traffic
TECHNOLOGY INTERNATIONAL

February/March 2013

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Features focusing on Compass4D, Toyota's autonomous quest, Sydney laid bare, AI-based signal control – and much more!

Street wise
Intelligent road studs paving the way for a new era in safety

Charging conundrum
The paradoxical relationship between EVs and ITS

In the zone

How smart planning and ITS can ease the pain of road closures – and avert 'Carmageddon' on your network

PLUS

Mike Proudfoot, TI Corp
"What we've achieved at Port Mann Bridge is the perfect model for toll authorities around the world"

Parallel universe
Virtual solutions for real-world problems – and how the cloud comes into play

Combination therapy
Why it's taking 21st century ITS to cure the ills of poor 20th century parking practice

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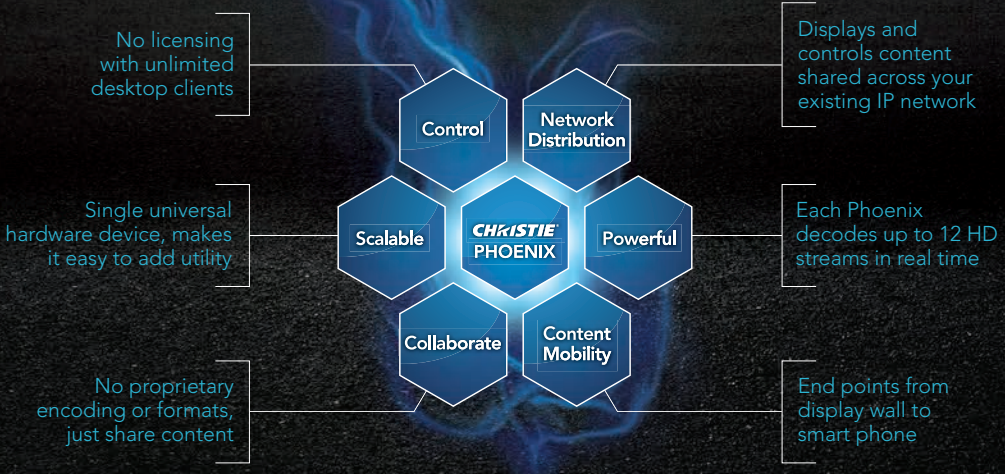


Christie Phoenix

Content mobility: redefined

when it matters.

CHRISTIE

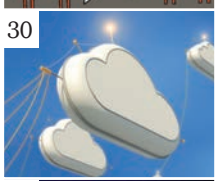
Cover story

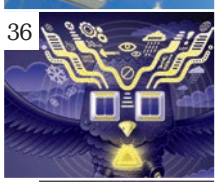
50 In the zone

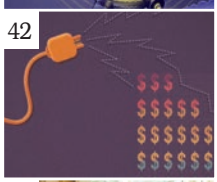
Ensuring safe passage through dangerous territory

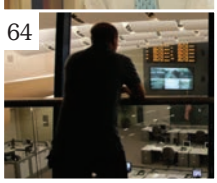
Workzones being highly complex areas, is it possible to ensure both drivers and workers are better protected?

Features









Interviews

Regulars

Foreword

I am convinced there be riches beneath the road in front of my house – oil, diamonds, perhaps the fossilized remains of a 15th century king. Because, for the life of me, I cannot fathom why my local utilities suppliers are out there every three weeks digging it up, sometimes the water provider within days of the gas supplier. And then the cable guys move in… again.

I could rant about never seeing anyone doing anything other than digging and filling-in trenches. About why companies never coordinate such 'essential works' to occur simultaneously, or why they're always started just as the kids go back to school. My only relief from this maelstrom is that I have a great vantage point from my bedroom window to watch how (irrationally) people behave in the bumper-to-bumper traffic. Sometimes I'm caught in the act and receive a stern glare, as if blaming me for their delay. The smart ones, though, smile smugly as they know I'll have to join the malaise myself at some point.

My wife is more philosophical, suggesting the work is a sign that improvements are being made. This is certainly true when it comes to the major upgrades we've had on our motorways over the past decade here in the UK. Roadworks have focused on widening from three lanes to four – and Active Traffic Management has recently been rolled out to make better use of the capacity.

The ATM projects in particular are a perfect illustration of how ITS has been used to control work and traffic, with almost as many temporary ITS tools deployed while construction was in progress as permanent installations once the work was complete. Tom McDonald from Iowa State University tells me this is a big trend in workzone management, the focus of our cover story (p50). "The goals seem more and more about completing the work as quickly as possible with minimal impact – both good goals," he suggests.

Certainly this was a major consideration for Mike Proudfoot, CEO of TI Corp, responsible for the Port Mann/Highway 1 Improvement Project (p59). I visited the Vancouver bridge back in January, with Proudfoot insisting that the long-term cure to the crippling congestion into downtown Vancouver justified the short-term pain resulting from the disruption.

There's a glut of highway improvements to be addressed in the USA, so combined with the challenges of rising traffic and increasing driver distractions, it's easy to see why workzone safety is a huge concern for DOTs. In the USA an average of 700 people a year still die in workzone crashes. So are we to assume the laudable Work Zone Awareness Week hasn't had the requisite effect on driver behavior? Tom McDonald thinks not. "The press pays no attention to the observance," he says. It would be truly disheartening if such indifference were more widespread.

McDonald has administered many construction projects for Iowa DOT and is open to involving contractors more. "Our project traffic control plans are often developed by engineers who have a great deal of education but not much, if any, field experience," he says. "Contractors have a great deal of knowledge in getting the work finished efficiently and safely, so maybe we need to let them have more input into how best to do that."

I'll have to remember the advice – and make some enquiries – the next time the cones are out on London Road. Enjoy the read!

Nick Bradley, Editor

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Vision Technologies

S E E I N G I S B E L I E V I N G

A project being conducted by Oxford University and Nissan has seen the creation of Robotcar – a system designed to take over from humans in slow-moving, heavy traffic or on a familiar route, such as a school run. This is in line with Audi's vision of an ever-alert co-pilot rather than a fully autonomous car – despite the name robot.

The system is activated via an iPad on the dashboard with the driver tapping on a prompt and the car's onboard computer 'taking the wheel'.

In an interview with *Sky News*, Professor Paul Newman, a faculty member of the University of Oxford's Department of Engineering Science, commented, "Instead of imagining some cars driving themselves all the time, we should imagine a time when all cars can drive themselves some of the time. The sort of very low-cost, low-footprint autonomy we are developing is what's needed for everyday use."

Autonomy rules

Driverless cars are the trend *du jour*, but aside from the hype surrounding the Google car, what does the future of self-driving automobiles actually look like? **Tori Read** finds out

Researchers from the Applied Artificial Intelligence Group and the Systems Intelligence Laboratory – both based at Carlos III University in Madrid – recently announced a system that they say can greatly improve the accuracy of in-vehicle satellite navigation. The concept combines a conventional GPS signal with those from other sensors – accelerometers and gyroscopes – to pinpoint a car's location to within 2m (6ft 6in). "We have improved the determination of a vehicle's position in critical cases by 50-90%," explained researcher David Martin. Such research is a boon to those exploring the use of GPS for autonomous vehicles because today's commercial GPS systems are just not accurate or reliable enough to be used for fully autonomous control.

> "We're living in a semi-autonomous world now – it's just that consumers may not realize it

By 2025, Continental's Ralf Cramer predicts drivers will be able to set their cars to automatic mode and watch TV instead of the road

If you paid much heed to the media froth surrounding Google's autonomous car, you would be forgiven for thinking that in a year or two you will be 'driving' a smart car that glides safely around the roads with minimum human input. All you will need to do is sit back and browse the menu of the restaurant the car has been programmed to take you to. But like anyone who invested in a first-gen robotic vacuum cleaner can testify, automation is not always all it's cracked up to be.

There are three main points that need to be comprehensively addressed before truly autonomous vehicles can be created: the technology; legislation to allow the car to take over control from its human operator; and consumer acceptance. Putting legislative wrangles aside for a moment, there has been a recent flurry of activity on the other two topics that helps to showcase exactly where we are with autonomous vehicles today and how the near-term future is likely to pan out. And there are no visions of drivers reading a newspaper while the car does all the work.

Following Google's ongoing efforts on both the tech side and consumer acceptance, a number of automotive players decided to use January's Consumer Electronics Show in Las Vegas to present their visions of autonomous vehicles. And they certainly did generate a response to their announcements. The world's

Hands-free kit

Audi's position on autonomous cars is clear from the headline of a press release it issued at the CES event: *Audi autonomous cars could ease driving drudgery*. The German giant claims that its technologies "enable drivers to turn their attention to other tasks while in traffic jams", which certainly fits in with the notion of cars doing all the work while drivers sit back and relax.

But Audi's innovations are described as 'hands- and feet-free' driving – and not as fully autonomous. The idea behind the self-driving technology is to reduce the driver's workload via piloted driving – hence Audi's system can help to steer the car in certain situations and can accelerate and brake autonomously.

The driver-activated assistance function is based on existing Audi technology – its Adaptive Cruise Control with Stop&Go – but is enhanced by lateral guidance.

In terms of moving beyond a prototype and getting cars on the road with this 'electronic co-pilot', Audi is looking to debut the system as an optional extra on its A8 model in 2016. In an interview with Germany's *Auto, Motor und Sport*, Audi engineer Björn Giesler said, "So far, our test car has logged 37,000km without requiring human input."

Audi also recently announced that Nevada has issued it a permit allowing the testing of autonomous vehicles on the state's public roads. Audi is the first OEM to obtain this permit, Google being the only other company that was granted one prior to this.

Toyota is testing functions to assist drivers rather than looking to remove human input from driving

media, the auto industry, academics and the ubiquitous presence on today's scene, the blogger, pounced on the news from the likes of Audi, Continental and Toyota. And there's a current of opinion running through the auto industry right now that says 'We are the automotive experts, not Google, and here's where we're at'.

Paying the price for autonomy

Meanwhile, when it comes to consumer acceptance, skepticism seems to have got in the way of hard data. But the team at Stanford University's Center for Automotive Research (CARS) in California is keen to address this imbalance and get to the heart of whether consumers actually want autonomous cars – and whether they'll pay a premium for such technologies. The CARS researchers recently conducted a survey to explore consumer acceptance. 'The safety disconnect' is perhaps the most illuminating part of the results, according to coordinator, Georges Nabaa: "Safety and fuel economy are critical parameters for consumers purchasing a vehicle," he says. "These traits do not translate into safe driving habits, however, hence the safety disconnect. Of the people we surveyed, 48% admitted to looking for driving directions on a smartphone at least occasionally; 29% admitted to texting at least occasionally; and 68% admitted to talking on a cellphone without a hands-free device. In addition, consumers do not trust other drivers' abilities to focus on the road. From a marketing standpoint, therefore, autonomous technology should be positioned as a way to bridge the safety disconnect."

Nabaa also reveals some interesting findings when it comes to the level of control consumers expect. "They are willing to give up complete control depending on context," he continues. In fact, 'around 76% probably would' take an autonomous taxi. But in general some driver control is important. Around 51% would like the same control as an aircraft pilot, being able to switch between full autopilot and full control.

Nabaa says that perhaps the most surprising finding was that 'people seem to be willing to pay for this technology'. The results show that 40% would pay up to US$2,000 and 30% would pay up to US$10,000. Less surprising was that age plays a factor. "Willingness to pay for the technology decreases as age increases, with the 25-44 age bracket representing the market sweet spot," Nabaa explains, offering OEMs some considerable food for thought.

Toyota is one manufacturer that's making its stance on autonomous cars very clear. *(cont. p8)*

CONTINUING THE JOURNEY TOGETHER

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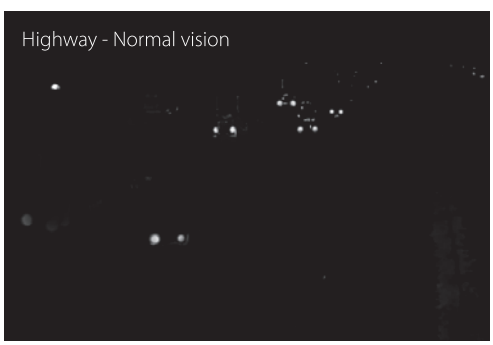

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Intelligent Transportation Systems

Toyota's vision is for an 'intelligent, attentive co-pilot' to assist the human operator

"A driverless car is just a part of the story," said Mark Templin, Toyota group VP and Lexus Division manager in January. "Our vision is a car equipped with an intelligent, always attentive co-pilot whose skills contribute to safer driving." This notion of the co-pilot is especially remarkable when you consider that Google has been using modified Prius vehicles in a number of its autonomous driving tests.

Michigan is fast-tracking legislation to allow testing of autonomous cars on the state's roads – hot on the heels of Nevada, Florida and California

At the CES event, Toyota presented its Advanced Active Safety Research Vehicle for the first time. Based on a Lexus LS, it was used to demonstrate Toyota's efforts in automated vehicle safety technologies, and is equipped with various sensor-based systems that can perform tasks such as scanning for moving objects around the vehicle and detecting objects approaching the vehicle. Camera, radar, lidar and GPS technologies are all put to work.

Brian Lyons, Toyota's manager of safety and quality communications, explains how Toyota regards the path of evolution to autonomous driving: "Antilock brakes were the first example of autonomous features," he says. "And the reason we relate autonomous driving to antilock brakes is that it's a mechanical device doing something better than a human can do. More recently, this has evolved to electronic stability control. Most people don't recognize these as autonomous features, but they are.

"We're living in a semi-autonomous world now – it's just that consumers may not realize it," Lyons continues. "That's why we brought the Lexus LS to the CES show: everything in that car was in some form of test environment just two or three years ago. Today we're at a point where the research, science and the sensors have evolved so that the reality of some day having a driverless vehicle is becoming clearer. There are three things we have to look at: the perception of driving, the processing of information while driving and the act of driving. We have to design algorithms that can identify situations, process the information and then automate features within the vehicle – and we have to do that better than a human. We are not there yet."

> "We're at a point where the research, science and the sensors have evolved so that the reality of some day having a driverless vehicle is becoming clearer

Regulatory hurdles

Cindy Knight, Toyota's product affairs manager, also makes the observation that we must not underestimate the importance of a regulatory framework. "There is now emerging a kind of patchwork in the USA of state-level legislation that enables autonomous vehicles to be tested on public roads. That's as far as it's got," she explains. "There's no single agreed-upon definition as to what an autonomous vehicle actually is. We don't have our act together even for the very basics."

Despite the legislative issues still to be tackled, technological progress is undoubtedly being made by Toyota. "We are now working on ways that will enable us to stop the vehicle from even higher speeds than we can do today," Lyons says. "That has to do with improving the sensors so that they see further down the road and identify an object, process the information and apply the brakes earlier. We're testing a vehicle in Japan that can autonomously go to 37mph and come to a complete stop. It can even tell if it's safe to change lanes, so it can actually steer itself to move out of the way of an object while it's applying the brakes."

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Answers for Infrastructure and Cities.

Travel guide

Some people regard rising traffic levels as a sign of a city's prosperity. If left unchecked in **Sydney**, Australia, though, it's going to bring this icon of New South Wales to a grinding halt – adversely affecting the economy and citizens' quality of life

Infographic courtesy of Andrew Locke

Travel forecasts produced by the Sydney Strategic Travel Model predict around **27 million trips** in the city on an average workday by 2036 – up from 20 million in 2006

Distance traveled will also grow by 1% per year, reaching **222,800,000km** per workday by 2036

18,031km

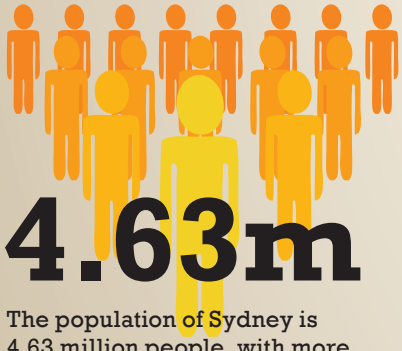
of roads in the State of New South Wales (NSW) are managed by the Roads and Maritime Services (RMS) department

Traffic congestion is predicted to cost nearly A$8.8bn a year by **2020**

Decision-making for planning and policy is centralized in Transport for New South Wales, within which there's the RMS department. Peter Duncan is the chief executive of RMS

NSW has 147km of privately funded toll roads

RMS manages 5,190 bridges and major culverts, 23 tunnels, **3,867** traffic signals and more than 12,000 other road traffic facilities, systems and corridor assets

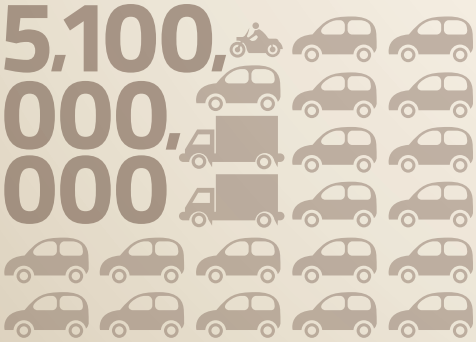


4.63m

The population of Sydney is 4.63 million people, with more than 2.1 million cars in the metropolitan area (as of 2012)

Traffic congestion in Sydney costs the economy **A$5.1bn** each year in lost productivity – the equivalent of nearly A$1,100 for every resident

5,100,000,000



A$1bn

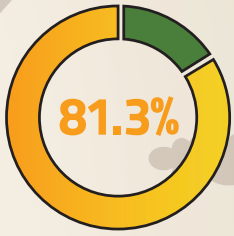
In 2011-2012, RMS spent more than A1$bn on major highway upgrades. One of the year's highlights was the completion of Pinch Point – a five-year A$100m program to improve peak hour travel times on Sydney's busiest corridors. Innovatively, a 50% discount on driver license fees was also introduced for people with a five-year blemish-free driving record

In 2010, 405 people died on NSW roads in traffic accidents, down 11% from 453 in 2009. In 2011, the statistic was 5.1 traffic fatalities per 100,000 population. And between 2008 and 2010, 48% of these were drivers, 21% were passengers, 15% were motorcyclists, 13% were pedestrians and pedal cyclists accounted for 3%. Speeding was a factor in around 40% of these crashes, meaning an average of 177 people die each year because people don't obey the posted speed limits

Sydney is the fourth worst major city in the world for transport and infrastructure, according to the fifth edition of *Cities of Opportunity* by PricewaterhouseCoopers

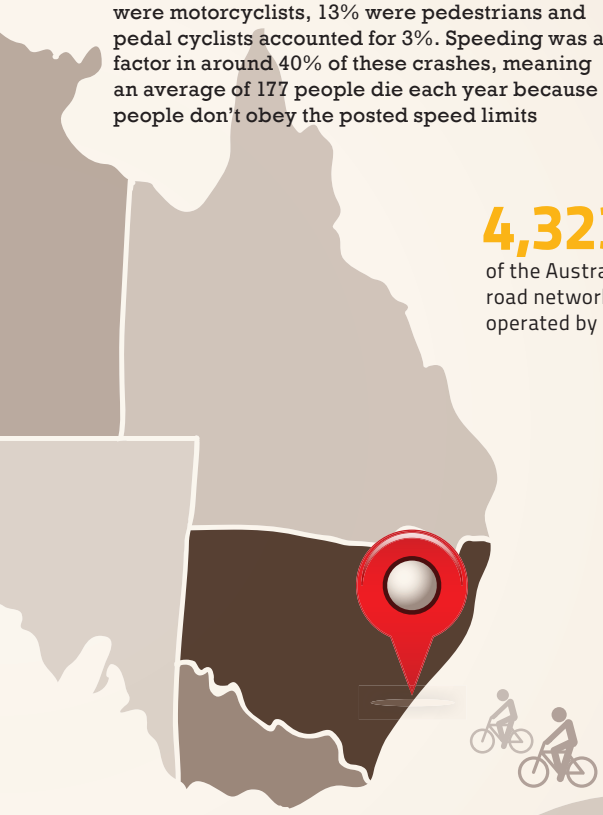
Together, on- and off-road mobile transport sources are responsible for an average of **81.3%** of NOx emissions in metropolitan Sydney

4,323km
of the Australian national road network is also operated by RMS



50%

In 2012, a National Roads and Motorists' Association (NRMA) annual Business Wise poll found increasing traffic congestion to be an issue for 50% of businesses – yet two-thirds of companies surveyed were opposed to congestion charging during times of peak travel



More than two-thirds of weekday journeys across Sydney are by private vehicle. And in the city of Sydney itself 28,806 people ride their bike or walk to work

100,000
users currently travel across the Sydney Harbour Bridge and through the Tunnel each day, both of which are operated by RMS

Traffic levels are forecast to rise **23%** over the next 15 years

In December 2012, the auditor-general of the Audit Office of NSW revealed that peak morning traffic speeds averaged between 23-27km/h (14.3-16.8mph), while the average evening peak speed was 40km/h (24.9mph) – down from 42km/h (26mph) in 2011

23-27km/h

Directional thinking

A new initiative could make roads around the world safer and more efficient for all users. **Louise Smyth** reports on the Compass 4D project

In a sea awash with European Commission-backed ITS projects, it's a rare one that catches the attention here at *Traffic Technology International*. But the Compass4D project is certainly one that stands out from the crowd.

The stated aim of the €10m initiative is 'to prove the benefits of cooperative systems and deploy services for road users to increase road safety and efficiency, while reducing the level of congestion in road transport'. But it's the use of the word 'deploy' that's particularly intriguing, emphasizing that this is far beyond a research project. Its focus is to have a real-world impact – and soon.

Targeted users of the new systems are drivers of buses, emergency vehicles, trucks, taxis, electric vehicles (EVs) and private cars – an extremely broad selection of road users. As to exactly how these users will benefit, the project will deploy three cooperative services. First, an Energy Efficient Intersection Service will allow the driver to adapt their speed when approaching an intersection so they can save fuel and stick to a comfortable speed – especially useful for drivers of trucks and buses as they consume considerable energy when braking and restarting. Second, a red-light violation warning (RLVW) service will notify the driver of a red-light violation – either his own or that of another vehicle at the intersection. This could be very helpful when emergency vehicles – which will be given priority at the equipped intersections – are dashing through red lights. Finally, a Forward Collision Warning (FCW) service will issue an alert to drivers approaching queuing traffic or vehicles suddenly braking ahead, the idea being to reduce both the number of accidents that occur and their severity.

Testing times

Compass4D will test these services on at least 550 users using 334 cooperative vehicles for a period of one year in seven European cities: Bordeaux (France), Copenhagen (Denmark), Eindhoven-Helmond (the Netherlands), Newcastle (England), Thessaloniki (Greece), Verona (Italy) and Vigo (Spain).

The project was launched in Vigo in January. In this component of the project, Vigo will be using 10 coaches, 20 buses, two emergency vehicles and eight taxis to conduct its primary testing. New equipment being deployed includes 40 onboard units, 40 HMI devices and 40 CAN dataloggers. In terms of 'reused' equipment, 17 equipped intersections are being used to test the services being developed.

Speaking with Pierpaolo Tona, the man responsible for coordinating the project, it's clear that he has high hopes for the scheme. "To achieve the main goal of deployment involves hitting a lot of subtargets – meaning not only the technology deployments but agreeing on who does

€18.5m
was the budget for the recently completed DRIVE C2X project, which aims to lay the foundation for rolling out cooperative systems in Europe

Key partners

In terms of technology suppliers, Siemens, Swarco Mizar and Peek will work on the road infrastructure units being used in the seven cities with the Compass4D project. Pierpaolo Tona comments that "a key part of their work will be to provide technical units that work like an iPhone. This means that you buy it once and if you need another app, you just build an app – there's no need to buy another phone. "The three services we will pilot will be just a baseline, so if a city wants to implement a new service in 10 or 20 years, they don't have to go back to the suppliers and ask for a new unit. And being interoperable means the technology suppliers do not have a monopoly."

Top priorities

As well as the tech suppliers, Pierpaolo Tona, project manager, ERTICO – ITS Europe (pictured above), explains how the cities themselves are equally important players in the project. "The role of the cities and the public authorities is fundamental," he says. "Getting technology on the roads is one of those vicious circles that we try to break by involving all of the stakeholders from A to Z. And cities have been the focus of the European Commission for a long time, so keeping them involved is a priority for this project." Given that it's the city authorities that will ultimately be investing in the services the project creates, it is sound business sense to prioritize their needs and objectives.

Intelligent signal control and energy reduction strategies can vastly improve intersections

what and working with the public authorities that will have to carry on the work after the project finishes, when there is no further funding. So we have to create good business models and we must identify deployment barriers and provide solutions. If we do this, we will create a model that we hope will be easily applicable to other cities beyond these seven pioneers."

One part of ensuring a wider adoption of these services involves standards. "We'll have economies of scale, interchangeable harmonized solutions and the technology implemented in Helmond will be same as, or interoperable with the technology used in Bordeaux or Vigo," Tona explains. "In this framework, we are also planning to work with the USA and Japan. We have a number of key partners in Compass4D – such as Peek, Siemens and Volvo – that don't want only European standards. They want global standards."

In 2012 the FREILOT pilot ended. It focused on reducing the energy consumption of goods delivery vehicles via methods such as energy-efficient intersections and eco driving

The visible benefits

Putting aside global penetration for a moment, Tona believes the project will provide very tangible safety benefits for the first seven cities to be blessed with these services. "It's hard to quantify how many injuries we will prevent or lives we will save through road accident reduction, but when we chose the roads that would be included in the scope of the project, we deliberately picked very highly trafficked ones (a mixture of urban and inter-urban) where we have a good idea of the accident situation today," he continues. "We will certainly see the benefits of these intelligent traffic lights and the energy-efficiency approach for public transport and emergency vehicles at these locations. And I hope this will also be visible to the users, to convince them of the efficiency of these services."

At the launch event, Francisco Ferreira, a former EC project officer, touched on the real-world benefits in his speech. He said: "I have been deeply involved in the deployment of ITS and directly responsible for projects that can be considered as the 'parents' of Compass4D. I am referring especially to CVIS, FREILOT, but also to DRIVEC2X, eCoMove, SafeSpot and COOPERS. It is a great satisfaction to see that the research of many years will not be kept in a drawer, but that the results of years of hard work will be effectively used to deploy services in seven European cities." He also stated: "I am convinced that Compass will bring some of the best examples of ITS into real life. We all know the complexity of cooperative systems and the many barriers such systems will encounter before solutions become sustainable for all."

It will be a fairly long time before any results from the project will be announced as testing might continue longer than the one year initially planned in order to ensure the services are fully functioning and self-sufficient. But there will be a big final event in 2015 when, in a timely fashion, one of the Compass4D partner cities, Bordeaux, plays host to the World Congress on ITS.

(Below) **Map of the route that Compass 4D will focus on in Vigo** (Right) **The city of Vigo**

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THE QUEEN'S AWARDS FOR ENTERPRISE: INNOVATION 2011

Ride the wave

The 'Traffic Light Assistant' research project involves traffic lights communicating with vehicles. The lights transmit information about their switching sequences. A proposal for an optimum speed is then given to drivers, enabling them to take advantage of a 'green wave'. The system can also warn drivers if they are about to go through a red traffic light. The Traffic Light Assistant evaluates the data received in the vehicle. If the traffic light at the intersection would already be red if the vehicle continued without changing speed, the person driving the car or motorcycle receives this information early enough to brake smoothly – naturally while complying with all the rules of the road. The driver is therefore able to look into the future and adjust his driving style to the timing of the traffic lights. The net effect is that you drive more calmly and more safely, save fuel and protect the environment all at the same time.

Urban collective

Lloyd Fuller discovers that in the UR:BAN research initiative, specialists from BMW are developing driver assistance and traffic management systems specifically for the urban driving environment

The trend toward urbanization shows no signs of abating, with an increasing number of people today leading urban-centered lives. As well as generating more traffic, this also poses a greater risk of congestion and accidents. To ensure continued unrestricted freedom of personal mobility in the future, traffic and transport systems must find a way to cope with these strains so that every road user is able to make their journey as safely, efficiently and comfortably as possible.

17%
of all EU traffic deaths are pedestrians, with more than half being over-65s. Males under 19 are twice as likely to die after being hit by a vehicle than females in the same age group

A total of 30 partners – comprising automotive OEMs and suppliers, electronics, communication technology and software companies, universities, research institutes and cities – have joined forces in the UR:BAN project (the German acronym stands for 'Urban space: user-oriented assistance systems and network management') to develop new driver assistance and traffic management systems for the cities of tomorrow. The focus is on the human element and the different roles of human beings in the traffic scene – as drivers, pedestrians, cyclists, or indeed as traffic planners.

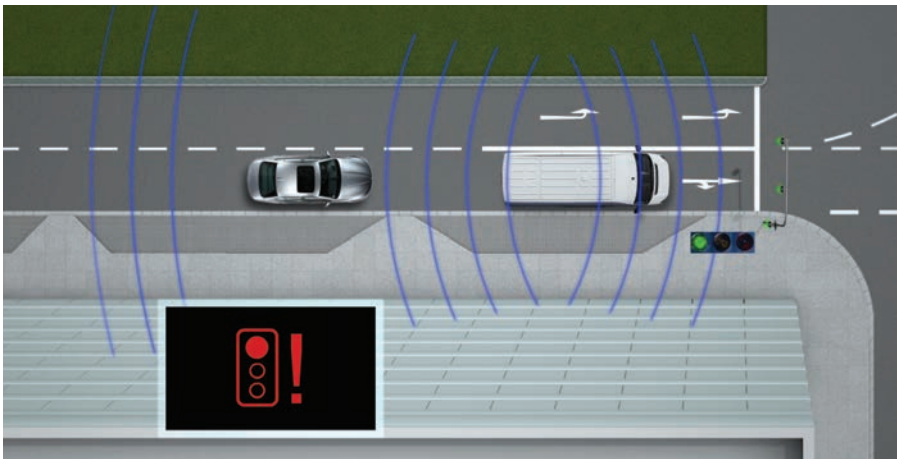
"UR:BAN will not only make a significant contribution to increased urban road safety," insists Susanne Breitenberger, UR:BAN project manager at BMW. "Through the deployment of an intelligent infrastructure and its integration with intelligent vehicles, it will also optimize traffic efficiency."

The UR:BAN partners' total budget over the four-year lifetime of the project will be €80m, with around 50% of the funding coming from the German Ministry of Economics and Technology within the Third Transport Research Programme of the German Federal Government.

Three projects – one goal

UR:BAN comprises three projects – 'Cognitive Assistance', 'Networked Traffic System' and 'The Human Element in Traffic' – each of which BMW will have a strong hand in.

Driver assistance systems introduced in recent years are designed to promote safer driving, particularly on freeways and main roads. In the city, though, drivers face an entirely different set of challenges. They have to be able to respond to more vulnerable road users such as cyclists and pedestrians, for instance, in a wide range of driving situations and often at very close quarters. "With the help of high-resolution sensor systems capable of scanning large areas of the driving environment, our aim is to make



drivers aware of hazards in good time and to help them respond safely with the goal of reducing the number and severity of accidents in urban driving situations," explains Dr Peter Zahn, UR:BAN project manager at BMW Forschung und Technik.

Methods that are already used in freeway environments to assess the driving situation, identify hazards and support proper braking and steering responses must be extended and refined to meet the requirements of city driving.

In the Cognitive Assistance sub-project 'Protection of Vulnerable Road Users', BMW Forschung und Technik is developing an assistance system to protect pedestrians that assesses the likelihood of a collision between a pedestrian and a vehicle on the basis of the current situation as well as the behavior of the pedestrian. A vehicle-pedestrian accident can thus be prevented by braking and/or steering.

Detection and interpretation of the driving environment in particular is a function that makes very high demands in terms of precision and reliability. In the Cognitive Assistance sub-project 'Sensing and Modeling of the Vehicle Environment', high-performance algorithms are being developed for environment detection, data fusion and situation assessment.

The Networked Traffic System for energy-efficient and stress-free driving project, meanwhile, is focused on optimizing traffic efficiency in urban environments, the aim being to reduce emissions, with a particular consideration of powertrain concepts of the future (electric and hybrid drive systems).

"Applications for the intelligent management of traffic – taking into account both the traffic situation and the potential for improving environmental performance – will work hand-in-hand with intelligent driver assistance systems to optimize driving efficiency and energy consumption," explains Breitenberger.

In the Networked Traffic System sub-project 'Smart Road', the project partners are developing a green wave/traffic light approach assistance system that uses advance information about traffic light phasing and the local traffic situation at intersections to ensure energy and emission-efficient driving on traffic light-controlled urban roads.

To help ensure that vehicles of the future can serve as an 'active helper' in hazardous situations, technical solutions must be combined with appropriate interaction concepts to achieve an optimal synthesis between safety, efficiency and comfort.

In the Human Element in Traffic sub-project 'Controllability', BMW and BMW Forschung und Technik are developing methods for assessing these aspects in collaboration with university partners and research institutes.

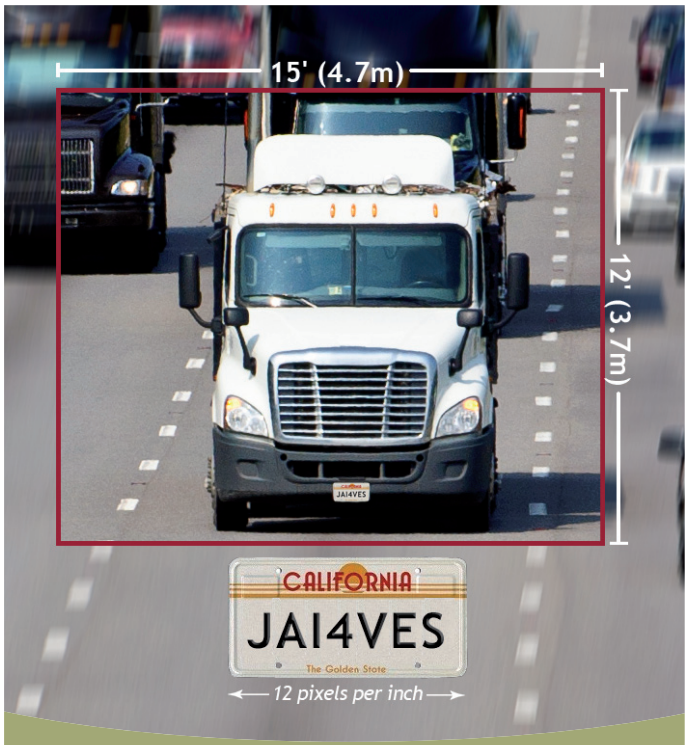
The aim is to ensure not only that drivers are able to enjoy the benefits of fast-responding technical systems, designed to provide effective assistance in avoiding accidents, but also that the vehicle equipped with such technologies remains under the control of the driver at all times.

Meanwhile, the sub-project 'Behavior Prediction/Intention Detection' is developing methods to identify the intentions of the driver of a subject vehicle, and other drivers, at the earliest possible stage, so that they can be taken into account in the subject vehicle's responses.

(Main image) **BMW is working on strategies to protect pedestrians in urban areas**
(Above) **Green wave assistance systems are being developed to foster energy-efficient driving**

Chicago is getting tough on pedestrian deaths after publishing a new plan with 250 recommendations to reduce its deaths down to zero; around 50 are killed a year currently

> "Through the deployment of an intelligent infrastructure and its integration with intelligent vehicles, it will also optimize traffic efficiency



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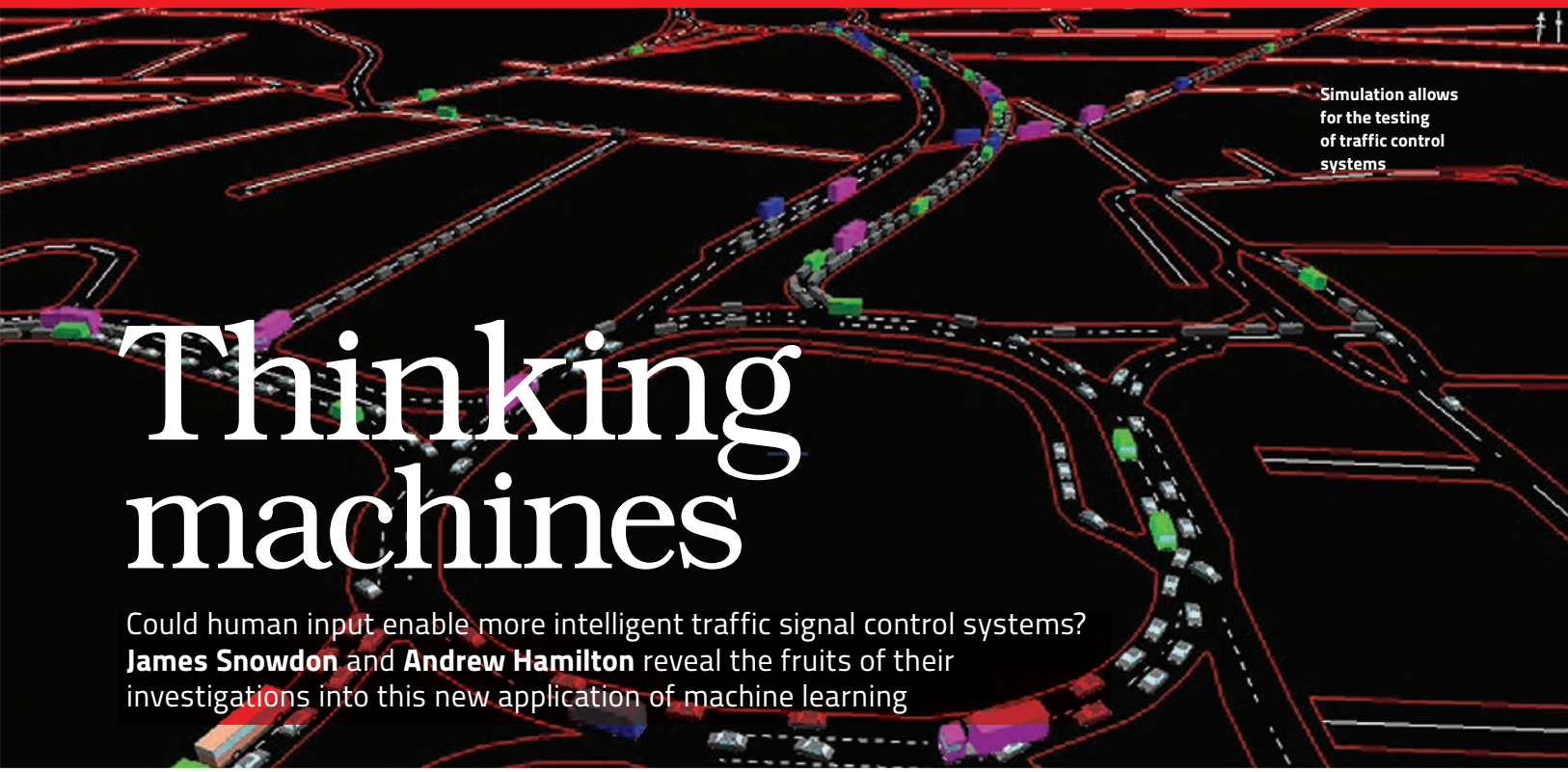


Simulation allows for the testing of traffic control systems

Thinking machines

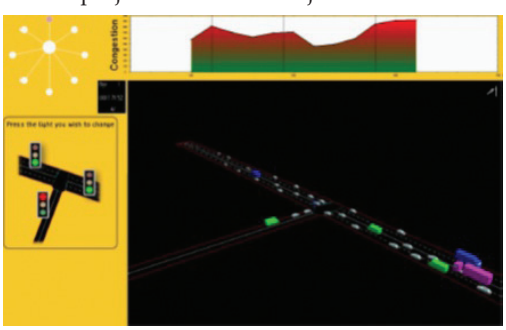
Could human input enable more intelligent traffic signal control systems? **James Snowdon** and **Andrew Hamilton** reveal the fruits of their investigations into this new application of machine learning

In the early days of traffic control, drivers arriving at an urban intersection would find themselves directed by a police officer skillfully coordinating complex traffic flows with a series of exaggerated waves and hand gestures. The officer held the unenviable responsibility of managing traffic, ensuring that no driver was held waiting for too long and that queues did not clog up urban environments.

Since then engineers have developed sophisticated traffic light control algorithms aimed at reducing delay at intersection arms and ensuring that city traffic flows smoothly.

But in an age of artificial intelligence and relatively cheap computational power, should we instead be using human 'teachers' to train a signalized junction to control itself autonomously?

A team at the University of Southampton in the UK has been exploring this concept, with promising results. It started as a computer simulation investigating what happens when a human takes control of a set of traffic lights, but the project has led to a major research effort funded by industrial partners interested in helping to develop the next generation of traffic control systems.



The game tests the ability of humans to control traffic lights

Game changer

The team from the University's Transportation Research Group developed an interactive traffic control game featuring simulated traffic in two 'levels': the first is a single, signalized T intersection and the second a more complicated junction layout. The player is asked to choose a traffic light configuration and keep average vehicle waiting times as low as possible. The Junction Control game enables the researchers to explore how a human controls the junction in a variety of traffic conditions. All human traffic light decisions are then fed into a computer junction controller program that tries to mimic those decisions through the application of machine learning, a branch of artificial intelligence research. Using the controller, which has been trained by a human expert, the researchers have achieved a major reduction in vehicle delay compared with a number of industry-standard traffic control systems.

Although the game enables the researchers to test hundreds of human traffic controllers in a simulated world, they also wanted to test their theory on a real junction with real driver behavior. At just the right time BBC television's *The One Show* became interested in the research and provided just the opportunity the team was looking for. In May 2012, the researchers and TV crew headed to the InnovITS closed 'city circuit'

A team at the University of Texas in the USA has developed an autonomous intersection management (AIM) system to address the rise of driverless vehicles

Smarter future

The recent research from the University of Southampton has focused on harnessing this wealth of new sensor data for accurate vehicle location detections, which aids the implementation of artificial intelligence-based controlled junctions in the real world. It is difficult to predict when this technology could be implemented in practice. However, the university is working with industrial partners to promote new ideas and bring them to fruition sooner rather than later.

Game of chance

The computer game developed by the researchers was built by adapting traffic simulation software (S-Paramics) to have a human interface. An interesting aspect of the Junction Control game is that while it is being played it can collect statistics and analyze how good the player is at controlling a junction. It can even be used to compare the player's performance with real-world junction control systems. The, perhaps surprising, result is that human beings can be very good junction controllers. In fact, in many cases players of the game greatly outperform today's automated traffic light controllers.

TV presenter Marty Jopson controls traffic lights via a laptop

at the MIRA test track facility in Nuneaton, UK, to film an experiment that gave TV presenter Marty Jopson the chance to control the lights at a test intersection through a laptop computer.

Human touch

Thirty volunteers drove a variety of vehicles through the junction in a series of 15-minute experiments. Jopson had no previous experience in traffic control yet he achieved a 30% reduction in average vehicle waiting times compared with a fixed-time control system. This result supported the team's hypothesis that humans could control traffic lights better than existing systems – although further experiments are required to determine how much better an expert could control a junction against one of the more sophisticated adaptive control systems currently available.

Urban traffic control systems, such as the UK's SCOOT and Australia's SCATS, were among the first transport applications to use AI in the early days of ITS

A human and the machine learning-based controller both have access to much more information about vehicles approaching the junction, such as their location and speed, than the simple inductive-loop detections that many traffic control systems rely on. The availability of this extra data in the research experiments undoubtedly helps both controllers to make traffic management decisions, and it is not far from being obtainable to practitioners. Modern vehicles broadcast more information than ever to their surroundings, enabling researchers to construct a richer and more accurate picture of road network conditions. There is great potential for the development of 'smarter' traffic controls, in a variety of forms, to exploit this information.

Human input is not the only source of information that can be employed in the development of junction controllers that use machine learning strategies. For example, modern traffic control systems can be calibrated optimally through simulation using lengthy processes. While these optimization techniques are too expensive to be practical, they can provide starting places for a machine-learning controller that will emulate optimization processes with a much lighter computational load. Research at the University of Southampton has shown that such approaches have come very close to human performance in testing.

The rise of AI

In the future it is expected that artificial-intelligence based systems will be able to manage entire city signal control systems. The performance of every intersection cannot be optimized individually, but instead requires a holistic view of the network. For example, coordinating junction controllers and creating 'green waves' during congested periods helps vehicles get into and out of the city quickly and reduces delay considerably. Coordinating more than a few junctions is a challenging task for a human expert as there is simply too much information for a person to process. The first step in addressing this problem, which the team at Southampton is investigating, is to coordinate small independent regions of manageable coordinated junctions.

The use of machine learning-based traffic control systems not only has the potential to provide a reduction in delay at junctions, but can help make calibration and setup faster and simpler, since a human expert just needs to 'play' the junction control game in simulation. New location detection technologies are now being embraced by councils and local authorities for traffic monitoring and can be incorporated in traffic control at a small extra expense.

> In the future it is expected that artificial-intelligence based systems will be able to manage entire city signal control systems

The experiments were conducted at the InnovITS test track at MIRA

• *James Snowdon and Andrew Hamilton are researchers at the University of Southampton*

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Space odyssey

It's been a long and at times arduous journey, but the sectors of traffic management and parking finally seem to be on the same wavelength, in doing so revolutionizing how this valuable resource is managed. **Timothy Compston** discovers how this convergence is impacting our cities

Illustration courtesy of Tim Ellis

We've recently witnessed a transformation in the way that cities think about and operate parking. The latest roadside, handheld and in-vehicle technologies are great platforms to which information can be pushed so drivers know in real time where available spaces are located and the rates being charged, hence can plan their journeys more intelligently than ever before. Moreover, the data gathered by in-ground sensors, smart meters and off-street parking lots means authorities are much better informed regarding the actual occupancy and turnover of spaces, ultimately leading to more effective pricing and resource management strategies.

Mile-High solutions

There has traditionally been a disconnect between the ITS and parking sectors, although it is Matt Wager's belief that transportation has to be seen as a system, within which parking remains one of the most crucial elements: "I am sure you've heard of the theory that 30% of cars on the road are looking for a parking space," begins the director of operations, Traffic Engineering Services, Denver Public Works Department. "My take on this is that 100% of the cars on the road are looking for parking at some point, so every single one of them is a potential customer."

Denver's system-based approach to parking can be seen in its city-wide strategic parking plan, according to Wager: "This gives us the guidance we need to manage parking as an asset. And as with anything in traffic engineering, we want to maximize how we use it and make it as efficient as we can with the existing infrastructure."

The Mile-High City's TMC is key in Denver's efforts to utilize its infrastructure more efficiently: "Whether it's managing a big event


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8 MILE RD
EAST
PARKING
1P
1 Hour
2 Hours
4 Hours
Custom
NO PARKING
Wi-Fi
Level 5
Level 4
Level 3
Level 2
Level 1

Technically speaking

UCLA economist **Donald Shoup** is convinced the marriage of available ITS technologies with a sensible pricing model can help unclog our congested cities

The application of technology is key to better coordination between traffic management and parking, according to Donald Shoup, distinguished professor of urban planning at University of California, Los Angeles (UCLA). Having studied and commented on the subject of parking extensively over the years, Shoup is perhaps best known for his influential book, *The High Cost of Free Parking.*

"You can use the technology that is available now to get the right prices for curb parking," Shoup says, outlining the specific areas where technology can make a difference. "This is something that's possible today that simply wasn't practical before. Cities can employ new innovations, such as occupancy sensors and smart meters, to offer smart parking prices that do a great deal to improve both parking and traffic management."

Moreover, adopting such technology means that cities have a much better idea of how parking is used and, significantly, how many vacant spaces there are on each block: "They can also apply this data to come up with the right price. You would typically aim for about one or two open spaces on every block so no-one has to drive around hunting for parking."

And a focus on parking is one of the simplest things that can be enacted to deal with congestion, according to this globally acknowledged parking guru: "It's a lot easier to charge a parked car than a moving one," he suggests. "Congestion pricing is very smart but it is still difficult technically, the technology is expensive and very elaborate." Shoup contrasts this with parking technologies that he says are relatively cheap, while also emphasizing that in terms of public acceptance people are accustomed to paying for parking yet less used to paying for driving around.

As cities adopt more sophisticated parking solutions, Shoup believes this in

or day-to-day traffic, we have DMS on our Interstate and the arterial road system coming into and out of downtown so as we look at parking facilities filling up – and congestion building – we're able to manage the whole process all from the same location within the TMC." Appropriate traffic advisories are also communicated via social media, email and on Denver's website. These feeds point out where parking is available as well as encouraging drivers to take alternative modes of transportation if necessary. Wager says: "When it comes to parking, we don't focus on a single aspect – it's viewed very much in the context of a wider system."

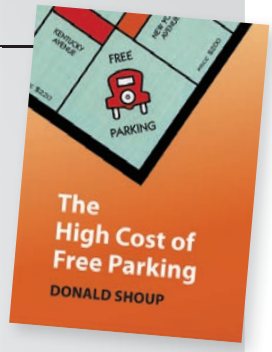
Denver's 14th Street, where better parking information is improving traffic flow

On the subject of parking information being relayed to road users, Wager says that where space availability is concerned, this relates to four facilities that Denver manages directly, accounting for around 4,000 of the off-street spaces: "Although there is a scheme that helps to identify other reputable off-street parking vendors, we don't have the technology in place as yet to broadcast the availability of these." As far as on-street availability goes, Denver has just completed a city-wide implementation of a smart meter that should help the city keep a better track of its precious resource.

A partnership approach

In the Washington State city of Seattle, a web-based parking map has been introduced that displays on and off-street parking facilities as part of the city's e-Park program. Seattle DOT's manager of parking operations and traffic permits, Mike Estey, says that because the DOT doesn't actually own or operate much off-street parking, it has needed to partner with private facilities to put in electronic parking guidance systems. "We've been up and running with this for a couple of years now," he says. "The first phase covers six garages in the downtown area, of which five are private facilities. We display real-time space availability on the parking map, in the off-street garages themselves as well as via VMS that are refreshed every three or four minutes. There's also a system of way-finding that's designed to get people to a garage quickly and efficiently."

> This technology is essentially a means to an end for parking and the end is to manage the curb parking supply properly



turn will lead to improvements in parking pricing policy: "This technology is essentially a means to an end for parking and the end is to manage the curb parking supply properly. Two decades ago people would have said, 'How can you do that?' But now you can have remote updates of parking prices, you can charge different prices at different times of day and on different blocks. I think it is to all intents and purposes a new world."

Shoup suggests the impact of the new technology in parking is akin to the invention of the cash register in the 19th century. "The cash register merchants previously had cash drawers but no way to easily count what was coming in and what was going out, however once the cash register arrived commerce just exploded as it enhanced revenue management practice. I think we'll look back at this time of rapid technological change in parking as having the same effect on transportation as the cash register had on commerce."

(Above) **Donald Shoup's influential book, *The High Cost of Free Parking*** (Center) **Parking prices are incrementally raised or lowered in SFpark pilot areas based on demand**

Intelligent sensors detect parking space availability

Seattle boasts around 2,200 multispace paystations that control 12,000 on-street spaces: "Some cities have gone further with technology than we have," Estey accepts. "San Francisco and Los Angeles, for instance, use in-street sensors and more dynamic pricing methods. We still do manual parking occupancy counts in all of our paid-for on-street parking areas and use that information to change the parking rates in neighborhoods on an annual basis."

In Seattle's case, though, the aim of adjusting the pricing rates is to achieve a target occupancy of one or two available spaces per block face, which Estey points out is similar to the advice offered by experts such UCLA's Professor Shoup (see *Technically speaking*, left): "You adjust the price according to demand. We may not do this as frequently as others but ours is a little bit of a lower-cost and lower-tech solution."

Estey and his team nevertheless continue to keep a close eye on evolving technology and what's needed to manage their parking systems: "The fact that our on-street parking is pay-and-display and spaces are not marked on the street means that sensors are probably not the best approach for us on a large-scale right now." One initiative that is starting to be investigated, though, is a pilot project looking at using pricing to better manage commercial loading and delivery issues and parking spaces: "It may in fact make sense in this situation to employ sensors for what is a limited application," Estey notes.

> When it comes to parking, we never really focus on a single aspect – it's viewed very much in the context of a wider system
>
> **Matt Wager, director of traffic operations, Denver DOT, Colorado**

The true value of parking

"Much of my career has been focused on ways to encourage more efficient use of transportation facilities, including roads and parking," says Todd Litman, author of the book *Parking Management Best Practices*.

Litman, the executive director of the Victoria Transport Policy Institute (VTPI) based in British Columbia, Canada, has identified around two dozen parking management strategies in his books and papers: "These range from more efficient regulation to control of who may use a parking space at a particular time, effective pricing and better user information

Information matters

Larry Schneider, president of the Parking Association of Australia, agrees there needs to be much greater integration of information for both on- and off-street parking. He feels that North Sydney is leading the way by providing on- and off-street data to drivers through parking guidance signage in its Crows Nest area. Although this is a step in the right direction, he says that it throws up a stumbling block to providing a bigger-picture view as not all of the off-street car parks are covered. He therefore believes that parking operators must overcome any suspicions they have about providing their data to a central server. However, he says that the City of Freemantle in Western Australia is about to implement a system that shows what is possible: "Freemantle has brought a major supplier of private parking on board. Crucially, the operator has agreed to supply its data to the system controlled by a single server at the council."

(including guidance on where to find a parking space), how much you are going to have to pay for it, improved walking conditions from your car to your final destination and encouraging more sharing of parking facilities."

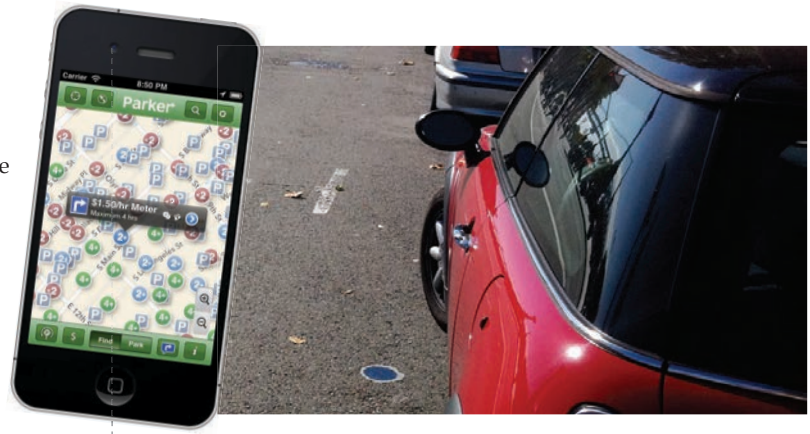
In Litman's eyes, parking spaces are a much more valuable resource than is often appreciated: "There are typically two to six off-street parking spaces per vehicle in most cities so vehicles are, potentially, worth less than the parking space they are actually occupying and, certainly, less than the total sum of parking spaces that exist for their use."

The VTPI man therefore believes it is time to move beyond what he refers to as blunt parking solutions. "The old way was to require your apartment or neighborhood to have lots of free parking sitting around so that any time a visitor comes, they're able to find a space." Litman's 'smart' method to achieve this is for motorists to have devices in their cars that can identify their parking options. "Instead of making it convenient to drive by supplying abundant free parking, we should make it convenient to drive by supplying abundant information about where you can park."

For Asdrubal Pichardo, the managing director of EMEA for technology vendor Streetline, the whole area of parking has been neglected for too long, being treated more like a commodity even though it's a huge problem for cities the world over. On a positive note, though, he feels a revolution in smart parking solutions can help to tackle these issues head-on: "We want to improve people's parking experience instead of having them waste 20 minutes looking for a space." And a critical element to smart parking is guidance: "Pointing motorists to parking spaces on the streets can be supported by putting sensors in for every space," Pichardo says. "But once that network of sensors is up and running, you can then offer several other associated applications." One example he cites is paying for parking with a mobile device: "If you're using your smartphone to find a space, why not use it to pay as well?"

And while the benefits of smarter parking solutions abound for drivers, metropolitan areas, too, are seeing the operational advantages up close: "Cities obtain a much better insight into the parking situation as they can receive analysis on the frequency and turnover of spaces. For local commerce, it is clearly important that as many cars as possible can use a space. And reports based on times of the day – or days of the week – can help authorities make more informed decisions around their parking planning as well as their policy in terms of pricing."

But what of the logistical and financial implications associated with installing multiple sensors across a city? As Pichardo responds, modern models are more straightforward to install than one might assume. "You don't need to dig very deep today," he says. "In fact, it's perfectly possible to put in between 200 and 400 sensors in a single day."



(Above) **Streetline's Parker app uses data from in-ground sensors to guide motorists to spaces**
(Below left) **Seattle's latest parking technologies**

Keeping count

Eugene Tsyrklevich, the founder and CEO of *parkopedia.com* (which provides information about 25 million parking spaces online, via SMS or as an iPhone, iPad and Android app) offers his thoughts on the evolution of real-time parking data. While he admits that the level of information that can be provided on parking availability has improved tremendously, he cautions that it still depends to a great extent on the

> Instead of making it convenient to drive by supplying abundant free parking, we should make it convenient to drive by supplying abundant information about where you can park
>
> **Todd Litman, executive director, Victoria Transport Policy Institute, British Columbia, Canada**

infrastructure in place on the ground: "Since we started five or six years ago, a much higher percentage of parking facilities have real-time information," he says. "If we take the system in San Francisco where there is data from sensors, you know on a street-by-street, space-by-space basis whether there is availability or not. Elsewhere, we may have to infer availability using other information sources, so rather than say there are two out of seven spaces left, we highlight your chances of finding a space in a certain street as good, bad or somewhere in between."

Tsyrklevich's inspiration for developing Parkopedia can be traced back to 2007 and the frustration he experienced trying to find a space in San Francisco: "I thought if I'm

A capital idea

Chia-Jen Liu, deputy manager, Department of Intelligent Systems, at CECI Engineering Consultants is currently focused on the role of parking information guidance systems as part of ITS engineering for Taiwan's capital city, Taipei, where finding a parking space is often fraught with difficulties.

To minimize the burden of traffic and to improve the urban environment, Liu says that there has been a focus on constructing parking lots in popular areas of Taipei and putting in parking guidance signage. He says it's important to understand drivers' needs from the outset: "Otherwise designs may confuse drivers due to where the guidance boards have been set up or the form and content of information that is communicated."

Liu outlines three key elements to meet drivers' needs: "Parking information guidance is set-up on the intersection of main roads. In addition, we have combined Google Maps and a mobile app to provide another way of understanding the current availability. Manufacturers of navigation devices can also be provided with unified parking information."

having trouble then surely millions of other people would be facing the same problem elsewhere," he says of his reasons for getting out the drawing board. "I set out to build a parking service that would answer this question anywhere in the world."

To put a solution in place, Tsyrklevich started to communicate with all of the main parties in the parking system 'value chain', from the parking operators to their commercial and municipal suppliers: "It included the people providing payment systems, sensors and barrier systems," he reveals. "They all have pieces of information: sensor companies might, for instance, have real-time availability information; the parking operator could have information on pricing; the payment operator the transaction data, and so on."

Tsyrklevich also touches on parking from a vehicle perspective and, in particular, what's happening in the automotive sphere with OEMs, the advent of the connected vehicle and the implications of this for intelligent parking systems. He says: "The majority of cars that are sold today are already 'connected', meaning the car has the ability to connect to a mobile network, either with an embedded SIM card or you connect your phone and use that as a modem to connect out."

With that connectivity in place, car manufacturers can thus deliver additional services that simply weren't possible in the past: "We're working with a number of car-makers to bring parking data into the car, in doing so allowing drivers to find where to park, how much they can expect to pay and if there's space available when they get to their destination. And all of this is taking place in real time."

> You can offer several other associated applications. If you're using your smartphone to find a parking space, why not use it to pay as well?
>
> **Asdrubal Pichardo, managing director, EMEA, Streetline, California**

(Below) **Use your iPhone to park your car? Welcome to Audi's vision of driverless parking**

Self-parking technology

And continuing on the theme of smart cars and smart parking, Audi recently took advantage of the Consumer Electronics Show to showcase a demonstrator that it feels could be the shape of things to come. Self-parking technologies are already available on various marques and are designed to free drivers from the hassle of trying to maneuver vehicles into tricky parking spaces or into garages.

Here, using a key fob or smartphone, drivers instruct the car to park autonomously under supervision, after which the engine shuts off, the ignition deactivates and a confirmation is sent to the driver. The system is still in the development phase. "If the vehicle recognizes an obstacle it will switch to safe mode," reports Tim Fronzek from Audi's headquarters at Ingolstadt, Germany. The more intriguing aspect, though, was the car's ability to 'talk' with public car parks, establish where the nearest parking spaces are and consequently guide itself autonomously to a specific space and then park, autonomously.

Questioned as to when we're likely to see the innovation on production models, Fronzek predicts Audi will offer various different piloted driving functions within the current decade.

What these and other developments reflect is the world of parking for the traveling public is changing immeasurably. And for traffic managers, as more cities move to adopt the latest available technology – and work out ways to bring into cars information from off-street and on-street parking as well as lots owned by private concerns – the flow of real-time parking data is going to be very much at the heart of a system-wide approach to transportation in our urban areas.

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Cloud analytics

Weathering the current climate of doing more for less involves innovative thinking and, as **David S Smith** reveals, those in the traffic modeling sector are stepping up to the mark – and harnessing the cloud

Illustration courtesy of Magictorch

New developments in traffic simulation software are emerging in response to the needs of traffic engineers out in the field. After all, those at the coalface know better than anyone what they want in a good piece of kit. And under serious pressure to produce models that accurately predict both costs and benefits, they're increasingly reliant on the best simulation has to offer.

Some of the major innovations are happening in the cloud. Citilabs, for example, says its Cube Cloud software works faster than traditional products and makes it easier to share models between all the engineers, clients, consultants and forecasters involved in a project. Meanwhile, Transoft's OTISS takes advantage of the cloud's infinite capacity for data storage. OTISS users get easy access to the Institute of Transportation Engineers' detailed trip generation data, which is normally only available in thick, weighty manuals.

Other software developers are focusing on the integration of different tools in response to the trend for different departments within agencies and authorities to share data. On this note, PTV Vistro can be used for both traffic impact analysis and traffic signal optimization. TSS-Transport Simulation Systems' Aimsun 8 software is another development in the emerging sector of integrated modeling.

The requirements of traffic engineers also motivated the development of Sidra Intersection Version 6. With so much congestion on the roads, engineers kept requesting software that could analyze networks of intersections, rather than just one intersection at a time. To discover how these latest software solutions could help in your everyday role, read on…

Taking trip generation to a higher level

By simplifying trip generation searches, OTISS transforms traffic impact analysis

> OTISS users can take advantage of the latest data without waiting for a new edition of the manual every three years

The cloud-based OTISS software is the result of a collaboration between Transoft Solutions and the global transportation association, the Institute of Transportation Engineers (ITE).

Users can log on to the OTISS website and begin a Traffic Impact Assessment (TIA) of the travel demands for a proposed land development application. Data from the ITE's *Ninth Trip Generation Manual* – which includes more than 5,500 studies of vehicle trips data – is available to assist the online assessment.

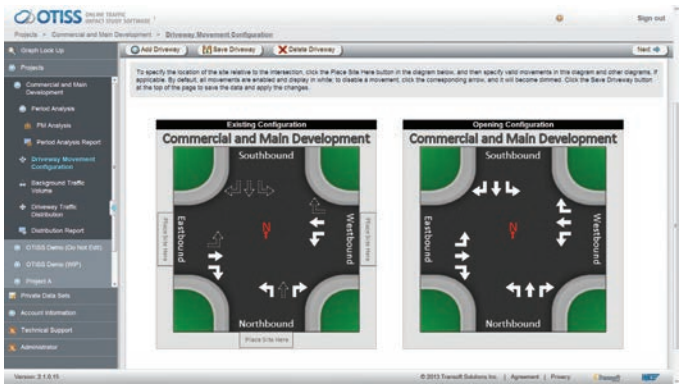
"This data was previously only found in volumes of 2in-thick manuals. But in books you can only display so much on so many pages," explains Steven Chan, senior product engineer. "By making the data available in the cloud, engineers can access data from the *Trip Generation Manual* any time and anywhere.

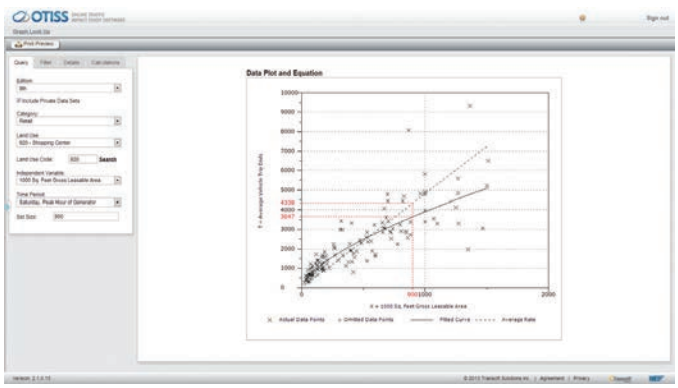
"OTISS also provides additional attributes to the data, including the year and region of the study. This allows engineers to display the data relevant to their desired region and time-frame. As studies are submitted to ITE on a voluntarily basis, submitters can easily identify where the additional data is needed in just a few clicks."

OTISS prescribes the best practices recommended by the ITE for conducting site impact studies. Not only will the system assist in looking up ITE's trip-generation data for different land uses, independent variables and time periods, users can also upload local data and conduct regression analysis in the program. The results can then be used for estimating site-generated traffic and determining the final volumes at major accesses to the proposed site.

Transoft is currently working to streamline the OTISS program. First, it is creating a system to allow users to submit data to the ITE online instead of via email or fax. Second, it is developing tools so that the ITE can review and submit the approved data to OTISS directly. "As a result, OTISS users can take advantage of the latest data without waiting for a new edition of the manual every three years," Chan continues. "We're also monitoring user feedback for clues about how to improve the product."

Chan says the partnership with the ITE is part of a trend in the industry towards collaboration. "It is exciting to be part of the crowdsourcing movement that started as early as the 1970s. The first edition of the ITE *Trip Generation Manual* came out in 1976 with 500 studies. Through crowdsourcing over time, the ninth edition now has more than 5,500 studies. We hope OTISS can help fast-track the collection of data through means of online crowdsourcing."





Loaded with more time-saving features

How a new software iteration is enabling engineers to analyze intersection networks

> Microsimulation does lane-based modeling, but ours is an analytical lane-based method using algorithms based on equations

Sidra Solutions' director Rahmi Akçelik says that the new version of his company's software, Sidra Intersection Version 6, has been designed specifically to analyze networks of traffic intersections – rather than the single intersections of previous software generations.

"We've designed the new version to do network modeling because that was what traffic engineers wanted us to do," Akçelik reveals. "There's a lot of congestion on the roads today as a result of higher traffic demands, so the engineers want to put intersections together and analyze the interactions between them."

Akçelik says there were three major developments added to the software. The first change was the modeling of how congestion affects both upstream and downstream intersections. "Queues often spread backwards from one intersection to another," he says. "Lane blockage causes congestion to increase upstream. Then the backward spread of congestion means less traffic can go downstream."

What this means is that arrival flow rates used in the model change as a result of congestion. "It is interesting how the model handles these two forces working against each other," Akçelik adds.

A second key new feature of Sidra Intersection is that it now models the movements of different vehicle classes (light vehicles, heavy vehicles, bicycles, buses, trams, large trucks), allowing users to allocate individual classes to different lanes, lane segments and signal phases – for example, in the analysis of bus priority lanes and signals.

"This was also inspired by the needs of engineers," Akçelik notes. "In Melbourne, for example, where Sidra is based, we have tram lanes, and in Australia in general, large trucks are now coming into the cities. On freeways, trucks may be banned from some lanes and

that kind of detail needs to be modeled on a lane-by-lane basis. By definition, microsimulation does lane-based modeling, but ours is an analytical lane-based method using algorithms based on mathematical equations."

The third and highly useful development deals with the handling of movements at intersections with diagonal legs and U-turns.

Community spirit in traffic forecasting

Embracing the cloud can yield major benefits to software users – not least in terms of cost

> Models need lots of data and can take hours, even days, to run on desktop computers. But in the cloud they might run in half the time

Some of the reluctance to move to the cloud is simply based on misconceptions, according to Tor Vorraa, Citilabs' regional director for northern Europe. One common fear is that cloud-based systems run grave security risks.

But Vorraa says Citilabs' new Cube Cloud system uses sophisticated methods to block unwanted intrusions. "We hire time from Amazon via its Elastic Compute Cloud 2, which is used by banks and insurance companies, so the security is far higher than most government departments can come up with," he explains.

Another misconception is that applications in the cloud are sitting ducks for the harsh reviews of rival software designers. "That doesn't have to be the case," Vorraa insists. "Normally, access is restricted by license agreements and passwords. Clients lease a certain number of hours per year and run the models for the groups around them. No one can see what you're doing unless you want them to."

The flexibility of the cloud makes life easier for engineers, he says, the first benefit being sheer speed. "Models need lots of data and can take hours, even days, to run on desktop computers. But in the cloud they might run in half the time. You can start 10 to 15 runs at once as there's no need for consultants to wait for hardware to become free."

A second advantage is the ease of sharing programs. "Sharing transportation plans is essential these days, yet typically, modelers find communicating difficult," Vorraa adds. "In the cloud, it's easier for modelers, planners and forecasters to form a community, with results stored in map templates and readily usable when you've created a scenario."

Vorraa also says that previous work is easier to access in the cloud. "It can be hard to keep track of different versions of the model made with different editions of the software, sometimes years before. In the cloud, you just click a button. Also, if you've given out copies to multiple consultants, it's easier to keep tabs of the model on the virtual server."

Cube Cloud provides download information and links to census information as well as datasets from commercial vendors of map, speed and time databases.

Citilabs is also working to integrate user forums and social media such as Facebook and Twitter into the model. "So if the cloud base is in London, everyone using it would be joined in a community where they could ask questions and take part in discussions and user groups."

Engineered for traffic impact analysis

Big Data and integration are two trends currently being addressed by some software vendors

> One of the obvious benefits is in enabling users to distribute model runs to different machines that reside in the cloud

Axel Leonhardt from PTV Group says there's an industry trend toward the integration of different traffic engineering tools. This is reflected in the company's new Vistro software, which can be used for both traffic impact analysis and traffic signal optimization.

"Integration is becoming increasingly common at an administration level within agencies and authorities," says Leonhardt, PTV's director of product management. "Different departments that previously never worked together now talk more and exchange data. So it's necessary to integrate different tools. Separate departments can then look at the same models and data from new angles. It also increases modeling efficiencies and is much less error-prone."

Leonhardt believes that Vistro's integrated approach makes life easier for traffic engineers. "Having two separate tools for signal optimization and traffic impact analysis requires an engineer to transfer data from one model to another manually. Now we have the two use cases combined, the data is automatically there."

Vistro is the first PTV product targeted at traffic engineering studies, offered as part of the PTV Vision Suite with Visum and Vissim. Users can transfer data from Vistro directly into Vissim to conduct analyses using microscopic simulation.

The company is now working to develop cloud applications to allow users to build more comprehensive models. "One of the most obvious benefits is in enabling users to distribute model runs to different machines that reside in the cloud," Leonhardt says. "An optimal design just makes the process faster: it's not about changing the modeling workflow and certainly won't make modeling obsolete."

And Big Data is also influencing modeling, helping to generate, calibrate and validate models – although not replace them. "The volume of data is huge, so efficient processing and sufficient computer power is needed. We have to ask the right questions to squeeze all the relevant information out. Cell phone data, GPS tracks, Tweets, and so on, all contain information relevant for transport modeling."

Complete traffic demand modeling functionality

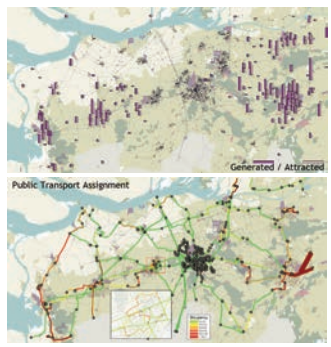
Similar to an open-source approach to software, smart developers are offering flexible, integrated kit

> We are not imposing a walled garden where clients have to use our software or they can't do anything

According to commercial director Alex Gerodimos, TSS-Transport Simulation Systems prefers to see its new release, Aimsun 8 Expert, as a development in the emerging sector of integrated modeling, as opposed to another addition to the established travel demand modeling software sector.

Gerodimos admits that TSS is aware that the transport planning market is well served with existing software, although he believes that Aimsun 8's originality is in its integrated approach, meaning it can support simulation projects from start to finish. "At first glance, it might seem strange that we would enter a saturated market but our aim is not to simply add another package to a long list," he explains. "Aimsun 8 Expert adds support for the four-step transportation planning process to a software application that was already capable of dynamic traffic assignment, coupled with mesoscopic, microscopic and hybrid simulation. Our primary audience is the users who see integration as a key requirement, perhaps those who have been using simulation all along while longing for access to travel demand modeling features."

Aimsun 8's approach is the opposite. "We are not imposing a walled garden where clients have to use our software or they can't do anything. We say, 'Yes, we have lots of things, but you might want to use a subset of what we offer as well as a subset of another package'," Gerodimos says. Modelers in the field will be pleased. "Cost efficiencies encourage them to build larger models and maintain them rather than build smaller ones they cannot keep. Also, they now won't be tempted to make blanket assumptions to avoid transferring data between packages either. They just change the inputs and run the model again and continue looping between the two."



TSS is building cloud support for Aimsun, and Gerodimos says browser-based user interfaces will soon be prevalent for output sharing and light editing. "For heavy network editing or 2D/3D animation, we may have to wait a few years – but as connection speeds to and from the cloud rise, interaction-heavy applications will probably also move there."

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Street wise

Peering into the world of pavement markings and road studs, **Max Glaskin** discovers a new level of intelligence being applied to these humble traffic tools to help drivers use highways more safely

Illustration courtesy of Lee Hasler

The term 'intelligent stud' was once a Hollywood oxymoron, but it's now a technology under intense development. Five UK transport and technology labs and two commercial partners, for instance, are collaborating on INROADS (INtelligent Renewable Optical ADvisory System), a €3.8m (US$5.07m) three-year project, €2.5m (US$3.33m) of which comes from the EU, to demonstrate road studs that combine LED lighting, sensors and communications, powered at least partially from renewable sources.

"They will be able to communicate with each other and with a central control," reveals project coordinator Martin Lamb of TRL, the UK's Transport Research Laboratory. "Integrating these technologies will enhance traffic management and driver information to improve safety and emissions."

Mitigating circumstances

INROADS has been underway for more than a year. "We now have a system design and a product specification where we've defined the conditions in which the stud will work, its robustness, and how the communications and sensors will work," Lamb continues. Among the likely applications will be pedestrian crossings, at which they can detect pedestrians and vehicles, and light up the danger areas appropriately. On the curves of rural roads, meanwhile, they could illuminate beyond the range of a vehicle's headlights and power down when it has passed. And they could even intensify lane delineation at an intersection to warn of vehicles emerging from a side road.

An ultra-low-power microcontroller has been selected as the best way to improve the autonomy of the INROADS stud, powered by a new hybrid capacitor that stores energy


30mph
CHECK SPEED
WARNING
LED

Human-centric design

Pioneered in the Netherlands, shared space is now showing its potential in the UK. *Traffic Technology International* talks with **Ben Hamilton-Baillie** about why the spotlight is currently on the Cheshire village of Poynton

Researching, developing, installing and maintaining technologies that give road surfaces the ability to sense their environment and react to make highways safer for all users is a sophisticated concept. Yet the question arises: why not rely more on the intelligence of highway users?

This argument is increasingly being raised in places where conventional traffic engineering and control methods haven't been able to solve longstanding problems. The answer might not be more new tech, but the creation of a shared space.

The formalized idea emerged in Europe in the past decade and is being applied in several countries. A striking recent example is an intersection in Poynton, UK, where two major roads cross in the center of a village. For decades, traffic flow was controlled by signals but, with 26,000 vehicles a day, tailbacks grew alarmingly at peak periods. "They stretched for half a mile and it could take 20 minutes to clear the junction," reveals Ben Hamilton-Baillie, a street designer and shared-space advocate who was instrumental in regenerating the village.

> "We're trying to engage drivers so that they read and understand their surroundings, not isolate them from their surroundings

The solution includes removing traffic signals, signs and conventional markings. The crossroads has been replaced by two small roundabouts. There are no significant curbs between road surfaces and sidewalks, and the numbers of lanes on some of the approach roads have been reduced. New streetscaping and pavement surface color schemes have also been introduced. "We're trying to engage drivers so that they read and understand their surroundings, not isolate them from their surroundings," Hamilton-Baillie explains. Drivers react to the new environment by slowing down and – without signal sequences to obey – traffic seems to flow smoothly, eliminating queues.

"Poynton has been designed so that vehicles move at 17-18mph," he continues. "But there's no 20mph limit in place or speed signs." The technology-deficient design prompts drivers to modify their behavior. "Signs do not override the stronger cues that they receive from the environment. If you have 'slow down' signs without changing the road space, then drivers will not change their speed," he suggests. But do shared spaces mean there will be no place for intelligent, cooperative infrastructure? "Shared space isn't appropriate everywhere," he admits.

Ironically, just four days before Hamilton-Baillie described the low-tech

from both a small, integrated solar panel and from a piezoelectric system. The latter, developed by Innowattech of Israel, harvests energy when passing vehicles put the stud unit under strain. "Prototypes will be installed and tested in TRL's accelerated loading facility to determine the potential power available from piezoelectric harvesting," Lamb reveals. "We need to understand the efficiency of energy generation at increasing distances. Will the strain generate any useful power if a vehicle passes, say, 20cm away?"

Another distance-related test is already ongoing at Austria's Institute of Technology, with researchers investigating magnetic sensors to see if they can be fitted into the INROADS stud and not only spot passing vehicles, but also differentiate between vehicle categories.

All-important human factors and behavioral research is being carried out using improved graphics of illuminated studs in a bespoke simulator experiment. In parallel, the photometric and colorimetric properties of different-colored LEDs are being evaluated by surveying volunteers, who are being shown video clips. "The aim is to obtain objective criteria and determine the visibility and legibility of the studs," notes Lamb.

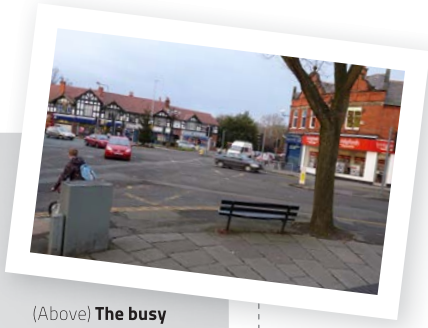
By the end of this year, demo INROADS studs will be sunk into a real road in Israel and their performance and impact monitored for six months. This will be followed by publication of a full report in 2014. "Effectively it'll be a handbook for the installation, use and maintenance of the studs," says Lamb. "The idea is that they can be put into production and strengthen European competitiveness."

The cornering market

Safety concerns at a staggered crossroads with an S-bend on the A41 in Chetwynd, UK, got so serious that the local road authority sought better infrastructure. UK-based road stud specialist Astucia brought in wired studs to delineate the road and solar-powered studs for the center line. Radar technology now detects vehicles traveling faster than the road's design speed and tells the wired studs to increase their intensity so drivers can better see the course of the road.

It's a practical example of robust intelligence being added to the road surface. "It's more complicated to add intelligence to solar studs," insists Graham Muspratt of Astucia. "They conserve their energy until ambient light levels fall below 100 lux and then they illuminate the LEDs. But if you incorporate other sensors and communications – either from stud to stud or stud to vehicle – power management and protocols have to be established."

success of the new Poynton intersection to *Traffic Technology International*, the European Community's ITS network, ERTICO, announced a three-year €10m (US$13m) high-tech project, Compass4D (see page 13). It has 31 partners across 10 countries and one of its three tasks will be to assess cooperative technologies that enable drivers to modify their speed as they approach traffic signals. In Poynton, though, the job is done not with cooperative technology or signals, but with respect for human intelligence.



(Above) **The busy intersection before the shared space theory was applied** (Below) **The Poynton scheme is showing early signs of being a success**

Pedestrian aware

There is already competition in the market for intelligent studs. The LED Smartstud from 3i Traffic of New Zealand is being offered by Traficon of Belgium as an enhancement to its SafeWalk pedestrian detection camera system at crossings. The Smartstud can be powered inductively, by wire or by daylight, and has two-way communication and diagnosis capabilities. It's fully programmable and addressable. In the Safe-2-Walk combination, the high-intensity LEDs are triggered by the cameras and delineate the crossing and the road center for drivers.

In Scandinavia, the iRoad research project based at Luleå University of Technology, Sweden, is proving its worth by helping Geveko ITS in Denmark to develop a new breed of intelligent stud. The latter's active LED-Guide senses its environment, processes information, communicates with infrastructure, and illuminates to inform road users. Based on Geveko's LED-Mark solar stud, the innovation can be glued to asphalt or milled-in to evade snowplow damage. Each is controllable individually, can sense the temperature, has room for four LEDs of different colors, and has a built-in transceiver. A lithium battery can power one stud for 4,000 hours.

A first application from Geveko is using them to sense vehicles traveling in the wrong direction along a ramp and to alert the driver to turn back before they join oncoming traffic on the highway. And with 260 such incidents a year in Denmark, about 500 in Austria and 1,800 in Germany alone, there is an acute need for such a solution. "We're also developing a system for curves," reveals Bruno Hansen of Geveko ITS. "It can detect vehicle speeds and right now it's just a question of perfecting the sensors and the algorithms. Another stud will be available by the end of this year that can count and classify five vehicle types. The university research has proved it and now we just have to get power consumption down."

It all sounds pretty exciting for ITS practitioners, but why exactly should public and private road operators invest in more clever, more expensive infrastructure when car makers are adding more sensors and intelligence to their products? "We want to make the road so intelligent that it can pick up information from vehicles and preserve it for the next driver," Hansen explains. "The goal is to give each unit its own IP address and make the information available via the internet. Then you can use smart studs to download information from the newest cars that have intelligence and use it to inform the drivers of older cars. It's not about adding intelligence to cars or to roads – you need both. Cars have a lifespan of about 20 years, so it'll be another 20 years before every car has a degree of intelligence."

> Prototypes will be installed and tested in TRL's accelerated loading facility to determine the potential power available from piezoelectric harvesting
>
> **Martin Lamb, INROADS project coordinator, TRL, UK**

(Above) **Safe-2-Walk combines Traficon's field-proven C-Walk or SafeWalk video sensors with on-road LED warning lights from New Zealand's 3i Traffic Safety** (Right) **Geveko's LED-Guide is an intelligent solar road stud with built-in sensors**

Disappearing act

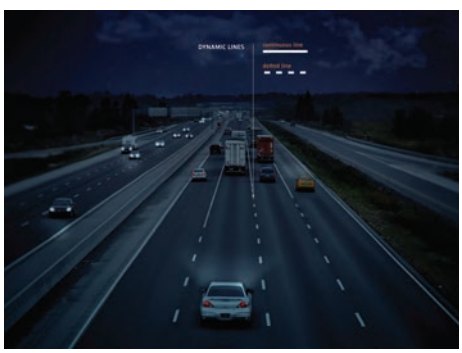
Although illuminated LED studs can be seen beyond the range of headlamps, conventional pavement markings stay dark. Worse still, they can almost disappear when wet – even

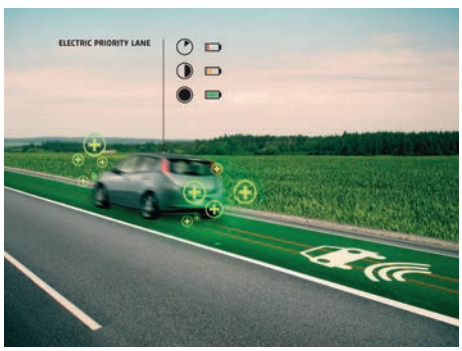
when full beams fall upon them. Researchers at the Texas A&M Transportation Institute in the USA, led by Paul Carlson, have assessed conventional road markings in wet, dark conditions and found that most markings provide wet-night detection distances only in the range of 140-200ft. The most visible by far on dark, wet nights are reflectorized raised pavement markings, which can be seen at more than 550ft.

Age concerns

Aware of these shortcomings, the European Union Road Federation (ERF) is currently analyzing how, under all weather conditions at night, different age groups and genders adapt their driving behavior on the basis of the visibility and retroreflectivity of road markings. "Previous European research has shown that good road markings have a positive result, but nothing's been done to see how drivers of different ages react at night under different conditions," explains Konstandinos Diamandouros, ERF's project coordinator.

Ninety people of varying age groups are undergoing simulator test drives with Aximum in France. "It's a three-mile secondary road, one lane in each direction, with no separation barrier," Diamandouros details. "The results will give us a base line." Further tests are due to be conducted at Test & Training International's track in Austria, where sprinklers will wet road markings of three separate grades of retroreflectivity. Thermoplastic markings from partner 3M are being used as they have to be removed promptly afterward.





More than meets the eye

Don't be put off by the name Road Nail. Rather than puncturing journeys, this concept – under development by RT-RK of Serbia and the University of Novi Sad – integrates sensors, wireless connectivity, lighting, local intelligent processing, solar cells and batteries, and puts them all inside a road stud. Each is part of a larger distributed system, creating a network of autonomous, cooperating objects that illuminate the edge of the road in front of a moving car when ambient visibility is poor.

It is based on spontaneous ad hoc cooperation between Road Nail units. To test the theory, a trial with 20 nodes and a cellular gateway to the internet has been examined. The studs detect passing vehicles using passive infrared and light sensors, but the radio signals they use to communicate with each other could also be harnessed to enhance detection. A vehicle passing a stud would alter the way its signal propagates. If a receiver in a stud notices the signal power has differed from the average, it may assume a vehicle is passing. So each stud acts like a passive radar.

(Below, top) **The first few hundred meters of glow-in-the-dark, weather-indicating Smart Highway will be installed in Brabant, the Netherlands, in mid-2013, and could also be used to indicate** (bottom) **priority induction lanes for EVs**

> Previous European research has shown that good road markings have a positive result, but nothing's been done to see how drivers of different ages react at night under different conditions
>
> **Konstandinos Diamandouros, project coordinator, European Union Road Federation, Belgium**

Meanwhile, the UK's Road Safety Markings Association (RSMA) is conducting the RainVision road test and it's being expanded to obtain robust statistics for analysis. The locations are secret and the speed of vehicles is being monitored before and during the test. "Toward the end of the research, we'll encourage local radio stations to ask listeners if they've perceived different levels of comfort or security on the test roads, and that will feed in to the final report," says the RSMA's director, George Lee.

Delivering smarter highways

Dutch designer Daan Roosegaarde and Heijmans Infrastructure made headlines around the world in January 2013 with their 'Smart Highway' concept, which included markings that react to the environment. Some change color when the road temperature approaches freezing; others are luminescent, absorbing energy during the daytime and emitting it as light during darkness. Although the announcement gained global interest, according to Reuters a 492ft test strip of the luminescent markings will not be applied until later this year, in North Brabant.

It won't be the first such trial in the world. "In our experience, the quality of luminescent markings today isn't good enough," states Geveko ITS's Hansen. "They fade and disappear within three to five months. Research continues, but it's at a lower level than we've seen in previous years. We need some improvement in the chemistry and that's up to the chemists." Graham Muspratt of UK road stud specialist Astucia is equally skeptical: "A big problem you have with any markings is their visibility when wet," he says. "The light simply gets scattered."

Unfortunately, the extraordinary level of global media enquiries meant that Daan Roosegaarde was too busy to return our requests for an interview. And while the idea received a national design award in the Netherlands for Best Future Concept, clearly there are others that have not only been researched and tested, but are also entering the market to make road surfaces intelligent. They began as concepts some time ago, but today they're the real deal.

Geveko ITS

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Scan and see the LED-Mark in action

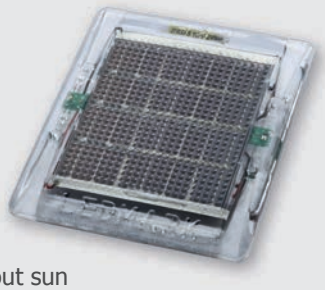
Scan and see the LED-Guide concepts

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

Find more information on

www.gevekoits.com

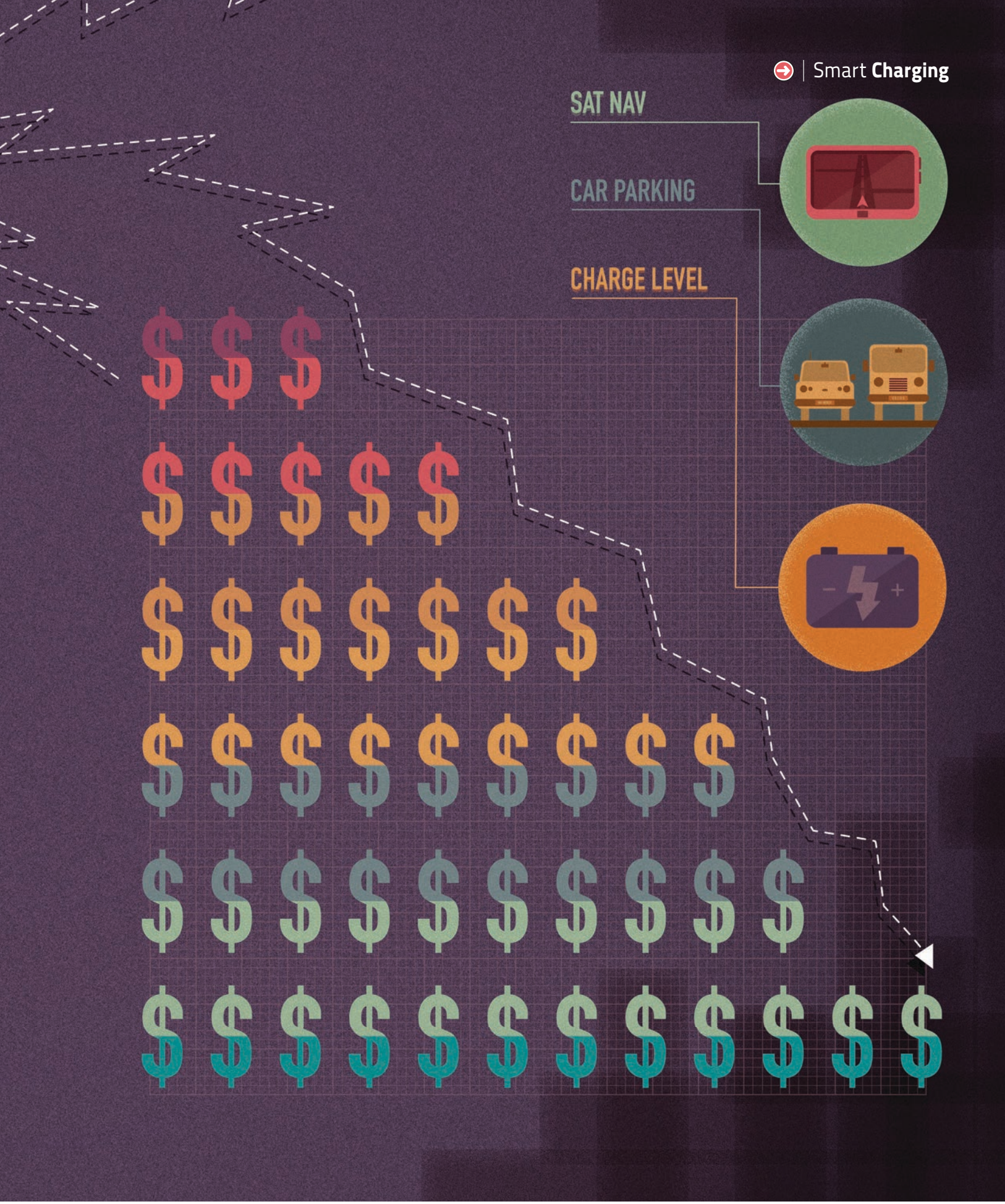
Friends or foes?

In contemplating how a fleet of cleaner, gas-tax-exempt vehicles may have a detrimental impact on DOTs' ability to deploy ITS, **Frank Millard** also discovers the recharging sector may need ITS to spark life into the electric vehicle market

Illustration courtesy of Ben White

Provision for electric (EV) and hybrid vehicles is fast becoming a priority in transportation departments around the world. But implementing charge stations in the best locations and making them convenient and accessible aren't the only factors to consider. As more drivers turn to EVs and hybrids, there will be a fall in revenue from gas taxes – already a diminishing resource for DOTs – with the potential for dire financial consequences. With this eventuality looming, DOTs are busy looking for alternative models of funding.

A further factor to be considered is how these increasing numbers of electrically powered vehicles and their hybrid cousins will fit in with intelligent transportation systems as they, too, evolve and become more sophisticated. Does, for instance, the technical evolution of EVs jibe with ITS technology and strategy – or are we placing brand-new dinosaurs on 21st century roads? The time to address the convergence of EVs with ITS is now, otherwise


SAT NAV
CAR PARKING
CHARGE LEVEL

Dynamic jewel

Dr Anthony Thomson from charging pioneer Qualcomm reveals how a wireless infrastructure could be the key to unlocking the potential of the EV market

The vision of Qualcomm's Dr Anthony Thomson is for EVs and their charging infrastructure to not only be ubiquitous but also wireless-enabled. Qualcomm is currently working on wireless EV charging (WEVC), the natural extension of which will be dynamic electric vehicle charging (DEVC) – in other words, charging on the move. The latter, though, is at the R&D stage and some years away from fruition, according to the company's vice president of business development and marketing.

A next step will be to build a full-scale test track. "This will provide us with experience of the deployment criteria needed to test our unique DEVC design," Thomson reveals. And while major infrastructure upgrades would be necessary for dynamic charging to be realized, Qualcomm is working with industry and the public sector to highlight the potential that the Qualcomm Halo technology could have in opening up the EV market. "This will come first with stationery charging, then semi-dynamic charging, followed by dynamic charging on the move," Thomson predicts.

> "We're running a WEVC trial in London this year that will provide us with some good insight into how EV drivers will charge wirelessly

"Over the past 20 years, we've progressed markedly from simple, rather primitive IPT systems where design was a black art into modern, technically mature solutions capable of charging a range of modern EVs/PHEVs," he continues. This research is now evolving into a deep understanding of how to develop dynamic powering of EVs.

Qualcomm's immediate aim, however, is to commercialize WEVC into series design and EV production. "We're running a WEVC trial in London this year that will provide us with some good insight into how EV drivers will charge wirelessly as well as the user benefits of WEVC over plug-in," Thomson adds.

The Qualcomm Halo WEVC technology is ideally suited to densely populated urban environments such as London, and it is hoped it will also help drive EV adoption which, in turn, will reduce city pollution levels. WEVC could even complement existing plug-in schemes. Qualcomm feels the technology to be viable for any city, though, especially given the trend toward growing urbanization as well as the pursuit of 'smart cities' initiatives.

One of these has the backing of UK Prime Minister David Cameron, with Qualcomm's large-scale pre-commercial trial of WEVC in London seen as the perfect mega-city environment. This will involve up

repentance and monumental expense will more than likely ensue in the future.

Time for an oil change?

Of all the countries in Europe that are actively promoting plug-in technology and its associated infrastructure, Germany is in the vanguard, not least when it comes to hydrogen. "It's the better oil for today," feels Dieter Zetsche, chairman of the management board of Daimler. "And that's why it's time for an 'oil change'." Daimler and Linde are currently working together to deliver a hydrogen fuel infrastructure for Germany.

(Left) **Linde and Daimler intend to more than triple the number of public hydrogen refueling points in Germany**

"EVs equipped with a battery and fuel cell will make a big contribution to sustainable mobility in the future," agrees Zetsche's colleague, Professor Thomas Weber, who heads up Daimler Group Research & Mercedes-Benz Cars Development. "Because it is very customer-friendly, with a great range and fast refilling, fuel-cell technology has enormous potential for greatly advancing our country on its path to becoming the lead market for e-mobility."

In another project involving Daimler, Hubject of Berlin is developing an interoperable Europe-wide public charging infrastructure to facilitate e-roaming. "In the future, e-mobility customers will be able to use the infrastructure of all our partners across Europe under a single provider's contract," says Andreas Pfeiffer, managing director at Hubject. "This will make charging an EV as simple as withdrawing cash at an ATM."

Fuel Britannia

In June 2011, the UK's Department for Transport (DfT) published *Making the Connection: the Plug-In Vehicle Infrastructure Strategy*, outlining its own charging vision for cities up and down the country. The UK government expects there to be tens of thousands of plug-in vehicles on its roads by 2015, and hundreds of thousands by 2020, so it wants to be in a position to deal with the demand.

Qualcomm is pioneering the development of WEVC technology as a way to bring EVs to the mass market

to 50 passenger and light goods vehicles, from passenger cars to taxis and car-share schemes, and is supported by a cross-section of stakeholders such as Delta Motorsport, Addison Lee, Renault, Transport for London and Chargemaster plc.

The objective is to allow partners to better understand how WEVC can be deployed in a dense urban environment and to gain feedback from WEVC drivers about their overall experience of wireless charging. Results are expected in late 2013.

Further into the future, early dynamic trials will take place in what Thomson anticipates will be the 2016-2017 timeframe. Still some years away, the Qualcomm man is nevertheless adamant dynamic charging will be a reality within the next 20 years.

The DfT's Plugged-in Places (PIP) program is one of the main initiatives to kick-start this UK-wide ultra-low-emission vehicle (ULEV) revolution. A recent government *Spending Review* also announced provision of more than £400m (US$619m) to support growing the market of ULEVs in the UK until 2015. Of this, the government made £30m (US$46m) available to match-fund eight PIPs to install and trial recharging infrastructure as part of a commitment to install up to 8,500 charge points.

American dreams

Enthusiasm for plug-in technology is growing in the USA, too – plug-in.com lists 1,625 charging stations – although it is largely confined to states on the east and west coasts. California leads the way with 1,056 EV, 140 natural gas, 18 liquefied natural gas and 33 biofuel stations – although only four hydrogen points.

In November 2012, the California Energy Commission announced an increase in funding to expand the Golden State's charging infrastructure in line with Governor Jerry Brown's Executive Order of March 2012 to be able to support an estimated one million zero-emissions vehicles on the state's roads by 2020.

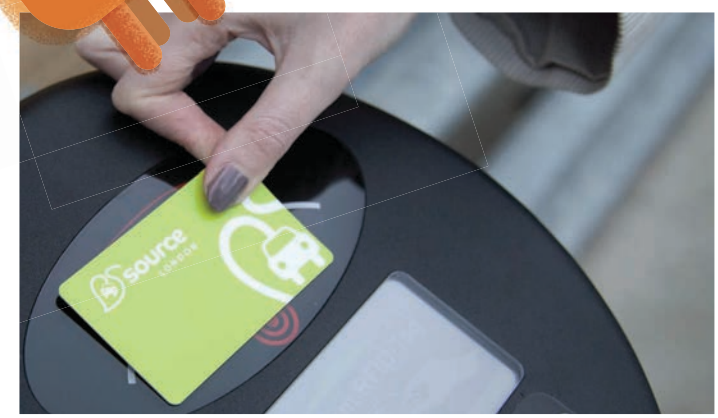
Oregon's DOT has been actively encouraging EVs onto its roads. Yet it has also been concerned about ensuring sufficient funding to replace dwindling gas-tax revenue, a small percentage of which can be attributed to EVs slipping through the taxation net. As the fairest and most efficient solution to the funding conundrum, the DOT has turned to a road-usage charge in the form of a per-mile fee, initially for all vehicles above 55mpg equivalent (estimated mpg as calculated by the US EPA standards). In the future, it is anticipated this number may include all vehicles above an mpg equivalent standard that might match the Federal CAFÉ fleet standards of 2016, which is 34.5mpg equivalent – which in 10 or 15 years could be the majority of vehicles on the road.

(Below) **In May 2011 the Mayor of London, Boris Johnson, launched the Source London charge point network – publicly accessible charge points located at supermarkets, on the street and in parking lots all over the UK capital**

Funding chasm

In 2001 the Oregon Legislative Assembly introduced the Road User Fee Task Force to "develop a revenue-collection design funded through user-pay methods, acceptable and visible to the public, that ensures a flow of revenue sufficient to annually maintain, preserve and improve Oregon's state, county and city highway and road system".

After considering more than 24 options, the Task Force decided a road-user fee held the most promise and a pilot scheme was introduced in the Portland area, which consequently proved the feasibility of the project. In late 2012 a second pilot study began, which concluded in January 2013, with a report being presented to the Legislature. Participants selected their choice of mileage-based user fee technology from a number of plans and their mileage was recorded, reported and then an invoice was generated.



> Our updated Road Usage Charge Pilot Program focuses on achieving public acceptance
>
> **James M Whitty, manager of the Office of Innovative Partnerships and Alternative Funding, Oregon DOT, USA**

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Way ahead, way out west

Alongside Oregon DOT (ODOT) and the Oregon Department of Energy (ODOE), in March 2012 US charging specialist AeroVironment opened

the first phase of the West Coast Electric Highway. "This will eventually stretch along I-5 from the Canada to Mexico borders," reveals Wahid Nawabi, senior vice president, general manager, Energy Efficient Systems for AeroVironment.

A few months after, in May 2012, this border-to-border vision moved closer to becoming a reality with the opening of eight EV charging sites along I-5 in Washington State, extending the highway right to the Canadian border.

There are now a total of 10 charging sites along I-5 in Oregon and five additional charging sites along major arteries, with 17 more sites in the works. "Most of the sites along the West Coast Electric Highway feature our fast EV charging stations, which deliver a full charge for a nearly depleted EV battery in less than 30 minutes," continues Nawabi. "Drivers can see the stations' availability via AeroVironment's mobile app."

Nawabi says the charging locations are strategically placed near desirable shopping, restaurants and entertainment venues, in doing so benefiting drivers and businesses alike.

A smartphone option featuring device compatibility with ICE vehicles and hybrids was also tested.

"Our updated Road Usage Charge Pilot Program focuses on achieving public acceptance by introducing new concepts such as motorist choice, open systems and a private sector administration option," explains Oregon DOT's James M Whitty, manager of the Office of Innovative Partnerships and Alternative Funding.

And Oregon could just be the start of this movement. "Minnesota is currently completing a pilot program as well, which began in 2011," Whitty reports. "Other states such as Washington, Nevada and Colorado are taking active steps, too."

This all leads Jack Opiola, the managing partner and president of D'Artagnan Consulting, to believe that the gas tax is no longer a sustainable source for transportation revenue: "We've reached a point where we have highly efficient IC engines, efficient hybrid vehicles plus new-generation plug-in hybrids and EVs. The newer-generation IC engines and hybrids are pushing 40-100mpg. When the fuel efficiencies are in these ranges, you can't possibly fund transport infrastructure through a consumption tax," he says.

A more direct source of funding of transportation infrastructure is the way forward, Opiola advises, which is why he also supports a distance-based tax on the user-pays principle. And he doesn't stop there: "Any urban environment should address its transport funding through a three-part revenue stream: a portion of property taxes, fare box collection revenues from public transport, and a distance-based tax on all vehicles. In the case of commercial vehicles, light and heavy trucks, it would be proper to charge them by their distance and the mass or weight they are rated to carry. Such a three-part stream helps provide a direct connection to sustainable transport infrastructure in urban environments."

Opiola goes on to point out that the steady reduction in fuel tax revenue is a concern for governments the world over. In 2004 the Australian government envisaged an eventual 24% drop due to the improved fuel efficiency of vehicles, and two years later New Zealand produced another study suggesting a similar decline. Back in the USA, Washington State recently increased fuel tax by 9.5 cents in an attempt to stabilize a downward trend in revenue, while in Vancouver the transportation authority TransLink currently identifies an approximate C$500 million funding shortfall between 2013 and 2015 as a result of these cleaner, more efficient cars.

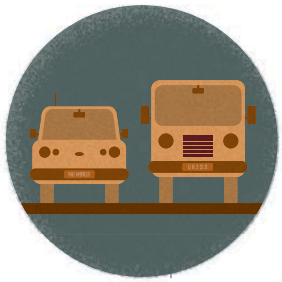
> "Infrastructure [in Europe] has been installed to 'encourage and support' the take-up of EVs, largely without a clear business case"
>
> **Phil Blythe, professor of ITS at Newcastle University, UK**

Phil Blythe, professor of ITS at Newcastle University in the UK, sees PAYD as the only logical solution to Europe's impending hole in road-related tax revenue. "Charging infrastructure here has been installed to 'encourage and support' the take-up of EVs, largely without a clear business case, particularly when co-funded by the Office for Low Emission Vehicles (OLEV) through its Plugged-in Places initiative," he says. "We now have almost 1,000 public charging points in North East England and have recorded more than 49,000 EV journeys and 16,000 charging events, so we're beginning to understand real charging behavior and informing other infrastructure providers on the best strategic locations for charge posts."

Thousands of new charging points for EVs are being installed across the UK to try to boost the market for so-called zero-emissions cars, such as the Nissan Leaf being built in Sunderland

Time for some intelligent thinking

Art James, senior project executive in the Office of Innovative Partnerships and Alternative Funding, also sees the imminent convergence of EVs and their associated



technology and infrastructure with ITS as having almost limitless possibilities. "A proliferation of EV car-sharing programs is exploding on the US west coast," he enthuses. "There are also trials using inductive charging – possibly embedded in the road – that could change how we perceive everything from driving, fueling and even owning vehicles in the future." (See *Dynamic Jewel*, page 44.)

A new generation of mass-produced plug-in vehicles is also being equipped with advanced onboard telematics that inform drivers of everything from energy use to the location of the nearest charging stations.

"The EV is what others have conceptualized as the 'connected vehicle' – it has to be!" Opiola continues. "I need the finer details built into the vehicle itself. I need a navigation system to plan not only my most direct route, but my most energy-efficient route – not the same thing! I need that satnav to indicate charging stations, parking lots, restaurants, hotels (with charging stations) and the like. Real-time data will tell me I am fourth in line to recharge at the nearest station with parking, so I can opt to go to a different location. All these 'features' are ITS features that aren't simply value-added services as we think of them today, but essential for an electric-powered world.

"I see the 'connected vehicle' of the future as *both* the 'ITS' vehicle *and* high-efficiency vehicle," Opiola adds. Further, he considers EVs and advanced hybrid vehicles as data-rich platforms. "As connected vehicles, they can anonymously feed their trip times, weather data, road conditions and other key data into our TMCs. Just think of the cost savings. If we had direct feeds from all these vehicles that were on the road, we'd be able to know and understand the exact conditions on the entire network without spending billions of dollars installing loops, cameras and our current suite of traffic detection sensors.

"More importantly, we could manage traffic more effectively with dynamic speed controls and navigational information to steer vehicles around congestion and accidents. In short, I think the future of ITS,

(Right) **Charge Your Car in the UK is expanding from a regional subscription-based EV recharging network to a national pay-as-you-go network, with a target of 10,000 charge points** (Below left) **Oregon DOT focused on choice, transparency, ease of use and protection of privacy when developing the road usage charge system piloted in its 2012 trial program**

traffic management, incident detection, modal choice, and so on, is tied to the future generation of EVs and advanced hybrid vehicles."

Phil Blythe is equally enthusiastic about how ITS could influence the eventual success of this electric future: "In order for EVs to succeed, we're going to need smart range estimators and navigation, and charging post pre-booking and management. Smart UTMC will also be a must," he says. "I'm thinking about systems that take into account EV performance – stopping them, for example, at the front of the line at a traffic signal because they accelerate away better than IC vehicles, hence can clear the queue quicker when lights go green. Eco driving assist is also critical and can extend range by 30%."

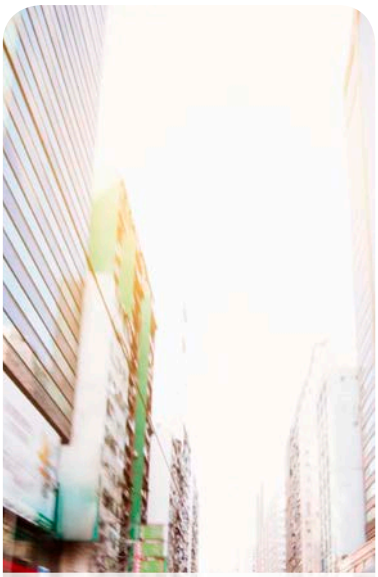
Certainly, the traffic challenges we face in 2013 are unlikely to have disappeared by 2073 just through the replacement of IC-powered vehicles with electric-powered variants. Population growth, housing development and urban sprawl will further exacerbate the situation. Accompanying these increases will be a corresponding density of vehicles on the roads. "Sixty years ago, who would have predicted the global use of cell phones or the information age of the internet?" responds Art James. "I'm confident we have the ability to apply technologies such as crash-avoidance, traveler information and route guidance to avoid worse traffic conditions due to demographic fluctuations," he says optimistically.

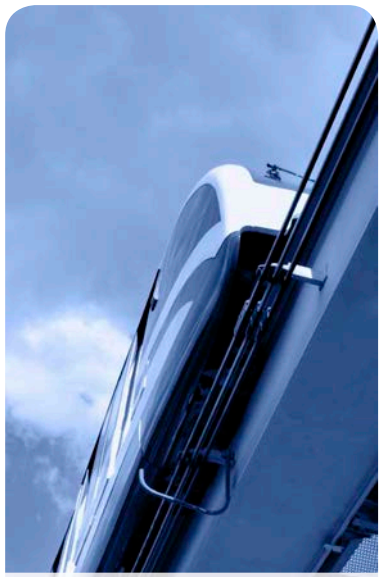
> "When the fuel efficiencies are in these types of ranges, you can't possibly fund transport infrastructure through a consumption tax"
>
> **Jack Opiola, managing partner and president, D'Artagnan Consulting, USA**

Smart choices for a smarter future

Opiola, meanwhile, links funding strategy with the avoidance of traffic problems, believing that if we apply the 'user-pays' principle and tax motorists by the distance they travel rather than the fuel they consume, we can provide the right price signals for people to make smart choices for their travel. Additionally, the data from these vehicles can be collected and provided back to drivers as value-added services. "The right answer may be a car trip in an EV or an advanced hybrid," Opiola says. "But the cost of the trip should be comparable to going by train, tram or bus."

A stark warning from the D'Artagnan Consulting chief serves as an ideal caveat to this topic. "If we make dumb transportation policy and tax hotels, hair salons, restaurants – and place a sales tax on goods and other services not directly related to travel choices – then congestion, accidents and other economic consequences will continue to sap our economic vitality and stall the economic engines driven by transportation."





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In the zone

Workzones present unfamiliar territory to drivers. But as **Saul Wordsworth** finds out, everyone from planners and engineers to law enforcement and drivers have a role to play in ensuring safe and efficient passage through the sites

Waiting at temporary traffic lights or funneling down from three lanes to one are both fine ways of squandering fuel, polluting the air and losing business. In the USA, it is estimated that 10% of total congestion is attributable to workzones, equivalent to 482 million hours. Meanwhile, in 2010, 576 highway workers were killed in and around roadwork sites – or one in 57 deaths on US roads.

"There is still much work to do but these numbers are coming down," believes John Corbin, director of Traffic Operations for the State of Wisconsin and vice chairman of the Standing Committee on Highways for AASHTO (American Association of State Highway and Transportation Officials). "Over the past decade, there has been a discernible shift in the management of workzones. A lot of decisions affecting workzone impact were traditionally made early in the project, with limited consideration for user delays. There may have been small efforts to mitigate delays or keep lanes open but these were mostly gestures. Today the order of the traditional message of warn, mitigate or avoid has been inverted."

Illustration courtesy of Ian Dodds


70
30
15
ROAD
LOSED
HEAD
REDUCE
SPEED

A week to remember

As a result of the efforts of VDOT's **David Rush**, every year states across the USA now remind motorists that safer driving means safer workzones. And the message seems to be getting through

David Rush, workzone safety program manager at the Virginia Department of Transportation (VDOT) is the man behind American National Workzone Awareness Week. He introduced it in Virginia in 1997 during the first week of daylight saving time, getting his employees to recognize that the construction and maintenance season was gearing up, and holding press conferences to remind the public to drive slowly in workzones. The following year he presented the idea to the FHWA and it's now a permanent fixture across the nation.

"The best way to keep workzones safe is to ensure employees are properly trained, that they know exactly what type of devices to use, and how to get them in the right order," he advises. "Most importantly, as soon as everything is set up, we tell our folks to drive their vehicle through the workzone. You may have put a sign behind another sign that's 50ft down the road, or your taper might be a little short. It's important that everyone wears their high-vis safety apparel not only out of the workzone but in it. Annually more workers are struck by equipment inside zones than by errant vehicles entering them."

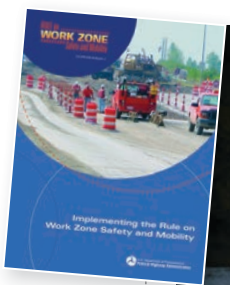
> "We try to stress work facing traffic as you never know when the next driver coming down the road might take their eyes off the road and swerve into the zone

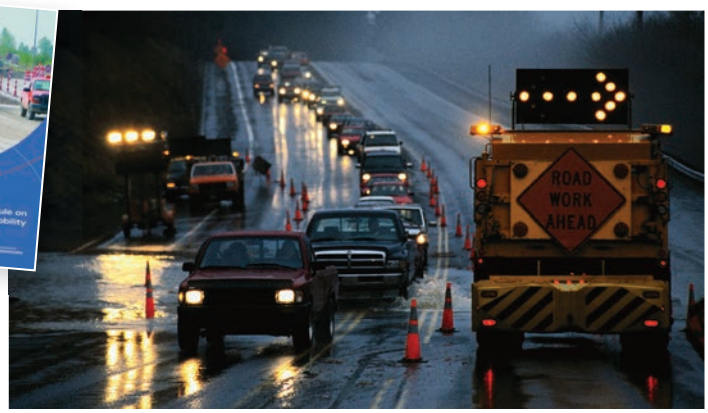
Rush sees a lot of rear-end shunts in his everyday work. In fact, 60-65% of workzone accidents are from-behind collisions, the reason being that almost all drivers slow down or stop inside a workzone. "Everyone wants to turn and see what the workers are doing. If you're not paying attention you'll run into the back of someone. People are invariably going too fast. When you see the orange signs, leave the radio alone, put your drink down, get off your phone, don't be texting, put both hands on the wheel and prepare to stop."

What this means in the USA is that efforts to avoid delays are now a priority and are built into project plans from the start. Roadways or bridges are widened to shift traffic lanes and keep them open. When avoidance isn't possible the mitigation option is taken, with greater forethought fed into the planning of lane closure and night work. Warning systems via variable message signs (VMS), broader public information broadcasting and social media have become more aggressive.

"The change can be boiled down to the three Ps: performance, planning and partnership," Corbin adds. "There's been a cultural shift in the way workzones are considered, both in terms of traffic flow and safety."

One of the reasons for improvement in the USA was an FHWA best practice report from 1998 that identified workzones as a major source of irritation and potential danger, and outlined a significant re-emphasis on traveler mobility and safety considerations. "Although there may have been groups and contractors taking safety and mobility seriously, that survey work made it a national focus," suggests Gerald Ullman, senior research engineer at Texas Transportation Institute, who works on TTI's Work Zone & DMS Program. "Advances made as a result include improvement of real-time dissemination of construction information. The ITS evolution over the past 15 years means that workzone ITS has moved from the experimental to the mainstream."





(Above) **The FHWA issues guidance on best practice in workzones** (Right) **Reducing lane access can cause major traffic problems so DOTs are now striving to conduct as much of this work as possible at night**

Similar changes have taken place in Europe, according to Anne Bolling, an analyst in Vehicle Technology and Simulation at VTI, Sweden's National Road and Transport Research Institute, who has seen workzone management shift from the neglected child of roadway thinking to a primary focus. "Priorities have undoubtedly changed," she says. "Along with improved traffic flow, safety for both driver and worker has become much more important. This can only be positive." Such an approach is

The most common mistake drivers make in workzones is simply not paying enough attention, hence the reason why every state celebrates National Workzone Awareness Week each April. What about the road workers?

"All too often they get used to being behind cones and plastic drums," says Rush. "They're not focused on what they're doing and a lot of them work with their backs to traffic. We try to stress the need to work facing traffic because you never know when the next driver coming down the road might take their eyes off the road and swerve into the zone."

(Above) **The VDOT Workers' Memorial provides a place where family members, friends, and colleagues can reflect on their loss** (Left) **Poster publicizing 2013's National Work Zone Awareness Week**

exemplified by the work conducted by ARROWS (Advanced Research on ROad Work zone safety Standards) in Europe, and by the European Transport Safety Council (ETSC), whose recent report PRAISE (Preventing Road Accidents and Injuries for the Safety of Employees) focuses on protecting road workers.

Before pondering where the future of safe traffic flow resides, though, it might be worth considering some examples of workzone management in practice.

Quick work

In December 2012, commuters on Utah County's I-15 had cause for celebration. Two years after the state's I-15 Corridor Expansion Project (or 'I-15 CORE') began adding two lanes in each direction over a 24-mile stretch, the job was complete. Disruption came to an end, two years ahead of schedule. Not only is I-CORE the country's fastest completed billion-dollar highways project, it came in US$260m under budget.

"We maintained full-lane access for 90% of the time," reveals Todd Jensen, I-15 CORE project director at Utah DOT. "Our standard lanes are 12ft wide, but we went down to 11ft – at times our hard shoulder went from 12ft to 2ft. As much as 90% of our lane and exit work was done at night to help reduce delays."

Using anonymous vehicle data, I-15 CORE employed the extensive use of travel-time sensors to measure traffic flow and provide arterial traffic data, which was subsequently fed directly to the trailblazer roadsigns for up-to-the-minute travel-time information. "This way the driver sees how long their journey is likely to take, and can then decide to try their luck on the Interstate or choose local roads," Jensen says. "Intercepting people at the decision point helps them make the right choice before it's too late and leads to a reduction in delays, stops, emissions and the number and severity of traffic incidents. The project was a real triumph in every respect."

> There's been a cultural shift in the way workzones are considered, both in terms of traffic flow and safety
>
> **John Corbin, director of Traffic Operations, WisDOT, USA**

(Below) **Construction on the I-15 CORE project was finished in 35 months, making it the fastest billion-dollar public highway project ever built in the USA**

Carmageddon: the return

Most will have heard of Carmageddon, California's much-heralded weekend closure of the I-405 highway in July 2011. But what of its 2012 sequel? "The main purpose of Carmageddon II (C-II) was to complete the demolition of the other half of the Mulholland Bridge that was left intact during Carmageddon," explains Jose Mortero, senior transportation planner at HNTB. "For safety reasons, the I-405 freeway – five lanes in each direction and infamous for its congestion – and Mulholland Drive had to be completely closed to traffic during the demolition operations. Closing both at the same time provided a challenge to reroute regional freeway and local arterial traffic."

Would more people decide to travel after seeing the outcome of C-I, when the roads were almost empty? Following C-I, Mortero knew the importance of social media campaigns, advanced warning messages (including portable VMS) and the coordinated efforts of the Unified Command and agencies involved in reducing traffic demand during demolition.

Highway versus urban zones

Speed is the principal difference between highway and urban workzones – highway speeds obviously being that much faster. This acts to reduce the time available for motorists to react to 'surprises' and increases the severity of crashes that occur.

Highway facilities are designed for uninterrupted flow, with drivers expecting them to operate as such. The introduction of a workzone – especially one that requires a substantial decrease in speed to negotiate safely – can be a greater violation of driver expectancy than a workzone on an arterial street that normally operates with flow interruptions such as stop signs and traffic signals. Consequently, a significant part of workzone management is an emphasis on minimizing the causation of speed differentials and avoidance of capacity restrictions that cause traffic queues to form during certain times. That, and getting the driver's attention sufficiently in advance to ensure preparation for the possibility of traffic flow disruptions.

The bigger issues for urban arterial street workzones tend to be associated with accommodating driveway access to residences and businesses along with maintaining pedestrian and bicycle mobility when work activities disrupt normal travel paths. Ensuring such travelers are positively guided through the work and protected from vehicular traffic and project hazards can be very challenging. Plus, frequent intersections, high traffic volumes, lack of available detours and night work hampered by noise and light disturbance for nearby residents also add to the complexity.

Efforts by the HA to communicate its campaign have been effective. Last year, its Supplier Recognition Award for Health and Safety went jointly to Costain Carillion Joint Venture and Tarmac. The former's safety record on the M1 Junction 10-13 managed motorways scheme saw four million man-hours without a single injury or fatality. This was ascribed to comprehensive staff training programs, a collaborative approach to developing best working practices and the promotion of a healthy workforce. Similarly, Tarmac had 2.5 million straight hours on Highways Agency contracts without a single major incident. Highly commended was A-One+, which devised Intellicone – whereby an alarm sounds if a cone is moved or becomes displaced, in doing so warning workers that an errant vehicle may be on a collision course.

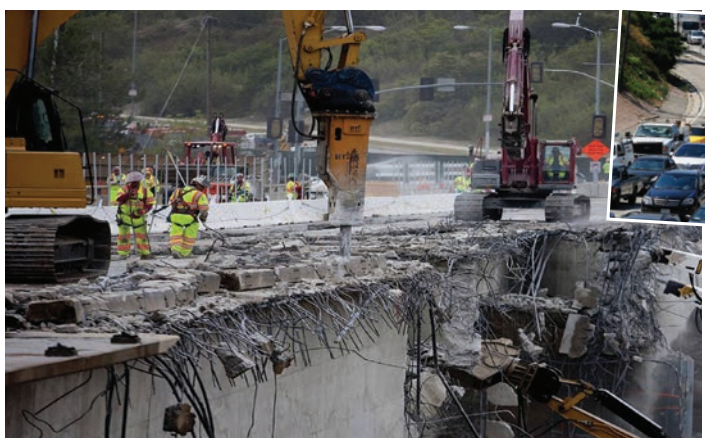
All stakeholders, including LA Metro, LADOT, law enforcement and Caltrans, bought into the idea. The terminology, 'Carmageddon', caught the attention of the public – but would it do so again?

As with C-I, the outcome of C-II was light traffic and demolition completed ahead of schedule. "Overall traffic activity in the Los Angeles region decreased by about 35%, traffic on freeways approaching the closure area by as much as 60%, and traffic on local streets by 25%," Mortero reveals.

Safety first

A 2006 survey by the Highways Agency (HA) in England claimed that "up to 20% of road workers had suffered some injury caused by passing vehicles in the course of their careers and 54% had experienced a near-miss with a vehicle". In 2009, the HA established its 'Aiming for Zero' campaign, with special attention given to road workers. Central to the approach was 'Exposure Zero' – the goal being to eliminate the need for road maintenance workers to be on foot on a live roadway.

> Intercepting people at the decision point helps them make the right choice before it's too late and leads to a reduction in delays, stops, emissions and the number and severity of traffic incidents
>
> **Todd Jensen, I-15 CORE project director, Utah DOT, USA**



(Top right) **Milwaukee's busy Zoo interchange** (Left) **Carmaggedon II actually saw less congestion than during usual** (inset) **I-405 operations**

Innovation in Milwaukee

The Milwaukee freeway system is the busiest in Wisconsin and includes two large interchanges. Marquette, named after the university, was reconstructed eight years ago. The other, where work has just begun, is known as the 'Zoo' interchange as a result of its proximity with Milwaukee County Zoo. The latter is the busiest in the state on account of commuter traffic and freight on its way to Chicago.

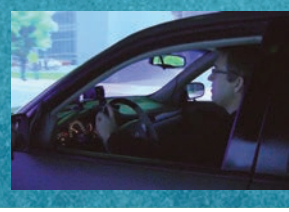
"The Marquette interchange was engineered with great planning and early budgeting to accommodate the maintenance of through movement of traffic with limited lane closures," continues Wisconsin DOT's

Human factors in workzones

Driving simulators have been used extensively to observe human factors on the open road but very little to record driver behavior in workzones. A recent study conducted at the University of Iowa using the National Advanced Driving Simulator (NADS) MiniSim, the world's most advanced simulator, sought to change that, however.

The study found that its participants were most comfortable driving in a workzone surrounded by the solidity of concrete barriers rather than by drums or channelizer barriers. Participants drove closer to these barriers – which are most likely used in long-term workzones – than they did the drums or channelizers. Although there was minor anxiety that they may scrape their car against the concrete, as one participant noted: "I felt they provided the clearest line and straightest line to judge against. I also felt the workers were the most protected by them."

Although participants drove fastest with concrete barriers present, their speed varied the least. This is important as even minor fluctuations in speed can cause back-ups or rear-end shunts. It's also worth noting that drivers tended to stay furthest away from the drums – which may cause problems on the other side of the car.



John Corbin. "What we learned from Marquette is being integrated into Zoo, however this is proving more challenging in terms of avoiding delays. What we are doing is deploying an Integrated Corridor Management (ICM) system. At its centerpiece is an inter-jurisdictional adaptive traffic signal control system."

Only a very limited number of arterial roads can divert traffic from the freeway that crosses through the Zoo interchange. Maximizing traffic flow while safeguarding the safety of those arterial routes thus requires some aggressive thinking about how the signals can be integrated across jurisdictional boundaries, as well as how that integrated signal system could be made more intelligent to respond in real time to what could be dynamically challenging and not completely predictable traffic patterns.

"The corridor management system will dramatically mitigate some of the user delays that couldn't be avoided in the design and the construction of interchange," Corbin says. "The corollary to this is the travelers' information services that will be addressed by an enhanced deployment of arterial dynamic message signs and dynamic displays of other types."

(Top left) **Portable message signs offer a valuable way to get information to motorists in real time** (Left) **A tribute to PennDOT employees who lost their lives in workzones**

The future

The construction industry will continue to innovate. A modular approach – for instance bridges removed for maintenance and being replaced by temporary structures – is likely to continue apace, the result being an increased likelihood of delays being avoided in the first place. So what of ITS? "I anticipate the use of simulation in workzones," predicts Tom McDonald, head of engineering, Institute for Transportation, Iowa State University. "Agencies are often hesitant to try new things on open roadways because of the inherent danger and risk. By simulating, you can try a lot of new ideas, make adjustments and not cause accidents. Although there has been no commercial use of simulators as yet, they have been used to complete scholarly evaluations of various workzone treatments." (See *Human Factors In Workzones*, above.)

> I anticipate the use of simulation … Agencies are often hesitant to try new things on open roadways because of the inherent danger and risk
>
> **Tom McDonald, head of engineering, Institute for Transportation, Iowa State University, USA**

And what of delay mitigation and driver warning? The FHWA predicts a future with greater use of project coordination, innovative design, contracting and construction strategies, and performance monitoring and management that can increase workzone safety, reduce mobility impact on the transportation system, and maximize the constrained funding resources available for transportation.

"I think we'll see a higher level of corridor- or network-level multi-agency integration and collaboration of traffic management and traveler information service systems," concludes Corbin. "In addition to this and minor technological breakthroughs, we must consider the future connected vehicle. This will allow us to leapfrog forward in terms of communicating with drivers. Active or passive interaction will enable us to track more accurately traffic patterns to assess in real time how effective our traffic management techniques are proving in fully utilizing available highway capacity within a corridor."

TI Corp's **Mike Proudfoot** reflects on a job well done across the Fraser River in Vancouver – and the tolling model that US operators could do well to replicate

Interviewed by Nick Bradley

> "Vancouver's a great place to live and the world is coming, so our transportation system has to be ready for that growth

Where do you start in heaping praise on Vancouver's Port Mann/Highway 1 Improvement (PMH1) project – a contender for an IBTTA Toll Excellence Award if ever there was one? How about with the bridge itself – the widest in the world (according to the *Guinness World Records 2013*), with eight lanes of traffic now and 10 by 2014 when the project is eventually completed? The slickest of customer services operations you're ever likely to see, with provider TC Flow (a Sanef/Egis JV) seemingly leaving no stone unturned in delivering satisfaction? The success of the outreach campaign prior to the bridge opening to traffic on December 1, 2012 – and the resultant 75% of users being registered with TReO accounts? Or the fact that it's the perfect blueprint for US tolling interoperability, with 6C, Title 21 and ASTMv6 tags all readable by the multi-protocol FastFlow solution from Sanef ITS?

Building your way out of congestion

Mike Proudfoot is in no doubt when musing over the project's numerous achievements. "If you'd have been here last November, you would have seen 14 hours of congestion on the old Port Mann Bridge each and every day. It was absolutely crippling," says the CEO of Transportation Investment Corporation (TI Corp). "We had 1960s infrastructure with 21st century demands. The population of the Greater Vancouver area back then was 800,000 and now it's darn near 2.5 million with another million on the way by 2031. Vancouver's a great place to live and the world is coming, so our transportation system has to be ready for that growth. This project has been long overdue, but from day one people were experiencing travel-time savings of 30-50%."

'What will you do with the time you save?' was a theme of one of the TReO advertising campaigns in September 2012 to drum-up toll registration. You get the impression from a clearly delighted Proudfoot that – if he could – he'd wait at one end of the 2,020m-long structure and ask every single user that exact question.

The 37km commute from Langley to Vancouver would previously have taken 1 hour 48 minutes in a car, a journey that will now take only 47 minutes. From the community of Surrey on the south side of the bridge to Coquitlam on the north, would once have taken 53 minutes; it is now just 21 minutes. "That's just huge," Proudfoot says with a smile.

Financed solely by TI Corp, PMH1 is the largest transportation project in the history of British Columbia at C$3.3bn, but Proudfoot says it's not just about the bridge. "The Province is spending C$1bn on the South Fraser Perimeter Road – a brand-new, 40km-long expressway to give people the choice if they don't want to pay a toll to use the Port Mann Bridge," he reveals. "There have also been huge improvements to the major highway to the USA-Canada border, the main connectors going east to west, the interchanges, HOV additions, park-and-ride facilities, and upgrades to the ports. It's also about bicyclists, pedestrians and transit. In late January, for example, a C$1.4bn investment was announced to construct the Evergreen rapid transit line. All in all, it's billions of dollars' worth of Provincial investment happening right now – and it's very much welcomed. PMH1, though, couldn't have happened without tolling."

The tolling debate

It's interesting – but perhaps unsurprising – that it took a great deal longer to reach a decision as to how the project would be financed than it did to actually construct the bridge. "The team was assembled in 2003 – just crystal ball gazing, concept

> I don't envisage we'll have the problems with bad debts and unbillables that dog other toll authorities

development, a lot of dialog – and then in 2006 we launched the consultation program and environmental assessment," Proudfoot recalls. "It was the broadest consultation process in the history of BC's Ministry of Transportation – every community, mayor, councilor and stakeholder – every group we could possibly find. We presented the facts and asked the question. Here's the problem, here's a solution, and it's going to involve a huge investment. Do you see tolling as an appropriate way to pay for that? It wasn't a massive majority until we added facets such as HOV discounts and priority movements for transit, but the fact that tolling was eventually embraced was a good outcome."

Serving the public trust

TI Corp, a Crown corporation, was established in 2008 with the independence, responsibility and accountability to deliver the project as conceived and approved by the BC government. This involved not only the construction of the bridge and upgrading of 37km of highway (at a cost of C$2.5bn), but the tolling, the collection and the paying off of the debt over a 40-year period, as well as the operation and maintenance of the corridor during that time – plus any upgrades and expansion that may be necessary in the future. Construction started in 2009 and on December 1, 2012 – as promised by toll system supplier Sanef ITS and TC Flow – the stage was finally set. "We are very proud of the work that everyone involved put into this," Proudfoot states.

"The fact that TI Corp is a Crown corporation is a big deal," he adds. "This structure is under public ownership, which isn't the case with a lot of other toll facilities around the world, for example in North America or even Ontario, where facilities are built and operated by the private sector, sometimes with some government ownership or involvement. We're different. There was some initial confusion among the public, which took a certain amount of clarification to convey a clearer understanding that we are a public agency that is protecting the public interest, and that we haven't sold an asset. And when it's paid for, the tolls come off."

On the subject of figures, Proudfoot projects toll revenues from the bridge of around C$200m a year. "We issued around 370,000 statements to registered customers and 250,000 invoices to unregistered users in mid-January. Based on what I know of other toll projects around the world, that's usually when the phone starts ringing and you get the media on the line asking about inaccurate bills, ghost reads and so on. But touch wood, the phone hasn't rung. By any standard that's a tremendous record of success in terms of accuracy around the statement and invoicing process, and also a reflection of the customer service focus. If problems do arise, they're dealt with quickly and professionally by our team."

We can talk about construction, steel, asphalt, concrete and tolling systems, but a valuable lesson for other toll operators was how TI Corp through TC Flow achieved such impressive registration levels. "We have a strong base of tech-savvy people here in Vancouver, not just youngsters but middle-agers, too," Proudfoot says. "Electronic tolling is easy. It's automatic and we had the right mix of payment mechanisms – by debit, by phone, over the web and with sticker tags.

"Our toll structure is unique in that everybody has access to the lowest rate of toll – as long as you pay within the seven-day timeframe," Proudfoot notes. "We don't necessarily have a transponder rate or a cash rate, but like all toll authorities we place an emphasis on registration because the registered customer is the most operationally efficient for us, particularly if using the sticker tag, as we don't then have to rely on the cameras and OCR for image review. The fact that 75% of customers are registered is a pretty solid performance."

Other initiatives that Proudfoot says encouraged take-up include a '20 free trips' offer if Vancouverites signed up by November 30, 2012, and also a discounted rate until December 1, 2013, if they signed on the dotted line by February 28, 2013.

"We had 60,000 people register 90,000 vehicles on the final day of the free trips offer, so that was a very successful exercise," Proudfoot reports. "We also have 25% discounts for HOVs if traveling during peak periods, and monthly passes set at the equivalent price of 50 trips, so for commuters/frequent travelers it can have the effect of a free weekend."

Insurance policy

TI Corp also has a watertight system in place to deal with those who don't pay the toll. "As TI Corp is a Crown corporation and all vehicles are registered by the Insurance Corporation of British Columbia (another Crown corporation), anyone with outstanding toll bills won't be able to renew their license or obtain vehicle insurance. So I don't envisage we'll have the problems with bad debts and 'unbillables' that dog other toll authorities," Proudfoot says. "And we have 'look-ups' with all the US states south of the border, so we can chase down out-of-towners too."

The new Port Mann Bridge can accommodate 250,000 to 300,000 vehicles a day. Currently and depending on the time of year, traffic levels fluctuate between 100,000 and 120,000 vehicles a day, hence there's enough capacity to go to well beyond 2031. So with the old Port Mann Bridge currently being demolished, disappearing altogether by 2014, Proudfoot is looking forward to the congestion problems of the past disappearing with it.

Environmental stewardship

Environmental programs have been a huge focus area during the development of the PMH1 project, which included protecting the interests of the First Nations Kwikwetlem communities. "They have been in the area for 10,000 years – twice as long as the pyramids in Egypt – and I'm always humbled by that," says Mike Proudfoot.

One project involved enhancing habitat in Colony Farm Regional Park. "With an investment of about C$4-5 million and with the engagement of the Kwikwetlem, we brought salmon back to the area for the first time in 100 years," Proudfoot continues. "We've won awards for that project. It's not always about steel and cars, it's about the environment and cultures."

Habitat enhancements involved widened and deepened river channels, new channels and ponds, and the installation of self-regulating tide gates.

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Made to measure

Evaluating TMC performance has been a longstanding headache. But as **Morteza Fahrtash** reveals, a tailored approach using a measurement-based system can ease this pain

Main photograph courtesy of Jae C Hong/AP/Press Association Photos

Over the years, California's state DOT, Caltrans, has invested heavily in Transportation Management Centers (TMCs). These operations centers are tasked with maintaining the safety and efficiency of California's highways by actively managing disruptions to the system caused by anticipated and unanticipated events that impact the available capacity and/or the demand to use individual facilities. Presently, however, no comprehensive methods are available to quantify the benefits of existing TMC deployments.

This situation prompted a team of researchers from the DOT to develop a method of evaluating TMC operations using data available from the Caltrans District 12 activity-logging software and the DOT's Performance Measurement System (PeMS). For a given incident, the research methodology first models the extent of delay caused by the incident using a novel mathematical programming technique. This provides a baseline delay from which various 'what-if' scenarios can be considered to explore how the absence of the TMC might increase delays incurred by travelers in the system.

To support this method, changes were made to the District 12 activity log software to record critical events more accurately during incident management. The District 12 TMC activity log records a range of actions carried out by TMC operators that are manually recorded using a web-based interface to the log database. Transactions in the database are cross-referenced with a CHP database called the iCAD system, which contains information (such as the incident's geographic coordinates) that is associated with each incident under analysis.

Although a range of techniques are available for valuing the TMC, the research team focused quantifying the delay savings that can be attributed directly to TMC actions

Identifying core events

One of the critical steps in this process was the identification of core events in incident management that can be directly recorded by the activity-logging system through a set of interviews and communications with District 12 staff and contractors.

The end product of this research is a web-based TMC Performance Evaluation (TMCPE) application that addresses this problem. The system allows TMC managers to evaluate the performance of various bundles of TMC technologies and operational policies by mapping their effects onto events in the system that can be measured using existing surveillance systems and daily activity logs.

The tool provides managers with the long-needed capabilities to justify valuable technology, personnel allocations and maintenance costs. It also allows them to identify technologies that aren't meeting their initial promise, as well as identify gaps in current operational strategies that might be filled with new technology deployments.

The evaluation method used considers delay savings that are attributable to specific

TMC actions. All computations are based on direct measurement of the system using available sensors and do not rely on speculative simulation models requiring extensive assumptions.

The new TMCPE tool will enable the DOT's TMC managers to evaluate the performance of various bundles of TMC technologies and operational policies by mapping their effects onto events in the system that can be measured using existing surveillance systems and daily activity logs.

Major delay savings are attributable to TMC operations even when only considering improved incident response times. The use of technologies such as CCTV for improved incident awareness and tight integration with other responders leads to vastly improved verification and response times. These, in turn, lead to reductions in incident-induced delay compared with the hypothetical absence of TMC operations.

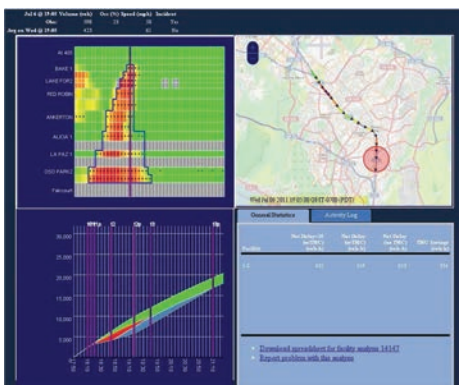
Furthermore, by enhancing the TMC activity logs to record the specific stages of incident response, this project obtained a finer resolution of TMC actions that allowed for more detailed modeling of incident dynamics. Similar improvements would no doubt be beneficial beyond District 12.

Researchers' recommendations

The researchers recommend continued development and fine-tuning of the TMC impact model, which estimates savings attributable to the TMC.

The alternative statistical techniques explored during this project also offer alternative and more robust approaches to determining which time-space sections are impacted by external disruptions. These data-mining methods are currently too computationally intensive to be included in the live website, but the techniques show promise for later deployment as the algorithms become optimized.

It is worth mentioning that many benefits offered by the TMC are not currently included in this tool, including the many direct and indirect benefits attributable to information dissemination.



(Left) **The TMCPE application shows four quads. The upper-right shows the location and context of the incident, while the upper-left presents the time-space diagram, reflecting the range of impact upstream of the incident. The lower-left presents the cumulative flow diagram showing the queuing dynamics. And the lower-right shows the delay saving attributed to the TMC, which graphically is the time difference between T3p and T3. In this incident scenario, the delay saving attributed to the existence of the TMC is 30%**

Driven by the data

Recent years have seen a considerable push toward better evaluation of highway systems using data-driven performance measures. A number of recent federally sponsored reports offer comprehensive overviews of current performance monitoring approaches and recommended practice for transportation management agencies.

A common theme of developing an effective performance measurement system for operations

is an early and complete definition of the goals of the traffic management system. These goals structure specific efforts in defining performance measurement tasks and applying the results to improve operations. Once system goals are defined, they must be translated into metrics that are obtainable from available (or feasible) data collection systems. Finally, the metrics should be integrated into management and operations to consistently evaluate the effectiveness of the system and, ideally, use that feedback across various timescales to improve performance over time.

> The new software tool will allow Caltrans' TMC managers to evaluate the performance of various bundles of TMC technologies and operational policies

It is however recommended that work be continued on enhancements to the TMC impact model in order to consider diversionary effects due to such information.

The final recommendation relates to the fact that the system is currently limited to analyzing incidents managed by Caltrans District 12, which is solely the result of the system's reliance on the augmented data now available from the District 12 activity log due to improvements made in support of this project. Because the TMC activity log (TMCAL) system currently being deployed by Caltrans appears to be a developing standard for recording TMC actions, it is recommended that the TMCPE system be augmented to accept data from the TMCAL data source as well as its current District 12 activity log back-end.

The TMCPE system was designed from the outset to be as portable as possible by using open-source, off-the-shelf software that runs on multiple platforms. It is implemented using a modular software architecture that can interface with a variety of existing and planned systems used by Caltrans. The initial deployment focused on delivering a reporting system accessible from the California Traffic Management Laboratories website. Future deployments could integrate the core performance evaluation models with real-time TMC management systems. In this mode, a real-time delay estimator component would actively monitor for identified incidents, and would query the incident impact model to estimate the relative costs of delaying action on all active incidents. These results could be broadcast to any TMC management application to assist operators in prioritizing TMC actions.

• *Morteza Fahrtash is a senior transportation engineer with the California Department of Transportation based in Orange County*

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ITS Tennessee's **Don Hicks** gives four reasons why ITS America's Annual Meeting & Expo is touching down in the Volunteer State

Interviewed by Louise Smyth

It's fair to say that Don Hicks is pretty darn excited about ITS America's 23rd Annual Meeting & Expo coming to his hometown of Nashville, Tennessee. And rightly so: for him, this is of great personal importance. Although his day job is with Kapsch, Hicks serves as president of ITS Tennessee – quite an apt role for someone born and bred in the Volunteer State. His enthusiasm for both the locale and the ITS industry is infectious. "On behalf of the ITS Tennessee membership, we are thrilled to be the host for ITS America's annual meeting," comments Hicks on the show coming to the Music City. "It's a wonderful place to visit and we look forward to having folks here from across the USA and other parts of the world – we'll give them an introduction to true Southern hospitality!"

1 Welcome to Nashville…

Upon speaking with Hicks, it's clear that cooperation and communication are big themes of the upcoming annual meeting, and he explains how these are well illustrated in his home state. "Tennessee is the case study on involvement between different agencies; we've got some fantastic projects under way that represent the involvement of state, county, city, transit authorities and planning organizations all coming together toward a common goal."

When Hicks describes the lay of the land in the region, it is evident why this cooperation is so important. "Tennessee is a very long state – it has two time zones and we also share borders with eight other states," he begins. "The state has four major metropolitan areas – Memphis, Nashville, Knoxville and Chattanooga - and those areas have considerable ITS deployments. Interstate 40 is the major corridor; it runs the entire length of the state and is the third busiest freight corridor in the country. We have a diverse economy from healthcare to automotive to freight to publishing and all of that relies on our transportation system. Memphis for example, is known as 'America's distribution center' – it's home to Federal Express and Memphis International airport has been the USA's busiest cargo airport since 1992. So understanding those elements within our state is critical because we have to move people and freight efficiently and quickly in and through our state."

> We have a considerable number of automotive companies and their suppliers here, a lot of those folks are involved with V2V and V2I initiatives

2 Relief efforts

In terms of ITS deployments in Tennessee, Hicks reports a growing trend in where these deployments are targeted. "We're now seeing ITS move from the freeways to the cities and counties," he says. "So we're seeing arterial management initiatives that mean when the interstates are congested, motorists are given travel alternatives - and that helps us manage our existing infrastructure better."

A great example of these kind of efforts is the work that Tennessee DOT has been doing to evolve its 511 information system. Hicks is full of praise for the statewide ITS network known as SmartWay: "We have the mobile website, mobile app and Twitter feeds so there are plenty of ways we can get information out to road users. Users of the mobile app can push a camera icon and see the video from that area to help inform them of their route options." And the app is proving immensely popular; since it launched in late December 2012, more than 35,000 users have downloaded it.

Another jewel in Tennessee's ITS crown is the city of Chattanooga, as Hicks reveals: "As well as the recent completion of an ITS system featuring cameras, roadway sensors and DMS, the city also has a new project coming online soon. They are creating a broadband wireless mesh network in the central business district, which is part of their regional ITS plan and will see some 400 signals updated to have adaptive control and traffic responsive feature sets."

3 The who's who of ITS

Unusually for a state that's such an integral part of the US ITS landscape, there is currently no tolling in Tennessee – though Hicks explains that this may well change soon, with several initiatives undergoing feasibility studies. However, Hicks is keen to showcase the other ways in which his home state is at the forefront of ITS. He observes, "Tennessee is home to the Oak Ridge National Laboratory and that's always been an incubator – if not the birthplace – of many of the innovations we use in transportation today. It's a blessing to have Oak Ridge and all the ancillary work that's being done for the Connected and Commercial vehicle initiatives – all the aspects that come out of extensive research and testing, which is what the center offers."

Hicks also gives a shout out to other respected institutions. "Along with Oak Ridge there is also the National Transportation Research Center. We're also home to the Center for Transportation Analysis. We have a considerable number of automotive companies and their suppliers here, a lot of those folks are involved with V2V and V2I initiatives. For instance, Oak Ridge has an advanced battery lab and right now they have a test under way with the Department for Energy on the commercialization of dynamic wireless charging that's close to being released. The Laboratory also houses the ITS Deployment Tracking project: this catalogs and analyzes all the ITS deployments nationally and has done so since 1997."

4 Regional sessions

The ITSA's Annual Meeting will feature some highly interesting Regional Sessions and Hicks is enthusiastic about the merits of these sessions.

"The key part is a 'state of the state' address which will basically be an update from TDOT in terms of project forecasts, organizational needs and an overview of where we are today. We'll also have a session on center to center data sharing: with Tennessee being such a long state and having four metropolitan areas hundreds of miles away from each other, we are now in a position to take advantage of direct center to center data sharing. We're also bringing in our local stakeholders from the emergency services, local agencies, our counties and the media – so they can see our data feeds from the centers and know what's going on statewide.

"Our rural ITS applications is another area we'll touch on in these sessions," he adds. "Tennessee has some rugged terrain and remote locations so we're challenged in deploying an ITS network where there are no communications systems or power supplies. So we'll be revealing lessons learned on deployments already conducted and also some forward-looking statements."

Reimagined

In addition to the attractive location, Hicks explains that the event itself will benefit from heading south: "Our theme for the meeting is 'Real Progress, Great Future' and that positions well with our region," he continues. "ITS America has seized the opportunity for this unique meeting location to also revamp the event's format. Firstly, they've reduced the rate package for public sector folks, our government attendees. It's a key driver to get these public personnel there and Nashville is a central location, easily reachable from major parts of the country. ITS America has also dedicated more exhibitor hours to allow exhibitors to spend more time with their customers. And they've revamped a lot of the session formats too – there's now a Town Hall Meeting-type format and that goes along well with our region as we have a good conglomeration of urban and rural ITS applications.

"Among the hot topics at the meeting will be the Connected Vehicle, Integrated Corridor Management and there's a symposium on knowledge-based user fees, which is a huge topic in transportation funding right now."

Great music, great hosts and a compelling event… what are you waiting for? Book your tickets and Walk the Line to ITSA's annual meeting, April 22-24, 2013 at the Gaylord Opryland Hotel and Convention Center in Nashville.

Christie's **John Stark** and **David Griffiths** lift the lid on their new open content management system for control room environments

Interviewed by Lloyd Fuller

> The device enables you to move content from space to space in a simple and intuitive way

Seeing John Stark clutch Christie's new Phoenix node – essentially a magic black box for TMC control rooms – is like watching a father holding his newborn baby for the first time. And that analogy isn't lost on Stark (above), Christie's senior director, product management, Collaborative Visual Solutions.

"Our new open content management system is a first for us. It has been 18 months in development and is the final piece in the control room jigsaw for Christie," he says proudly, just hours after unveiling the solution at the Integrated Systems Europe exhibition. "I can't go into much detail about exactly what's inside the appliance," he warns, "but there's technology in here that we've leveraged especially to develop Phoenix – and which wouldn't exist were it not for Phoenix."

Content mobility

Clearly holding a handful of cards close to his chest, Stark is more open when revealing what Christie's new box of tricks does – and how it will improve life for TMC managers. "It's a network-distributed AV content management platform designed specifically for command-and-control applications," he explains. "It features a network streaming solution at the core, so we can ingest DVI content and encode high-resolution content into H.264 streams and then decode and display those streams into multiple outlets, such as the real-time windows on your TMC display walls and single displays."

Using common IP networking technology, the 19in rack-mount Phoenix node comes with DVI, KVM (keyboard, video, mouse) and audio input/output connectors as standard, all of which can be used simultaneously.

But it's the fact that it's a single-stream device that will pique the interest of systems integrators and TMC managers. "That's key," Stark insists. "It enables you to move content from space to space in a simple and intuitive way. And because it's network distributed, with nodes throughout the system rather than everything being at a central location, it's fault-tolerant and you can expand and redeploy it in the field without having to do a whole load of re-engineering work."

Collaboration and control

One or many Phoenix nodes can be integrated in a system, depending on requirements. And they can all be combined to create synchronized display walls of virtually any size or used as desktop processors to augment a single user's operating environment. "It's simple and cost-effective to configure, deploy and manage – and all from one box," Stark says. "It's particularly applicable in the world of traffic management and ITS because – as an H.264 streaming device – it complements the intelligent traffic and surveillance solutions proliferating in the marketplace right now. It's compatible with the majority of existing network and surveillance cameras – Econolite, Pelco, Sony, Panasonic, TransCore and so on – that might use other formats but will all have H.264 video coding. And by using our intuitive drag-and-drop desktop software, Phoenix can pull all those field cameras into the TMC and put them directly onto any displays.

"We do some pretty neat things within the box, too," adds Stark. "If the input is a uni-cast camera, for instance, we can output it as a multicast signal, hence our ability to distribute that content around any number of locations. So what might have once been complex hardware networks can now be replaced with a simple network overlay."

Network distribution is, Stark believes, Phoenix's overriding selling point. "It

> It's a real merging of data, the backbone of what I would call true content mobility – and Phoenix can enable all of that to happen

completely redefines what a control room visualization system can be," he says. Such a feature is crucial for the modern-day TMC, where there is a trend toward them becoming inter-agency hubs in which the sharing of up-to-date, accurate information across departments is vital for fast, informed mission-critical decisions.

"The node itself is very powerful – much more so than your typical computer in the sense that it can actually decode 12 HD 30Hz cameras at the same time with full scaling and compositing, which gives true display flexibility," Stark goes on to explain. "So in a TMC and traffic management scenario you could have all your cameras running in full frame on your desktop screen or video wall while other applications – changeable message signs, incident detection, ramp metering, you name it – are unaffected by all the video decoding that's going on locally."

Power in the field

Stark's European colleague, David Griffiths (top right), market development manager, Control Rooms, EMEA, pinpoints active traffic management (ATM) schemes as the ideal advanced ITS solution where the advantages of Phoenix would really shine. "Many technologies converge for ATM to run smoothly. In the UK, the Highways Agency has hard shoulder running and variable speed limits to ease motorway congestion and optimize traffic flow during peak hours," says Griffiths. "But within ATM, you've got live data feeds from the loops, audio, video streams, IP video [the actual camera information], as well as sensor alerts [data from computers], and all these inputs can be viewed not only on the main TMC video wall but also in separate crises rooms around the TMC and onto individual operators' desks. You could even push it out to HA traffic officers who could extrapolate the data and feed updates back to the TMC. It's a real merging of data, the backbone of what I would call true content mobility – and Phoenix can enable all of that to happen."

And while the very latest strategies such as ATM are the ideal showcase for Phoenix's potential, Stark and Griffiths are keen to highlight its suitability for control-center environments across the spectrum, regardless of sophistication and DOT purse strings. "Financial constraints remain a concern for DOTs and the focus on return on investment is acute, which is why cost-effectiveness was an extremely important factor during our development work," Stark continues.

"It's difficult to put a figure on the financial benefits that come from faster decision making in the TMC – the cost implications between implementing our system or not – but we all know there is an economic hit from congestion and traffic accidents, so better management of the roadways through enhanced visualization of the real-time scenario will clearly have a cost benefit."

"This is an inexpensive piece of kit that can pay huge dividends," Griffiths notes. "It employs the customer's existing network; we're not creating dedicated networks."

And when Griffiths says Phoenix is plug-and-play, he really means it – it couldn't be simpler to install and set up. "You plug it in to the network, it automatically recognizes all the different nodes on the system and then you configure it from a web page," he says. "It's not running a full-blown OS. It's not a complex piece of PC-based software that might require other vendors to spend time, money and engineering to configure their systems for each customer. We believe it meets – and hopefully exceeds – today's TMC control room requirements."

"Life-critical decisions are made at the speed of information," concludes Stark. "When events are unfolding rapidly, the ability of decision makers to see, manipulate, share and display critical roadway information from virtually anywhere can quite literally be the difference between life and death. Now with Christie Phoenix they can assess, contain and resolve crises faster than ever before."

The future in front of you

When asked how the traffic management center of the future may look, both John Stark and David Griffiths are not short of vision. "Lots of people talk about touch and 3D, but ultimately the idea with any control room – whether now or in 2050 – is to come up with the most efficient way to help people interpret information so that they can make the best decisions," says Stark. "Rather than that *Minority Report*-style operations center depicted in the Tom Cruise film, I think it's more likely that you will see display walls through augmented plus reality."

"In the shorter term, we're going to see much more in terms of device integration – people bringing in their iPad-type technologies from the field and dragging what they have on their mobile devices onto video walls," suggests Griffiths. "But Phoenix is really geared up to that sort of environment already."

Christie's Phoenix node

The competitive edge

The TMC equipment market is already well served by a number of vendors. So those bringing new products to the table must have some compelling USPs. John Stark is adamant that Christie's new product has what it takes.

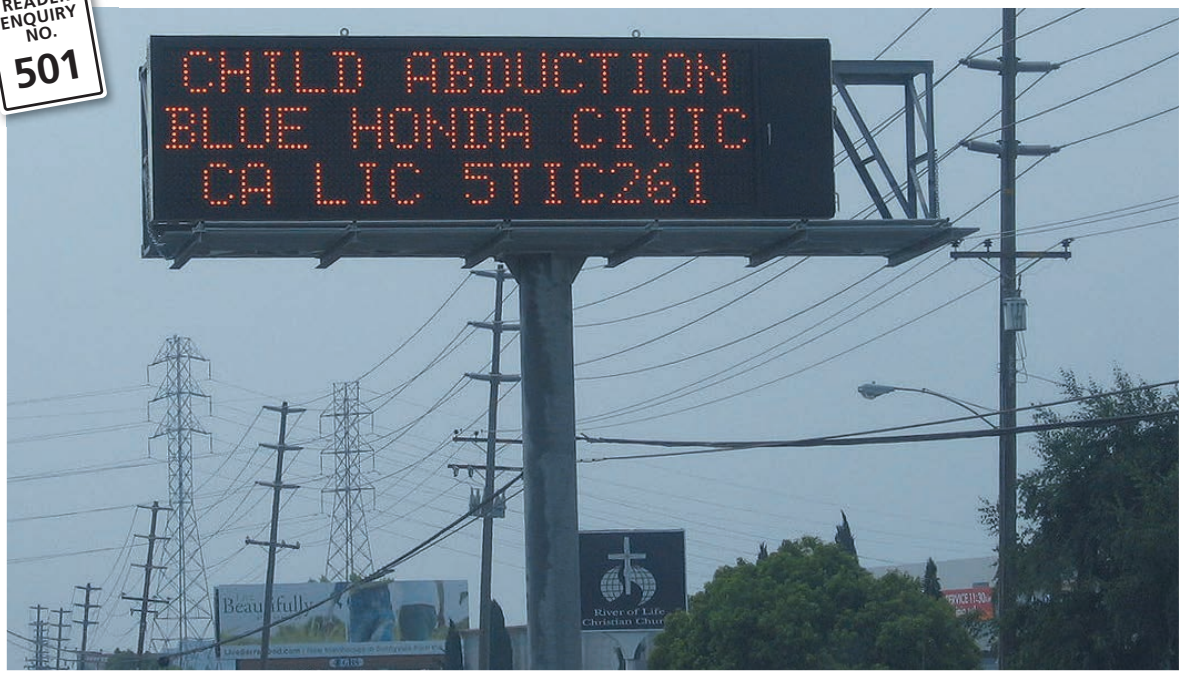
"We consider it to have three primary advantages. Unlike competitive systems, it uses a single universal device that is designed for scalability and redundancy – providing guaranteed 24/7 operation. By tapping into an operation's existing IP infrastructure there is no expensive investment in cabling required.

"The next benefit is that there are no license fees. It's a non proprietary system."

Stark's third point relates to the ability to do more with less – a critical factor today. He explains: "A single video wall equipped with Christie Phoenix can utilize up to 128 nodes, each with the ability to decode and display 12 videos in native HD; up to 1,536 videos can be decoded and streamed on the videowall."

Giving law enforcement more eyes on the road

READER ENQUIRY NO. 501



Automated systems aid jurisdictions in enforcing traffic laws that ensure citizen safety and mobility. Increasingly, automatic license plate recognition (ALPR) is used as an effective force multiplier, allowing more efficient identification of vehicles of interest, as well as for other mobility and compliance tasks such as bus lane, tolling and parking enforcement.

A recent International Association of Chiefs of Police (IACP) study concludes, "ALPR technology is a significant tool in the arsenal of law enforcement and public safety agencies. It automates a tedious, distracting and manual process that officers regularly complete in their daily operations, and vastly improves their efficiency and effectiveness in identifying vehicles of interest among the hundreds or thousands they observe in routine patrol."

The data proves it. Some agencies employing ALPR have seen a rise in stolen vehicle recovery of 68%, increases of 55% in arrests, and a 35% increase in solve rates. Importantly, some agencies have experienced an increase in police productivity of 50%.

Hundreds of law enforcement agencies across North America and Europe report significant increases in criminal apprehension through the use of ALPR systems for auto theft, vehicle and traffic enforcement, and other investigations. PlateCheck, ATS' popular ALPR offering, assists police by automatically reading license plates, evaluating those plates against law enforcement and municipal databases in near real-time and providing only actionable information back to officers. Common database matches include: stolen vehicles

(Main) **AMBER alert**
(Above) **ALPR improves police efficiency**

or tags; AMBER alerts; officer-involved situations, known as Blue alerts; missing senior citizen (or Silver alerts); missing persons; BOLO (be on the lookout) alerts; and plates associated with investigations.

System setup

PlateCheck consists of two high-speed cameras (one with infrared capability and one that's a color overview camera), a processor with an application that performs sophisticated OCR to create an alphanumeric for each license plate, an application that can compare the license plate to the databases of vehicles of interest, communications capabilities to facilitate data transmission, and a user interface. PlateCheck can be deployed in a variety of configurations.

ATS has a vast network of existing infrastructure with approximately 300 municipal clients across 21 states and Canada. Installing PlateCheck onto poles with power and communications already present saves time and money and reduces the burden for permitting and other pre-installation requirements. The solution provides a quantifiable return on investment by providing a proven, efficient, and cost-effective force multiplier. For a law enforcement agency, the possibility of identification and information

Need to know?

Using ALPR enables law enforcement agencies to greatly improve operations

- Agencies that deploy ALPR systems reap the benefits of improved arrest rates, solve rates, and stolen vehicle recovery rates
- ALPR means that databases can be checked and alerts generated faster than humans can do manually
- ATS' core business enables law enforcement agencies to improve traffic safety and citizen mobility and ALPR is an additional tool to do this, making it a natural choice for the company to offer

sharing across multiple geo-spatial dimensions is immensely powerful and allows law enforcement personnel to meet their mission more effectively.

Where new infrastructure is required, ATS' expertise in fixed automated safety camera programs helps secure the appropriate components and required permits in an efficient and thorough manner to the benefit of the client. Customers don't need to be in the construction, maintenance, IT and field technology business – but they want outcomes from the implementation of all of these elements.

Another factor to consider is the installation cost of the system as well as the back-end software and resources that power the technology. Law enforcement agencies may have multiple options when acquiring an ALPR system. ATS provides a service level (24x7x365 plate identification and notification) for a monthly fee to overcome the need for any sizeable upfront capital investment, which sometimes requires federal grants. The company also provides a turnkey solution with advanced technology and a robust back end, which prevents customers from having to piece together a complex system.

The efficiency of a law enforcement agency can be increased by an ALPR system that has clear goals, is carefully selected and expertly deployed. PlateCheck assists an agency in achieving its goal of improving safety in its community.

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I've been driving for nearly 50 years and studying traffic for more than four decades. I've seen lots of progress. But in one area, little has changed. Back in 1969 – when I took my first traffic engineering course – the rule of thumb on capacity of a highway was 2,000 vehicles/hour/lane (vph). That rule of thumb, articulated in the 1950 *Highway Capacity Manual*, is still valid more than six decades later. However, I am excited to say, that's set to change in the not-so-distant future.

Last year saw some major milestones for self-driving cars. The US states of Nevada, Florida and California passed the necessary laws permitting them on their roads – provided that a driver is behind the wheel. The poster-child of the movement, Google's own Driverless Car project, has surpassed 300,000 miles without a single accident when controlled by a computer (one crash occurred when the car was manually controlled and another when it was rear-ended through no fault of the system), proving the concept is indeed viable.

January's Consumer Electronics Show in Las Vegas was also another milestone, not because of any particular technology that was showcased but because – for the first time – the notion of a self-driving car crossed from science fiction into commercial feasibility and took another step closer to becoming mainstream. And while it'll still be many years before we see self-driving cars in dealerships, they can't arrive soon enough.

Their advantages are numerous and considerable. For one, there'd be fewer traffic collisions, as the act of driving can be reduced to focused, repetitive tasks that computers are far better at performing. They can't be distracted by a text message or impaired from alcohol and are less prone to making mistakes. And as a computer's reaction time is much better than any human's, autonomously driven cars can drive closer together at higher speeds.

In fact, a recent study presented at the IEEE conference on vehicular technology by Patcharinee Tientrakool of Columbia University compared the projected highway capacity between manually driven vehicles, autonomous vehicles that don't communicate and autonomous vehicles that can interact with each other. Compared to manually driven vehicles, a highway with independent autonomous vehicles saw an increase in capacity of 43%. Now have those vehicles work together and the capacity rises to an astonishing 273%. By traveling in groups and driving much closer together than humans can safely do, the capacity gained is more than threefold. Suddenly, that rule of thumb value may jump to 6,000vph. That is a tremendous gain in capacity without having to spend billions of dollars on building more highways.

It can get even better. What if vehicles could also communicate with the highway itself, with each vehicle on the road telling the highway where it is and where it needs to be? Using all of this gathered data, the highway could find the optimum way of moving every vehicle on it. Not only could vehicles platoon more efficiently, further increasing capacity, but with truly dynamic routing, congestion would be greatly reduced as traffic could be micromanaged within the network. Only when our vehicles become at one with the road can we achieve the maximum potential of our highway system.

Henry Ford revolutionized the world of transportation when the first Model T rolled off his assembly line in 1908. We've since seen auto technology innovations and advances that have increased vehicle power, safety and comfort. The way we drive, though, has largely stayed the same. Well, more than 100 years later, we're on the cusp of a revolution that will lead to a paradigm shift in transportation as a whole. An exciting new frontier is before us – and I can't wait to take part in it!

> By traveling in groups and driving much closer together than humans can safely do, the capacity gained is more than threefold
>
> **Sam Schwartz, Sam Schwartz Engineering, USA**

The eyes of the system: cameras in ALPR applications

Today's increasingly sophisticated ALPR solutions require far better image quality and higher resolutions than analog or cheap IP cameras are able to provide. This has made machine vision cameras, which offer a wide range of resolutions, the ideal choice for ALPR.

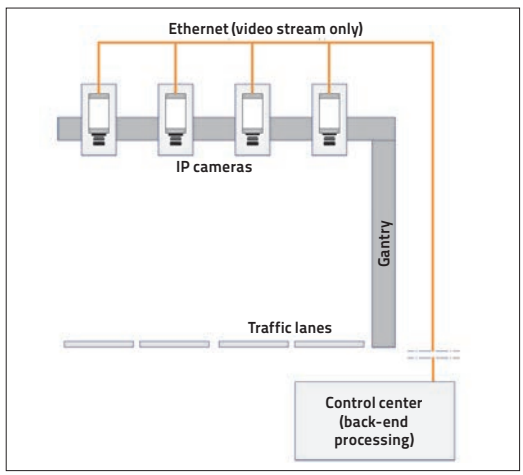
Machine vision cameras deliver uncompressed (raw) images on various interfaces such as GigE, Camera Link and USB 3.0. They offer real-time capability, which is important for high-speed traffic applications. Technological evolution means that manufacturers can now provide high-quality cameras with an excellent performance/price ratio. Consequently, there are suitable price-competitive products in the machine vision portfolio even for low-end traffic applications.

IP cameras (or network cameras) compress the images they record. As their name indicates, they provide a standard Ethernet interface (TCP/IP). IP cameras can also be a good fit for ITS applications because their price level is still somewhat lower due to huge camera volumes driven by big surveillance projects.

Due to strong price pressures, the majority of IP cameras incorporate cost-sensitive sensors with small pixel sizes and low sensitivity. These sensors need a significantly higher exposure time (up to several milliseconds) to compensate for this. On moving objects, this causes motion blur, making the images unusable (see main image).

Low-cost sensors are also usually based on rolling shutter technology, where the sensor lines are read out line by line. This creates a distortion on moving objects called rolling shutter effect (see image on the following page). Another weakness of IP camera technology is a higher latency and jitter than in machine vision cameras, which is an issue on triggered applications such as radar- or laser-based enforcement systems.

To manage these limitations, Basler equips some of its IP camera models with high-sensitivity CCD sensors with global shutter and real-time trigger functionality for instantaneous image acquisition.



(Above) **Example of the motion blur that can occur due to long exposure times**
(Left) **Schematic showing back-end processing**

Technical approaches

Two different approaches currently dominate the ITS market. The first is based on an integrated 'vision box' containing one or two cameras, a processing unit, illumination (mostly infrared at 850nm), and a trigger/measuring tool such as radar or laser. In this set-up, processing is done on site. Another option works with a remote camera location, for

Need to know?

How to choose the most appropriate machine vision technology for your license plate recognition solutions

- Machine vision cameras are proving increasingly popular for ALPR applications but IP-based cameras do still play a role
- Camera manufacturers that offer integrators both machine vision and IP cameras are a step ahead of their competitors
- In choosing the best solution for a specific task, the processing method remains a key consideration

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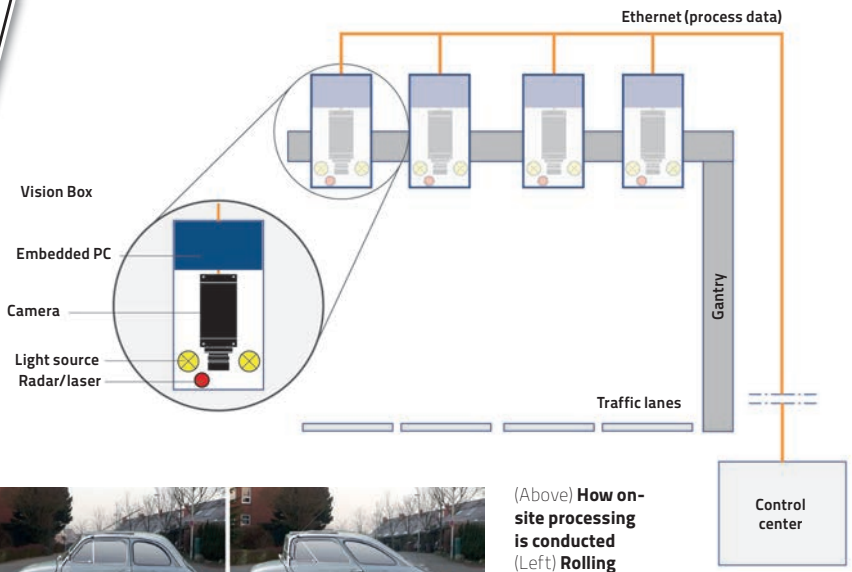

(Above) **How on-site processing is conducted**
(Left) **Rolling shutter effect**

example in a tunnel with back-end processing. This is usually the case in surveillance-based environments.

Vision box configurations are used in tolling, enforcement and other applications that require on-site processing, such as vehicle classification or ALPR. This approach is usually employed by big tolling companies or integrators with substantial R&D resources. More than others, ALPR-based applications require uncompressed images for better recognition performance; they also need adequate processing power, through solutions such as an embedded PC. Machine vision cameras are a good choice for this ALPR task; the higher data volume due to raw images poses no problem since this data is not directly transmitted through the whole network, but in the vision box environment only. The final result (e.g. license plate, location, speed, date, time, and sometimes one or two compressed images) is transmitted to the control center for further handling.

In the case of back-end processing, with the camera transmitting the video footage through a wide network environment to a remote processing location (e.g. a control center), bandwidth limitations are a major factor. Uncompressed image data from machine vision cameras can easily exceed the available bandwidth – especially in multi-camera installations. Furthermore, applications such as parking garage access control, incident detection systems or traffic flow analysis require the video stream to be transmitted to the control center for regular traffic surveillance and long-term storage. For this approach, IP cameras are the better choice.

Specialized for ALPR

A variation of the on-site processing approach utilizes very compact specialized ALPR cameras. These cameras provide: a housing, one or two camera modules, an 850nm IR LED panel for high-contrast license plate images, and a processing unit running an appropriate ALPR algorithm. Two cameras are usually used, with a monochrome camera dedicated to ALPR and a color camera providing an overview image or video stream. This compact module is designed for specific traffic tasks such as parking access control, journey time measurement (JTM), or comprehensive surveillance tasks using ALPR for crime investigations. These highly integrated ALPR cameras are especially interesting for integrators with limited or no R&D resources, as they simplify the installation effort.

Some ALPR solutions of this type incorporate different off-the-shelf machine vision or IP cameras with interfaces such as GigE or Ethernet. This approach benefits from falling camera prices, and its modular concept is able to provide the flexibility needed in the wide range of ITS applications. These requirements include aspects such as the higher resolutions needed for recognition of smaller characters on license plates in China or the USA.

Another good example is the video streaming functionality frequently required for the enforcement environment, which can easily be provided by substituting one off-the-shelf machine vision camera with an IP camera. Manufacturers that offer both camera technologies – such as Basler – can help solution providers select the right combination of machine vision and IP cameras for their applications.

Some ALPR camera manufacturers follow a different strategy, preferring their own hardware design for the camera part, which enables them to provide a tailor-made solution for some ITS applications. However, in-house design and manufacturing is associated with low volumes, typically ranging from 50 to 500 cameras per year, leading to high prices for this type of vision box.

Ultimately, when choosing a suitable camera for any ITS application, the informed buyer must consider: does my technical setup require on-site or back-end processing? What is my main focus – providing a flexible solution or integrating ready-to-go modules? And finally, which features are essential to my application and which can be bypassed for better cost efficiency?

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Dual-capability enforcement system

READER ENQUIRY NO. 503

There is a growing trend in the enforcement sector for products that offer users a greater degree of flexibility. Manufacturers must step up and meet this demand by creating innovative new solutions.

The D-Cam from enforcement specialist Truvelo is a versatile and multi-functional camera that can be deployed at speed-only as well as at speed/red light sites. Additionally, it can be moved from one type of site to another and back again, as desired. Speed violations are recorded by means of a single front or rear photo, while red light offenses are recorded using two images. The D-Cam also provides up to three lanes of coverage with just its single color camera.

Dual purpose

As a speed camera, the D-Cam can be used for front or rear image capture, and in numerous different layouts, more of which later. Three sub-surface sensors are used for speed measurement and simple vehicle classification, and these are installed just before the stop line such that the 1.8m (6ft) secondary check line is 750mm (30in) beyond the stop line. Vehicle classification allows the new camera to automatically select a lower speed threshold where required, and the sensors also provide lane ID information, displayed in the image data field.

In speed/red light camera mode, the D-Cam acts as speed camera during the green and amber phases of the traffic signal, as well as for the red 'grace period', using a single rear photo. After the grace period, the camera switches to red-light enforcement and captures two red light photos. The first records the vehicle's true speed and secondary check timing information, and also shows the front wheels 750mm beyond the stop line, and within the secondary check lines. As a result, the vehicle is shown to have crossed the stop line. The distance of 750mm has been selected so that the front wheel of a motorcycle is shown to be beyond the stop line, while the rear wheel remains behind. The second photo will be set for 12m (40ft) or 15m (50ft) later, depending on the junction size. This distance is specified at the outset by Truvelo, in conjunction with the local law enforcement agency, and programed into the camera. In doing so, this confirms that the offense has been completed. At speeds above approximately 109km/h (68mph) the camera will automatically change to a 0.5 second photo interval, since at high speeds there isn't always sufficient time for the flash to recharge fully in the time it takes to travel 15m. The D-Cam system then reverts to the standard 12-15m interval automatically.

For integration with LED traffic lights, Truvelo has a UK Home Office agreed, patented solution for monitoring red and amber times on

Need to know?

Unveiling the latest in dual-capability speed-only and speed/red light cameras

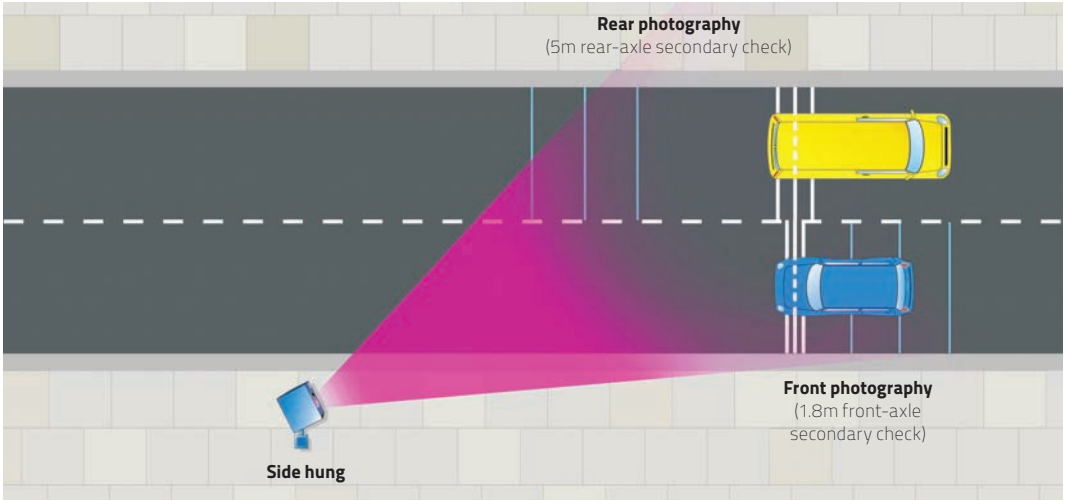
- Various speed measuring technologies are available including piezo sensors (D-Cam P) and laser (D-Cam L)
- Specially designed Integra-Post features a combined camera housing to provide greater vandal resistance and a modern streamlined appearance
- All cameras feature Truvelo's single photo secondary speed check verification method features for operators

(Right) **The aesthetic Truvelo D-Cam P for speed only or speed/red light enforcement**
(Main) **Speed offense – offending vehicle in lane two**

LED-based signals, a solution that forms part of the Home Office approvals process.

Secondary checks

The standard secondary check distance for a single front or rear photo is 1.8m, a distance that is measured between the last piezo sensor – the point at which the speed calculation is made – and the center 1.8m line. Supplementary lines 18cm either side reflect the Home Office requirement for ±10%. However, Truvelo has now introduced a 5m front axle secondary check for speed/red light sites, which allows the check lines to be left just beyond the stop line, while being able to move the sensors further back when required in order to avoid embedded loops or metal work in the road surface. The 5m front axle secondary check is also used for simple classification to select a lower speed threshold when required. A rear axle 5m secondary check is another new innovation devised to work with Truvelo's simultaneous bi-directional sites.



(Above) **D-Cam classifies vehicle and selects lower speed threshold** (Top) **The new simultaneous bi-directional site layout**

Multiple site layouts

As mentioned, D-Cam has been designed to provide even greater versatility. As well as front or rear photography speed sites, various 'combination sites' are possible, including front and/or rear photography, bi-directional front photography and bi-directional front-plus-rear photography. These are all achieved by rotating the camera housing and pointing the camera toward different sensor arrays. The new simultaneous bi-directional site layout is unique to Truvelo (see illustration above). The camera is able to monitor traffic in two directions at the same time (one lane each way) and take photos on demand as speed violations are registered by either set of sensors. A front photo will be taken of vehicles in the lane adjacent to the camera, and a rear photo of vehicles in the opposite lane. For the rear photo, the D-Cam provides a rear axle 5m secondary check – yet another Truvelo feature that allows users to place both the front license plate and the rear plate at essentially the same distance from the camera, and within its field of view.

Back office

A pair of servers can be supplied capable of handling in excess of 25 cameras. The TBOS (Truvelo Back Office Server) receives encrypted images, stores them and writes them to a CD, which is then inserted into the TVM (Truvelo Violation Manager) where the images can be viewed. This creates the 'air gap' required by the Home Office. The D-cam has been designed to be compliant with both the StarTraq and Serco back-office systems.

Images are continually transferred to the TBOS via an ADSL line or 3G connection, which must be received by the TBOS within 24 hours and provides a constant workflow for the back-office staff. When required, it is also possible to visit a site and download the encrypted images on to a shuttle PC. This feature is of benefit should there be delays in connecting ADSL to a new site or if the connection to the back-office should go down for an unacceptable period of time. In these instances, the site can still be used or the camera could be removed to another site. The camera technician with the shuttle PC is unable to view the images. The shuttle PC image transfer option is only intended for instances where the ADSL/3G connection is down or otherwise unavailable.

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Traffex STAND D52

The benefits of edge-based analytics

In traditional traffic monitoring systems, the video images captured by cameras are first sent to a central server where the actual video analytics is performed. The drawback of this approach is that high-quality video needs to be transmitted to the server over a network, which results in an increase in network traffic load.

In an edge-based approach, however, the analytics functionality is positioned closer to the traffic camera – to the edge of the network, so to speak. With Traficon's VIP-TX board product, for instance, video encoding and analytics are integrated into one unit, which means that if analytics is running on the edge, the network traffic is heavily reduced. In fact, there is no traffic as long as nothing relevant happens. Analytics can even be integrated into the actual camera, taking the edge-based principle one step further. This is the case with Traficon's recently launched box camera, TrafiBot.

The VIP-TX (left) **generates traffic data and incident detection information** (Main) **The technology supports operators with alerts on stopped vehicles, wrong-way drivers, pedestrians, lost cargo, smoke and traffic flow data**

Living on the edge

Traficon used 2012's ITS World Congress to announce an extended portfolio of automatic incident detection products that embrace this growing trend of edge-based analytics. And it's not hard to see why this trend is so compelling right now.

The key driver of this evolution is increased processing power. Moving the intelligence to the camera used to be difficult because of the very limited processing power in cameras, leading to severely limited capabilities or badly performing analytics. However, with evolving processor technology, an increasing number of manufacturers are moving powerful processors into their camera designs. In the TrafiBot product, the camera has even been designed bottom-up to handle the complex Traficon video analytics.

Some may argue that cameras are the weak link in the video detection chain. However, the truth is that cameras have become far more reliable in recent years. This is certainly the case with IP cameras, which have more robust electronics than their analog counterparts. Already in the security market, more IP cameras are being installed than analog cameras. The traffic market – usually somewhat more conservative – will follow that trend eventually. With the TrafiBot,

Need to know?

Why a new approach to video analytics is proving to have the edge

- The VIP-TX is a high-quality video server with integrated Automatic Incident Detection (AID)
- VIP-TX combines field-proven incident detection capabilities with advanced video encoding and powerful processing technology in a single unit
- The TrafiBot All-in-one is a cost-effective camera solution with integrated AID
- The TrafiBot is both multi-codec (H.264, MJPEG) and multi-streaming

READER ENQUIRY NO. 504

(Above) **Traficon's TrafiBot Box camera with integrated AID and dual H.264 video streaming, providing image quality in full D1 resolution (720x576), superior low light performance and wide dynamic range**

Traficon can even offer an MTBF of 38 years.

Both the VIP-TX analytics and encoding board and the TrafiBot box camera, which were launched in Vienna, are ONVIF compliant. ONVIF is a global standard for communication between several IP products. ONVIF video streams are able to carry metadata. In the long run, it will also become possible to include analytics information into the ONVIF stream. But for now, it means that these products are compatible with different equipment suppliers, which will result in much easier installation and integration.

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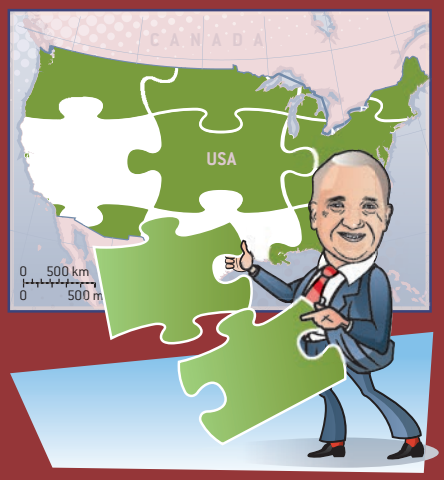

J J Eden

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When I was young, my dad loaded us into the car and took us for a 'Sunday Drive' on the Pennsylvania Turnpike. I remember stopping at the toll booth to pick up an 80 column punch card ticket and talking to the friendly attendant then driving to Howard Johnson's for ice cream cones.

At a recent IBTTA conference there were several Master's students from North Carolina State University competing in a contest to develop a cell phone application for tolling. After the contest, one of the students addressed the audience. He asked, "When are you old people going to figure out that our generation doesn't carry cash?" He had just tried to travel from North Carolina to his home in New York and stopped at a toll booth that didn't accept his debit card and the North Carolina Quick Pass tag he had was not interoperable with E-ZPass. Today's generation is not only more tech savvy, they are more aware of time and their management of it. This growing demographic does not understand or accept how their cell phone can work seamlessly wherever they go (not only to make calls but to access data networks), while their toll account cannot.

The tolling industry has always focused on technology, mostly from the lane side. Advances in technology have allowed us to go from those punch card tickets to automatic coin machines with slug detection and then to transponder-based electronic toll collection (ETC). At the time transponders were being introduced, no one saw the need to develop standards for interoperability. Cash was King and every toll facility was interoperable; ETC was a supplement to cash collection, which provided the interoperability we seek today.

Today our customers have changed, and the industry must continue to adapt as well. Their demand for a speedy transaction has created such innovations as all electronic toll collection (AETC). These innovations created another 'problem' because they have given customers the perception that wherever they go their transponder or license plate will pay their toll.

We have already made great strides toward improving customers' experience with seamless transactions between agencies. Networks such as E-ZPass, SunPass and TxTag have offered millions of customers regional interoperability. The latest success has been not only to expand these networks but also to provide interoperability between regions.

So far this year, we have seen North Carolina's Quick Pass join the E-ZPass network as a national affiliate member. In addition, Florida's SunPass and Georgia's Peach Pass will be interoperable with each other and North Carolina sometime this year. Kapsch and E-ZPass have placed their transponder and back office intellectual property into the public domain. IBTTA's interoperability committee has developed a long-term concept to write technical interoperability standards. ATI is continuing to move forward with the HUB and enforcement projects. There is now a coordination group that combines the efforts of ATI, IBTTA, OMNIAir, AMVA and I95 Corridor Coalition.

2013 is the year for interoperability. Tolling regions will expand and combine with other regions to offer customers the solutions that they are now demanding. As with all complex problems, great solutions create new demands. The original quest for technological solutions has caused the tolling industry to look at its business rules and methodologies to provide the interim path forward. The most important tool that we have in developing the necessary solutions for moving the industry forward is the continued innovation and leadership of the people dedicated not only to our industry but also to all generations of our customers.

> You will see tolling regions expand and regions combine with other regions to offer their customers the solutions that they are now demanding
>
> **James Eden, director of tolling, AECOM, USA**

Mobile measurement tools

READER ENQUIRY NO. 505

Efforts by national and state road authorities to make driving safer are increasing in momentum. A key reason for this is the aging population in the Western world. It is well known that elderly people react more slowly to incidents and that they need more light than younger people to see traffic guidance tools. In addition, growing traffic intensity is adding more stress to driving, which particularly affects elderly people.

On sections of road where there is no street lighting, retroreflected light from vehicle headlights and good quality traffic guidance tools such as road markings and traffic signs are key in assisting the driver.

Markings can be measured at highway speeds

On the move

Measuring the retroreflection of traffic guidance tools has traditionally been undertaken with handheld instruments. Such instruments provide spot measurements, hence only offering a limited – and often biased – overview of the condition of markings and signs. More recently, the use of mobile retroreflectometers has ensured an improved and more complete overview.

DELTA has contributed to this development by the 2011 launch of its LTL-M mobile retroreflectometer. LTL-M is based on a patent-pending technology using a flash system, digital camera technology and real-time digital image processing. The technology delivers a retroreflectometer that ensures accurate measurement results under all driving conditions, as well as being easy to install, calibrate and operate. The system is based on the 30m geometry as outlined in EN 1436 and ASTM E-1710 compressed to a 6m measuring distance.

The LTL-M's measurement field of 1 x 1m makes use of 70,000 pixels, which allows the system to accurately detect and measure the full width and length of markings. The result of the measurement is provided as an average of the individual pixels detecting retroreflection within the given field of view. At speeds of up to 90km/h (55mph) the system will provide a complete performance check of markings presented per meter (if required) or per any average length chosen by the driver after measuring has been conducted. Above 90km/h, testing is still possible but it will not provide 100% coverage of the markings.

With measurement data at hand, the overall condition of a road can easily be studied using Google Earth, in up to three threshold levels and four colors. This creates a full overview of the performance of the measured markings. If parallel measurements have been made on the same road, e.g. during a separate drive through, all measurements can be displayed at the same time.

For later review of the measured markings, the system can be added to a plug-and-play overhead video camera positioned in the vehicle's windshield, which records the road as seen by the driver. If odd or unexpected results are revealed, the video can help to explain the reason.

The Google Earth presentation of data and the overhead video are both valuable and easy-to-understand tools when data has to be shown to road owners. They gain an instant visual overview of conditions on the road and can use the tools to plan maintenance work – in both the short and the long terms.

Need to know?

The safety and technical benefits of the latest mobile retroreflectometers

- Road markings must be kept in optimal condition to ensure safety, so measuring their efficacy is critical
- A new breed of mobile retroreflectometers is offering major safety and technical benefits
- The gathered data can be visualized using the Google Earth virtual globe, making it easier to understand

The LTL-M for measuring retroreflection of pavement markings

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Non-intrusive enforcement tools

READER ENQUIRY NO. 506

Multi-tracking radar technology is proving invaluable in the ongoing effort to reduce speeding and red-light running and improve traffic management. The new breed of radar-based solutions offers both an impressive level of precision and a higher level of legal security than alternative technologies. Another advantage of radar-based systems is that because they are non-intrusive, they are easy to install and therefore very cost-effective.

The Swedish ITS expert Sensys Traffic specializes in multi-tracking radar solutions. Its product range contains systems that can reduce environmental pollution in traffic and identify road accidents. The company's advanced automatic monitoring systems help to reduce average speeds on the roads and minimize the number of red-light offenses.

The proprietary RS240-Series multi-target tracking radar is at the heart of all Sensys products and systems. It features the functionality to allow versatile use in applications such as speed enforcement; red-light monitoring and enforcement; and traffic counting.

The multi-target tracking functionality enables the measurement of each vehicle's location and speed with impressive performance and accuracy, irrespective of environmental and traffic conditions. Additionally, the RS 240-Series systems provide a high level of legal security due to their dual-algorithm speed measurement capability. The range includes the well-proven RS240 radar along with the newer RS242 radar. This latter model includes '4D technology' – the name represents the radar's ability to measure speed, distance, lane identification and vehicle class. It has been developed for the most complex and demanding operating conditions.

Mobile speed enforcement systems also contribute to road safety. The Mobile Speed Safety System, gen 2 (MSSS II) is a compact and versatile product that includes radar, processor, data storage and digital camera. It takes just a few minutes to set up and requires no intervention on the roadway, which makes it very cost-effective. It also boasts low energy consumption. Further to a speed-check session by the roadside, the data may be transferred to a memory stick or laptop for further processing in an office.

The MSSS is a true point-and-shoot device, and after a couple of initial test pictures it can operate unattended. Its operational time span is only limited by battery capacity.

Tripod-mounted units remain popular with law enforcement officers

The small size of the unit enables covert operation from a patrol car's dashboard or through the rear window. Tripod use or concealed use by measuring from within suitable roadside fixtures is also easy to achieve.

Traffic officers have praised the system for its light weight, flexibility as well as the fact that it is easy to set up.

Flexible enforcement

The characteristics described above render the MSSS a valuable tool for flexible speed enforcement as a response to changing traffic behavior.

It has been observed that a tendency for speeding can be halted when the applicable speed is enforced more powerfully over a certain period of time. A mobile speed enforcement system enables this to be done repeatedly and randomly on a specific road at any time of day.

Need to know?

Multi-target tracking radar solutions are proving their worth in traffic enforcement

- A far-reaching traffic safety strategy involves the use of mobile enforcement systems as a complement to fixed speed cameras
- Solutions that are automated and easy to set up are top of the list for traffic officers
- Multi-target tracking radar technology offers both accurate measurements and a high level of legal security – attractive features for operators

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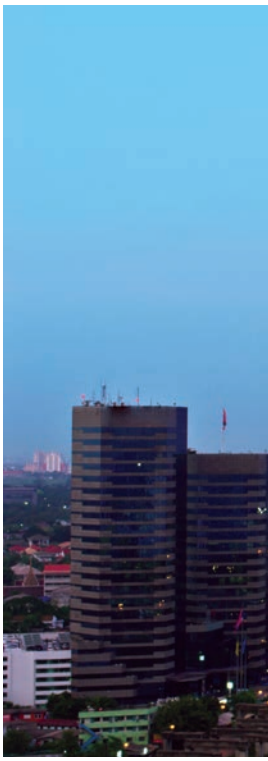
Business process management for the smart city

READER ENQUIRY NO. 507

Much has been written recently about building smart cities, but a number of companies have been providing solutions, software and services for core infrastructure systems for decades. Schneider Electric is one such organization. Its guiding principle – encompassed in the term smart city – is to make our built environment more efficient, more livable and more sustainable. Indeed, *The Smart City Cornerstone: Urban Efficiency*, a recent white paper by Charbel Aoun, senior vice president for Schneider Electric's Smart Cities initiative, detailed an approach to the successful transition to smart cities, with five basic steps identified: setting the vision; bringing in the technology; working on the integration; adding innovation; and driving collaboration.

Applying this approach to each critical domain of a city can help eliminate the obstacles to a more intelligent infrastructure and open the path to achieving smart city operability. Building on the general theme of Aoun's paper, below we take a look at an important aspect of implementing a smart city: business process management.



Need to know?

How business process management can help in making a city's traffic management activities smarter

- Solutions tailored to the unique needs of each city, designed to improve efficiency, sustainability and livability
- Setting a smart city vision and moving towards it with a bottom-up, systems-based approach
- Overcoming transportation congestion issues that undermine business processes and citizens' quality of life

BPM explained

Business process management (BPM) has been referred to as a 'holistic management' approach to aligning an organization's business processes with the wants and needs of its clients – in this case, the citizens of the smart city. BPM both promotes and enables effectiveness and efficiency. Business processes can – and, in fact, are – encouraged to change to accommodate continuous innovation, flexibility and improvement as technology and community goals evolve. Through this evolutionary path, BPM becomes more of a 'process optimization process'.

BPM supports many types of organizational structures, including commercial business and government agencies. Its greatest benefit is that it enables organizations to be more efficient, more effective and more capable of change than a functionally focused, traditional hierarchical management approach.

In their publication *Handbook on Business Process Management*, Jan vom Brocke and Michael Rosemann summarize the six core elements of BPM as strategic alignment, governance, methods, IT, people and culture. It is not coincidental that these elements of BPM align very closely to the approach outlined above for achieving a smart city, which, in effect, is about managing the business of the smart city. Both methodologies focus on establishing a smarter way of doing things.

One of the goals of a smart city is to integrate operations across all of a city's 'silos', or verticals within the organization. A key element in achieving this aim is technology that supports a common view of city systems, from transportation and utilities to public services and security. Where relevant, this technology may involve sensors and communications, integrating systems, and supporting analytics and intelligence that create situational awareness. Many cities are well on their

(Far left) **BPM can enable the move to smart cities**

way to building the basics of a smart city by selecting technology and/or new processes that improve efficiency and deliver better value for their citizens.

Uses for mobility management

In the transportation arena, process management basics typically include cameras, traffic sensors, dynamic message signs, and smart traffic signal controllers – all managed from a transportation management center (TMC). Predetermined or automatically generated traffic incident response plans add a higher level of intelligence to TMC operations. An emerging technology is the use of decision support systems (DSS) that provide guidance on the selection of the most appropriate response strategy in complex situations.

(Above) **Traffic surveillance is incorporated within a BPM strategy**
(Below) **Existing systems can be streamlined and automated via BPM**

At a very basic level, a well-designed DSS is very much akin to a BPM system. It incorporates transportation strategies and provides expert system rules, and sometimes even analytic and traffic modeling capabilities, to give quantitative support to its recommendations.

By expanding on the DSS concept toward a full-featured BPM approach, the TMC can address factors beyond transportation, to support decision making across agencies, or verticals.

Consider, for example, the number of city agencies involved in crisis management, such as those involved with Superstorm Sandy in October 2012. For transportation alone, there were dozens of TMCs and thousands of miles of highway and transit facilities affected. There were no predetermined response plans for dealing with the impact of the storm. There were, however, business processes and procedures that were called upon by the managers in every one of these TMCs, as well as by the governmental agencies for all the jurisdictions impacted.

Now imagine that these business processes are supported by a BPM system that leverages the technologies of data sharing, modeling, analytics, communication, and visualization to present a common view of the situation to all key stakeholders and decision makers. In addition, BPM can automate basic protocols and workflows, enabling decision makers to focus on the necessary ad hoc response strategies to the challenges that an unforeseen event such as Sandy presents.

Consider, as an example, a simple incident management response that may involve multiple jurisdictions and several agencies. The basic process of response first involves traffic management, but additional resources such as fire, emergency and hazardous materials responders are also required. With an appropriate BPM tool at their disposal, it is not necessary for the TMC operators to know all the protocols of each agency: the system takes care of the notifications, as well as monitoring the status of their response. The various different workflow steps can be as complicated as required and include conditional executions and even branching to related workflows.

Conclusions

BPM is both a policy tool and an information technology system. It does not require replacement of existing legacy systems. Instead, it enables process and workflow among those systems. BPM supports a city's business operations by enabling holistic management and the optimal use of city resources, assuring that everyone has consistent and complete information so that the key decision makers can approve, disapprove or delegate important decisions.

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Traffex STAND F31

Transport technology and the road to economic recovery

READER ENQUIRY NO. 508

After years of economic instability across Europe, 2013 promises to bring some much-needed relief for the transportation industry. The European Central Bank is predicting gradual recovery this year and positive economic growth in 2014.

Sustaining an efficient infrastructure, including road quality, has been identified by the World Economic Forum (in its 2012-2013 Global Competitiveness Report) as an essential building block for economic recovery. Poor roads and traffic hinder the ability of businesses to transport their goods to markets in a safe and timely manner, as well as the movement of workers.

Another important factor for increased global competitiveness is a country's technological readiness – its ability to adopt existing technologies for improving productivity and information management across sectors.

Photograph courtesy of Gevas Humberg & Partner Ingenieure

(Main) **Setting the scene for automated traffic data collection** (Right) **Miovision's Scout unit** (Below) **Intersections reap the gains of this efficient data-collection solution**

A combined approach

On their own, improved road quality and adoption of technology are not enough to accelerate a country's economic recovery. But integrating technological advancements into transport infrastructure projects will provide noticeable cost savings and efficiency gains to the government agencies of every country. Transportation engineering firms that take advantage of innovative technology to collect and manage information for these projects will have a distinct business edge.

In these days of fiscal belt tightening and budget cuts, a solution that has been proved to reduce staffing and overhead costs for transportation projects and recoup lost productivity is a must-have for government agencies and engineering firms. There are numerous examples of transportation projects that have seen labor costs for traffic data collection reduced by 85%; efficiency increased by 60%; data accuracy rates improved to 98%; and productivity increased by 100%. These results have been attributed to the Scout video collection unit (VCU), manufactured by Miovision.

The Scout collects video of traffic movements at an intersection or on a given road. Unlike manual methods of data collection, it eliminates the need for onsite vehicle counting and classification. The unit can be set to record traffic data for up to 72 hours, or longer with a battery pack. This functionality, combined with its non-intrusive setup, makes the system a safe and efficient solution for automated traffic data collection.

Collected data is uploaded to the Miovision web-based traffic data management portal, where it's analyzed and produced as industry standard reports. The portal provides centralized access and sharing of all traffic data, video and reports with stakeholders. Nine traffic studies are available: turning movement counts; average daily traffic; roundabout counts; trip generation; ALPR study; origin destination study; travel time; and parking study.

License plate-based studies are completed via the ALPR study kit, which uses an infrared camera with six pulsed LEDs.

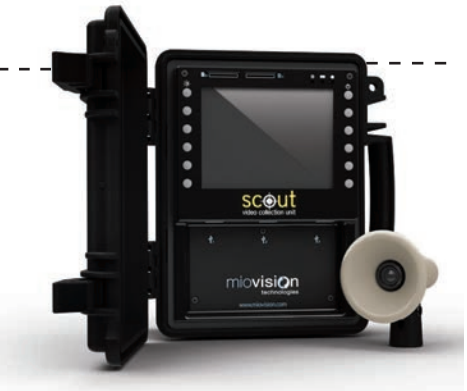
Future focus

With the transportation industry looking to rebound in

Need to know?

The costs and labor savings that can be achieved with video data collection

- Miovision was founded in 2005 and today has customers in 28 countries
- New customers in the Middle East include The Government of Sharjah and RTC
- Miovision is using Traffex in Birmingham (16-18 April, 2013) to reunite with some of its UK customers, such as Cornwall County Council, Northern Link and Gloucestershire County Council



2013 (however moderately), we can expect more government agencies and engineering firms to leverage technology to improve the cost effectiveness and resource productivity of their transportation projects. Those that choose the Scout will therefore be making a financially and technologically sound investment based on validated results. On the road to economic recovery, the building blocks may come in different shapes and sizes. But each block has its unique fit, and all count.

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Woody Allen was famously quoted as saying he got into trouble in his metaphysics class by looking into the soul of the boy sitting next to him. Today we have an opportunity to look into the soul of the transportation funding debate – and if we can't predict the future, we can at least see the metaphysical edges of the debate.

This seems to be playing out in Virginia right now. In the past few months, we have seen a Republican governor advocate an increase in sales tax and the elimination of the gas tax at the same time as Republican legislators proposed that a toll road be taken over by the state and its tolls removed. I can't even begin to understand why both these positions came from Republicans and clearly the *Wall Street Journal* was distressed, as it issued an editorial opposing the tax scheme but praising road funding based on tolling.

For readers of this magazine, no details on the transportation funding crisis are needed. It's worth noting, however, that a solution may not emerge, leaving Federal funding on a long, slow downslope as VMT grows gradually and hybrid and plug-in electrics begin to gain marketshare. I do not see an outraged public complaining about infrastructure while the attitude in DC is, 'We have limited resources so all programs need to pay their share.' We might just be dealing with less Federal funding for an extended period.

In Virginia, the governor gave up on the gas tax. In fact he proposed eliminating it and switching to an increase in sales tax as a basis to fund transportation. I guess that it incorporates the argument that everyone benefits from the transportation network even if they don't drive. Since my economics training ended with a BA, I won't argue with it, but politically it's probably a non-starter as it raised taxes and violates the pledge than many politicians took to never do that.

The Northern Virginia proposal is even more bizarre. A group of Republican legislators wants the state to buy out an existing privately operated toll road and eliminate the tolls. I guess they assume that if the DOT operated it without a toll collection system, there would be no additional costs or that they would be so minimal so as not to be noticed.

It seems to me that both are examples of magical thinking. In one case, let's not charge the users of the road but instead charge everybody. In the other, let's not charge anybody because roads ought to be free and can be run for free.

So why did I describe this as a view into the soul of transportation funding? Because for the first time in a generation there is a serious argument being made about whether we ought to be making any special provision to pay for it at all – or if we do, to eliminate the connection between using and paying. This connection has been an article of faith since the start of the Interstate era and is the bedrock upon which all funding has been built.

If the connection is broken, then who knows where we are headed.

> We have an opportunity to look into the soul of the transportation funding debate – and if we can't predict the future, we can at least see the metaphysical edges of the debate
>
> **Larry Yermack, Wendover Consult, USA**

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ITS or common-sense technology?

READER ENQUIRY NO. 509

The UK has some of the best ITS in the world, with extensive and increasing coverage of road surveillance, speed enforcement and traffic flow management. Capital and maintenance budgets run into billions of pounds.

This inevitably leads to the question of incremental spend versus incremental gain. What more can technology deliver?

There are differing schools of thought but most focus on the two strands of safety and making traffic flow better. Most involve a future vision that sees cars traveling at a uniform high speed along multi-lane expressways, possibly with technology in the car – built in to allow it to work in coordination with the road infrastructure – taking over driving duties.

The vision is compelling. It improves journey times and reduces the risk of death or serious injury. But the vision is expensive to bring about and the incremental gains would need to be substantial to generate a real return. In the UK, the cost of a single road fatality has been assessed at as high as £1.8m (US$2.8m).

Not in the future but happening right now, the UK is investing in improving the motorway system to provide Managed Motorways. This fits in with the future vision. It is a relatively inexpensive means of increasing the number of lanes on a motorway by bringing the hard shoulder into use full time or at peak times of the day. Hard shoulder running (HSR) is a good idea, although it does place additional burdens on the ITS infrastructure to ensure it can be managed successfully to deliver the forecast benefits.

However, in the rush for all the exciting bits with flashing lights, sometimes we lose sight that ITS can and should include the lumpy bits of concrete and metal that make up the physical infrastructure of the motorway.

Maybe we need smarter road surfaces that can provide telemetric connectivity or reduce rolling resistance to improve fuel economy. Maybe the road surface could be self-healing. Maybe road schemes designed to improve traffic flow are the answer. Or perhaps the key is to have infrastructure that's built to minimize the impact on the road user and operator when maintenance is required, so that all the road space created is not then shut down because an essential maintenance task has to be undertaken.

As an example, we currently feel the need to tell each lane user the speed limit on that stretch of Managed Motorway by hanging a sign above each lane on a gantry that spans all eight usable lanes. We have rushed to get the technology out there but not necessarily thought about the how or the why. If we intend to have different speeds for different lanes of a given stretch of motorway, all well and good. If not, then why deploy such a large and relatively expensive structure?

Then let's look at the maintenance issues of the signs and also the fixed signage alongside the motorway. The sign technology has improved immeasurably but will still suffer from failure and have maintenance requirements. So the superhighway being built today will still require people to fix things. It still requires people to risk their lives working at height and there are also the costs of lane closure and traffic management to the traveling public – all expensive and all adding to the ongoing costs.

A sensible approach

So let's apply some common sense. How can we build low-cost structures that reduce the ongoing costs of operation?

Lightweight gantries, more intelligent signs, newer technologies such as more in-built technology? Maybe.

Reduce the signage, move it to the side of the road, make it accessible from ground level without the need for lane possession and traffic management. Seems like a good idea. Estimated operational savings of 20% per annum versus fixed structures and no working at height. Sounds like common sense.

Crown International's VMC Pole is a rotating and lowering cantilevered pole – a smart solution for easier access to highway equipment

Need to know?

When deploying high-end technology, we must remember not to lose sight of the basics

- To achieve the best results from ITS equipment, the hows and whys of its implementation need as much attention as the technology itself
- When it comes to roadside technology, the best future vision involves making it easier, safer and less expensive to maintain
- Flexible structures offer huge financial and operational gains to road operators

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Increasing situation awareness

Noptel's SpeederX1 laser sensor unit

Finland is currently undertaking a national research program focused on the area of big data. The aim of the Data to Intelligence (D2I) program is to develop intelligent tools and methods for managing, refining and utilizing diverse data across a variety of sectors. Within the overall program, the D2I traffic project (which began a year ago) aims to create situation awareness for traffic circumstances in day-to-day life. The project gathers together measurement device providers collecting and pre-processing measurement data; companies realizing wireless data communication and data storage; as well as companies, institutes and universities developing data pre-processing methods and providing processed data for customer use. The goal is to invent products, solutions and services that use traffic data and related data sources to provide added value to the customers and good business for the providers.

Business cases

The work is organized into two business cases; traffic-related data from city regions and a data marketplace. The general goal for both cases is to improve the situation awareness of traffic-related players. Situation awareness is enabled by modeling traffic flows, environmental conditions and the behavior of individual drivers based on data collected from a city region. Furthermore, the development of the business ecosystem and technology for the data marketplace is emphasized. The data marketplace is a meeting place for producers and consumers of data. It opens up new possibilities to sell data that has already been collected, to do business by processing data that was not previously accessible, and to buy data that enables novel end-user applications. Due to the aforementioned aspects, the data marketplace would be an excellent test bench for studying situation awareness in other areas of daily life as well.

Need to know?

A key part of a national research program is proving highly valuable to the ITS market

- The traffic project within Finland's D2I program is deploying innovative traffic data collection and analysis solutions
- Intelligent sensors are being used to gather traffic data to improve situation awareness
- For a country such as Finland, winter road maintenance is an essential part of traffic management and sensors can also assist with this

Laser radars in situ above the road

Applications

The vehicle stopping distance application developed by the FMI (Finnish Meteorological Institute) is an example of the novel applications that are created when parties with expertise in processing data get access to new data sources. This particular application exploits Noptel laser radar technology installed above the road. The laser radars detect passing vehicles and measure their velocities. The distances between the vehicles are calculated based on their velocities and accurate timestamps. The gathered data is available for project participants who can then process and refine it.

In addition to knowing distances between vehicles, the stopping distance application requires information about the slipperiness of the road (i.e. friction between a vehicle's tires and the road surface). Road slipperiness is measured continuously by dedicated instruments at the roadside and it can also be calculated by the FMI's road weather model. When all required parameters – i.e. the velocities of the vehicles, road slipperiness and the distance between the vehicles – are known, the required stopping distance can be calculated.

The calculated stopping distance is presented to drivers via roadside message signs or on an in-vehicle display. Warnings are given to drivers who are traveling too close to other vehicles.

Winter maintenance quality monitoring

Winter maintenance of roads and tracks in snowy conditions typically relies on weather forecasts and weather station data. However, since Noptel laser radars are placed above the road, they can monitor the road surface as well. Therefore Noptel laser radars are applied to winter maintenance quality monitoring by constantly measuring the thickness of the snow on a road or track. By adding this real-time snow quantity information to the road models, users can improve control over winter maintenance. Moreover, when laser radars at multiple locations gather snow quantity information, road users can be advised to select routes with the best conditions.

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Traffex STAND Z69

Wireless sensors for smart parking

READER ENQUIRY NO. 511

We are all acutely aware of the time and effort it takes to find a place to park. However, most people never realize that while they're searching for a spot of their own, a quarter of the drivers near them are also doing the same thing. The good news is that smarter parking systems alleviate issues such as this and have already made their debut in a big way.

At the heart of these systems are the sensors that have become key components of many current parking solutions. The advent of advanced parking management has seen the rollout of guidance systems that direct users to vacant spaces, variable pricing for specific areas and mobile access to parking information. All of these solutions can include some form of sensor technology to collect data and communicate it direct to users, enhancing the user experience and increasing parking efficiency.

One way to realize a smart parking solution is to use a network of vehicle detection sensors to collect local data. However, this can sometimes be difficult to install within existing infrastructure. Banner Engineering, an expert in sensor technology for the traffic and parking industry, has developed a simple, robust, battery-powered wireless parking sensor for modern parking systems. Each sensor uses onboard intelligence to detect the presence or absence of a vehicle in each parking space and delivers the data over a wireless network. The data can then be made available to the operator, municipality and mobile users for specific applications.

Need to know?

The new breed of sensor-based parking solutions is proving a big hit

- Smart parking applications rely on sensors, but even smarter applications make those sensors wireless
- Wireless sensors are an attractive choice for parking operators as they can easily be used in existing infrastructure
- Operators can do more for less with the data such systems generate
- Wireless gets around the limitations of mesh-type ZigBee sensor solutions

(Right) **The Gateway can communicate with several sensors and interfaces with the parking system controls**
(Below) **Wireless systems integrate with a variety of equipment**
(Far right) **The battery-powered M-GAGE sensor can be installed aboveground or flush with the road surface**

The advantage of wireless

Banner's wireless sensor network offers the ability to quickly configure and place sensors throughout an area, whether it is an on-street location or surface parking lot. The fact that each sensor is a wireless device bypasses the need to install long runs of conduit and cabling, which can take a considerable time and is costly for larger facilities or complex areas. Sensor data can be relayed to a central location for control using a gateway and/or repeater radios to easily form scalable networks. A quick 'site survey' to each sensor node in the network returns a qualitative measure of its RF link to the network. As well as ensuring up-to-date data, each sensor contains a mechanism for simultaneously determining its own radio link 'health status'. Moreover, the communications sequence is designed to minimize RF interference, while the proprietary protocol in use has the added benefit of retaining data integrity (through a cyclic redundancy check) and maintaining data security as it is unable to route or process malicious packets from other sources. This enables asset observation and

management in real time, while maintaining the accurate status of each device in a secure, well-controlled network.

Aside from the sensors themselves, the overall system is versatile and capable of integrating with the equipment used in modern facility control, access or payment systems. It can accept electrical signals or data from various sensor types, PLCs, gate controls, counters, timers, etc. For example, Banner's sensor networks can be used to detect vehicles at entry/exit points for accurate counting and verify when a specific space has been occupied. In turn, operators can determine whether to adjust pricing and servers can send mobile notifications to users if their allotted time is about to expire. When larger data packets need to be sent wirelessly from a controller or payment system to another location for processing, the network can be configured to transmit this data as well.

Overall, wireless sensor networks form the foundation for comprehensive parking solutions. They integrate with new and existing infrastructure and are easy-to-use sensors for acquiring on or off-street data. This puts advanced, smart parking capabilities in the hands of professionals industry-wide and furthers available options for users everywhere.

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I occasionally write about vehicle-highway automation and have at times been a bit dismissive as a result of concerns about the safety proposition. (I would think to myself how impossibly reliable the system would have to be across all sorts of traffic, road and weather conditions.) At other times, I've been enamored of the technology. ("Hey, Google is doing it. They are successfully pushing frontiers. And by the way, I love my Android phone.") Then I would become concerned about the enormous infrastructure investment needed to get some concepts literally and figuratively on the road. ("Dedicated lanes on major roads? Who can afford that? What is going to precipitate this major institutional and operational change?") With this cacophony of voices in my head, the one telling me to shut up prevailed.

Par for the course, automated vehicles are once again at the tip of everyone's tongue. Now the loudest voice in my head is telling me to give the readers what they want. I have not shut up….

In the USA, the Transportation Research Board sponsored a summer workshop, and that spawned a new subcommittee aptly monikered 'Challenges and Opportunities for Road Vehicle Automation', and attended by interested government, academic and industry parties. Moreover, trade associations dedicated to military robotics are interested in what they call 'driverless cars'. The USDOT has recently publicly expressed interest in the topic, and the US Department of Defense has a long-standing involvement, as the limelight from the DARPA Challenges a few years ago has not diminished for, among other parties, the US Army.

Especially important, carmakers have publicly embraced a future with vehicle automation and some now offer cars with a high degree of automation. For example, if I lived in Europe and had a very high salary, I could this year buy a high-end car with 'Traffic Jam Assist'. From this industry there has been a plethora of recently announced research, product plans and prognostication that automated vehicles are coming.

And there are governments, both provincial and national, who eye automation with a mixture of excitement and dread. However, they are lining up to research, license, consider legal definitions and constraints and, importantly, consider the costs and benefits along with the safety. Vehicle automation, it is widely believed, is inexorably upon us.

I often consort with academics, and in those hallowed halls there is still the Dr Jekyll and Mr Hyde skepticism. There are the out-and-out engineers who are developing control laws, sensor systems and even concepts with human-machine interfaces and transfer of control that could make automation very real. There are those who consider the yoke of infrastructure finance, the likely existence of legacy systems, the advent of potentially enabling and at least (to many) synergistic vehicle-to-vehicle and vehicle-to-infrastructure communication and the safety or capacity proposition – and declare automation as the Dr Jekyll of the future. Others are more cautious and imagine the future of automation as a carefully conceived step-by-step proposition. Yet others with the same set of evidence pronounce their love for a positive Mr Hyde and believe that he is just around the corner.

What is the real, non-fiction story? I can't tell you, except that it will likely unfold with plot twists and at a rapid pace. It is a veritable 21st century Jekyll and Hyde story. I can't wait for the next page!

> [Autonomous vehicles] will likely unfold with plot twists and at a rapid pace – a veritable 21st century Jekyll and Hyde story. I can't wait for the next page!
>
> **Jim Misener, transportation and technology consultant, USA**

Intelligent radars capture critical event data

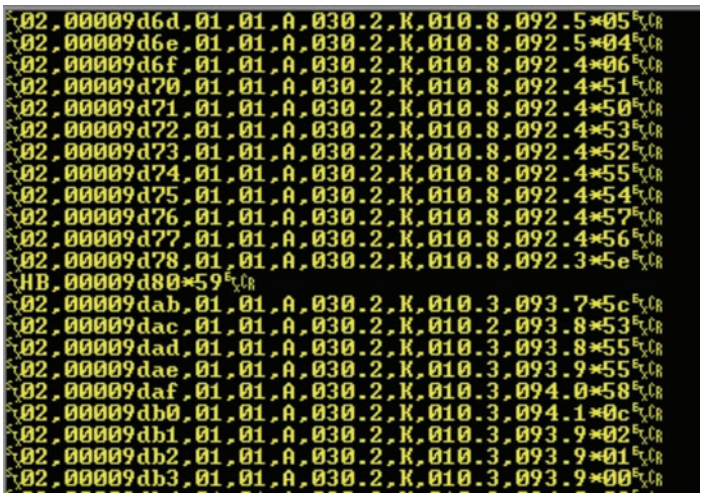
READER ENQUIRY NO. 512

The development of intelligent radar detection systems continues to play an important role in the ITS arena. There is now a greater understanding of the capabilities that radar technology can provide in terms of target speed and range measurement, vehicle count, occupancy, classification and vehicle gap, among others, for varied applications in both urban and inter-urban environments.

Working together

To fully exploit radars within the context of ITS, the technologies deployed must be aligned with more demanding customer applications. Through close collaboration with client technical teams, manufacturers of intelligent detection systems are better able to tailor their platforms' specifications with customers' data capture requirements to provide optimal performance.

(Main) **AGD's 318 FMCW radar detection system**
(Below) **Typical 318 radar output message string**



Need to know?

A new family of radar systems has been designed to meet the needs of various ITS applications

- Following on from AGD's earlier 315 radar, its offerings have evolved to the sophisticated products available today
- The 318 is the latest product and is well suited for demanding ITS tasks
- As well as speed and range measurement, the 318 can be used for incident detection and congestion management

As part of the development process, on-site demonstrations of existing systems can help customers clearly identify their particular critical event data capture requirements, and shape how the end radar will perform.

Partnering with manufacturers allows the flexibility to move to product trials in the on-street environment. This ensures both parties can double-check how the performance criteria of the radar detection platform meet the original brief. While further iterations in the design phase are likely to follow, this method allows the customer to participate in the development process, to arrive at a robust and sustainable detection solution.

Features such as onboard target simulation and continuous radar self-check routines give users the confidence of long-term reliability and premium detection performance.

High-speed RS422 serial communications transfer detailed event data to host systems in clearly defined message structures with user selectable baud rates up to very high speeds, for example, 921600.

Further detailed testing in a bespoke environment that re-creates specific vehicle target speeds, directions and ranges provides additional reassurance of product performance.

These tests can include, but are not limited to: true range simulation of target; target speed and direction at a given range; radar target processing optimization; and transmitted radar frequency modulation measurement.

So how does this process manifest itself in a production item that can be easily integrated into a host system? New for 2013 is AGD's 318, using the company's learning in speed and range measurement for the exacting speed enforcement market.

The 318 has been designed to measure the speed and range of passing vehicles in multiple lanes for traffic monitoring. The

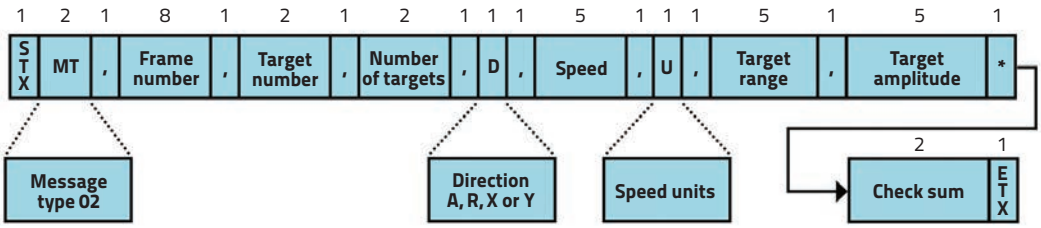
radar is able to simultaneously track up to 10 target signals in either approaching or receding direction or five in each direction if using bi-directional mode.

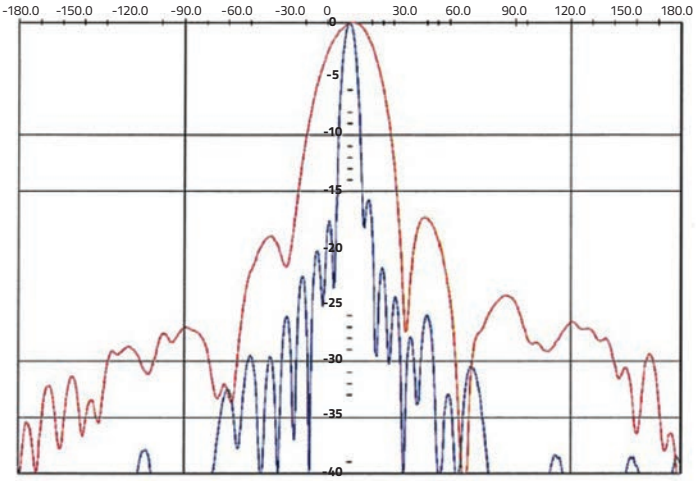
This new product is a frequency modulated continuous wave (FMCW) radar that operates in the 24GHz band. It can measure speeds from 20km/h (12mph) to 300km/h (186mph) across multiple lanes and make target range measurements of up to 70m (230ft) from the mounting position at a fixed frame rate of 48fps. The 318 will output a target message stream when a target is detected by the radar and for its travel in the radar beam. When there is no target only the heartbeat message will be sent, if enabled. The radar is designed to send target event data and not make decisions on incidents that may be specified.

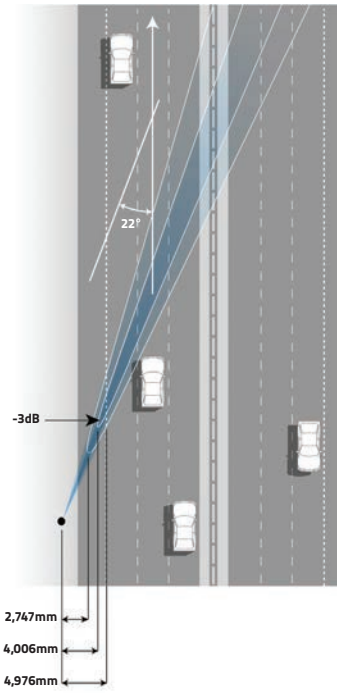
The host system's data processing is responsible for ensuring the correlation of the target speed/range data from the radar satisfies the fit-for-purpose requirement. The sequence of messages will comprise target detect messages and heartbeat messages to allow the host system to interpret the event information correctly. The heartbeat provides assurance to the host system of correct radar operation in the absence of passing targets.

Set-up and installation

The importance of correct set-up and installation is critical to the reliable performance of the radar. The 318 units are supplied factory-programed to be used for a specific mounting angle of 22°, ie. the angle the radar points across the road from the vehicles' direction of travel. This angle is used by the radar to adjust the speed it measures to the actual speed, so it is important that it is set up correctly. Incorrect mounting angles can result in either under- or over-reporting of vehicle speeds.







(Top) **Target detect message structure**
(Left and above) **Recommended radar mounting angle to traffic direction and antenna plots**

A range of radar star (*) commands allows users to query the set value of a command or adjust this value. Commands include *ANGLE, *DIR and *SU, to ensure the radar is correctly aligned to the direction of travel and that approach, recede or bi-directional modes have been selected and the appropriate speed measurement units are reported in mph/km/h.

The optional in-built target simulator is activated using the *TS command and allows 12 self-test targets at specific speeds and ranges to be simulated in either recede or approach direction. There are recommended pass and fail criteria for the host system to employ for this innovative radar self-test routine.

*BAUD and *HBP enable adjustment of the serial comms baud rate and for the heartbeat message to be enabled at a frequency of between 5-600 seconds.

The intelligent 318 FMCW radar family offers complete flexibility of deployment for the primary function of speed and range measurement in a multi-lane environment. This platform also lends itself to strategic incident detection and congestion management.

Later versions are planned with a user-friendly GUI and Bluetooth communication for speedy and convenient set-up. Users will be able to detect valid targets within or above defined speed thresholds and at specific set distances from the radar, giving them clearly defined zones of detection.

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Integrated Corridor Management on I-15 in San Diego

READER ENQUIRY NO. 513

The world's transportation network is the most extensive, high-profile and expensive public utility ever built. Undoubtedly visionary for its time, transportation infrastructure is increasingly being squeezed, with more vehicles on the road than ever before, increased commute times in most metropolitan areas and more vehicle miles traveled per person. These challenges – largely driven by an increase in the world's population, plus economic advances – have created a difficult environment for those charged with maintaining and operating these systems. Traffic system managers strive to improve mobility, safety, air quality, and return on taxpayer investments. In the midst of declining resources and increasingly complex political dynamics, their job is more challenging than ever.

Current transportation networks are made up of multiple independent systems managed by various agencies and, until recently, efforts to manage these networks to improve mobility, safety and reliability focused on optimizing each individual system. The limitation with this approach is that the independent transportation systems – freeways, public transit, bus systems and local arterial roads – do not have the capacity to respond to demands from other networks. Another limitation has been the application of ATMS that have typically been reactive systems designed to detect adverse conditions (such as a traffic incident or recurring congestion), verify the situation and provide a response.

When the USDOT conceived the concept of Integrated Corridor Management (ICM), it was designed to address these challenges. The vision was for metropolitan areas to realize significant improvements in the efficient movement of people and goods through aggressive, proactive integration of existing infrastructure along major corridors.

ICM is being implemented in four phases. Phase 1 conducted research into the current state of corridor management in the USA as well as around the world. Phase 2, though – which runs concurrently with Phases 3 and 4 – develops analytic tools and methods that enable the implementation and evaluation of ICM strategies. The ICM program recently completed Phase 3 (Corridor Site Development, Analysis and Demonstration), in which San Diego and Dallas were selected as pioneer sites to demonstrate their strategies. Phase 4 will be Outreach, Knowledge and Technology Transfer.

Need to know?

The inside story on how a four-phase project in San Diego is leading the way in ICM deployment in the USA

- Demand outstripping supply has led operators of transport networks to look to ICM as a capacity-increasing solution
- A phased approach helps ensure that all players are working toward the same aims at the same times
- Achieving a number of specific goals (defined at the start of the process) will demonstrate the benefits of ICM in a highly tangible way

ICM in California

The San Diego ICM corridor is Interstate 15 (I-15), a congested north-south interstate corridor. This 20-mile facility – stretching from SR 78 in Escondido to SR 163 in San Diego – forms the primary artery for the movement of commuters, goods and services from northern San Diego County to downtown San Diego. It is already a model for the deployment of the latest technologies for data collection, demand management and pricing strategies through its I-15 HOV Express Lanes project.

With the San Diego Association of Governments (SANDAG) taking the lead, a strong group of agencies

worked together to make this project a success. Project partners include Caltrans, the cities of San Diego, Escondido and Poway, the Metropolitan Transit System and the North County Transit District.

These agencies collaborated to set five primary goals for San Diego's ICM. The first goal is that the corridor's multimodal and smart-growth approach should improve accessibility to travel options and attain an enhanced level of mobility for corridor travelers. Next, the corridor's safety record should be enhanced through an integrated multimodal approach. The third goal is that the corridor's travelers should have the informational tools needed to make smart travel choices within the corridor. The institutional partners also committed to employing an integrated approach through a corridor-wide perspective to resolve problems. The final goal is for the corridor's networks to be managed holistically under both normal operating and incident/event conditions in a collaborative, coordinated way.

To achieve these goals, a number of Active Traffic Management (ATM) strategies were deployed to proactively manage multiple modes through and along the corridor. Strategies to empower the motorist and aid their decision-making include

(Top) **I-15 is a congested north-south corridor**
(Above) **The HOV Express Lanes**

I-15 forms the artery of transportation between northern San Diego County and downtown San Diego

both pre-trip and en-route traveler information.

On-road activities involve everything from freeway-coordinated adaptive ramp metering and signal coordination on arterials with freeway ramp metering to regional arterial management.

Further operational strategies include real-time multimodal decision support, network traffic prediction, online microsimulation analysis, and real-time response strategy assessment.

Tools to succeed

As the nucleus of the ICM solution, Delcan's Intelligent NETworks ATMS is used for field device monitoring and control, center-to-center data fusion, event management and intelligent decision support system (DSS) response plan generation. This adds to a list of successful ATM and/or ICM projects for Delcan, including its award-winning Route 8 project in Hong Kong.

In addition to the Delcan product, at the heart of the DSS is Aimsun Online, a simulation-based prediction system from TSS-Transport Simulation Systems. Aimsun Online uses live data feeds and simulations to dynamically forecast traffic conditions based on the current state of the network, and to help operators evaluate incident response or congestion management strategies.

"The San Diego ICM project is unique for incorporating both the network prediction subsystem (NPS) and real-time simulation subsystem (RTSS)," notes Peter Thompson, technical manager at SANDAG. "Through the use of these tools, decisions are made based both on current and predicted traffic conditions, a capability that has been missing from ATMS solutions over the past 20 years."

Alex Estrella, SANDAG ICM project manager, highlights the importance of the project to the region: "Its completion will augment this region's longstanding commitment for working together and demonstrate the San Diego region's ability to develop and implement innovative solutions and strategies for addressing congestion."

Through the deployment of these tools, a 'smart' traffic management system will give operators comprehensive awareness of the current and likely future performance of the entire corridor. Building upon the systems already in use on I-15, operators can now take proactive steps to prevent system breakdown using enhanced controls across multi-jurisdictional devices, such as traffic signals, ramp meters and DMS.

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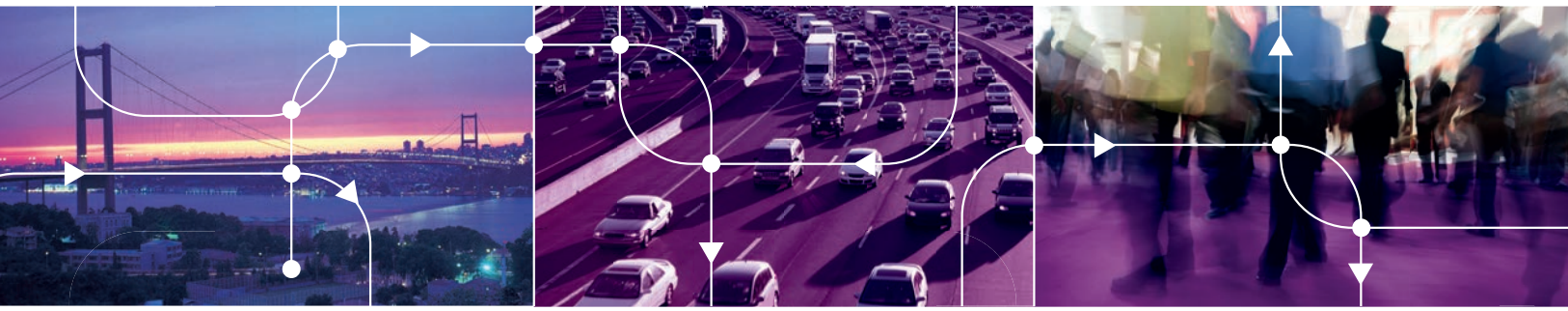

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Traffex STAND D50

The power of sharing through smart IT platforms

READER ENQUIRY NO. **514**

Time, resource and budget constraints are the typical factors that make any business challenging. When it comes to offense management today, there are more cars on our roads and more violations that require processing, and police forces are tasked with enhancing our road safety with less money and fewer people. Innovative technology solutions help police forces deal with the continuously increasing pressure of 'delivering more with less'.

The main challenge is the complexity of the entire lifecycle of processing traffic violations and the potential that exists for delays at different turning points. Today, a police force may experience a backlog in verifying images, but tomorrow it could be the communications area where a delay is happening.

How can an organization optimize the utilization of staff at all times and make its central ticket office more efficient?

Dynamic sharing and automization of the workload can be the answer. Interfacing with all major camera manufacturers, StarTraq's smart technology platform DOME (Dynamic Offense Management & Enforcement) enables a police force to process all traffic violations through one single back-office system. No need to train staff on multiple offense processing applications.

Advanced permission control settings allow the dynamic re-allocation of resources to support areas experiencing higher volumes than usual.

This flexibility enables a police force to keep its teams small and still increase the number of offenses processed on time.

In the UK, police forces in Hertfordshire, Bedfordshire and Cambridgeshire started a regional collaboration program in 2011. They recently awarded StarTraq with the contract to provide a single back-office system to process all of their traffic offenses across the three counties. The benefits of such collaboration include: split license costs and the ability to spot backlog situations in the workflow early. Other benefits include a reduction in the time spent on software training and the ability to process more traffic violations, faster.

The different forces can also choose to keep individual processes where desired, which helps to preserve the identity of each force.

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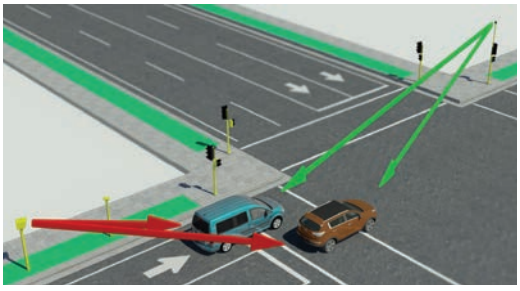
The latest in non-intrusive enforcement technology

READER ENQUIRY NO. **515**

Non-intrusive enforcement technology, by its very definition, does not require any intrusive means in order for a system to be implemented or run – no major alterations to the existing infrastructure are necessary. This innovative technology enables the highest possible detection rates, ensures near total flexibility and is extremely cost efficient.

Redflex has developed systems and software in response to the increasing demand for this technology. The company's Mapping Radar uses a low-power ultra-wide beam, which means entire intersections can be covered by a single sensor and the system has the ability to enforce across six lanes simultaneously.

The company has developed a hybrid twin-radar tracking system, employing both on-board target analysis and on-computer tracking. The algorithms running on the computer have the advantage of extensive memory and CPU power to perform the data analysis necessary to guarantee all detections. These algorithms not only execute vehicle tracking models to establish position, speed and acceleration of each vehicle, but also trace through potential reflection and noise patterns, analyze the effects of 'wheel scatter' and combine the readings from the two radar sensors installed at each site, optimizing the accuracy of each detection.



Primary mapping radar (green arrows) and secondary (red arrows)

The results being achieved by the Mapping Radar systems demonstrate higher volumes of accurate vehicle detections and fewer false positives, due to the system's verification component.

One of the concerns pertaining to non-intrusive traffic enforcement technology and enforcement technology more generally is that of the environmental sustainability of implemented projects. Solar power is regarded as being cheaper and more efficient. However, due to issues with the reliability of solar power, more development is still required to perfect this method. Other potential power source options include generators, fuel cells and wind power – although at present, none of these options have been seriously considered as long-term power solutions.

The demand for non-intrusive traffic enforcement technology is growing all the time, and because of this, fresh developments are occurring regularly.

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What needs to be done to encourage a more integrated approach to the issue of parking within the broader traffic management picture?

"The resources devoted to vehicle parking in our cities are huge but parking facilities are not efficiently managed. As a result, we are not extracting all of the potential value from each parking space. The positive way to explain this is that if we apply more efficient management of parking, everybody can be better off. Motorists will gain because they will be wasting less time searching for a parking space, governments can be better off because they won't have to subsidize so much parking, and there will not be the same demands on building developers to supply as much parking. Alongside this, with better traffic flow our city streets should be safer, and air pollution reduced. There really are huge advantages to managing parking properly. We are only starting to tap into the potential here. Most cities are applying a few parking management technologies but almost no cities are doing everything that they can. There is, consequently, a tremendous opportunity at the moment to start using the new technologies that are coming on stream to transform the way we think about and operate our parking facilities."

Todd Litman
executive director, Victoria Transport Policy Institute, British Columbia

"From Parkopedia's perspective, the most important issue is the availability of accurate and rich parking information. We need information that is not locked within a proprietary system and that third parties can integrate into broader traffic management and journey planning tool sets. If parking operators, municipal or commercial, were to provide such information, organizations such as Parkopedia could then build on it to provide innovative consumer and automotive solutions. A new 'open data' initiative was recently launched by the UK government to open up municipal data and allow everyone to create such innovative services. We need to make sure that parking and traffic authorities worldwide understand the value of such open data and the benefits it can bring to their own organizations, as well as to all other stakeholders."

Eugene Tsyrklevich
CEO, Parkopedia,UK

"In my view, what needs to be done is to first convince all of the private parking operators that the initial data they provide to services which then re-transmit it in some way, whether that be through a smartphone app or on-street signage, can remain confidential – and that taking this step will not impact negatively on the way they run their businesses by passing on what they might see as trade secrets. Another step is to reassure all of the suppliers of parking – in what is a very competitive market – that it is actually in their best interests to indicate to the drivers out there that there are spaces available in a particular area. Often drivers may be reluctant to travel to part of a city because there is a perception that parking is going to be in short supply. In many cases this is contrary to the actual facts, but they can't change their journey plans because they simply haven't been given the information to make them aware of the true level of parking availability."

Larry Schneider
president, Parking Association of Australia

"I think there has to be a continued focus on the reality that parking is part of an overall transportation system. In Denver this is reflected in our strategic parking plan, which looks citywide. Parking certainly isn't a standalone entity. In practice there are multiple components to parking: the planning, engineering, operational and enforcement elements. Consequently, everything we do in parking needs to involve key stakeholders alongside outreach to the community and user groups. We are not even just talking about car parking here in Denver; we have cycling as part of the system alongside transit parking and taxi cab stands. There are all of these competing and varied demands for the curb lane on our streets that need to be carefully managed as a system. You have to make sure that one individual stakeholder isn't over- or under-represented. To me that is one of the biggest challenges right now, because demands such as car shares want a piece of the curb lane (and taxis too) for what in the end is a very limited resource."

Matt Wager
director of operations, Traffic Engineering Services, Denver Public Works Department, USA

Readers are invited to answer the Burning Question for the April/May 2013 issue:

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

email answers to:
louise.smyth@ukipme.com

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