartphones in mind. Parkmobile allows drivers to pay for parking using a simple app. The driver scans a special code printed on a sign near the parking space with the app to activate a parking session and then selects how much time to pay for. The driver's license plate is then forwarded to parking officers to let them know that they're parked legally. An added bonus of this method is that drivers don't have to return to their cars to pay for extra time. They can extend their parking duration from within the app, so no more running back to your car after a couple of hours to feed the meter! Another benefit with Parkmobile is that as each parking space is tracked, you can use the app to find the closest available parking space to your destination. Gone are the days of circling block after block looking for an open spot.

Now imagine taking these recent parking meter innovations a step further. At this year's Consumer Electronics Show, Audi demonstrated a prototype 'self-piloting vehicle' that could be called from a parking spot and drives itself to the owner's location at the push of a button in a mobile phone app. It doesn't take a great leap of the imagination to envision a self-driving car that can communicate with a parking meter network. The driver could get out of their car in front of their destination and send the car to park itself. With the help of a wireless parking network, the car could find an available spot to park and tell the parking network to start the meter running.

Advances in parking meter technology benefit motorists in many ways. They mean easier and more convenient payment methods, so there's no more having to carry quarters around or asking people for change. It also means spending less time looking for a parking spot, which results in considerable savings of time and gas and a reduction in local traffic congestion. With continuing innovations in mobile technology, wireless networks and self-driving vehicles, the future of parking meter technology is looking to be truly intelligent, giving traffic commissioners the time to do what they like doing best – keeping vehicle traffic, bicyclists and pedestrians moving more swiftly and safely!

> With continuing innovations in mobile technology, wireless networks and self-driving vehicles, the future of parking meter technology is looking to be truly intelligent
>
> **Sam Schwartz, Sam Schwartz Engineering, USA**

Road stud technology and its role in improving safety

READER ENQUIRY NO. 502

To develop ways to prevent and mitigate the effects of road accidents, it is important to take into consideration that changes must occur at all levels, starting from infrastructure and legislation through to people and behavior.

Aware of the severity of the problem and the need to find sustainable solutions, Sernis has been working with authorities over the past few years to improve road safety in cities via a strong warning system with advanced technology.

Road studs are one of the main elements used all over the world to improve safety. Being highly versatile, they can be used for delineation and guidance, as well as for applications ranging from traffic management to tunnel guidance and ice detection. When strategically placed, road studs can alert drivers via their brightness (flashing or steady) to the presence of dangerous zones and consequently increase driver attention, which itself helps prevent accidents.

Sernis offers a wide range of road stud solutions that combine technological innovation with efficiency, corresponding to the major challenges of quality and competitiveness. The company has road studs with features that are adapted to external conditions such as heavy traffic and extreme temperatures. The studs have mechanical resistance from 20 to 135 metric tons. The solar studs on offer have high autonomy and can be powered by a battery or capacitor, while the wired systems can be powered by solar energy or the electrical grid.

Sernis recently developed a new concept within its solar road studs. The i-stud is applied to the SR-i15 and SR-i20 studs and enables countries with severe winters, adverse temperatures or low solar radiation to take advantage of solar-powered studs.

Host of new features

The main advantage of i-stud is the use of microcontroller technology inside each stud, which allows several beneficial features and control options, including a function that sets the studs into sleep mode to prevent the battery from discharging before installation. The studs are then activated through a special programming tool. This is especially helpful in countries that have severe winters or where sun exposure is too low, making it harder to charge the battery.

Road studs in operation during adverse weather conditions

Automatic brightness control is another new feature that allows the i-stud to adapt to the brightness and regulate its light level in accordance with the energy charged during the day.

The working period function allows the user to set up the number of hours that the i-stud should work after night detection. This is particularly relevant for installations where studs do not need to be operational all night, as it means they can save energy for when they do need to be active.

With the operation mode function the user can switch the stud's mode from 'flashing' to 'always on' and vice versa after installation. Therefore, if the operation mode needs to be changed for any reason it can simply be programmed in,

Need to know?

A Portugal-based company is determined to use technology to improve road safety across the world

- Well known for its road studs, Sernis is now offering intelligent solar technology
- The flash-rate function within its i-stud innovation enables the flash rate of a stud to be varied, up to a maximum of 3Hz
- As well as road studs, integrated traffic solutions that incorporate items such as LED signs and street lights have huge potential

whereas conventional studs would all have to be replaced.

This advanced technology ensures the development of solutions with high levels of intelligence and autonomy in an eco-friendly device.

The whole portfolio

However, this is not the only way in which Sernis has been working to improve road safety.

Integrated traffic solutions have huge potential. When combined, LED message signs, road studs, flexible bollards, intelligent pedestrian systems and LED street lights are a highly effective tool for urban traffic management, contributing to enhanced road safety. Integrated solutions are especially helpful in situations of bad visibility – such as adverse weather conditions, blind spots or at night. Integrated solutions also adapt easily to the location they are to be deployed at because of features such as the option of solar or electrical power, low power consumption and ease of maintenance.

(Main) **SR-20C studs in operation** (Left) **Studs can also be used to warn of ice**

Specific road safety problems have been identified in some urban zones with high accident rates and authorities have started looking at means to solve their individual problems.

Real-world case study

As one example, in the Portuguese city of Braga the biggest causes of road accidents and injuries were found to be speeding and inappropriate driver behavior. The most critical places for such behavior were crosswalks in roads with high traffic and school zones. "This situation threatened the security of all road users, especially pedestrians," explains engineer Alfredo Barata from the Road Safety Division of Braga Municipality. Therefore an integrated solution was decided upon as the way to reduce these traffic problems.

The deployment of the integrated system from Sernis has had a very positive impact on traffic safety since its installation. After just over one year "the number of crashes at crosswalks has significantly reduced and accident risks have decreased," declares Barata. He adds: "The system encourages responsible driving and helps to keep the roads safe." The Road Safety Division of Braga Municipality reports that road accident rates are declining sharply; there has been an increase in driver attention; vehicles have been driving at lower average speeds; and the number of crashes and victims with serious injuries has decreased.

Sernis's intelligent integrated system offers traffic authorities across the world a strong contribution to reducing the number of crashes and decreasing injury severity on the roads.

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Illumination solutions for ALPR

READER ENQUIRY NO. 503

When it comes to machine vision for license plate recognition systems, not all solutions are created equal, so it helps to take some expert advice.

Most manufacturers of ALPR systems propose the more established 'fixed camera' installations, while the market leaders offer both fixed and mobile camera variants. Today's challenge lies in developing a system that will function in both.

A specialist in this sector is the Cork, Ireland-based company Epi-Light. Its team of technical experts works with ALPR system manufacturers and machine vision partners – such as ClearView Imaging – to meet demanding IR and visible illumination requirements for luminaires that can be utilized in both fixed and mobile installations.

Epi-Light's LED spotlight product range for ALPR applications is based on the Dell computer principle; in that it offers customers a number of different wavelengths for semi-covert, covert and visible setups, varying divergence angles and alternative LED optical powers inside the same mechanical housing. This enables the customer to pick and choose the components based on the field installation specifications without having to design a new system. If the radiation characteristics of the light source can be matched to the optical properties of the camera system without incurring re-design or additional development costs, this gives the customer an added advantage in terms of time to market.

This 'pick and mix' approach coupled with the performance of Epi-Light's IR illuminators for fixed camera positions resulted in the company winning a high-profile project with a major customer in early 2012. One of the company's standard ALPR illuminators was found to outperform a competing product by a factor of 2:1 for a range of 30-35m. This not only resulted in a 15% saving on the illumination costs for the project over the course of 2012 but it also saved the customer time and additional hardware costs that would have been incurred to house a secondary light source to meet the optical power required for a covert operation at 30m.

Need to know?

Once a neglected area, the role of illumination for ALPR tasks is now taking center stage

- The industry is demanding solutions that cater to both fixed and mobile camera installations: technology vendors need to respond to this demand
- A modular approach to lighting components helps customers choose the most appropriate tool for their end task
- Combining image processing techniques with optical testing techniques is paying dividends for one expert

(Main) **Epi-Light ALPR spot is ideal for both fixed and mobile installations**
(Below) **Open-road tolling could be a potential application**

Nature of the LED industry

The fast-changing landscape of LED technology gives rise to rapid improvement in optical efficiency, durability and reliability of LEDs. However, this doesn't always equate to advantages for today's manufacturers of ALPR systems. On one hand, the advances in high-power emitters allow for increased range and improvement in performances for current systems. But on the other hand, the changing face of LED technology can amount to continual product development for R&D divisions, which drives up the cost of the overall system.

System accuracy is a function of the capture rate as well as the accurate interpretation of the OCR software of those captured plates. The lighting aspect of ALPR systems is increasingly critical. To address this growing trend, Epi-Light engineers combine image processing techniques (e.g. contrast analysis) with optical testing techniques to improve the optical efficiency of the company's LED modules and provide customers with a distinctive competitive edge.

Facilities at the company's headquarters in the south-east of Ireland include a 1,210m^2 enclosed test area, which allows for the suppression of ambient light – so night-time conditions can be replicated during daytime hours. This testing procedure, combined with the modularity of its approach methodology, permits Epi-Light to offer a straightforward solution for both fixed and mobile solutions.

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Advances in lens standards help solve ITS woes

READER ENQUIRY NO. 504

When an application involves imaging objects at differing distances from the camera, a specific lens aperture is required to maintain a usable depth of focus. The smaller the aperture, the larger the depth of focus – but also, the less light available for properly exposed images. Increasing the exposure time creates blurred images at speed. The speed needs to be slowed to compensate. An increase in camera gain hikes up noise in the image, resulting in sub-optimum images. The field-of-view of a fixed focal length lens may be too large when capturing objects further from the camera and too small when capturing objects closer. In some traffic applications the object of interest is moving in relation to the camera, and in others the camera is moving in relation to a stationary object of interest. Yet there is also the scenario where both object and camera are in motion.

How do we deal with these types of negative domino effects where one fixed parameter causes a progression of compromises to image quality?

The answer is easy: by using available technologies in lens standards and camera design to provide the flexibility needed to adapt to ever-changing ambient imaging conditions.

The ability to easily re-focus, re-zoom and set the aperture to match the conditions, all from the comfort of an operations terminal, is the key to coping with these effects. Today's advances in combining lens control standards derived from high-end consumer digital photography with the technology of modern, industrial-grade high-resolution cameras makes this possible. And not only for roadside and tunnel inspection tasks, but also for mobile and stationary traffic surveillance, access control and, of course, incident management and speed enforcement – to name just a few uses.

The technology

The Micro Four Thirds (MFT) lens standard was developed by Olympus, with the company forming a consortium for the advancement of this optical standard. The objectives were to create a lens interface that allows camera bodies and lenses to be interchangeable, to provide a flexible and compact platform for future developments in optics and cameras, and to facilitate the addition of movie capability. Since its inception, many well-known companies have joined the consortium to design, promote and market products adhering to the standard. Companies such as Carl Zeiss, Joseph Schneider Optical Works, Leica Camera, Panasonic and SVS-Vistek are designing and producing products that take advantage of the superior qualities of this future-oriented optics standard.

An MFT lens with remote-controllable focus, aperture and zoom, coupled with an industrial camera that has auto/manual-gain, auto/manual-exposure control and PWM outputs that can drive a pan/tilt mount, gives the user the fullest flexibility imaginable in

(Main) **The Evo Tracer camera and** (right) **how the camera looks with its MFT lens**

(Above) **Close-up of the lens mount** (Left) **Connectors at the back of the camera unit**

Need to know?

The move towards lens standards is helping to create new solutions to old ITS problems

- ITS applications that use cameras have been plagued with issues that compromise image quality, but a recently introduced standard looks set to eliminate the need to compromise
- The MFT standard is being adopted by vision industry pioneers to create a new breed of lenses
- SVS-Vistek's Evo Tracer product fully incorporates this standard

adapting to ambient spatial and radiometric parameters. Since the MFT standard addresses the optical requirements of modern large-format CCD/CMOS sensors, image quality is superior to many of the lenses currently being used for high-resolution cameras. The ability to finally implement optical zoom tracking in ITS applications using a high-quality industrial camera can be viewed as a minor breakthrough.

The solution

A member of the growing MFT standards organization, SVS-Vistek has combined the best of both worlds to create the Evo Tracer. This product fully incorporates the MFT lens standard into the company's popular Evo series industrial GigE Vision cameras, utilizing 1MP to 8MP quad-tap sensors to achieve high frame rates and excellent image quality. The lens' parameters, as well as those of the camera and those of the PWM outputs, can be controlled through a single Gigabit Ethernet interface using simple commands. A second Gigabit Ethernet port is available for maximum data throughput as well as increased frame rates.

The Evo Tracer opens up new avenues of approach for ITS integrators and end users alike. The simple ability to adapt to an erratic environment by easily controlling all possible parameters that affect image quality and usability can help put an end to the negative domino effect.

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Vacations may be a good time to reflect on our lives but they're not often a good opportunity to think about ITS, especially when the vacation is in a tropical paradise. My wife and I just spent a week on Kuai, one of the smaller and less populated Hawaiian Islands. We were last there around 10 years ago and as I drove around during this trip, I was struck by how much transportation intelligence I was flooded with and how starkly different it was the last time I was there. The travel experience was especially different and the implications for public transportation departments profound.

For a moment I reflected on my vacations 20 years ago, when contact with the office was pretty attenuated. By 10 years ago, I had my BlackBerry so was up to date with all the work-based information that I could have lived without, but travel around the island was still low tech. We used paper maps, read paper brochures, depended on local recommendations for where to go and where to eat, and took friends' recommendations with us from home. All the electronic assistance we had was in the car, mostly the radio for weather. In the hotel there might have been a wired internet connection but websites were more like newspapers. Even if there was a mobile device, such as my BlackBerry, the sites were not designed to serve mobile customers.

Now it's 2013 and my travel buddy was my iPhone or my wife's Android device. Want lunch when we landed? Check out the noodle joint by the airport that we heard about, get directions and turn-by-turn guidance. Need a dinner recommendation? Check Yelp or TripAdvisor for where to eat, read menus, make a reservation on OpenTable and again get turn-by-turn directions.

Since Kuai is a small island with essentially one outer roadway, traffic information was largely irrelevant, but on a larger land mass, traffic and congestion information is instantly available. Several years ago this would have only come from a public 511 system but today private services collect and disseminate traffic from probes, sensors and crowdsourcing. Hour-by-hour weather is a touch away. Where's the best surf? I'm sure we could have gotten that information too.

State DOTs have the responsibility for safety and emergency response – and these can't be delegated – but there is a vast array of companies distributing information. What should the government do in this new world? Lead, follow or get out of the way?

One option is for local government to stay competitive with new apps for iPhones and Android devices. Another is to provide their information to private companies. A third is to incorporate private data in public systems. A final option is to abandon public dissemination of traffic data and leave the field to the private sector completely. They are difficult choices, each presenting hard issues, but the wealth of free private intelligence makes these questions important and the answers will shape government ITS programs for years to come.

> Vacations may be a good time to reflect on our lives but they are not often a good opportunity to think about Intelligent Transportation Systems
>
> **Larry Yermack, Wendover Consult, USA**

How NFC technology is changing the face of tolling account management

READER ENQUIRY NO. 505

Increasing numbers of toll roads are converting to open road tolling (ORT), while more and more high occupancy vehicle (HOV) lanes are also converting to high occupancy toll (HOT) lanes that not only relieve congestion from traffic but also create a new source of revenue to fund infrastructure improvements.

The majority of ETC systems use RFID transponders that are associated with a prepaid debit account. Typically, a prepaid account is periodically replenished by linking it to a credit card or bank account. When an account reaches a preset balance threshold, it is automatically funded with a preset amount determined by the user at the time of enrollment. Funds can also be topped up by mail, by telephoning customer service, or by logging into the account via the internet or in person using cash/check/money order at any authorized merchants.

Now there is another option for funding an account: use a near-field communication (NFC) cell phone to communicate directly with a dual-frequency RFID transponder.

The benefits of such an approach are numerous. First is the basic fact that it offers easier access to ETC services. Beyond this, it also enables better control of funding an ETC account, recharging only the amount and at the time the user considers it to be most convenient. Another benefit that is particularly attractive to users is that lower fees can be offered than those charged by point of sale (POS) locations such as convenience stores and automatic teller machines.

However, an NFC-based approach is not without its challenges. There are two potential operational hurdles that must be considered. One is a scenario where the user's account balance is depleted and the user attempts to cross a toll entry point, resulting in excessive queues at the entry point. The user must then be redirected to an escape lane to verify his account status. The other challenging situation is when a user realizes that his account balance is insufficient to perform an ETC transaction and there is no POS nearby; resulting in a manual cash transaction, slowing down the process and generating cash handling issues at toll plazas.

The overwhelming point about NFC technology is that it's simple. It's a short-range, low-power wireless link that can transfer data between two devices held a few centimeters from each other. Unlike Bluetooth, no pairing code is needed and no battery is required in the transponder being read.

(Left) **Neology's NFC switch tag** (Main) **NFC-enabled smartphones are making life easier and more convenient for consumers**

Need to know?

Why near-field communications RFID technology is proving to be a gamechanger in the US tolling market

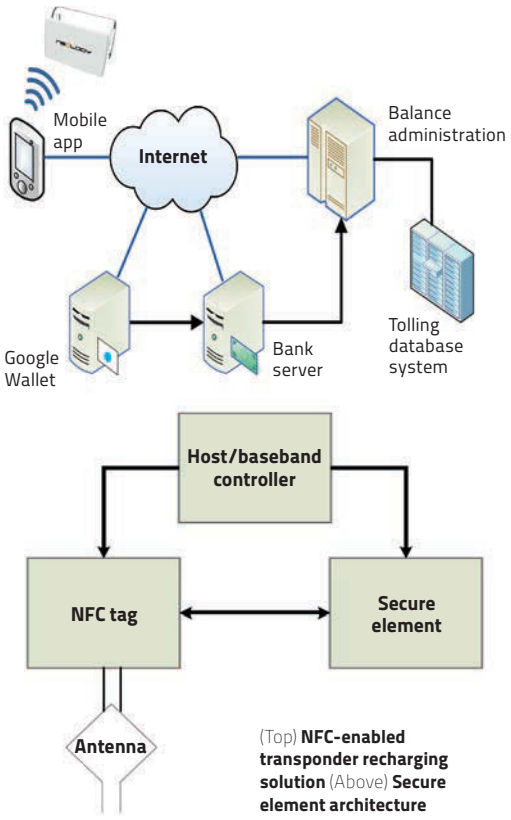
- Using an NFC-enabled cell phone to communicate with a toll transponder opens up a whole new approach to toll payment and account management
- The benefits are most demonstrable in the areas of cost and convenience
- Google Wallet can be used to conduct balance reload transactions for NFC-enabled toll transponders

Dual-frequency transponder

Neology has added NFC to an ultra-high frequency (UHF) RFID transponder to create a dual-frequency transponder that can identify itself to a smartphone. The smartphone can be linked to an e-wallet or other funding account so that in a matter of seconds, a user can pay his toll and continue on his trip without further delay and without ever leaving his vehicle.

The reloading process is performed in seconds. Tapping a smartphone to an NFC/UHF RFID dual-frequency transponder will automatically open a corresponding application on the phone and read all relevant information from the transponder. There is no need to type any information except the amount to reload, credit card or other account to be used for this transaction and the security PIN code assigned to the e-wallet when it was created.

(Left) **Neology's hard-cased tag** (Below) **NFC phones could be used to communicate with tolling transponders**



(Top) **NFC-enabled transponder recharging solution** (Above) **Secure element architecture**

NFC technology is based on 13.56MHz frequency using the ISO/IEC 14443 standard for contactless transactions, reader-to-reader or reader-to-tag processes.

NFC smartphones have an embedded NFC reader secure module (secure element) capable of communicating with other NFC phones, NFC-enabled POS and NFC transponders. By holding the phone as close as 10cm to another NFC device, the phone will detect and respond automatically to establish a link with the other device without having to search for and open an application. All these steps are performed instantaneously and relevant data is retrieved, simplifying the process to such an extent that any user without special knowledge can complete a transaction in seconds.

NFC technology

NFC has been promoted extensively by Google in the Android operating system. Several cell phone manufacturers now provide an NFC module embedded into their latest Android-based smartphones.

Android OS offers security for Google Wallet by activating the NFC transmitter only when the screen is active and via the secure element after the Google Wallet PIN code is typed and validated.

To enable Google Wallet integration within an application, the Android software development kit (SDK) provides three basic application programming interfaces (API) that will be used according to the transaction modality being implemented: Google Wallet online commerce API; Google Wallet for digital goods API; and Google Checkout API.

To perform a balance reload transaction using a dual-frequency NFC-enabled UHF toll transponder, Google Wallet Instant Buy API is used.

Flow of data

Google Wallet uses signed JSON data objects called JSON Web Tokens (JWTs) to exchange payment information between Google Wallet and the third-party app. The flow of information occurs in five parts.

Firstly, the app sends a masked wallet request JWT to the Google back-end to request wallet information including a masked, or partially hidden, credit card number.

Next, Google returns a masked wallet response with the requested wallet information. The app uses this information to display a confirmation page and other options.

To complete the order with full credit card information, the app requests a full wallet JWT.

Google then returns the full wallet information, including the credit card number.

Finally, the app responds to Google after contacting the payment processor, providing the status of the transaction. Along with failure/success status, this JWT contains data that Google uses for important risk analysis.

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When traffic meets surveillance

READER ENQUIRY NO. 506

Each ITS application requires a different combination of technologies and features to carry out its task. Some applications are focused on safety, as in speed or red light enforcement, traffic surveillance or incident detection. Others increase the efficiency of existing infrastructure, by traffic flow measurement, dynamic traffic signal control, parking applications and open road or city zone tolling. But which sort of camera is best: IP or industrial?

Cameras have always been a critical element of ITS. But over time, their role has changed. In the beginning, cameras served only as a simple monitoring or capturing device for observing traffic flow. Today, the camera is the 'eye' of the ITS system, contributing high-quality images for demanding traffic control applications. In general, the important factors when choosing the right camera technology for ITS applications are resolution, frame rate, cable length, real-time capability, the choice of raw images versus compressed images, and/or video streaming capability.

IP alone or combined with industrial cameras?

ITS designers face multiple requirements. Sometimes they can be fully met by industrial cameras; in other cases, network camera technology is the better choice. In general, network cameras come into play whenever motion sequences need to be monitored. They are particularly suitable for applications that require high image quality even under challenging conditions, such as outdoors with changing light and weather. Network cameras are indispensable when image data must be stored. Unlike industrial cameras, which transmit raw images directly to a PC, network cameras compress the images they record. This becomes even more important when multi-camera systems or long-term storage of the image data requires maximum storage space and bandwidth. With modern compression technologies such as MJPEG, MPEG-4, and H.264, network cameras compress the data to 1/40 to 1/100 of the original volume, while maintaining high quality levels. For traffic flow monitoring or incident detection systems, for example, this compression process is essential, especially when combined with multi-channel video streaming. Beyond image compression, IP cameras offer additional features such as DC- or P-Iris, and day/night mode, to cope with the changing light conditions outdoors. As these features are not required in industrial environments, they are not usually included in industrial cameras.

Basler offers a portfolio of cameras for all ITS applications

Need to know?

For ITS applications, are IP or industrial cameras – or a combination of both – the best fit?

- When assessing camera technology, ITS designers need to consider the merits of different solutions and decide which features best meet their individual application's requirements
- Basler's large camera portfolio includes both industrial and network (IP) cameras
- The Basler cameras are designed to meet the needs of all mainstream traffic applications

Robust solutions

Network cameras also play to their strengths, both alone or in combination with industrial cameras, in tasks ranging from speed enforcement, red light or lane violations, through to all kinds of traffic monitoring, such as road and weather conditions or tunnel monitoring. While IP cameras in outdoor applications are typically installed on gantries, bridges, poles or other fixed structures, they are equally efficient in or on moving vehicles. For example, to better protect their young passengers, school bus operators in the USA have begun to equip their buses with cameras that monitor the traffic while the stop arm of the bus is deployed. Whenever cars illegally pass a bus, the cameras capture high-definition video and high-resolution images of license plates and drivers. With a resolution of five megapixels, the Basler IP cameras used can easily monitor three lanes so that no violation goes unrecorded. The captured image data is then submitted to local law enforcement to determine whether a citation is warranted.

Nowadays, most ITS applications incorporate cameras of various price levels with a range of different features, for tasks ranging from simple surveillance to highly sophisticated image processing. Whatever an application's requirements, either industrial or network cameras, or both combined, will provide an efficient solution.

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The rapidly growing role of in-car systems for traffic management

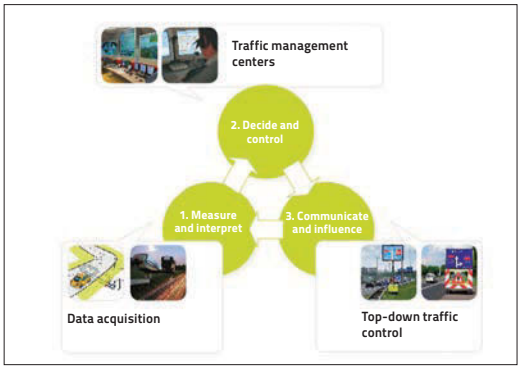
READER ENQUIRY NO. 507

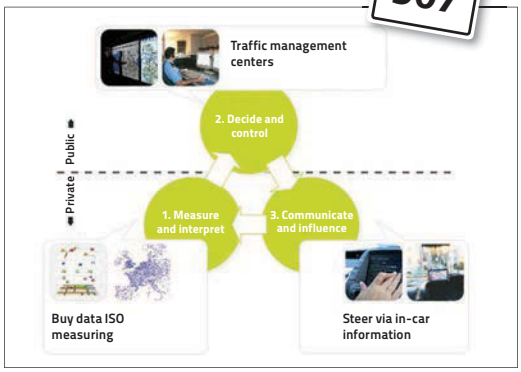
Despite initial skepticism from road authorities during the emergence of widescale use of personal navigation devices, the latest generation of connected devices is now being considered as an important enabler in the efficient management of road networks. In projects such as SPITS (Strategic Platform for Intelligent Transportation Systems), it has already been shown that the power of connected navigation systems can be used to implement ITS services in a much faster way.

As the number of vehicles equipped with these devices has grown, so have the devices' capabilities and their usefulness in the traffic management cycle. The more commonplace 'connected' devices connect to a services infrastructure – both to pass back information about the local traffic situation they are experiencing and to receive information about the road ahead. This form of community input and dynamic information is known to optimize the travel times both for the device users and for general road users, as it better distributes the traffic over the available road network.

The typical traffic management cycle delivering an ITS service is considered a three step process: measure (determine what is happening on the network); decide (what should we change, if anything?); and communicate (share any proposed changes and try to influence driver behavior).

Within this cycle the first step has been traditionally fulfilled with sensor equipment, and the communication step largely through roadside VMS. This cycle can be significantly improved if the traffic managers could harness the power of the in-vehicle devices in both the data collection and the communication steps. By linking this missing component to the existing process, the road authority can influence the routing advice delivered directly to the driver using preferred alternative routes and it can benefit, through the navigation system provider, from cost-effective traffic situation data feedback. Using these in-vehicle devices as nomadic traffic situation probes – commonly known as a Floating Car Data (FCD) system – in a traffic information service already reduces the need to invest in the installation and maintenance of roadside infrastructure such as inductive loops and CCTV cameras.





(Above) **The flow of data within TomTom's traffic solutions** (Left) **Connected navigation devices represent the future of ITS**

Get yourself connected

Connected navigation systems in the car are unquestionably booming, with cars and devices being connected directly to the mobile data network. It is up to public-private cooperation between the system providers and road authorities to maximize the advantages for them and the driver in the sought after 'win-win-win' situation. In the Netherlands, the Ministry of Infrastructure has accepted that the future of traffic management will be based largely on a self-steering system of well-informed individuals, within accepted societal borders. Future policy is often defined as "self-steering, unless…", but the classic catch-22 for ITS systems is that services add value only when a lot of devices are connected; but these devices are not sold until the services are adding value. Utilising widely used nomadic devices such as navigation systems will help ITS to be implemented quickly. The future offers even more – extra data can be sent from the vehicle sensors that can help safety information dispersal, such as icy roads or rain ahead. And, for example, the inclusion of traffic light condition data can be used to offer speed-to-green advice.

TomTom is working with cities and regions to implement this traffic management system of the future today.

Need to know?

Why navigation systems will play a key role in future ITS deployments

- Road authority information can be sent via influential in-vehicle devices through public-private partnerships
- A navigation-centric approach offers cheaper traffic management systems and optimized routing for drivers
- This method is relatively easy to implement on any scale – it's low risk, has an immediate effect and has a high acceptance by participants

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Big Data – what then?

READER ENQUIRY NO. 508

One of the frequently used buzz phrases of recent times is 'Big Data'. The concept promises to solve some of the most challenging issues in the context of Smart Cities. But simply collecting all kinds of traffic and city data and storing it away in big databases does not solve any problems. Data itself has no sign of intelligence yet. What this boils down to is not an issue about data; it's about mathematical models and algorithms for decision support or for automation and control. Of course, these need data to be developed, calibrated and validated properly. This need is especially great when using the powerful, flexible methods and procedures from the field of data mining (specifically, machine learning), where such mathematical models and algorithms can be developed extremely efficiently and almost automatically. But useful and economically viable applications do not simply come out of the data on their own.

Andata is an engineering consultancy company that specializes in the field of data mining for technical applications. It has seen (and even worked on) too many projects hindered by technical issues related to data collection not coming to the fore of the project, to believe the hype surrounding Big Data.

Number crunching

In typical data mining projects, about 80% of the effort goes into data collection and assembly and only about 20% into the analysis and digging out of mathematical models and knowledge from the data. And these numbers imply that the data is already stored and available in some form of databases. The Big Data issue can even make these numbers worse (in the sense that the analysis and mathematical modeling part is the most valued task).

Because of these issues, the developers at Andata follow a different strategy – but without ignoring the fact that data is still the central source for the development of 'intelligent' solutions for most Smart City applications.

Machine learning methods are applied as soon as new data comes in, to train and update the relevant machine learning models (as shown in Figure 1), instead of sequentially storing the data away and analyzing it sometime afterward (Figure 2). With the tight process integration, the mining part of data mining comes far more into focus and the excellent features of these methods can better show their advantages.

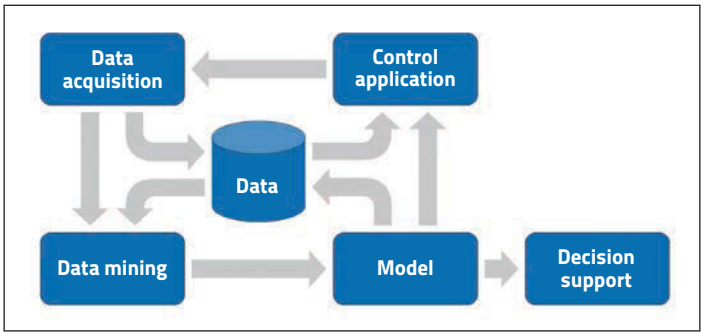
Data already captured by the models no longer needs to be stored. Also, the specification for data that does have to be stored is built up with the development of the models. So the requirements for the data come from the according applications and not from preconceived data retention, which most of the time only leads to over-specified, expensive and unused data graves. This alternative approach results in far more concise solutions.

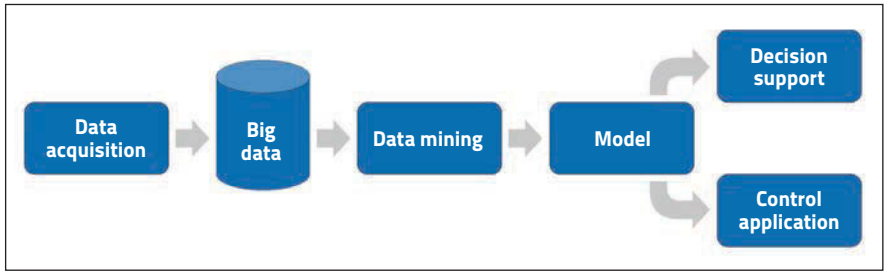
Another cornerstone for reducing data complexity and increasing manageability lies in the control architecture. Smart City applications, such as traffic control, smart grids and so on, can be arranged into a decentralized, hierarchical, subsidiary structure. Therefore, not all sensor data necessarily needs to be sent into a (big) data

Need to know?

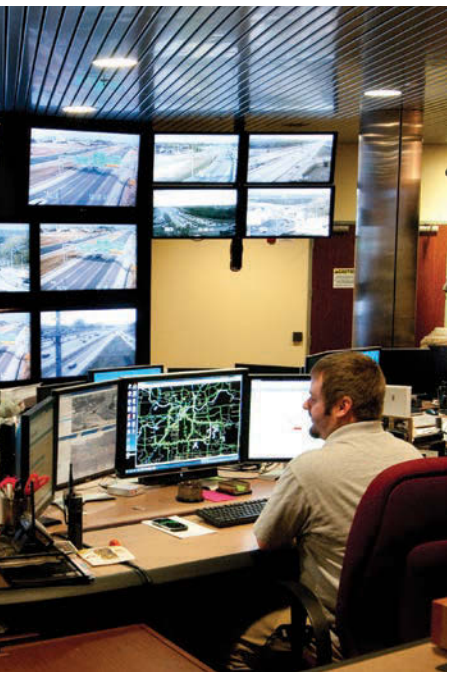
When it comes to Big Data, it pays to ignore the hype and focus on the finer details

- Beyond being a popular catchphrase, how does the idea of Big Data actually work within the context of Smart Cities?
- For traffic management applications, data is obviously critical; but just as important is how this data is collected, stored and disseminated
- Machine learning methods are highly adaptable – and as such, useful – in this environment





(Main image) **Traffic control rooms rely on the right data** (Figure 1, above) **integrated data mining procedure** (Figure 2, right) **Big Data procedure**



center for storage. Local data is only used for local decisions within local models. The data mining and machine learning procedures are only applied at the corresponding hierarchy levels locally. Across these different levels only the according accumulated data or the locally resulting models are sent. This reduces the data volumes and necessary bandwidths dramatically. As a beneficial side effect, any privacy concerns are also solved by this approach.

Of course, data is the key factor to solve some of the Smart City challenges. But it is not a matter of Big Data: it's a matter of the right data.

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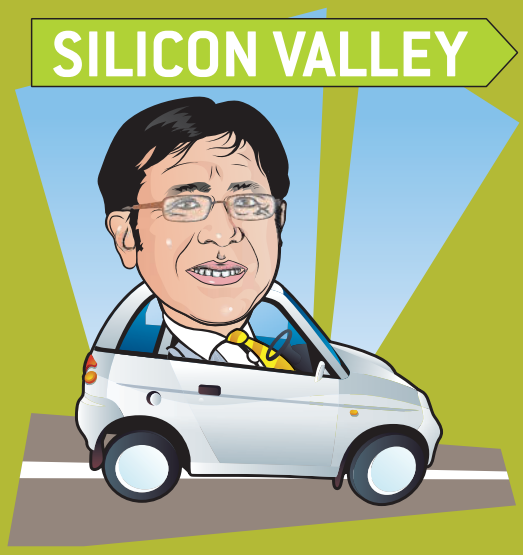
SILICON VALLEY



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In recent weeks I've had the privilege of attending two networking events that addressed the emerging influence of Silicon Valley on the automobile. I am aware that both these events occurred in the environs of the Valley, and I do fully acknowledge that believing that this high-tech epicenter can be all things to all industries is part of the air we breathe here in the San Francisco Bay Area. So yes, I too wallow in the regional pool of self-congratulation.

But at least for the duration of this particular column, let's embrace the concept of Silicon Valley's contribution to the so-called smart car. Nowadays, a smart car may be defined as having loads of digital content and high connectivity. You don't believe me? Just ask any so-called Millenial. That's easy for me to do, as one of them is my son. I am used to yelling down the hall, 'Hey William, what do you like about cars?' The reply being,'What did you say, dad? I was doing things on my iPhone.' Case proven. (Yes, I brazenly conjecture based on a sample size of one. But in truth, there are studies – some of them high-priced, commissioned studies – that proclaim some truth to what I state, and with real confidence intervals.) By and large, the new generation of car buyers may view the car as an application – or collection of applications – put on Earth to deliver a transportation service.

Enter the Silicon Valley. Or better yet, enter to the Silicon Valley the auto industry. I am not necessarily talking about the automaker Tesla, or the full suite of research, development, engineering and manufacturing you find in, for example, Michigan, Stuttgart or Toyota City. I am talking about developing telematics applications, the enabling information technologies, then providing start-up and even mature ventures with the operating infrastructure for these applications. I am talking about new pioneers, who span the definition of invention, providing cool applications, all the way through to a very large – and originally only a – search engine company that may literally and figuratively map the future to automation, all the while giving and getting data. And I am not the only one talking: the vehicle industry has taken notice, establishing technology scouting operations, research and development arms and high-tech liaisons in the region. Several have even established venture capital funds, which is the thing to do here. Things are humming, but the sounds you hear are not revving car engines. Rather, they are disc drives and happy, newly wealthy entrepreneurs singing happy tunes.

Will the music continue? Maybe, I contend. But the Silicon Valley will never be the whole ensemble. It may be the rising star soprano, with clear dulcet tones that sing the virtues of telematics, M2M or whatever, but with the exception of some electric car manufacturing, it will be but one shining voice in what it takes to make a car. However, be very aware that as our next generation of car buyers covet car features, there will be more and more Silicon Valley in our cars and therefore more and more car content and requisite connectivity available. The Silicon Valley will in certainty reinvent important aspects of an ever-smarter car.

And just for the record, this column was made in the Silicon Valley!

> At least for the duration of this column, let's embrace the concept of Silicon Valley's contribution to the so-called smart car

Jim Misener, transportation and technology consultant, USA

Reducing costs and improving quality of service in traffic telematics

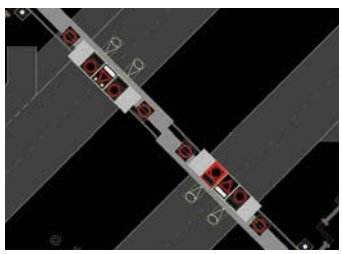
As an integral part of ITS, telematics systems contribute greatly to the safe, economical and sustainable transportation of people and goods, and also enable new operational scenarios. On the other hand, however, the costs of such systems do not allow a complete coverage of telematics-based traffic management on all highways and other important roads. There are not only the investment costs but also the costs of maintenance – which, as we can see today, limit the use of these systems to highly busy or hazardous road segments.

Both the telematics systems and the required communication systems consist of highly integrated and complex devices. In the case of microprocessor-controlled equipment and communication devices (such as routers and servers), the outdoor location, with its substantial alterations in temperature and humidity, constitutes a highly unfriendly environment.

To encourage a wider dissemination of telematics systems, there are currently two main goals to be achieved. One is to reduce the maintenance costs of the equipment and the other is to make the installed systems as reliable as possible for use on busy or dangerous road segments. An expert in the sector, PSI Production, has devised a solution that enables road operators to considerably reduce maintenance costs, detect possible defects earlier and thus reduce or even avoid downtimes.

Introducing the OMS

PSI's Operations Management System (OMS) can cut maintenance costs while encouraging greater adoption of telematics equipment. The implementation of the OMS helps to support road operators' tasks. Because ITS telematics systems are often used to enforce traffic laws, their operation and set-up must be properly monitored and maintained. And newer ITS applications such as dynamic lane management require a secure operation. OMS can help address both of those issues. As traffic operations management requires both process control and operation control functions, PSI's OMS consists of two components: the SCADA (system control and data acquisition) and the MES (maintenance execution system).



The SCADA component is completed by geographic-location features and used to monitor the entire telematics and communication infrastructure. Using reliable front-end components, the health of the equipment is determined via different communication channels and protocols such as TLS, TLSoIP or SNMP. In short cycles, request messages are sent to all devices and the responses are evaluated. If abnormal states are detected, alert messages are generated following flexible rules. The alert messages are analyzed by the correlating locations and topological dependencies. Therefore powerful tools for geographical and schematic visualization are introduced, helping the user to identify the cause of a fault. As a result of these analyses, fault notifications are initiated to be handled by the MES module.

The MES is designed to manage both the event-driven and planned maintenance. Therefore the telematics and communication equipment is managed in an inventory component. For each device, the lifecycle documentation – consisting of master data, installation locations, faults, planned maintenance schedules and availability figures – is available. A contract management component handles all obligations for internal and external service providers with respect to fault clearance and planned maintenance. Based on existing agreements, 'trouble tickets' are generated from the fault notifications initiated by the

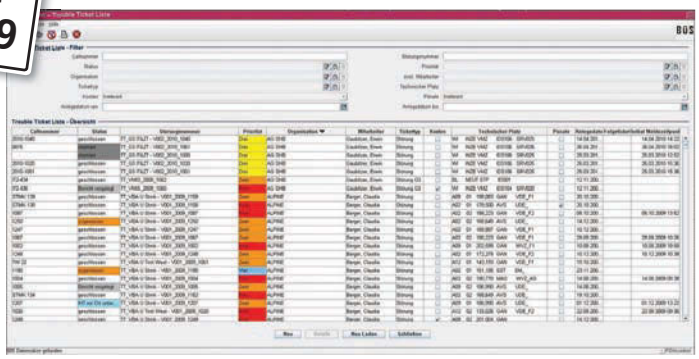
(Main) **ITS applications such as the control of VMS can benefit from the OMS** (Left) **Screenshot of a schematic VMS gantry presentation in the OMS**

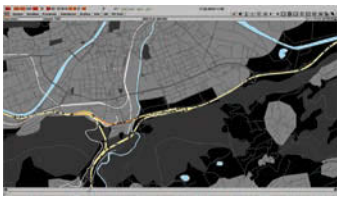
Need to know?

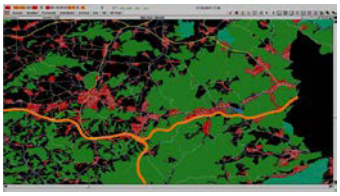
How an operations management system (OMS) can streamline efficiencies in traffic telematics systems

- A powerful OMS can be used for the monitoring and maintenance of traffic telematics/communication infrastructure
- The OMS provides a reduction in maintenance costs while improving the quality of service
- Because of the cost savings it produces, the OMS pays for itself in a short time compared to the lifetime of the telematics equipment

READER ENQUIRY NO. 509







(Above) **The OMS generates trouble tickets to show where system faults are** (Left) **Geographic road presentations in PSI's OMS**

SCADA component and assigned to the responsible service provider. The complete workflow of fault clearance is monitored. If deadlines are exceeded by the service provider, alerts are generated to inform the operator and help to escalate the fault clearance process.

Planned maintenance orders are also managed and scheduled by the MES module. According to the different requirements of the telematics and communication devices, maintenance orders are generated automatically and assigned to the responsible service provider. The coordination process for terminating the execution of the service orders is supported with respect to the current operational and seasonal situation.

Lower maintenance costs

The combined evaluation of the telematics systems and communication network in the OMS yields maximum information for fault identification and avoids any unnecessary and cost-intensive workload. A fault event in the communication network, for example, may be responsible for non-responding telematics devices. If this can be determined via the OMS, the service team (with the appropriate tools) can be sent to the correct location.

In addition there is a potential of cost reduction while coordinating planned and event-based maintenance work. If low-priority faults are detected by the OMS, the related trouble tickets could not only be executed separately but also together with planned maintenance orders. Therefore it is essential to know the maintenance schedules and the acceptable variation in execution dates. Work packages consisting of planned orders and lower priority trouble tickets could be assembled without influence on the quality of the availability. This leads to a reduction in travel costs and working hours.

An often underestimated task is the verification of the performance of equipment and the fulfilment of contracts by third-party service providers. In the OMS, all information about abnormal operation states and the reliability of the telematics and communication equipment is available. Key Performance Indicators (KPIs), which often have to be calculated manually based on insufficient base data, can be provided automatically at a very high quality level.

Telematics devices are often maintained by third-party service providers or the original manufacturers, which have to fulfil contractual obligations. The fulfilment of the obligations is usually the basis for the calculation of payments or fines. As one of its in-built features, the OMS tracks the activities – thereby generating a basis for the unambiguous evaluation of whether contractual obligations are met in respect to response and repair times. The key values for the services are generated by the OMS and forwarded to financial systems such as Enterprise Resource Planning.

Improving availability

Using an OMS reduces outages in at least two ways. Planned maintenance orders are automatically generated according to technical guidelines and their execution is monitored. This guarantees the substitution of defective or worn parts before downtimes occur. In addition, while acquiring life data and states of telematics and communication devices, it is not only current information that is available; the operations history is also collected and can be used to adjust the planned maintenance schedule. If specific devices fail more frequently due to a hostile environment at their location, their planned maintenance could be intensified. On the other hand, necessary maintenance orders could be balanced to an acceptable level if given performance limits are more than met.

Overall, the use of the OMS offers transparent maintenance processes and a good database for future investment decisions.

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Cloud control: a new approach to traffic management

READER ENQUIRY NO. 510

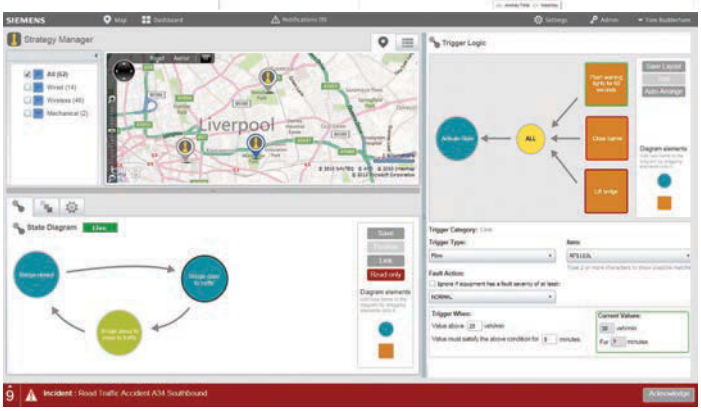
Developments in IT infrastructure and the continuing explosion in the availability of communication bandwidth have led to new possibilities for traffic management and control. Changing demographics and modern working patterns demand greater flexibility in delivery of solutions, with flexibility also key to addressing the needs of traffic managers and the effective use of the existing transport network. Planned events, congestion and incidents do not always fall within a regular pattern to suit traditional office hours – or even locations – and traffic management solutions must evolve in order to effectively manage the network within these constraints.

With flexible working patterns and systems being managed away from traditional control room locations, the reliability and capability of the infrastructure is crucial for effective operation – especially with increasing demands on shrinking staff resources. The adoption of cloud technology, already widely used for traditional IT applications, offers flexible deployment options and access from any connected location to support these demands. With the ability to deploy solutions across locations with true 'hot standby', operators and traffic managers can deliver effective network management with confidence, knowing that it is backed up by fully redundant hardware installations without critical, single points of failure.

The traditional deployment of infrastructure on-site brings overheads and costs that influence the total cost of ownership for any solution. Servers require floor space, power, air conditioning and communications, as well as periodic hardware, operating system and software upgrades. And the specialist nature of modern traffic management solutions often requires specific visits from suppliers to support upgrades and enhancements. Additionally, the need to deal with peak processing loads often leads to servers being highly specified for the task while spending much of the time essentially idle. The migration to cloud deployment brings the ability to share processing power over larger solutions, offering economies of scale as well as a simple path to upgrade if required.

The adoption of core application and user interface technology from mainstream IT applications brings benefits in flexibility of use – with easy access from any connected PC within the traditional office environment as well as custom mobile device applications for remote use. The use of mainstream technology also reduces or removes the concerns of IT managers when faced with unusual requests from traffic managers for the deployment of IP communications and associated interfaces that are invariably outside the normal comfort zone associated with the delivery of core IT applications in the office.

(Far right) **A traditional TMC with its array of data coming in and going out** (Right and below) **Screenshots from Stratos, Siemens' latest traffic management solution**



Need to know?

Assessing the benefits of moving traffic management to the cloud

- Cloud computing follows the wider trend for flexible working that's not confined to one location – a trend also seen in the traffic management sector, making it a perfect fit for cloud applications
- The benefits outlined here are all in addition to the existing benefits of redundancy and support, which are delivered as a matter of course with cloud deployments
- The reduction in operating costs is attractive to the cash-strapped ITS market

Real-world project

Cloud deployments allow easy scalability of applications where additional processing power is needed. One example of this is a recent project by Siemens with the UK's Technology Strategy Board and the University of Southampton, looking into a new network-wide algorithm for performance monitoring and journey-time calculation. Using an extended Kalman

filter, it fuses data from a variety of sources into a consolidated overview of the current network situation using cloud computing technology.

Integrated within Siemens' new Stratos traffic management system, it is now being deployed at the first trial location, South Gloucestershire, with other UK sites that are introducing cloud-based traffic management set to follow soon. The solution will then extend to include all traffic monitoring and control applications, simplifying network management and reducing the overall cost of ownership associated with traffic management solutions.

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There has been a surge in Managed Lane projects in the USA, from Miami's I-95 Express Lanes, Houston's Katy Managed Lanes to the recently opened Metro Express Lanes in Los Angeles – and many others in between. This surge is opening the path for regional or statewide transportation agencies to 'dip a toe in the water' of the world of tolls and highway user fees. As a result of this surge, an identity crisis has emerged. But who is getting involved? Who needs to be involved? Are Managed Lanes ITS projects or toll projects?

First, Managed Lanes are designed to manage traffic and improve mobility. They can provide an easy means to improve driver travel times without major environmental impacts, since the project is often within existing rights-of-way, by using wide medians or under-utilized HOV lanes. The design of Managed Lanes requires traffic engineering professionals who understand the effect that Managed Lanes traffic will have not only on the mainline roadway but also on the surrounding roadway network. Project professionals with a keen understanding of appropriate design criteria and the current practice with respect to signing, traffic control and notification of varying toll and occupancy rates, are important to ensure successful highway design.

Managed Lanes require the input of toll traffic forecasting professionals who understand the traffic mix of today and can project the needs of the future and make the best judgments on traffic flows and the need for and placement of entry and exit points. Managed Lanes also require project resources with in-depth knowledge of roadside electronic toll collection (ETC) and back-office systems (BOS), as well as ITS communication systems to detect vehicles, determine validity to use the Managed Lanes, post pricing information, build a financial or toll transaction, and transmit all that data to the back-office where the system is operated. All this has to come together in a system that doesn't just monitor traffic but actually manages the flow with pricing designed to optimize travel operations while collecting revenue.

Finally, successful Managed Lanes rely on customers, and a customer service center (CSC) to support them. A toll CSC must manage accounts, provide transponders, collect and enforce payments, audit and track financial operations, conduct media relations, and support all the day-to-day customer interaction that is required to support road and bridge operations. BOS and CSC also require coordination with other related entities such as Departments of Motor Vehicles (DMVs) to identify unregistered customers, and other toll operators and transportation modes to address regional interoperability.

Toll professionals are needed who can develop fair and equitable toll concepts, business rules and enforcement mechanisms, and who can work in the challenging toll highway statutory and regulatory environment.

So, are Managed Lanes projects ITS projects or tolls projects? Actually, Managed Lanes are customer service projects, providing reliable, improved traffic flow for customers while maintaining uncompromising customer service in the management of customer toll accounts. Service to the customer must thus be the primary goal of both the ITS professional in highway and traffic engineering and of the toll professional in the concept, deployment and operation of the toll and customer service components.

> An identity crisis has emerged. But who is getting involved and who needs to be involved? Are Managed Lanes ITS projects or toll projects?
>
> **James Eden, director of tolling, AECOM, USA**

The evolution of traffic information services in Turkey

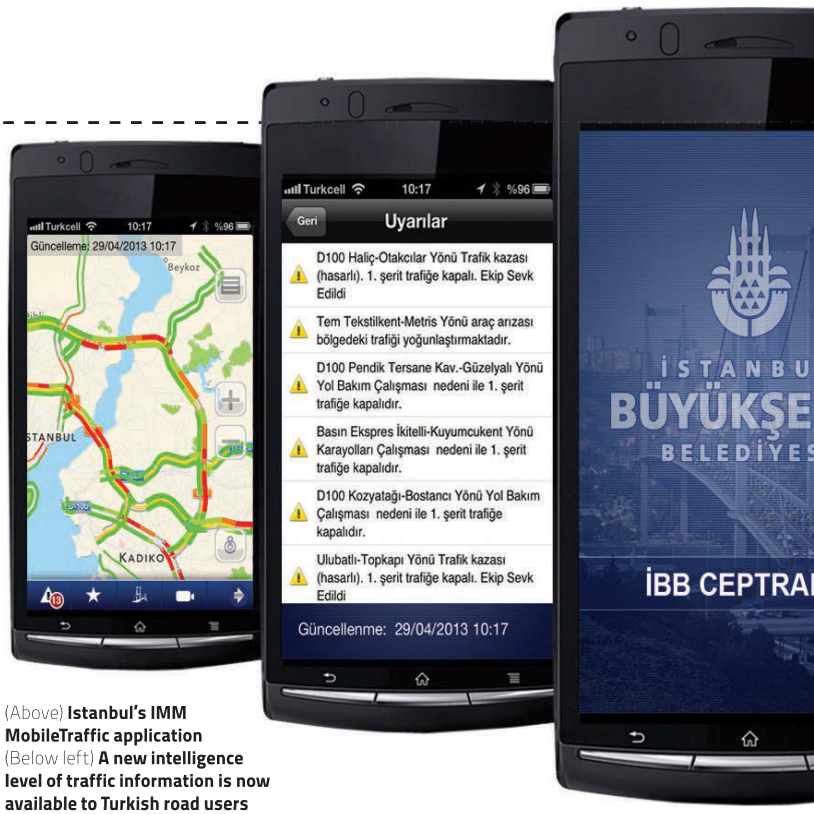
Although there are many definitions of ITS, most conclude that it is about using existing road capacity in the most efficient way. Transport authorities are spending millions to create such systems to decrease travel times and make driving an affordable mode of transport, with traffic information systems being one of the most useful tools to help achieve those goals.

Istanbul in Turkey has long been a pioneer city for various ITS programs. Istanbul Metropolitan Municipality (İBB), for instance, has been using TV, radio, internet, cell phones, VMS and call centers to disseminate traffic information via its affiliate company, ISBAK, for almost a decade.

Need to know?

How Turkey is transforming mobility in the country with advanced traveler information services

- Turkey – and Istanbul in particular – already has a wide range of pioneering traffic and travel information services
- A new company is learning from existing systems and incorporating the best of all features into its own advanced service offering
- The latest idea sees IVR deployed to offer valuable travel information to users



(Above) **Istanbul's IMM MobileTraffic application** (Below left) **A new intelligence level of traffic information is now available to Turkish road users**

The CepTrafik app

Indeed, it was back in 2004 when CepTrafik, a mobile traffic information application, was first announced. At that time, cell phones all used the Symbian operating system, hence the first version being released in Symbian mode. The İBB, though, made a strategic decision and opted to create native applications for each platform instead of just one WAP page. This foresight means Istanbul citizens can now access traffic information in a highly useful and flexible manner, with CepTrafik currently available via the Apple store, Google Play, the BlackBerry store, Windows Marketplace and also the Nokia store. CepTrafik, in fact, is Turkey's most downloaded and most used cell phone app. Additionally, some smart TV applications are also available.

İBB uses its own sensors to generate the traffic information, with hundreds of RTMS sensors and traffic cameras feeding the system. And together with ISBAK, the Municipality is now developing a traffic prediction algorithm and working with Turkish GSM operator Avea to generate more accurate traffic information to deliver predictions on traffic density.

National Transport Portal

CepTrafik is just one of the new tools available to Turkish travelers. After Turkey's e-Government project, the National Transport Portal is the country's second largest e-portal and offers a wide range of fully integrated traveler information. Private car drivers and public transport passengers, for instance, can find any information they need about their various travel options. Special features of the portal include location-based weather information, a regularly updated Point of Interest (POI) list for all highways, all airline and bus operators' real-time schedules, a panoramic view of the roads, and route calculation. And while real-time traffic information is not currently integrated into the system, it is something that is on the cards.

Yandex comes to Turkey

Meanwhile, the Russian search engine Yandex entered the Turkish market in 2011 with an aggressive marketing strategy. Although its core business is being a search engine, the company wanted to differentiate itself from competitor Google by offering local services, a major initiative in this case being in the traffic information systems sector. A detailed Yandex map with traffic information is now available for Turkish road users.

Floating Car Data (FCD) and crowdsourcing is employed by Yandex to generate its traffic information, not only for the city of Istanbul but throughout

READER ENQUIRY NO. 511

(Left) **The National Transport Portal provides multimodal traveler information** (Above) **Numerous data sources – including probes and RTMS sensors – are used to generate traffic information**

Turkey, with around 350,000 'probe' vehicles used to gather location information.

Popular demand

Following the Yandex offering, the two main Turkish digital map companies, Başarsoft and Infotech, released their own traffic information systems in early 2013, with both using FCD data to generate traffic information. Başarsoft CEO Alim Küçükpehlivan has stated that the traffic information market in Turkey is "highly promising". In fact, it's taken no time at all for more than 20,000 people to have downloaded the Başar Trafik application, which is available via the Apple store and Android market.

In other travel information developments, Turkcell has just announced Turkcell Traffic IVR, which is neither a mobile application nor an SMS service but an Interactive Voice Recognition (IVR) system that automatically turns speech into text or text into speech, and gives real-time traffic information to users. Essentially, it is a fully automated call center.

Users calling Turkcell's dedicated call center are asked by an automated voice to declare where they want to go. After divulging their destination information, the system then automatically detects their current location using the GSM operator's base station analytics, before calculating estimated travel times between their location and the destination via a traffic engineering-based algorithm. Once the calculations have been completed, the 'robot' voice then offers travel time and route suggestions based on the current traffic conditions.

Turkcell's solution provider, Verisun Informatics, developed the system and describes it as a combination of different technologies including FCD, speech-to-text, location-based services and traffic engineering.

A second phase of the project is already in the pipeline and will see the system detect a user's 'popular' locations automatically – home or work, for instance – and provide the travel times to those destinations without requiring any user input whatsoever. However, this will only be possible subject to the user's permission, and to provide peace of mind about privacy, the Turkish Telecommunications Authority will be regulating the security of all location information.

A third phase of the project will make predictions and then 'call' or SMS users without any prompting at all. Fully integrated and automated, this will make people's lives easier while reducing the time they spend in traffic. Verisun Informatics is cooperating with Infotech and Sestek to develop and operate this system with full functionality.

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Integrated city management tool developed

READER ENQUIRY NO. 512

A new platform has been launched by Imtech Traffic and Infra for providing strategic control through integration of data-driven systems.

By collecting information from many sources, ImCity enables decisions and action plans to be made, providing practical benefits to the community. This also leads to further benefits including the provision of services that were previously unavailable.

In both normal and abnormal situations, ImCity supports the city manager in keeping the public informed by automatic dissemination of information to, for example, city websites. From a city manager's perspective, having ImCity's common user interface to multiple systems encourages efficient operation and provides a more immediate way of identifying scenarios that might escalate into more serious situations.

The design of the system makes it highly scalable and equally applicable for both a small local transport office that simply wants to integrate variable message signs with its car park information, and for a large central management hub integrating information from disparate parts of a city's systems, e.g. transport, energy and waste. In an environment where the term 'big data' is increasingly used, ImCity focuses on practical data and facilitating practical solutions that enable real-time problems to be managed, while supporting strategic planning for future possible events. The built-in scenario manager is the key to automating these events.

Recent bouts of extreme weather have brought home the need for joined-up planning for situations involving flooding, vulnerable people, emergency services, power interruptions, public information and recovery. Such devastating events seem set to become more frequent and dictate the need for improved coordination through data-driven services.

Imtech is looking to a future where the city serves its inhabitants by providing increased safety, improved mobility and a better environment – and ImCity will contribute to the realization of this vision.

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New machine vision camera brought to market

READER ENQUIRY NO. 513

Point Grey has announced a new addition to the Grasshopper3 camera family, featuring high-quality, high-resolution CCD sensors with a USB 3.0 interface.

The new Grasshopper3 GS3-U3-28S5 camera models are based on color and monochrome versions of the fast and highly sensitive Sony ICX674, a 2/3in CCD featuring 4.54 micron square pixels and capable of sending 1,932 x 1,452 images at 26fps. The ICX674 sensor supports high-definition (HD) 1080p30 imaging and uses Sony's EXview HAD CCD II technology – a further evolved version of the well-known EXview HAD CCD technology – to improve quantum efficiency, reduce smear and increase sensitivity, including into the near-infrared. The Grasshopper3 is built on an FPGA and frame buffer-based architecture to provide optimal reliability, a rich set of features, and a full image processing pipeline including color interpolation, look-up table, gamma correction and pixel binning.

As Point Grey's director of sales and marketing, Michael Gibbons, reveals, additional Grasshopper3 cameras using 6MP and 9.1MP EXview HAD CCD II sensors will be released later this year.

"The Sony ICX674 sensor, with its 2.8MP resolution and larger pixels, is quickly becoming the new industry standard for low noise, high-sensitivity CCD imaging," Gibbons explains. "Customers in machine vision want to capture the best possible images with the highest dynamic range from a wide range of USB 3.0-enabled desktop and laptop computers where other digital interfaces, such as Camera Link, are not an option. This new Grasshopper3 camera addresses the needs of these customers, making it ideal for a wide range of applications, including ITS deployments."

The Grasshopper3 GS3-U3-28S5 color and monochrome models are available to order now from Point Grey and its network of distributors.

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What concerns (or otherwise) should traffic and roadway managers have as autonomous vehicles seemingly edge closer to deployment?

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

Tweet your response to @ttieditor

"Driverless vehicles won't hit our streets overnight. In fact there will be quite an evolution from today's ADAS to vehicles driving themselves. But on the road toward that scenario we will see more and more driving tasks being taken over by automated systems. What that means for traffic and roadway managers is that new traffic situations, shared responsibilities, and – yes, sorry to say this – also new accident patterns will evolve. Automated systems will need to 'understand' how humans behave in traffic (sometimes irrationally), for the driving task needs to be rethought depending on whether the human or the computer has the control over the vehicle (and that might need to be communicated to surrounding vehicles), and incidents might happen because a computer didn't understand the situation correctly (which would have been no problem for a human, but the computer was in charge this time). Roadway managers need to prepare for a new kind of traffic, one that to some extent will require new regulation and organization to reflect these changes. The solution for this might very well lie in C2C and C2I communication. If everything talks to one another, that should make things much smoother – i.e. safer, more efficient and more enjoyable."

Sven Beiker
executive director, Center for Automotive Research at Stanford, USA

"Two trite but relevant metaphors illustrate two of my countervailing concerns. 'All that glitters may not be gold', and 'You can't put toothpaste back in the tube'. The glitter metaphor is to consider carefully the claims of safety, efficiency and of market acceptance. An automated vehicle is a machine built for the road but not built for all roads all the time. However, it is here to come. There's enough momentum and engineering reality to render some driving functions to be automated. The comfort, convenience and under certain circumstances, safety benefit is likely to come. Therefore, judicious use of the figurative toothpaste will make your planning glitter. What are the local needs? Can there be certain rights of way set aside for heavy trucks? Will cybercars link transit facilities? Can pedestrians be restricted from certain lanes where automation makes sense? At what point should infrastructure-based communication take hold, and can that segue from impending connected vehicle implementations? Not succumbing to hyperbole and care in planning will be key to real deployment and to avoid my trite metaphors!"

Jim Misener transportation and technology consultant, USA

"As the automated vehicle environment evolves, roadway managers will face governance, legal, technical and financial challenges. But automated vehicles also offer tremendous potential for safety, mobility and transportation accessibility. As most crashes are the result of driver error, automated vehicles should deliver significant safety benefits. However, it is difficult to predict what will happen in a mixed traffic environment, where automated vehicles, non-automated vehicles and pedestrians share the same space. Liability is a key concern. Must a 'driver' always be able to take control? Will drivers become complacent and put themselves and others at risk? Who is at fault if a driverless vehicle crashes? How much infrastructure will be needed to support an automated vehicle environment? Must they be connected to the roadway? For some applications, autonomous sensors are sufficient, but communication with the roadway is needed to realize the greatest benefits. And how do we fund the infrastructure needs of the automated vehicle environment? Security is yet another concern. Can automated vehicles be protected from hackers? To address many of these concerns, it is likely that automated vehicle features will be rolled out incrementally, which will lead to increased consumer acceptance and buy time to deal with some of the bigger issues, while also delivering early benefits."

Jim Barbaresso vice president – ITS, HNTB, USA

"Driverless cars will allow more people and goods to travel further by road with ease. Google, for instance, recently released a film of Steve Mahan, a blind man, taking his first journey 'driving' on major public roads behind the wheel of one of its cars. Such vehicles could turn our roads into national 'conveyor belts' of unmanned freight shipments and passenger carriages, which some believe may trigger the largest change in land-use since the arrival of rail, as urban environments sprawl over larger areas. Road capacities will soon be boosted by the presence of driving computers that can travel safely at closer headways and react faster than humans. Their routefinding abilities will also outperform humans, alleviating some congestion, so there is great scope for transport managers to direct traffic more effectively by issuing routing orders or traffic information to passing vehicles. Traffic managers can definitely benefit from working constructively with those people developing driverless vehicle systems."

James Snowdon
transportation researcher, University of Southampton, UK

Readers are invited to answer the Burning Question for the June/July 2013 issue:

With many tunnels in Europe still failing to meet Directive 2004/54/EC, what more can be done to improve both traffic safety and efficiency in tunnels?

email answers to:
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