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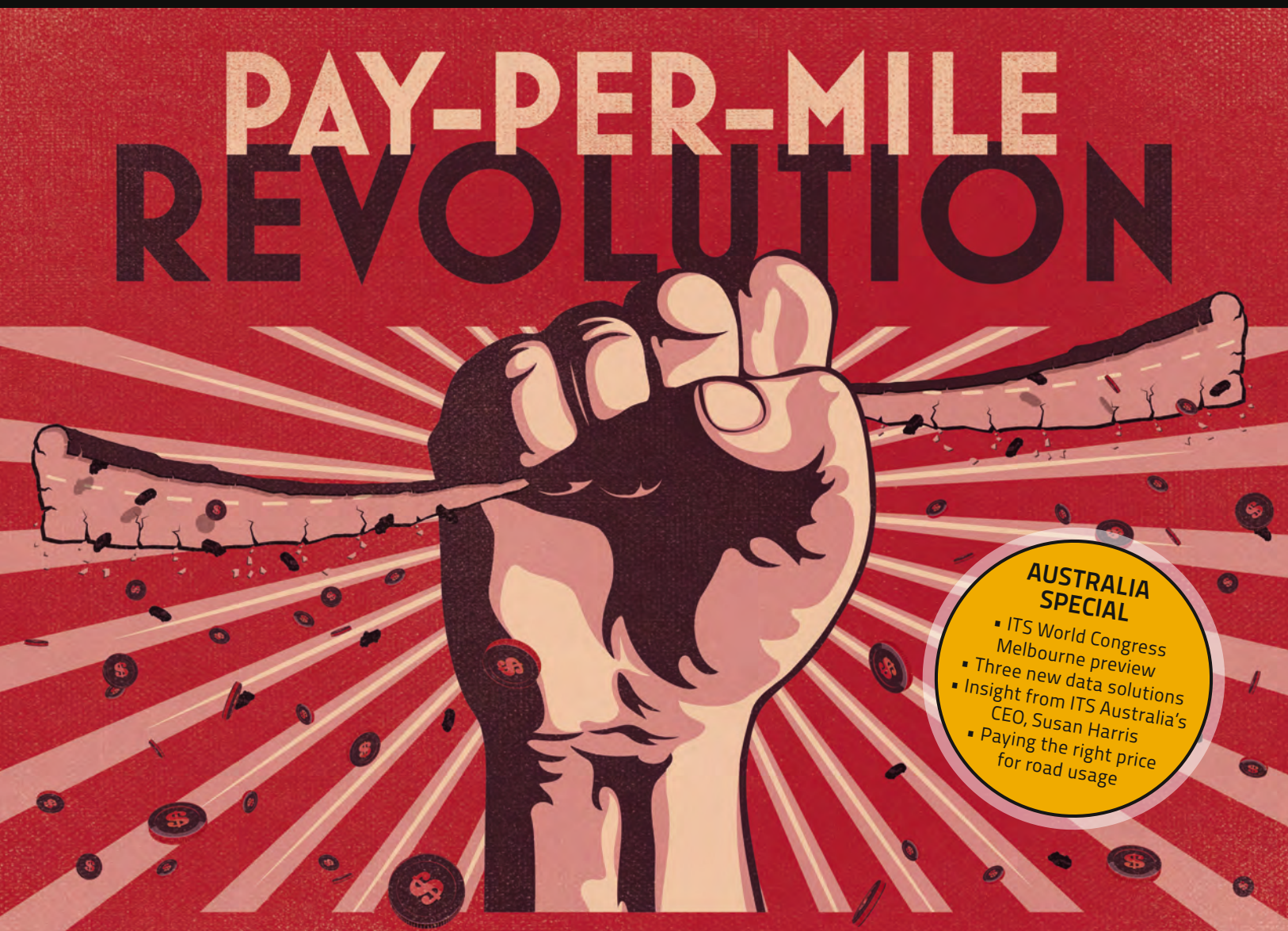

AUSTRALIA SPECIAL
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- Three new data solutions
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Can road user charging solve the funding crisis and cut congestion?

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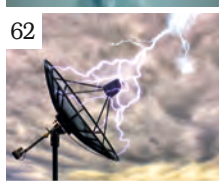
Will renewables one day make uniterruptable power supplies obsolete? David W Smith investigates on page 60

Cover story

32 Paying the price

Will road user charging solve the transportation funding crisis and cut congestion?

Saul Wordsworth reports on the need to shift public attitudes in a world where gas tax revenues are in free fall



Technology Profiles

Editor's letter

Communication is at the heart of every system that organizes transportation. This fact was brought home to me recently on a trip to Marrakech, Morocco. Here, where the old town meets the new, motorcycles and donkeys coming out of narrow streets compete for space with cars on wider roads. It was at one such point that I encountered, one sweltering afternoon, what seemed to be complete gridlock. Cars jammed in from all directions, with only foot traffic able to fit through the tiny spaces remaining. As frustration began to build, horns began to sound. Then an old man emerged from a doorway waving his stick and shouting. Initially I assumed that his anger was going to make things worse, but then a strange thing happened. Cars gradually began to inch around each other, and it became clear that the man wasn't needlessly ranting, but was actually directing the traffic. Within the space of a few minutes the intersection was clear, the man returned to minding his shop and the flow of traffic returned to normal. The system may have been simple, but it shared one important feature with advanced ITS: successful communication.

In the West, transportation is at the heart of a new era of communication. However we get around, we are constantly generating and consuming data. The better these connections, the more efficient our transportation systems can become. That's why this issue we are launching a new section called Comtrans (page 69) – your essential guide to the future of transportation communications. In it, each issue we'll be investigating in detail the systems and networks that are needed to get the most out of traffic technology: Bluetooth, wi-fi, 3G/4G, GPS… the list seems to grow with each passing month, although we can be fairly certain that 'men waving sticks' won't be joining it any time soon.

Of course, installing new technology is only the first stage in creating a robust transportation network. Technology becomes useless if not properly serviced. So over the coming months we'll also be giving you greater insight into the maintenance that roadside infrastructure requires. Look out for the spanner logo (above) as you flick through.

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comtrans

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Traffic Technology International USPS 012-893 is published bi-monthly – in January, March, May, July, September, and November by UKIP Media & Events Ltd, Abinger House, Church Street, Dorking, Surrey, RH4 1DF, UK. Annual subscription price is £78/US$125. Airfreight and mailing in the USA by agent named Air Business Ltd, c/o Worldnet Shipping USA Inc, 155-11 146th Street, Jamaica, New York 11434. Periodicals postage paid at Jamaica, New York 11431.

US Postmaster: send address changes to *Traffic Technology International*, c/o Air Business Ltd, c/o Worldnet Shipping USA Inc, 155-11 146th Street, Jamaica, New York 11434. Subscription records are maintained at UKIP Media & Events Ltd, Abinger House, Church Street, Dorking, Surrey, RH4 1DF, UK.

Air Business is acting as our mailing agent.

published by UKIP

Member of the Audit Bureau of Circulations

Average net circulation per issue for the period January 1–December 31, 2015 was 17,412
Annual subscription US$125/£78
USPS Periodicals Registered Number **012-893**

ISSN 1356-9252 (Print)
ISSN 2397-5970 (Online)
Traffic Technology International

Printed by William Gibbons, Willenhall, West Midlands, WV13 3XT, UK

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- Establishing an international agreement on rules and regulations for autonomous vehicles
- Safely integrating autonomous vehicles with other road users
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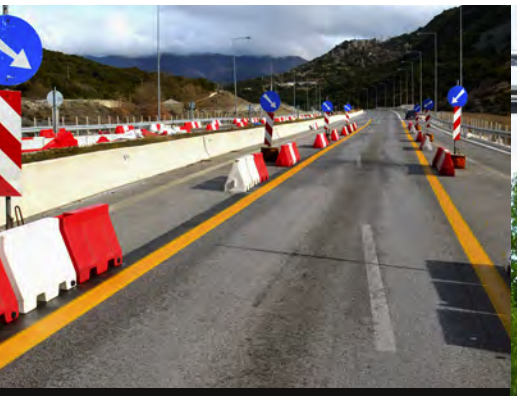

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PREVIEW

Autonomous Vehicle SAFETY REGULATION WORLD CONGRESS 2016

This October (25-26), the first and only conference dedicated to defining autonomous vehicle regulations will take place in Novi, Michigan, alongside the Automotive Testing Expo North America show. *Traffic Technology International* reveals exclusive not-to-be-missed highlights

While the world eagerly awaits the advent of fully self-driving vehicles, there is a plethora of legal and regulatory questions surrounding them which have yet to be answered, or even fully addressed. The technology cannot reach fruition until the regulatory regime is clear.

Now, at the world's first and only conference entirely dedicated to defining the rules for the testing and use of autonomous vehicles on public roads, industry experts have the opportunity to discuss and explore how this regulatory framework can be established.

Organized by the publisher of *Traffic Technology International*, the two-day Autonomous Vehicle Safety Regulation World Congress will take place at the Suburban Collection Showplace in Novi, Michigan, on October 25-26, alongside Automotive Testing Expo North America, with delegates representing all areas of the automotive and transportation industry aiming to define the legal guidelines, rules and regulations for autonomous vehicles.

Highlights of the two-day program include keynote sessions from the US National Highway Traffic Safety Administration's (NHTSA) Office of Rulemaking and Vehicle Safety Research; Carlos Braceras, director, Utah Department of Transportation, USA; Collin Castle, connected vehicle specialist, Michigan Department of Transportation, USA; and Pam Fletcher, executive chief engineer of autonomous vehicles, General Motors, USA.

Attendees can also look forward to moderated panel sessions and individual speaker presentations from a host of other experts.

Visit the website below to book your place and turn the page for more speaker highlights…

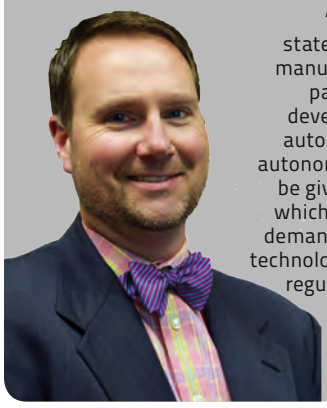
To book your delegate pass for the Autonomous Vehicle Safety Regulation World Congress 2016 visit

www.autonomousregulationscongress.com

Making the leap from testing to deployment

SPEAKER HIGHLIGHT!

James Fackler, assistant administrator, Michigan DOT



"I'm going to be involved in the 'How national and state government departments can work with vehicle manufacturers to develop safe testing on public roads' panel discussion. I'm hoping to focus on Michigan's development of state legislation and policy related to automated vehicles and discuss the progression from autonomous vehicle testing to open deployment. I'll also be giving an overview of Michigan's policy discussions, which include industry-led requests, such as using on-demand service pilots as a way of bringing autonomous technology to the public. I'll also give some context to the regulatory policy discussions happening at the national and state level, involving NHTSA and AAMVA."

Wednesday, October 26 at 11:35am

Adapting in a world of incremental change

Catherine McCullough, executive director, Intelligent Car Coalition, USA

SPEAKER HIGHLIGHT!

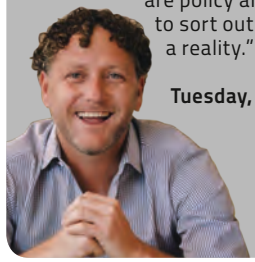
"We know that cars with self-driving capabilities make us safer by reducing crashes, but fully autonomous vehicles won't be on the roads for several more years. In the meantime, semi-autonomous cars are making their way into dealerships, which means consumers can choose from different levels of autonomy. But what issues do we have to consider – technological, legal and societal – for any level of autonomous vehicle to thrive?"

Tuesday, October 25 at 4:10pm

Autonomous vehicles and future mobility

Michael Masserman, senior director, government relations, Lyft

"This past year, Lyft announced a partnership with GM to launch an on-demand network of autonomous vehicles. This deal is rooted in the belief that the transition to autonomous vehicles will not be via single-car ownership, but rather through a network of on-demand vehicles. Through this partnership, Lyft is advancing a vision that has the potential to greatly reduce traffic congestion and greenhouse gas emissions, creating a better future for our cities. But there are policy and regulatory issues to sort out before that becomes a reality."



Tuesday, October 25 at 2:25pm

SPEAKER HIGHLIGHT!

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LEADING THE WAY

Melbourne mobility

The ITS World Congress 2016 will take place in **Melbourne** this October. Australia's second-most populated city, its roads and transportation systems must be robust enough to handle the travel needs of its growing population

Infographics: Andrew Locke

4.5 million

The estimated population of Melbourne

Total length of Melbourne's roads

(342km) **268 miles**

Melbourne metropolitan area covers

6,207 square miles

(9,990.5km²)

23 minutes

average trip time

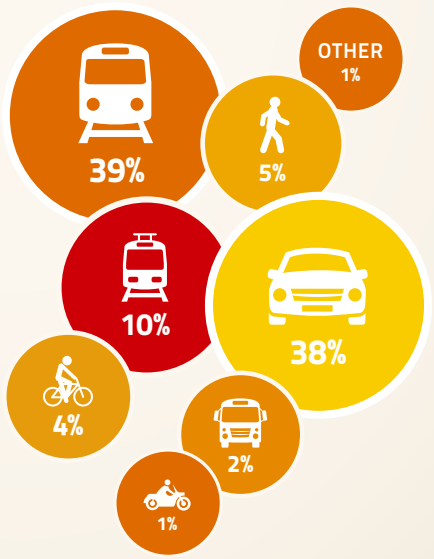
12,000,000

trips are made each weekday

11,000,000

trips are made each weekend day

Methods of traveling to work



8:30AM

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1.6

vehicles per household

Melbourne has the largest tram network in the world

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1,763 tram stops

25 routes

Walking is the main form of travel for trips less than **0.6 miles (1km)**

SOURCES

Australian Bureau of Statistics
melbourne.vic.gov.au
City of Melbourne, Mapbase
City of Melbourne Census
VISTA Survey 2013
Metlink, Department of Transport
yarratrams.com.au

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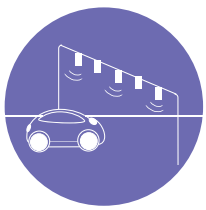

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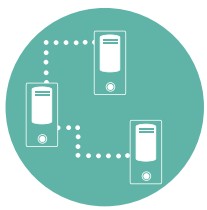

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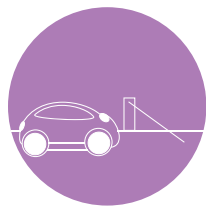

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Scientific Committee notice to the author(s) about paper acceptance –
BY 1st DECEMBER 2016

Paper submission –
BY 10th MAY 2017

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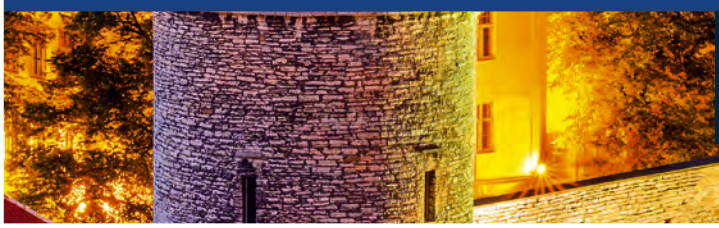
1st MAY 2016



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Maintenance system gives 99% ITS device availability

Georgia DOT's NaviGAtor Comprehensive ITS Maintenance system proves it's important to have a long-term investment strategy in order to get the most out of intelligent transportation systems

Left: **Timothy Bean (far left) of Serco and Georgia DOT's Mark Demidovich (left) celebrate winning a Best of ITS Award at ITS America San Jose**

99.34%
The maximum availability of 3,000 ITS devices in Georgia achieved with efficient maintenance
Source: Serco

When transportation departments plan to invest in ITS, all too often it's viewed as a one-off hardware purchase. Something that's installed and then continues to deliver the same results for years, perhaps with some light maintenance from in-house teams. But this common misconception can lead to initial investments being wasted as hardware deteriorates and stops delivering results. Without dedicated, expert maintenance, complex ITS can become expensive roadside junk.

It was a situation Georgia DOT found itself in before it formed a public-private maintenance partnership with Serco.

"We used to do our ITS maintenance in-house, but we struggled with limited resources – both equipment-wise and labor-wise," GDOT's assistant state traffic engineer Mark Demidovich, tells *TTI*. "We were trying to do everything with four or five guys and a bucket truck, and it was just impossible to keep up with our maintenance needs.

"We build these great systems that are very expensive, but they're also very expensive to maintain. Some states will put in these great big systems, and then they don't have the budget to keep them up. After a few years they'll be fading and broken."

It's a situation that is understandable when you begin to look at the diversity of hardware that needs to be monitored and maintained. Some of the GDOT systems that Serco is now responsible for servicing include CCTV, VMS, traffic cameras, radar systems, ramp metering, video detection and thermal cameras.

"When we maintained our own systems, our percentage of working

> "We build these great systems that are very expensive, but they're also very expensive to maintain
>
> *Mark Demidovich, assistant state traffic engineer, GDOT*

Right: **Atlanta, Georgia, played host to the 1996 Summer Olympics. The event was a catalyst for establishing a new traffic management center**

175,200
The total hours of continuous service GDOT's TMC recently celebrated
Source: GDOT

devices gradually dropped into the 50-60% range. When we contracted with Serco for ITS maintenance services, they were able to bring the system back up into the 98-99% working range," says Demidovich. "So although the costs for maintenance are higher now, we get a working system – and that's what the taxpayers expect."

Award winning

The Georgia NaviGAtor Comprehensive ITS Maintenance system has been so successful that back in June it was recognized with a prestigious Best of ITS Award at ITS America San Jose – topping the 'Show Me The Money' category that highlighted efficient use of funds.

"Through constant monitoring, and preventative and responsive maintenance, we have reduced costs and maintained device availability for the 3,000 ITS devices on the system," says Demidovich. Which just goes to prove that you often have to spend money in order to save money.

Anniversary celebrations

Georgia DOT is better placed than many to gain detailed knowledge of the way ITS degrades and what needs to be done to maintain it, because its systems are among the oldest in the country – its traffic management center (TMC) has just celebrated its 20th anniversary.

The catalyst for it being set up was when Atlanta won the bid to host the 1996 Summer Olympic Games. GDOT knew then that it was vital to address traffic management for the two million visitors that would come to the region. They had been discussing the development of ITS since the late 1980s. In 1992, long before smartphones, wireless communications and in-car GPS, the agency received federal assistance to develop a TMC that would use ITS to combine technology, information processing and communication, making travel easier and safer, and saving time and transportation expenses. By January 1996, the TMC was open and in April, the NaviGAtor 511 travel information system was launched.

"Starting up a program like this at a time when traffic technology was in its infancy provided some interesting challenges," says Marion Waters, who was state traffic engineer at the time of the system's inception. "We didn't have IP cameras or an Ethernet network; things we take for granted today. The program represented a significant milestone for Georgia. We went from building roads to actually managing the traffic and incidents on our Interstates. I think that what we achieved was really extraordinary."

The traffic management center not only houses the NaviGAtor program, it is now also home to the state's emergency operations center and the Highway Emergency Response Operator (HERO) program that focuses on incident management and motorist assistance helps to keep traffic moving on busy metropolitan Atlanta Interstates.

> "Starting up a program like this at a time when traffic technology was in its infancy provided some interesting challenges
>
> *Marion Waters, state traffic engineer when GDOT's TMC was set up for the 1996 Summer Olympic Games*

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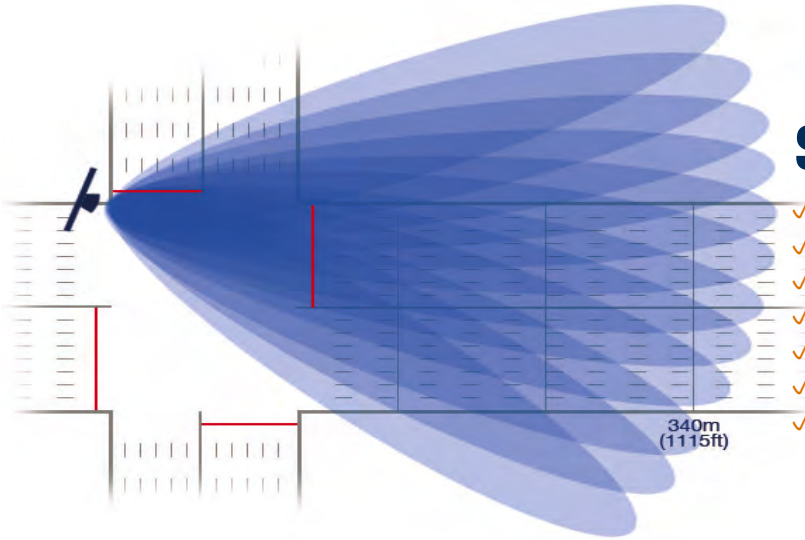

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Mean streets

In terms of improving compliance and safety, average-speed cameras have an excellent track record. But are they worth the extra investment? **David W Smith** investigates

Average-speed cameras (ASC) were once so expensive that few road authorities considered them a viable option. But costs have plummeted and their popularity has soared. In 2013, 127 miles of UK roads were covered by ASCs. That figure has doubled in three years to 263 miles on more than 50 stretches of road, according to research by the not-for-profit transport research company Road Safety Analysis.

Richard Owen, operations director at Road Safety Analysis, says the cost of ASCs is now £100,000 (US$132,000) per mile, compared with around £1.5m (US$2m) when the first ones were installed on the A6514 ring road in Nottingham back in 2000. "Expensive fiber-optic cables had to link all the cameras, which meant major civil engineering projects to dig trenches," he says. "There used to be roadside cabinets connected to the network, too, which gathered up data about offenses. CDs had to be taken out and data downloaded onto laptops and taken to police stations. These days we don't need fiber optics, or cabinets. SIM cards are built-in and they use 3G to speak to other cameras. Data is automatically captured and sent regularly to police stations via the cellular network. The cost of digital cameras has also dropped a lot."

Another reason for price falls is that Vysionics no longer has a monopoly on the market, Owen points out. The British company – now owned by Jenoptik – enjoyed a decade of free reign. But RedSpeed, 3M and Siemens now all manufacture rival average-speed cameras.

Geoff Collins of Vysionics argues that the psychological reasons behind the success of average-speed cameras are much better understood than they used to be. "It's not just about the cameras perched on rusty columns. It's more about the psychology of changing driver behavior. When people are aware they are being monitored, driving improves. If cameras become more advanced and high-resolution, it won't make roads safer. It's more about subliminal awareness. It might be that only cameras two and three out of 10 are live, but no one knows which ones so they modify behavior along the whole stretch. With spot cameras, some drivers who know the roads well speed up on stretches between cameras 5km apart."

Collins says average-speed cameras have also become standard

Average success rate

The installation of Europe's longest average-speed camera zone, over 99 miles of Scotland's A9 road, has had a dramatic effect on safety, compared with 2012 baseline figures

Sources: A9 Safety Group, Aecom

for contractors installing temporary roadworks. They have proven more effective at keeping the traffic flowing than spot cameras. "A decade ago traffic crawled through, or became stationary. Now, it usually flows along because harmonization of speeds means everything is moving at plus or minus 5% of the speed of everything around it," he says.

Positioning of ASCs is also less distracting than spot cameras. Spot cameras tend to be located on tricky bends, or other danger areas. The risk is that drivers might concentrate on cameras rather than bends. But ASCs are usually located 500m, or so, upstream and downstream of any issues, he says. "We aim for the most conspicuous spots so you can usually see the next column 1km away – they are 6.5m [21ft] tall and bright yellow, so they are really easy to notice."

Collins is keen to dismiss a myth propagated by former *Top Gear* presenter Jeremy Clarkson. "He always used to say that it's possible to drive past one at high speed, then stop for coffee and then drive off incredibly quickly again. But no one does that. Everyone wants journey reliability," he says.

> These days we don't need fiber optics, or cabinets. SIM cards are built in and they use 3G to speak to other cameras
>
> **Richard Owen, operations director, Road Safety Analysis**

Examining the evidence

There is mounting evidence of the effectiveness of permanent ASCs, although to date it has come from self-interested parties in the industry. The RAC Foundation recently commissioned an independent research project from Road Safety Analysis and the results are in the process of being peer reviewed.

In the meantime, there is still plenty of evidence to consider. One of the most closely monitored projects is the A9 safety camera system in Scotland. The A9 used to be the most dangerous road in Scotland. In the five years between 2006 and 2010, 67 people were killed and there were

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1,026 collisions. By 2012, road accidents in Scotland were at an all-time low, but the A9 remained as perilous as ever.

An A9 Safety Group was set up to find solutions and their studies demonstrated clearly that speeding was the key issue and driver behavior had to improve. ASC had already been used successfully on the A77 project in Scotland (see right) and it became part of a multipronged strategy. A vital element was education and two multimedia campaigns ran throughout 2014/2015 focusing on overtaking and speed awareness.

In November 2014, Europe's longest average-speed system opened on the A9 across 99 miles. There are 27 camera sites between Perth and Inverness covering undivided highway sections and 23 camera sites between Dunblane and Perth with a visible focus on at-risk junctions. Each camera has infrared illuminators fitted on gantries so they work at night-time and there are at least two cameras a minimum of 200m apart. Each records a date and time stamp and photographs the license plate. Using automatic license plate recognition (ALPR), the computer calculates average speeds between the cameras using photographic evidence.

Above: **The rural A77 in Scotland was the average-speed camera proving ground that led to the A9 installation** (left and bottom left)

Above average

The first average-speed cameras installed in Scotland have recently been upgraded due to their continued delivery of improved safety

The A77 Safety Group in Scotland has just replaced its original SPECS 1 average-speed cameras (named after the now defunct Speed Check Services, which first manufactured these cameras) with the latest SPECS Vector digital camera technology. The A77 was the first road in Scotland to have ASCs in 2005 between Bogend Toll and Ardwell Bay in Ayrshire, but the technology was considered to be toward the end of its useful life. There has been no increase in the number of camera stations, but some have been repositioned based on operational experience and to improve visibility.

Transport Scotland backed the upgrades because of clear evidence of effectiveness of ASCs. Since 2005 there have been significant reductions in casualties along the length of the A77 on which the system operates. Stewart Leggett, Transport Scotland's head of network operations, says, "The latest available figures for the A77 show that in the past three years there have been 77% fewer deaths and 74% fewer serious injuries compared with the 2005 baseline. We expect the new and improved cameras will continue to support this reduction in casualties."

Figures also show the number of drivers exceeding the speed limit has been reduced by 80% or more in some areas, while average speeds are 5-6mph lower.

According to analysis by the A9 Safety Group, the cameras have produced major improvements in driver behavior and big reductions in casualties (see chart on previous page). The number of vehicles exceeding the speed limit is also down significantly, says Stewart Leggett, chair of the A9 Safety Group. "Average-speed camera systems have proven very effective at achieving compliance and generating a low number of speeding tickets," says Leggett. "This approach to speed management works especially well on longer routes."

AECOM carried out an independent survey of the before and after reactions of drivers to the A9 cameras. In response to a series of questions, 70% of A9 users interviewed felt safer, less likely to have an accident and less likely to speed than before. The consultants concluded there had undoubtedly been improvements in safety, although they added, "It is difficult to ascertain whether this is down to the presence of ASCs, other factors, or a mixture of both."

ASCs have also helped to reduce accidents on what used to be another

POLL RESULTS

Are average-speed cameras worth the investment?

Despite average-speed cameras costing around £100,000 (US$132,000) per mile to install (as opposed to around £23,000 (US$30,000) for a single-site camera) industry experts visiting our website, traffictechnologytoday.com, came out heavily in favor of the technology, as these results of our online poll (right) prove.

> Average-speed camera systems have proven very effective… this approach to speed management works especially well on longer routes
>
> **Stewart Leggett, head of network operations, Transport Scotland**

of the UK's most dangerous roads, the A537 'Cat and Fiddle' between Macclesfield and Buxton. The windy and steep road across the hills of the Pennines attracts many motorcyclists and was a notorious accident blackspot. It was a constant presence in the Road Safety Foundation's list of Britain's most persistently high-risk roads and topped the list in 2010. Fatal and serious collisions rose from 15 in the three years to 2005 to as high as 34 between 2006 and 2008, despite various speed-reduction measures. The road was often closed, with domino effects in terms of traffic congestion on the surrounding road network.

But the latest round of safety measures has proved so effective that last year it dropped out of the list of most dangerous roads. ASCs are one of the measures, but others include improved road barriers, a 50mph speed limit and regular road maintenance. "Traffic volumes have increased on the Cat and Fiddle because people feel it's safer and are more willing to take the kids for a nice drive on a Sunday," says Collins.

More evidence of the positive influence of ASCs came from a case study of the Nottinghamshire area. On 18 roads with ASCs, KSI figures have fallen by an average of 76% for the three years after ASC installations compared with three years before. Average speeds have slowed, too. For example, during the first three years following the ASC installation on the A610, an average-speed reduction of 9mph was recorded.

Few completely independent studies have been conducted, however, which is why the RAC Foundation has commissioned Road Safety Analysis to carry out research. Richard Owen has also been careful to design a rigorous methodology that isolates the influence of ASCs on accident rate reduction.

Owen's team has used data for individual months going back to 1990. Computers drew maps of all ASCs on 255 miles of roads – all those installed before the end of 2014 – and matched collision data with locations. "Most analyses published previously were done by manufacturers or local authorities. They've tended to look at a handful of cameras they've installed, but we've drawn all the cameras in for the entire road network to create a very large and robust sample size," says Owen.

"We're separating out the effects of installing cameras against all other background effects. Whatever the results are of our statistical model, it will help give guidance to people evaluating interventions." The Foundation will publish the results in the near future.

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Bringing order from chaos

The drive to make multiple systems completely interoperable is one of the biggest challenges facing tolling right now. Ahead of the year's key industry event – the IBTTA Annual Meeting & Exhibition – **Sally Cranfield** chats with the association's CEO to get an insight into this and other hot topics certain to fire up discussions this September

The chief executive of the International Bridge, Tunnel and Turnpike Association (IBTTA) draws a compelling analogy to the process of making tolling interoperable across North America. "Imagine you've got 100 'mom and pop' lunch shops, each with their own way of working. You might give your order at the counter, or at your table, or collect your food cafeteria-style," says Patrick Jones, describing the huge variety of ways these businesses are run. "They might write your order on a pad, or key it in to a digital cash register or enter it on a touchscreen tablet. You might pay when you order or when collecting your meal or afterward, with cash, by credit card or even by iPad. Now, imagine someone says they're going to change things so it's the same experience at each shop."

That's exactly the challenge his association and its members face in making all the USA's tolling operations interoperable nationwide. In 2010 an IBTTA steering group announced this would be achieved by 2016. "We have to harmonize so many different ways that tolling operations are run. They've grown organically in the ways that have suited each best and we've been knitting them together," says Jones.

Whether it was naivety or optimism in 2010 to believe this could be achieved within six years, it's clear it will take a little bit longer – but not much. "The biggest hurdle will have been institutional inertia caused by all the technologies and business rules each tolling operation has developed," says Jones.

Nevertheless, interoperability is now in place in regions, so it's


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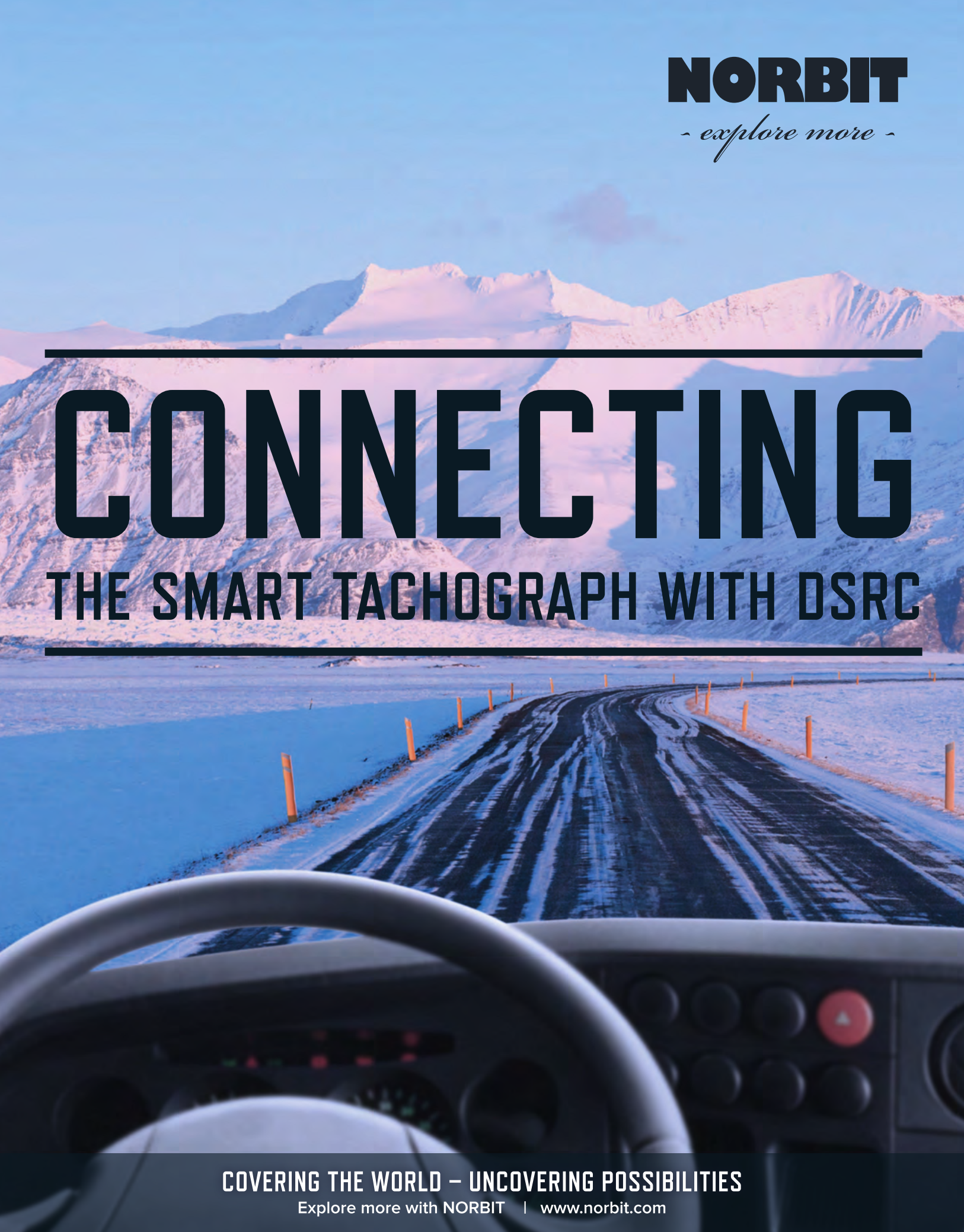
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a matter of knitting those regions together. "We've completed conformance testing and now we're about to begin performance testing, which will be completed in 2017," says Jones. "It will happen because everyone wants it to. The toll operators see it as a convenience for the customers because it eliminates barriers. We all have the same goal – to offer greater mobility."

Preparing for Denver

Jones is encouraging and inclusive in the run-up to IBTTA's 84th annual meeting and exhibition, in Denver. His association's tightly knit community will be looking to strengthen the sector, so progress reports and plans will be discussed keenly, not only through the formal sessions, but perhaps more energetically at the social events and technical tours. The 900 or so executives of IBTTA will have to be receptive and on their mettle.

Clearly Jones has done his homework. When *Traffic Technology International* asks why, out of the 250 million vehicles registered in the USA, only 55 million have transponders, he has the figures to put it in perspective. "There are four million miles of roadway in the USA," he says, without missing a beat. "Of those there are a little less than 6,000 miles that are toll facilities. Yes, there are tolling facilities in 35 of the states, but there are vast lengths of road that aren't tolled, so not everybody wants or needs a transponder. Actually, I think 20% of the total US population having transponders is quite a high percentage. I use E-ZPass when I go over the Bay Bridge in Maryland and there are a lot of people queued in the cash lane – maybe that's because they use the tolled facility only once in a while."

His case is supported by other data. The number of people with accounts for electronic tolling grew from 20 million in 2010 to 34 million in 2015. "We're continuing to see growth in transponders and accounts, particularly as priced managed lanes develop," says Jones.

> "As for connectivity and cooperative systems, they have the potential to allow services to converge and the extent of that will be limited only by our imaginations"
> **Patrick Jones, CEO, IBTTA**

Getting connected

Technology for collecting payment is mature, but other emerging digital and wireless technology will undoubtedly affect the operators of tolled facilities. For example, how does the sector view the rush toward connected and autonomous vehicles? "One of our major concerns is safety and this is going to be the real key for us," says Jones. "Our members' facilities have safety as a priority, so

Getting technical

Delegates at IBTTA's Annual Meeting, this year being held in Denver, Colorado, have two technical tours to choose between

There's a tough decision to make on the morning of Sunday, September 11 for delegates at IBTTA's 84th Annual Meeting & Exhibition in Denver. The two technical tours both promise insight into how toll operators have adopted new technologies to improve the services they offer. But which tour to sign up for?

The 25-year-old E-470 is going from strength to strength, with a widening project eight miles long to accommodate current and predicted traffic growth along the 75mph non-stop all-electronic toll road. The facility's HQ has recently been renovated, with an expanded call center and image processing. The tour will reveal all.

The alternative to the E-470 tour is a package describing several innovative road technologies and partnerships, tagged as 'congestion Kryptonite'. The tour takes in three very different roads: the I-25 Central through downtown Denver, which is a barrier-separated reversible HOV, bus and express lane; the I-25 North, which features a 24/7 single lane buffer-separated express lane and the Northwest Parkway, a traditional new-build toll road with recently deployed ITS solutions; and US 36, which has been completely reconstructed with new buffer-separated express lanes that also operate 24/7, under a public-private partnership between the Colorado Department of Transportation and Plenary Roads Denver.

To guarantee a place on a tour that will be most relevant, delegates are advised to make a booking without delay.

if the new technologies improve safety, they will be welcomed.

"So, as for autonomous vehicles, human drivers offer each other subtle cues that enable maneuvers to happen safely. Emulating that with autonomous vehicles is a challenge," says Jones. "As for connectivity and cooperative systems, they have the potential to allow services to converge, and the extent of that will be limited only by our imaginations."

Pay-per-mile revolution

Without doubt, IBTTA members will be aware of the growing interest of state Departments of Transportation in changing the way they raise revenue. The improving fuel consumption of new vehicles means income from gas taxes has been falling in relation to the costs of road construction and maintenance costs. So states, including Oregon, California and Washington, as well as several East Coast states, are investigating the reliability and acceptability of pay-per-mile systems as a replacement for gas taxes.

If such revenue-raising systems are eventually adopted by state DOTs, Jones believes there could be some synergy with the way toll operators collect tolls. "Depending on which choices are made by the states, it is possible that a pay-per-mile system could use some of the technologies we use already for electronic toll collection," he says.

Whether or not the technologies ever chosen for pay-per-mile are complementary to electronic toll collection, Jones suspects that interest in the alternative structure for raising revenue for DOTs can be good for IBTTA's members. "The debate makes the need to pay for roads more visible," he says. "Some people suggest that roads, once built, have already been paid for, but we say that there are no free roads and, further, they are never fully paid for because of the need for ongoing repairs and replacements."

Everyone who's eaten at a 'mom and pop' lunch shop will know this is true. Only an establishment that is well maintained and efficient, and which prioritizes the well-being of its visitors, will be able to serve its community effectively. The same for the nation's tolled facilities. ○

The 84th IBTTA Annual Meeting & Exhibition takes place at the Hyatt Regency Denver at the Colorado Convention Center this year from September 11-14

To register visit ibtta.org/events

Event highlights

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If you are planning to be at the IBTTA Annual Meeting this year (September 11-14), then here are some must-see moments

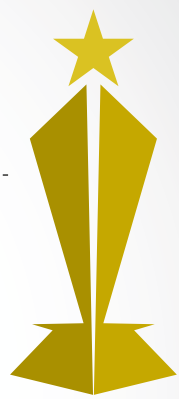
Sunday afternoon, September 11, is the time when new members and first-time attendees can meet IBTTA officers, staff and directors at an informal reception. In the evening, all delegates can meet at the official opening event in the city's performing arts complex, with time to meet old friends and colleagues, and to network.

The winners of IBTTA's Toll Excellence Awards (see below) will be presented with their accolades on Monday, September 12 to celebrate their achievements. No doubt they'll be feted again at the evening reception in the exhibition area, before all delegates move on to the LoDo Street Party.

All parties must come to an end and the best ones go out on a high note. After some intense time at the meeting, sharing with and learning from each other, delegates will be able to unwind at the closing reception and banquet on the Tuesday evening.

From Wednesday, of course, it'll be back to the day jobs and making sure the nations' tolled facilities continue to deliver reliable mobility.

Toll Excellence Awards winners



The IBTTA's annual awards are the most prestigious in the industry. Here we can reveal 2016's winners

Award: Administration & Finance
Winner: Florida's Turnpike Enterprise
Project: I-4 Connector

Award: Customer Service & Marketing Outreach
Winner: North Carolina Turnpike Authority
Project: Multi-Agency Interoperability

Award: Social Responsibility
Winner: The Foothill/Eastern Transportation Corridor Agency
Project: State Route 241 Wildlife Safety Fence Improvement Project

Award: Technology
Winner: Harris County Toll Road Authority
Project: Prohibited Vehicle Rapid Alert System (RAS)

Award: Toll Operations, Engineering & Maintenance
Winner: Central Florida Expressway Authority
Project: Wrong-Way Driving Pilot Program

Award: Private Sector
Winner: CDM Smith
Project: National Interstate Tolling Analysis Tool

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Welcome to

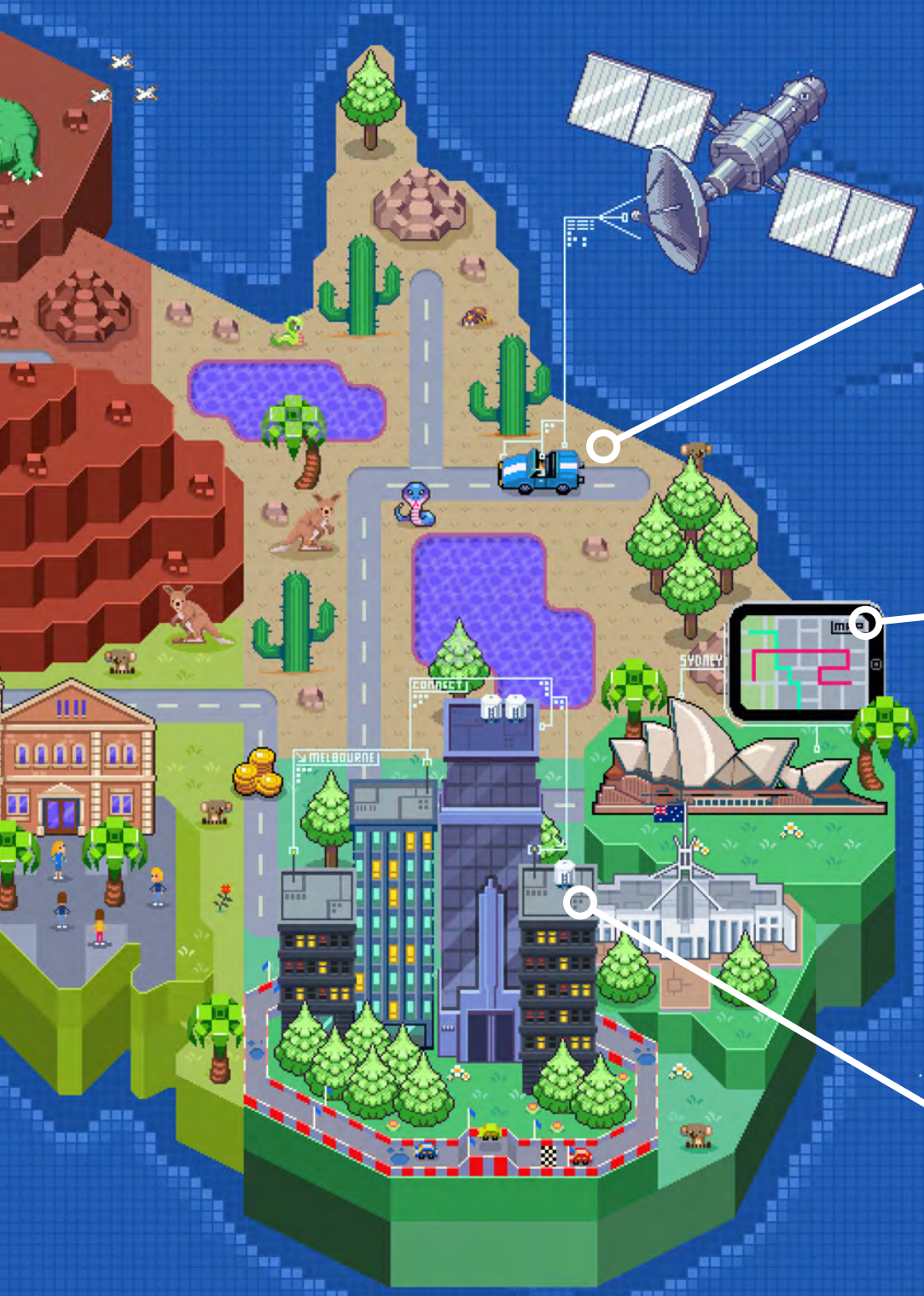
It's not a coincidence that this year the ITS World Congress takes its second trip Down Under – the continent is seeing transportation innovation at lightning speed. Over the next 28 pages we invite you to take a fact-finding tour – whether or not you're planning to be in Melbourne this October, you should prepare to be inspired...

Illustration: Armyoftrolls.co.uk

"A remarkable statistic on carshare in Australia is that for each car shared through the service, up to 10 other privately held cars are removed from the roads" **Justin Passaportis, general manager, Victoria and South Australia GoGet Carshare** (*ITS World Congress guide*, page 48)

"Connected platoons are a real opportunity. Bringing technology into the heavy freight sector will improve the safety of our freight operators. It's still a dangerous job and there are opportunities to leverage technology to really improve that situation" **Susan Harris, CEO, ITS Australia** (*Exclusive interview*, page 58)

Australia



"Once we had installed GPS devices in their cars, participants drove around for a period of three months in what we called the baseline period" **Scott Charlton, CEO of Transurban**
(*Paying the price*, page 32)

"The Roads and Maritime Service is using Google data as the primary source of travel time data, both for real-time and for historical analysis needs. That's a major shift from how we have done things in the past and it is beneficial to everyone involved" **Andrew Mehaffey, principal manager for ITS, RMS, New South Wales**
(*Data revolutions*, page 40)

"With Melbourne predicted to grow to 8 million people over the next three decades, smart cities and connected mobility to improve our safety and livability is something that is high on the agenda for our World Congress" **Brian Negus, president, ITS Australia**
(*ITS World Congress guide*, page 48)


Melbourne $5.40
Sydney $10.17

Paying the price

When vehicles become so fuel efficient that gas tax revenues dry up, charging road users per mile driven seems the most appropriate solution. **Saul Wordsworth** finds that, in Australia, a new pilot project is not only testing the technology necessary, but is now looking more deeply than ever at public attitudes to such schemes

Road funding is heading for a global crisis. With an ever-increasing shortfall between funds raised through gas tax and those required for future projects and maintenance, the calls for road-pricing reform are growing. Population growth and the rise in electric and hybrid vehicles mean there is greater demand, coupled with a decrease in the excise revenue it is possible to gather from fuel duty. Meanwhile, the lack of understanding about road infrastructure funding models means the average citizen is unaware of a problem and resents any notion of road charging.

"In today's world we generally accept that you pay for a service you receive," said Jamie Briggs, Australia's then minister for cities and the built environment at last year's Australian Financial Review National Infrastructure Summit. "Roads remain an exception to this."

"There are a lot of people who think that driving is tax-free," said Scott Charlton, CEO of toll roads developer Transurban, at the Australian Financial Review National Infrastructure Summit this year. "Raising that awareness level is a fundamental first step toward maintaining funding for our road network. If we wait until we hit a crisis point before we implement any change, then we will have left it too late and the productivity and livability of our cities will be likely to

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> We generally accept that you pay for a service you receive. Roads remain the exception to this
>
> **Jamie Briggs, former Australian minister for cities and the built environment**

4.8
Average number of car trips made per weekday in Melbourne's road user charging study

be impacted for decades to come. If we don't start looking at some level of how we price utilities, when everyone thinks they are free, we end up with these crazy congestion issues that are only going to get much worse."

Ask an average Australian what issues they wish their government to tackle most urgently and road congestion consistently comes out second only to healthcare. Furthermore, according to a 2015 Infrastructure Australia report, a user-pays road pricing model would save each household A$3,000 (US$2,318) per year.

"Funding gaps are not unique to Australia," says Jeremy Nassau, group team manager at Transurban. "We see them all around the world, but we expressed some frustration that we're going around in circles with a debate that's stuck in the theory of road pricing as a logical solution. Nothing was being done to try to understand public attitudes to different types of road pricing."

Last year, Transurban embarked upon a Road Usage Study in Melbourne, in an effort to understand driver behavior and preferences toward road-pricing models.

The Melbourne study

The initial task was to find 1,200 volunteers who would test three pricing models in real-world conditions over the course of a year. Transurban's case was aided by its position within the private sector; few government officials could hope to convince members of the public to place a tracking device in their vehicle.

"Once we had installed GPS devices in their cars, participants drove around for a period of three months in what we called the baseline period," says Stephen McDonald, general manager of strategic initiatives at Transurban. "This was when we assessed what we called the volunteers' normal driving behavior – their everyday patterns including distance, time and location. One of the study objectives was to assess changes in that behavior once

8 million
members of Australian AA – one-third of whom are unaware they pay 40 cents per liter in fuel excise

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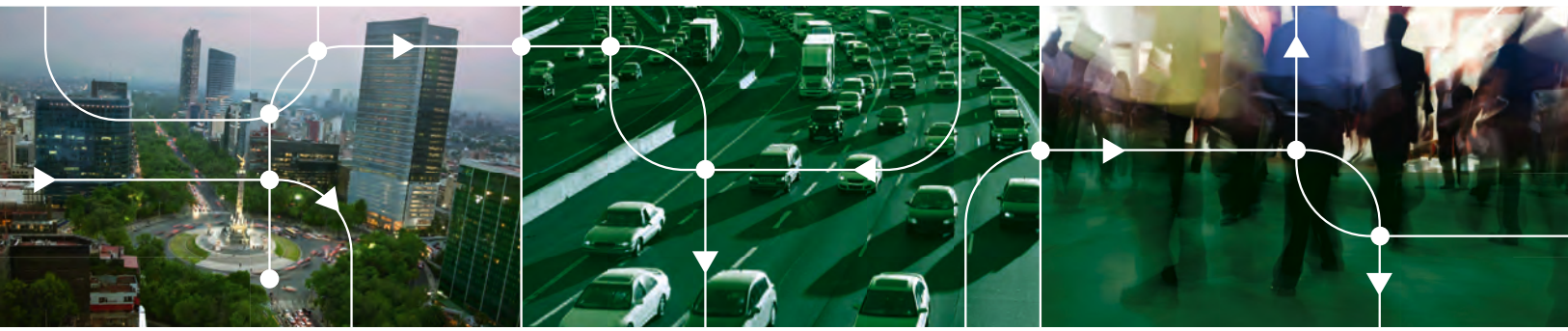

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the pricing models were introduced to participants. After the three-month period we asked the volunteers how much they understood about paying for road use before explaining the concept of user-pays."

One of the insights that surprised the study team was just how few people in the city were aware of the way they currently paid for their road use. Only a low percentage knew there was a surcharge on every liter of fuel. Great effort was required to help people to understand this and therefore to have an open mind about user-pays options, which was the next step in the study.

Charging options

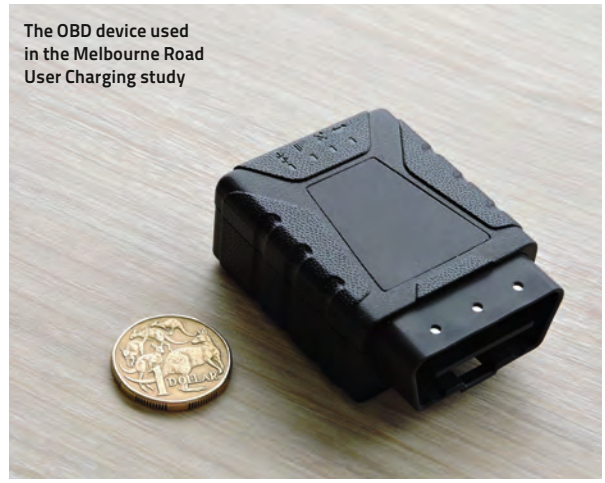
Participants could decide whether to pay for their road use based on cost per mile, cost per trip, or a flat rate for a set number of miles. To incentivize volunteers and give the project a seal of authenticity, each driver had an account pre-loaded with a designated amount of money based on their normal road usage, to cover an average month's driving.

"If during the baseline period you'd driven 1,000km (621 miles) per month and you chose to go on the distance plan at 10 cents per kilometer, we would preload your account with A$100," says McDonald. "If you drove more than 1,000km (621 miles) that month, your balance would return to zero. If on the other hand you only drove 900km (559 miles), A$10 would accumulate in your 'piggy bank', which was paid out at the end of the trial."

The financial impact from changing driving behavior made the study as 'real' as possible, with savings accrued when road use was reduced. Meanwhile monthly statements, similar to utility bills, were issued to volunteers, clearly showing the impact their driving choices had on their existing balance. Also of interest was the baseline data, which provided insight into the injustice of the current road-funding model, benefiting as it does those who can afford more modern, fuel-efficient vehicles and thus purchase less fuel for the same distance traveled.

"I think it's important that one of the pricing schemes we tested was the flat rate," says McDonald. "It lends itself to people who are uncomfortable putting any kind of device in their vehicle. This way, they choose how many miles they'd typically drive and pay the appropriate amount. Then there's a calculation done at the end of the designated period."

In a potential future scenario, where a rebate of fuel excise might be in place, the flat-rate model would enable people to predict at the beginning of a month, quarter or year what their driving limits are and prepay for that amount. At the end of the period they could self-report actual distance traveled from their odometer. This could then be used to balance against how much extra would need to be paid if they drove above the prepaid limit, and also to inform them of the amount of fuel excise to be refunded against this self-reported travel.


The OBD device used in the Melbourne Road User Charging study

> I think it's important that one of the pricing schemes we tested was the flat rate. It lends itself to people who are uncomfortable putting any kind of device in their vehicle
>
> **Stephen McDonald, general manager of strategic initiatives, Transurban**

1,500

Number of volunteers involved in the Melbourne road user charging study (1,200 for study, 300 for control)

535

longest recorded trip (in kilometers) by a participant of the Melbourne road user charging study (332 miles)

Congestion suggestions

As well as pay per mile, the Melbourne trial is assessing a congestion charging scheme

Cognizant of road-funding issues the world over, Transurban considered and sought inspiration from other projects currently being undertaken, in particular the MyOReGO study in Oregon, and the Caltrans scheme in California. The main difference between those and Melbourne is that Transurban was keen to test out three different pricing plans – not just one.

A second phase in Melbourne, separate from the funding study and less central to the thrust of the project, concerned congestion, with congestion charge schemes in London, Singapore and Stockholm analyzed

"We tested attitudes to two different congestion models," says McDonald. "One was similar to London, with a cordon around the center of Melbourne. Any movement in that area would trigger a daily charge. The other was a peak pricing plan, where during predefined peak periods of the day – in our case 7:00-9:00am and 3:00-6:00pm – we charged the premium price of 15 cents per kilometer, with an off-peak price of 8 cents."

> Our key motivation was to remain unbiased in how we recruited our participants. This meant our solutions would have to fit all vehicles
>
> **Jeremy Nassau, group team manager, Transurban**

Testing technology

"Our key motivation was to remain unbiased in how we recruited our participants," says Nassau. "This meant our solutions would have to fit all vehicles, leading us to two technologies: one was an onboard diagnostics second-generation (OBD-II) device that plugs discreetly under the dashboard; and for vehicles that are not OBD-II compliant, volunteers were given an accessory port-powered GPS device that fitted into the 12V cigarette lighter socket."

Transurban worked very closely with Ctrack to ensure the OBD device, purchased from Australian telecommunications provider Optus, met requirements. Its built-in SIM collects data from sensors located in the engine, suspension and ABS system, and sends it via a mobile data network. Older vehicles that used the accessory port device often featured an antennae on the dashboard.

"No one is suggesting that if we rolled out the scheme tomorrow we'd use these exact technologies, but for the purpose of the study they made sense," says McDonald.

Changing behavior

Did the volunteers' travel patterns and behaviors change? Early indications are that they might have, but the full and final answers will be revealed for the first time at the ITS World Congress in Melbourne.

"The study raised issues I hadn't thought about before, including the times of the day that I drive," said volunteer Pam. "The other thing I would not have thought about is how a government might tax us. That might encourage or inhibit us from traveling; it reinforces that someone who makes 200 trips per month should be charged more than someone who makes five."

"You do need to try to decongest roads and advocate public transport where possible, then make sure public transport is working well," added another participant, Stacey. "Around here it's going to be really hard to drive. In the past 12 months, 10,000 new apartments have gone up. That's why I've been so willing to participate. Anything to do with traffic is important, as it's one of our biggest problems. I have assumed outcomes from this will lead to better outcomes for the community."

What we do know is that whatever it tells us, the study will provide real-world data – something above and beyond theory and talk – and therefore promises to be a vital source of information for the road-pricing debate, helping us to better understand driver behavior, attitudes and preferences for road pricing.

"I have an open mind regarding the next steps," says McDonald. "It depends heavily on the feedback, but another trial scheme in a different location or over a longer period of time are both feasible. If it comes off, vehicle registration fees and fuel excise charges could be abolished in place of user-pays road systems. As for when, based on a recent Infrastructure Australia report, we think it is likely to happen 10-12 years from now."

75
The percentage of Australia's population growth that is projected to take place in its four largest cities – Sydney, Melbourne, Brisbane and Perth

33
Greatest number of trips made in a single day in the Melbourne road user charging study

200,000
Total trips made during three-month baseline study in Melbourne, totaling 2 million kilometers (1.2 million miles)

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3 new data solutions

Max Glaskin reports on how road operators Down Under are revolutionizing the world of collection, transmission and management of road traffic data

1. Mobile networks take the strain

A predicted population explosion in Melbourne, Australia, will present huge data-handling challenges in transportation – a 5G-centered solution is planned

Victoria road statistics

- 22,500km (13,980 miles) of freeways and arterial roads
- 128,500km (76,740 miles) of roads for general traffic
- Roads valued at A$27bn (US$20bn)
- 50,000km (31,070 miles) of minor roads and tracks
- Almost 100% of goods in metropolitan Victoria are transported via the road network

Traffic data is crucial for the host city for this year's ITS World Congress. "Melbourne's the fastest-growing city in Australia," says Nick Fisher, director of operations at VicRoads, the state of Victoria's statutory roads corporation. "We're expecting 80% growth in the next 35 years, from the current population of 4.5 million up to 7.8 million. We've still got traditional programs for building more capacity and more roads, but that's an expensive, unsustainable approach to transport. So we're using traffic data to build reliability into the network and change modal share."

To service future demands, different data collection and transmission technologies are being adopted. Lasers, radar and cameras provide virtual loops, obviating the need to dig up roads for installation. Cellular signals are transmitting the data from increasing numbers of intersections for the all-important SCATS (Sydney Coordinated Adaptive Traffic System). "Rather than bring expensive copper to intersections on new estates, we're going cellular, 4G, with the intention of putting the signals onto fiber eventually," says Wayne Harvey, manager of VicRoads ITS infrastructure and systems.

Nothing stays still for long these days and the need for more real-time information has prompted VicRoads to review the technologies it uses for communications. "At some point we're going to feed data into cars in real time so we'll have to remove latencies, like those in copper wire," Harvey acknowledges. "Dedicated short-range communications [DSRC] for cooperative ITS is starting to come in but we need to know how it fits in with other technologies and at what point we move one way or the other. My personal view is that cellular is going to become one of our main streams, especially as we move to 5G."

> At some point we're going to feed data into cars in real time so we'll have to remove latencies, like those in copper wire
>
> **Nick Fisher, director of operations, VicRoads**

VicRoads is obliged to integrate transport operations with its sister agency, Public Transport Victoria, so, along with the data from SCATS loops, real-time Bluetooth counters and the traffic data stations every 500m (1,640ft) on the 150km (93 miles) of managed motorways, it will have to add information about buses, trams and trains to the mix. "We've got to do some work to enable that integration. Location data is critical to enable us to marry it and we're now developing our own standards," says Harvey.

As VicRoads grows in its reliance on data to optimize the capacity of its network and help increase use of public transport, the way it spends its budget is changing. "Investment in data collection, transmission and management will grow relative to investment in roads," says Harvey.

2. Google leads the way

The transportation authority responsible for Sydney and its home state has switched to gathering its predicted travel-time data from Google

New South Wales road statistics

- 4,317km (2,682 miles) of national roads (with funding coming from central government)
- 13,718km (8,524 miles) of other freeways and arterial roads
- 2,950km (1,833 miles) of regional/local roads
- 3,945 sites controlled by traffic signals

The potential to harvest increasing volumes of traffic data forces officials at the Roads and Maritime Services (RMS), the statutory authority for the Australian state of New South Wales, to think carefully about what to gather and what to leave at the roadside.

"The primary consideration is to ensure data is fit for purpose," says Andrew Mehaffey, principal manager for ITS for RMS. "Accuracy, reliability, timeliness of delivery and cost-benefit are all important."

Some road and transport operators release data freely into the public domain for public analysis. "This can have great benefits, particularly if it can be easily utilized," says Mehaffey. "We have had great success in making data available to app developers, particularly for real-time public transport information." However, some raw traffic data for specific operational needs isn't very easy to interpret and providing support for people intending to use it can be a significant cost.

"For the past eight years we have made our data available to a third-party that has the expertise necessary to interpret and analyze it," says Mehaffey. "They combine it with other data and disseminate the enhanced information to the public. That's an indirect way we can provide complex data in a user-friendly format."

> Rather than being the primary source of traffic information, road authorities will become consumers of data services
>
> **Andrew Mehaffey, ITS principal manager, Roads and Maritime Services, New South Wales**

Mehaffey predicts there will be substantial change in traffic data management in the next decade. "Road authorities will be making much greater use of third-party crowd-sourced data. Rather than being the primary source of traffic information, we will become consumers of data services," he says. "Also, once we have many connected cars driving around the network, that could become a rich source of data for the road authorities."

To some extent, this has already begun in New South Wales. "One example is our recent change to using crowd-sourced Google data as the primary source of travel-time data in RMS. We started looking at it two years ago. We did an in-depth analysis to assure ourselves that this data was comparable in quality to data we were collecting from our own infrastructure. When we convinced ourselves it was, we introduced it for motorway travel time advisory signs 18 months ago," says Mehaffey. "It's a much simpler, quicker and cost-effective mechanism for sourcing data. The success of this project means Google is now our primary source of travel-time data, both for real time and for historical analysis. That's a major shift from how we have done things in the past and beneficial to everyone involved."

3. Barriers are broken down

A drive for open data in New Zealand is being coupled with a desire to break down artificial barriers between data sets

New Zealand road stats

- 199km (124 miles) of motorways
- 11,000km (6,835 miles) of state highways
- 8,300km (5,157 miles) of local roads
- It costs NZ$341m (US$250m) per annum to operate and maintain the state highways (excluding any emergency works) and NZ$158m (US$116m) in renewals and preventative maintenance

The New Zealand Transport Agency (NZTA), which is responsible for the nationally strategic state highways, has won awards in the past for using data to manage asset maintenance and renewal, but now change is underway, with focus switching to gathering real-time information and disseminating it to the public.

"In Auckland we have a combination of radar and loop data collection every 500m on the motorway, feeding journey time info to signs and web interfaces," says Deryk Whyte, director of the DWG ITS consultancy in Wellington. "NZTA makes that data available through InfoConnect, in Auckland, Wellington and Christchurch."

It's not just the country's three largest cities where advances are happening. Rural networks often don't give much choice of routes and incidents can require long detours. "So there's a desire for improved situational awareness, in real time," says Whyte. "The sooner we can get information in and share it, the better."

New Zealand's stunning mountain ranges pose challenges for data transmission. "Traditionally the telephone network has been used but now we're finding that cellphone coverage is good, even in rural areas," says Whyte. "We've just done an in-car messaging project between Christchurch and Queenstown, using Bluetooth. We'd expected 30 points out of 64 on the route wouldn't have connections. Only 12 points didn't."

> Trying to put data together with another silo to extract useful information is a massive challenge
>
> **Deryk Whyte, director, DWG ITS, Wellington, New Zealand**

Nevertheless, satellite comms are used for some remote VMS. "Satellite can be expensive but it's reasonably cost-effective here because of the low data rates for traffic information," says Whyte. Occasionally, microwave line-of-sight links have been used to transmit video from distant units.

Making the best use of the aggregated information is a separate task. "The big data problem is that it's stored in silos," says Whyte. "We know what's in there but trying to put it together with another data silo to extract information is a challenge." The Ministry of Transport recognizes this and has just begun a project, called Data Opportunities for Intelligent Mobility. One of the outputs will be getting the right data accessed and utilized by the right people, to enable intelligent mobility in New Zealand.

At the moment, InfoConnect takes information only from NZTA assets, whether by radar, loop or Bluetooth and converts it for the SCATS Standard Data Format (SSDF) platform. "In theory it could take data from local authorities but not all councils wish to share their data," says Whyte. "Even when they do, I don't think SSDF is the most efficient way to handle all the possible different data sources and types."

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ITS World Congress Guide

The 23rd ITS World Congress is taking place from October 10-14, 2016, in Melbourne, Australia – the first event of its kind in the country since Sydney in 2001. Here we look at what has changed in transportation since then and outline the show's most anticipated highlights

ITS WORLD CONGRESS GUIDE

The 23rd ITS World Congress, the biggest ITS event of the year, will take place in Melbourne, Australia, from October 10-14. Over 7,000 delegates are expected from across the globe, who will gather to discuss and debate key ITS issues around the theme 'Enhancing liveable cities and communities'.

"The Congress is a one-of-a-kind opportunity to hear from international specialists at a single event," says Brian Negus, president, ITS Australia.

The Congress will host more than a dozen technical tours showcasing innovative features of Australian transportation. There will also be more than 300 international exhibitors and numerous expert-led sessions exploring eight key areas in ITS – vehicle network and safety; big open data; policy, standards and harmonization; mobile applications; environmental sustainability; smart cities and urban mobility; future freight; and automated vehicles and cooperative ITS.

Fifteen years have passed since the ITS World Congress was last in Australia. Observing changes in ITS since then, Negus says, "Technological advancements such as GPS tracking, geospatial mapping, big data collection and connectivity, advanced traffic management and emergency management systems, have restructured the way we think about ITS. We are now increasingly reliant on mobile apps and we expect immediate access to information for our convenience. With the population of Melbourne expected to reach eight million over the next three decades, smart city technology and connected mobility will help to improve safety and livability."

Carsharing is one of the ways that Australia is combatting this increase in population. "It is enabling smarter transportation in a city like Melbourne, where the population is booming and we're pushing the limits of existing infrastructure," says Justin Passaportis, general manager, Victoria and South Australia, at carsharing service GoGet. "A remarkable statistic on carshare in Australia is that for each car shared through the service, up to 10 other privately held cars are removed from the roads."

Delegates can also look forward to ITS demonstrations at Melbourne's grand prix circuit. "The track is just 10 minutes from the convention center," says Susan Harris, CEO of ITS Australia. "We will shuttle delegates along a connected urban corridor, so they will have a demonstration en route to the location."

With a packed five-day program, the 23rd ITS World Congress is an event not to be missed. "I'm looking forward to learning from global leaders about the innovative approaches they are taking and the progress they've been making to improve mobility," says Negus.

"Things are moving so quickly, you don't want to miss out," says Harris.

> Australia has a history of innovation in transport. Large open spaces between cities and concentrated populations in cities mean getting the most out of tax dollars is critical
>
> **Phil Charles, professor of transport, University of Queensland, Australia**

On each of the next four pages, Prof. Phil Charles recalls key ITS developments from the 15 years since the World Congress last visited Australia – in 'From Sydney to Melbourne' – alongside show highlights from TTI *partners*

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MANAGED MOTORWAYS

Over the past 15 years variable speed limits, variable message signs and lane-use management systems have become commonplace on Australia's motorway network.

ROAD SAFETY

Road safety enforcement has been enhanced through the widespread introduction of fixed red light and speed cameras at high-risk intersections, particularly in Sydney, Brisbane and Melbourne. Fixed speed cameras have also been introduced at blackspots across Australia.

Austria meets Australia

Swarco will present its capabilities in road safety and ITS at the ITS World Congress

A range of energy-efficient LED-based variable message signs (VMS) and traffic signals, adaptive traffic control and smart mobility software platforms will be on display.

At its booth at the Congress, and under the motto 'Austria meets Australia to jointly take traffic management in a new direction', Swarco will feature its Sydney-based partner Braums, which provides excellence in delivering, supporting and integrating Swarco's leading ITS products and solutions to the Asia-Pacific ITS market.

Visit Swarco at Booth 2909

Service focused

Xerox delivers innovative urban mobility solutions to private and public sector clients all over the world

The company provides fare collection and smart ticketing, on- and off-street parking systems, tolling operations and vehicle occupancy detection solutions. A key strength is its back-office systems that handle transactions, enable data analytics and provide operations overviews to make life easier for operators and travelers alike. Its solutions are policy adaptive and support new Mobility as a Service (MaaS) offerings.

At the Congress, Xerox will showcase its newest solutions – its seamless payment and information solution, and its Go Denver and Go LA MaaS operations.

Visit Xerox at Booth 3517, MR9

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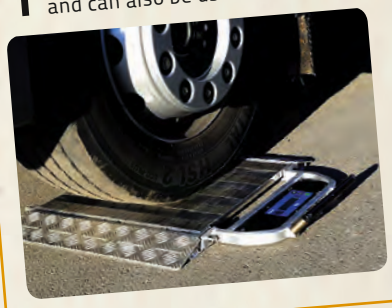
ITS WORLD CONGRESS GUIDE

New weighs to succeed

International Road Dynamics (IRD) will showcase its new SAW III portable axle scale and VectorSense technology

The SAW III scale is certified for the enforcement weighing of trucks and can also be used for screening vehicles at slow speed using weigh-in--motion (WIM).



The VectorSense tire sensor suite is an in-road sensor technology that provides vehicle position and individual tire footprint data for use in traffic data collection programs, commercial vehicle operations, and toll road operations. VectorSense sensors' ability to distinguish vehicle types by tire characteristics makes them particularly well suited to multimodal traffic data collection.

Visit IRD at Booth 2313

Unlocking location

Here will be demonstrating how its technology will be central to tomorrow's smart cities

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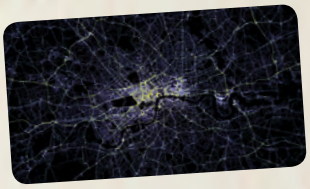

At the ITS World Congress, Here will demonstrate its portfolio of next-generation mobility, transportation and infrastructure services that will form the heart of tomorrow's smart cities and will deliver smart solutions for a safe, satisfying and sustainable future.

Visit Here at Booth 1701, MR8

TOLL COLLECTION

There has been a revolution in electronic toll collection over the past 15 years with interoperable tolling now fully implemented across all Melbourne, Sydney and Brisbane facilities.

ROAD SAFETY

Point-to-point speed enforcement has been in place in Victoria since 2007. It's now found in five locations on the Hume Freeway.

FREIGHT VEHICLES

The Intelligent Access Program (IAP) is a national program developed in partnership with all Australian road agencies and commenced in 2009. It uses satellite tracking and wireless communication to remotely monitor where, when, and how heavy vehicles are being operated. It enables transport operators to access more of the road network and increase allowable mass, in exchange for compliance.

STRATEGY

In 2012, both the Australian National ITS Industry Strategy 2012-17, and the Cooperative ITS Strategic Plan were published.

PUBLIC TRANSPORT

Travel planning and real-time information apps on smartphones have rapidly spread in Australian cities since 2001: for example, Sydney now has numerous publicly available apps that have been fostered by Transport for NSW.

VEHICLE SAFETY

New requirements for Electronic Stability Control (ESC) for light commercial vehicles were mandated by Australian Design Rules for new light commercial vehicles, which came into force in November 2015.

PUBLIC TRANSPORT

Integrated fare collection systems have been progressively introduced in major urban areas: Smartrider (Perth, 2007), GoCard (Brisbane, 2008), Myki (Melbourne, 2010), Metrocard (Adelaide, 2012) and Opal (Sydney, 2014).

POLICY

In 2012, the Policy Framework for ITS was adopted by Australian and New Zealand transport ministers to provide guidance to ensure that the technology used in each jurisdiction is compatible and is developed around a set of agreed policy principles. The Policy Framework has identified a number of priority action areas including: national ITS architecture, cooperative ITS strategy, use of 5.9GHz band, and managed motorways.

Trailer technology

Vitronic Machine Vision will showcase its Enforcement Trailer at the ITS World Congress

The autonomous enforcement system has been successfully deployed in several countries across Europe and the Middle East, with 300 units expected to be operating in France alone by the end of this year.

The Enforcement Trailer is a mobile system that can operate on its own for several days, offering increased flexibility, while at the same time reducing the risk of injury for the operator carrying out regular mobile enforcement methods.

Vitronic will also showcase its Tollchecker tolling solutions and the Poliscan FM1, its latest generation in lidar enforcement.

The multimodal enforcement capacities of the Poliscan FM1 will also be a topic in the Safety 2 session of the Congress program on Thursday, October 13.

Visit Vitronic at Booth 1913

AUTOMATED VEHICLES

South Australia became the first Australian jurisdiction to introduce legislative measures to prepare for the introduction of driverless cars and conducted on-road trials of driverless vehicle technology in late 2015.

ARCHITECTURE

Austroads, the association of Australasian road transport and traffic agencies, is progressing the national ITS architecture planned for completion in 2017 as outlined in the *Roadmap* published in March 2016.

PUBLIC TRANSPORT

Comprehensive data collation and analysis is being made available in a cloud-based service through a service provider netBI, including fare transactions, schedule and actual performance.

V2X solutions

Mobile Mark will be showcasing bidirectional antennas with Australian distributor Step Global

Mobile Mark antennas are used in vehicle-to-everything (V2X) projects across the globe, including Michigan Department of Transportation (MDOT) and the University of Michigan, USA; SCOOP, France; Compass4D, across Europe; and C-ITS, Korea.

A range of Mobile Mark antennas can be used in ITS/V2X systems, from mobile vehicle-to-vehicle (V2V) antennas to infrastructure vehicle-to-infrastructure (V2I) antennas. Mobile options include DSRC-only antennas and multiband antennas, which combine DSRC with GPS, cellular and wi-fi. Infrastructure options include network antennas, as well as antennas that mount directly onto DSRC roadside units.

Visit Mobile Mark at Booth 9

Transportation inspiration

Michigan DOT director Kirk Steudle is one of the hugely respected thought leaders who will be presenting at the World Congress

Kirk Steudle is an internationally recognized proponent of connected and autonomous vehicles, but when at the 23rd ITS World Congress he'll also discuss his role as a DOT chief, as disparate agencies carve out their space in an unprecedented time of mobility disruption.

"It's more than herding cats," he says. "It's cats, antelopes, jaguars and turtles." He routinely juggles the interests of government, auto makers, startups, and a robust research and development community.

The newest part of the solution is Planet M, a branding effort under which all things mobility can evolve. "It's about how we get the public and private sectors to share a common cadence.

"You've got to get them synchronized so that everybody's running at the same pace."

See Steudle in the Mobility as a Service session: ES10, Friday, October 14, 8:30-10:00am, Plenary Hall 3

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ITS Australia CEO **Susan Harris** sets out her vision for the future of advanced traffic management, both Down Under and around the world

Interviewed by Tom Stone

As delegates pack their bags for this year's ITS World Congress in Melbourne, classic images of Australia may come to mind: vast areas of sparsely populated outback and roads that have more trouble with wandering kangaroos than traffic congestion… But such images, while true up to a point, give a false impression of the transportation challenges facing the country.

"The preconception that Australia isn't densely populated is false," says Susan Harris, CEO of ITS Australia, which is responsible for hosting the Congress this year. "Australia is the most urbanized country in the world. Even though we've got these vast distances, which are a significant challenge, people live in the cities. So we've got these big, metropolitan areas, with large urban sprawl. Melbourne's got 3.5 million residents. And that brings with it all the normal challenges of congestion. So we're looking to technology to help."

Having the ITS World Congress in town this October 10-14 will, of course, provide an unrivaled opportunity to tap into the very latest traffic technology and keep Melbourne in its position toward the top of the 'most liveable cities in the world' tables, where it has consistently been placed in the past few years.

"The 'last mile' is a real challenge," Harris tells *TTI*, when we meet her on part of her international promotional tour for the event. "The courier industry and the local-delivery industry are looking at how they address that challenge. They're looking at drone technology and whether that might be part of the solution. Around the world, that last mile is an ongoing challenge. And it's something that will be discussed at the World Congress in Melbourne."

> A challenge is identifying where people might be breaking the law just because they're driving a piece of new technology that the regulations haven't caught up with yet

Beyond exchanging ideas for technological innovation, Harris is hopeful that discussions at the ITS World Congress will foster collaboration on a much deeper and longer lasting level.

"We are starting to look at collaboration between government and industry, particularly around connected and automated vehicles," she says. "We're actually quite a collaborative country in Australia and we've got different cities taking a lead in different areas. We're trying to understand the commercial opportunities and the role for government in terms of encouraging technology, while not restricting it. I think over the next five years we'll get much greater clarity. And that will provide a strong basis for rapid roll-out of connected autonomy across our cities."

Australia has already been leading the world in getting such discussions underway. Back in May, Australia's National Transport Commission (NTC) released a discussion paper entitled *Regulatory Options for Automated Vehicles*, which finds a total of 716 potential issues or barriers in existing legislation that could restrict the increase in vehicle automation across the country. "People in Europe were saying, 'Do we have something like that for Europe?'" says Harris. "A challenge is identifying where people might be breaking the law just because they're driving a piece of new technology that the regulations haven't caught up with yet."

Long distance

Of course, while population centers are as dense in Australia as in any other developed nation, if not more so, the huge distances involved in getting from one side of the country to the other are unusual. But that doesn't mean that there aren't already transportation technologies out there that are able to help with the challenges this creates.

"We have huge trucks on our roads and we have new technology to monitor those vehicles, to make sure they're operating within the law and are doing so efficiently over vast distances," says Harris. "That requires transport certification, and Australian representatives will be presenting on that and also participating in the exhibition in Melbourne."

Beyond certification, communications technology is of increasing importance in the industrial vehicle realm. "We've got heavy vehicles going out to mine sites," says Harris. "Standard practice is that they will have a satellite phone to communicate, to check the safety of the driver if there's an incident. But we've also got a cooperative ITS trial taking place on the coast near Sydney, with heavy vehicles on some very steep and remote terrain without access to power. We've had to put broadcast devices along this road without the luxury of having mains power, so some challenges that come with that terrain have been good to explore, so we look forward to sharing those learnings with everyone in Melbourne."

Melbourne's Grand Prix circuit, in Albert Park, will be used for technical demonstrations during the ITS World Congress

Australia Special

Last, but certainly not least, one of the key new developments in terms of moving freight is in the potential to use connected vehicle technologies to form truck platoons. "Connected platoons are a real opportunity," says Harris. "Bringing technology into the heavy freight sector will improve the safety of our freight operators. It's still a dangerous job and there are opportunities to leverage technology to really improve that situation."

ITS coming home

On a personal level, this October will represent an 'alignment of the planets' for Harris in career terms – as CEO of ITS Australia she has succeeded in bringing the ITS World Congress to her home city of Melbourne at a point in the industry's development that could hardly be more exciting. "It's such a fast-moving world at the moment," she says. "I think we're hitting a peak of maximum change. The Congress will be an opportunity to get an update on what's happening around the globe, and we have a sense that the event in Melbourne will be truly international. We won't be dominated by Europeans or North Americans, and while there will be a strong attendance of Australians there, they're not going to dominate the numbers either." In short, all voices will be heard.

The road to Melbourne

A complete rundown of ITS World Congress host cities

1st	Paris (1994)
2nd	Yokohama (1995)
3rd	Orlando (1996)
4th	Berlin (1997)
5th	Seoul (1998)
6th	Toronto (1999)
7th	Turin (2000)
8th	Sydney (2001)
9th	Chicago (2002)
10th	Madrid (2003)
11th	Nagoya (2004)
12th	San Francisco (2005)
13th	London (2006)
14th	Beijing (2007)
15th	New York (2008)
16th	Stockholm (2009)
17th	Busan (2010)
18th	Orlando (2011)
19th	Vienna (2012)
20th	Tokyo (2013)
21st	Detroit (2014)
22nd	Bordeaux (2015)
23rd	Melbourne (2016)

Power anywhere

What is the ideal battery type for uninterruptible power supply? And will renewable energy sources one day take transportation infrastructure off grid? **David W Smith** investigates

Above: **Solar arrays are a major source of grid power, but can scaled down versions be useful for roadside infrastructure?**

Environmentalists envisage a time when renewable power will provide all the world's energy needs – which, of course, would include transportation infrastructure. In such an ideal world, could the harvesting of wind and solar energy become so efficient that battery backup, or uninterrupted power supply (UPS), would be irrelevant at important intersections on road networks? Batteries of some sort would always be required – energy from intermittent renewable sources must be temporarily stored somewhere – and because renewable power would simply never go down, it follows that no major fail-safe mechanism would be required.

In practice, it's not clear if renewable energy could ever become so efficient as to replace all the UPS at critical points of the road network. In fact, in the near term, the opposite appears to be happening – UPS solutions are becoming more popular as higher-performing battery materials replace potentially hazardous lead-acid batteries.

Mark Taylor, a traffic signal operations engineer at Utah DOT, says his state is reluctant to rely on solar and wind as it has to be sure the traffic signals will always function. "We can't have a situation in winter when it's dark and there's no more solar available and we have no backup power," he argues. "We always use direct power from the local utility company at major intersections and some of that will be sourced from renewables, but only indirectly."

> Nickel-zinc batteries have a longer life than lead-acid ones. We like the fact they're more mobile and can fit inside existing cabinets
>
> **Mark Taylor, traffic signal operations engineer, Utah DOT**

After searching widely for an environmentally sound system, Utah opted to trial an innovative battery backup system that uses nickel-zinc electrochemistry rather than lead-acid, lead-crystal, or led gel variants. The claim is that the battery is 70% lighter than lead-acid and provides twice the energy in half the space. Its bendable design allows it to be squeezed in to tight spaces.

Taylor says, "The batteries certainly have a longer life than lead-acid ones and we like the fact they're more mobile and can fit inside existing cabinets with the electrical components we're using. The legacy lead-acid ones needed a separate power pedestal and a separate cabinet. There were aesthetic as well as practical considerations as you needed multiple cabinets."

The nickel-zinc batteries are also much less dangerous, he says. "Lead-acid ones can leak on-site after many years exposure to a variety of temperatures, and technicians have to be very careful. In Utah we also have a huge range of temperatures, from 115°F to close to 0°F, and they

The right chemistry

Sacramento, California, opted for a new type of battery backup when updating a failing legacy UPS

The City of Sacramento had installed lead-acid battery backup systems at rail crossings and intersections with high traffic and power issues, but over time 80% of the batteries had stopped functioning. Failures were leading to potential hazardous material issues.

One of the major intersections, near Rio Linda and Bell Avenue, was of particular concern to the City and a nearby school. Instability in the utility line power was causing regular circuit breakers to trip inside the cabinet, causing intersections to go dark.

Norm Colby was then city operations general supervisor and he opted to trial a nickel-zinc battery system at the junction. City engineers tested the system over two years. "We've had no issues of circuit breakers tripping and we are now replacing lead-acid battery backup systems at all key intersections and where light rail is expanding," he says.

Safety was also a major concern when the choice was made. "When we were searching for a replacement for lead-acid, we wanted a green alternative and nickel-zinc batteries are environmentally friendly because they don't leak. It's a smart technology," he says.

110%
Technical advances in cathodes, anodes and electrolytes could increase the capacity of batteries by 80-110% by 2025
Source: McKinsey Global Institute

handle extremes better than lead acid," he says.

Material gains

Nickel-zinc batteries are part of a trend toward using new materials to produce batteries specifically designed to back up the road networks. Until recently UPS systems were fairly primitive. They frequently used the same batteries that backed up office equipment, despite demanding different characteristics. "UPS solutions designed for road traffic are a relatively new phenomenon. We've had to work closely with UPS suppliers and battery manufacturers to find dedicated solutions," says Keith Manston, head of product management for Siemens.

UPS solutions are steadily growing in popularity in the UK and in the USA as road planners have more faith in them. New lead-crystal battery technology is easier to transport than lead-acid and is

Above: **Lead-acid solutions require more space in roadside cabinets**
Left: **Nickel-zinc UPS controllers take up less space**

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classified as non-hazardous. For most traffic applications, using lead-crystal batteries also eliminates the need for special cabinets, and has an improved operational life of 6-12 years, surpassing the lead-acid ones, which typically last between two and four years.

"The standard lead-acid ones were the same ones used in cars and they had serious issues when temperatures fell much below freezing, or rose above 100°F," says Manston. "Lead-crystal performs much better in such extremes. The reliability of the kit has contributed to their growing popularity. Right now it's still quite expensive, but as LED lamps improve their performance, the price of UPS and batteries will fall and more intersections will be equipped with them."

Cost considerations

However, not all the companies in the UPS space have abandoned lead-acid solutions, as some of the new materials on offer are too expensive to make them a viable option for most DOTs. Government agencies often don't see the cost benefits of using newer materials and are put off because they don't get better warranties, so they stick with what they know.

The final choice of battery type is often dependent on the technology used at a specific intersection, as well as the controls used to manage the batteries and different algorithms. Other important considerations include dealing with rugged environments with broad temperature extremes, vibrations, bugs, dust and dirt. Batteries are chosen that can withstand these extremes and they are then enclosed in cabinets for added protection. Where there are extremes of cold, heaters in the enclosures prevent

Check it out

UPS systems traditionally require a high level of maintenance, but new types of batteries are reducing that burden

Battery maintenance has always been an issue for operators of lead-acid batteries. Like car batteries, they tend to malfunction over time and require constant monitoring.

Utah DOT's Mark Taylor says, "Most agencies struggle to maintain batteries. It's time-consuming and difficult to individually test each one. There are also competing demands on the technicians' time with other items that require maintenance."

The process of maintenance is different for lead-acid batteries compared with modern materials. Lead-acid batteries are easily the cheapest to buy, however most vendors suggest DOTs 'exercise' the batteries each month by scheduling the inverter to turn over to battery power for a short time. Every 6-12 months they require a more detailed inspection. Meanwhile, for nickel-zinc technology, the process is minimal. "Just keeping track of when the battery was installed is good enough. We expect to remove the battery packs after five years and have them refurbished," says Taylor.

Keith Manston at Siemens says lead-crystal batteries also require less maintenance than conventional lead-acid batteries. "Apart from normal inspection of terminals, no real maintenance activities will be required for five years or more," he says. "Within the UPS system the batteries are arranged in banks of four, with the whole system accommodating up to five banks. As long as more than one bank is used, individual banks can be easily exchanged, even while the system is operational."

> The variable nature of renewables is one of the biggest issues we are grappling with as we try to address climate change through higher levels of renewable energy penetration
>
> **Apurba Sakti, research scientist, MIT Energy Initiative**

Left: **Busy city intersections are prime locations for UPS systems**

Left: **Cabinet space required for UPS systems is decreasing**
Below: **Safety is so critical at railroad crossings that UPS is always considered**

temperatures plummeting to well below freezing. Severe heat presents an even bigger threat, so heat sinks, cooling fans and ventilation must also be considered.

Powering forward

Judging by the dynamism in the UPS market, the notion that battery backup will disappear any time soon is really no more than a pipe dream. Apurba Sakti, a research scientist at MIT Energy Initiative, cannot imagine a time when traffic operators would rely entirely on renewable and abandon UPS. "Renewables are inherently variable in nature," he says. "This is one of the biggest issues we are grappling with as we try to address climate change through higher levels of renewable energy penetration. Currently, batteries are one of the handful of options available to address this variability."

Typical intersections have tight space availability and to generate enough power from wind and solar big arrays are essential. Currently solar can be a good option for supporting low-power infrastructure such as cameras, but for large intersections of 16 signals or more, it wouldn't provide enough power consistently.

For the foreseeable future, battery backup power is likely to increase in importance. In the USA, Utah is one of the states that has led the way in demonstrating its strategic importance with careful placement on its networks. "It's mainly used at intersections near railroads, but there are many categories, such as at intersections with more than 40,000 vehicles a day, or where speeds are 50mph or higher and there is a volume greater than 20,000," says Utah DOT's Taylor.

Meanwhile, in the UK, the demands on the national grid, which is at the limit of its generating capacity, especially in winter, could increase the need for UPS. "If we got to the state of the South African network, where they have regular timed blackouts, the last thing we'd want is for the road network to fall apart under those circumstances. So there's a case for installing a lot more UPS," says Manston.

While renewables might become an increasing part of power generation on a national scale, it seems likely that using solar or wind to power individual pieces of roadside technology will remain a small-scale endeavor: useful for rural locations, but unlikely to take over from grid power at large-scale city intersections. So, no matter how green our primary power grid gets, UPS will always be needed in case the grid fails. ○

Power increase

Global revenue from stationary storage battery sales is predicted to rise from 2013's level of US$2.3bn to US$4.8bn by 2020

Source: Cairn Energy Research Advisors

> If we got to the state of the South African network, where they have regular timed blackouts, the last thing we'd want is for the road network to fall apart. So there's a case for more UPS
>
> **Keith Manston, head of product management, Siemens**

Right: **A lead-crystal UPS unit from Siemens**

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Your essential guide to the future of transportation communications

Hello world!

Global market in communications for transportation is predicted to grow by an average of 17% per year until 2020

The transportation world is at the center of the Internet of Things (IoT) revolution. Everything is becoming more connected, and those connections can't happen without advanced communications. That helps to explain why market analysts at Technavio recently released a report which predicts that the global IoT market in transportation will expand at a compound annual growth rate of almost 17% until 2020.

The introduction states: "One of the primary drivers for this market is the rising need to automate transportation management systems. Automated transport management solutions increase safety, security and visibility, the efficiency of tracking systems, and also reduce transportation costs." The increasing adoption of ITS by countries around the world is singled out as another major predicted driver of this huge growth.

70 – Weather communications

Accurate and timely weather information makes roads safer and cuts congestion. Here's how advanced communications are helping.

74 – The world's smartest city

Columbus, Ohio, recently won the USDOT's Smart City Challenge. We look at the new comms that are now being rolled out on its streets.

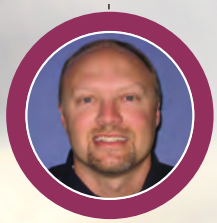
When the weather gets bad, road users need to know

Extreme weather communications

Road weather information, by its very nature, is often most needed in the remotest locations. That's why, when no fiber is available, the cellular network becomes crucial to keeping road users informed and safe, as **Max Glaskin** discovers

Weather can change quickly and unexpectedly, which can cause chaos on a road network. So the fast, robust and efficient transmission of road weather information to traffic management centers (TMCs), vehicles and connected infrastructure needs serious consideration.

> "Utah DOT allows telecommunication companies to install fiber in their right of way. The value of the land is returned to Utah DOT in exchange for fiber connectivity
>
> **Jeff Williams, weather operations program manager, UDOT**



Utah DOT employs an unusually large number of meteorologists – 11 in all – and they get data from 100 road weather information stations across the state, including five on portable trailers. "They're good for monitoring events on the fly or for assessing whether a site needs a permanent station," says Jeff Williams, UDOT's weather operations program manager.

"For a rural state we have surprisingly good cellular coverage, so we can get the data out using 3G or 4G signals. Sometimes we even use 1X because weather data doesn't need much bandwidth," he explains.

They had to rely on 1X at a burn scar site in a canyon recently. The hazard for road management lay in the fact that rainfall of just 0.1in in 10 minutes had the potential to trigger a mudflow and overrun the road, so crews were on hand to help keep the traffic moving. Unfortunately, cellular communications were unusually poor in this location. "However, there was just enough signal to get a text message out, so when the crew got these messages automatically from our portable weather station they'd get the alerts. But if you'd tried to call them you wouldn't have got through," Williams says.

Elsewhere, around 45% of UDOT's permanent weather stations

communicate via the fiber network. "Our fiber network is over 2,000 miles long and reaches rural areas," says Williams. "We trade land value for fiber. Utah DOT allows telecommunication companies to install fiber in their right of way. In return, the value of the land is returned to Utah DOT in an exchange for fiber connectivity. So there's no money exchanged – they lay their fiber and we get connectivity at minimal cost."

The value of communicating weather information between vehicles and infrastructure is increasingly recognized in sectors beyond DOTs. For example, the US Department of Energy is involved in a project in eastern Idaho where it operates a nuclear research facility across 870 square miles – Idaho National Laboratory (INL).

Some 490 vehicles make up its transit fleet on routes from six cities across highways managed by Idaho Transportation Department (ITD). Journeys can be hazardous. Winter storms, high winds, dust and range fires mean scout vehicles must often patrol the routes in advance of scheduled buses so that transit departures managed. Nevertheless there was an annual average of 365 crashes on the routes from 2010 to 2014.

So INL, ITD and seven partner organizations have collaborated in a proof-of-concept project to collect, analyze and disseminate road weather information to connect vehicles and infrastructure. DSRC is used because of the fast network acquisition, low latency, high reliability and interoperability. The security certificates of DSRC are also an important element. Cellular 3G and 4G are also used, particularly to connect to the cloud.

"The project's not finished," says Bob Koeberlein, HQ operations engineer at ITD. "We have the proof-of-concept equipment – one roadside unit and three on-board units. We still need a back-office system to manage the data, but we've got a start on that."

One important learning point so far has been the security of cellular communications. Project partner Vaisala provided and managed communications to all road weather stations, with a firewall to give protection from hackers. ITD's own cellular modems for dynamic message signs and highway advisory radio have a private, password-protected network run by Verizon.

"We've used the proof of concept as a model for an upcoming grant opportunity from USDOT," says Koeberlein. The request is for US$7.8m and, if granted at the end of September, would enable 14 signalized intersections on US 20 to be upgraded with new controllers, detectors and, importantly, DSRC radios. Even if the bid fails, all is not lost. "Idaho National Laboratory is a field station for the US Department of Energy. It is very much into research and will continue to expand the project, though on a limited basis," says Koeberlein.

Clearly the message is getting through – communicating road weather data through secure, robust and timely transmissions will benefit anyone who depends on road operations. That is to say, everybody.

The future is video

As available bandwidth increases it will become more viable to transmit video to improve road weather information systems

Faster, further, stronger – three ideals similar to those of the Olympics but actually also suited to comms systems. Cellular has moved swiftly from GPRS to 3G and now 4G is spreading invisibly. While these are more than adequate for the small data packets from most weather information stations, the possibilities of a better service would open the door to information that needs more bandwidth, such as video.

"Exploiting the potential of cameras on vehicles is interesting for road weather information," says Dr Timo Sukuvaara, senior research scientist at the Finnish Meteorological Institute (FMI). "There is a lot of activity here testing automated cars in winter conditions and we are involved with this research. Also, 5G communication is emerging and FMI is considering 5G as part of its road weather communication environment."

A European collaborative project to improve safety critical wireless comms for cooperative cyber-physical systems has road weather as one of its five focus cases. Known as SafeCOP, it aims to help ensure the data exchanged between weather stations, vehicles, infrastructure and the cloud will be validated continually as pure and secure. The results of the project will be known when it ends in 2019.

> We have the initial proof-of-concept equipment – one roadside unit and three on-board units. We still need a back-office system to manage the data, but we've got a start on that
>
> **Bob Koeberlein, HQ operations engineer, Idaho Transportation Department**

Right: **One of Utah DOT's five portable road weather stations, which communicate via the cellular network**

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Advanced transportation communications will enable the smart cities of the future to run more efficiently

1,000

The number of signalized intersections having their comms upgraded in Columbus, Ohio

150
The total, in millions of US dollars, given to Columbus, Ohio, in grants to help it realize its smart city ambitions

Smart city Connections

A seamlessly connected transportation system is at the very heart of the concept of a smart city. Knowing this prompted the USDOT to run its Smart Cities Challenge earlier this year. **Sally Cranfield** catches up with the latest developments in the winning city: Columbus, Ohio

If it's the dynamic use of data gathered in real time that makes a city 'smart', then comms are as vital to it as synapses are to the brain. Without communication between the right nodes, potentially useful information will end up in dark silos. It sounds straightforward but, while deploying the correct systems for fixed assets such as buildings is relatively easy, there are challenges when the information has to be gathered from and transmitted to disparate moving elements that vary in location, speed and time of day – traffic, transportation and travelers.

Columbus, Ohio, must grapple with these issues as it plans to spend the US$40m it received as winner of the USDOT's Smart City Challenge earlier this year. The city will also receive US$10m from philanthropist Paul G Allen's Vulcan Inc. and has secured a further US$90m from private partners. "It sounds like a lot of money but it's not a silver bullet," says Arpana Dial, program manager for Smart Columbus.

"Transportation is very important. We're the 15th largest US city and number one in the Midwest for jobs growth, but we have aging infrastructure," says Dial. The pressure to renew infrastructure increases annually. By the end of 2016 the city is predicted to have created 22,000 jobs since the start of the year. Visitors also need to be considered. Columbus gets 35,000 a day, rising to 450,000 on Independence Day. With fewer than 50,000 surface parking spaces, the city clearly needs to reduce congestion and improve access to jobs – smarter comms can help.

One part of the smart-city strategy is to build smart corridors – routes equipped with digital technology for gathering, transmitting and analyzing information about the movements of people, transit and traffic. The output data can be used to regulate flows, through connected infrastructure and vehicles.

Cleveland Avenue has been chosen as Columbus's first Smart Corridor. A new traffic signal system is being installed to replace an

> There will be a new bus rapid-transit line equipped with DSRC which will give the vehicles prioritization at signalized intersections
>
> **Arpana Dial, program manager, Smart Columbus**

outdated, high-maintenance system. As part of the upgrade, 450 miles of fiber-optic cable and several hundred wireless radios have been installed to connect the signals to a recently built traffic management center. Signal control equipment has been upgraded at more than 1,000 intersections and a network of integrated electronic signs will be deployed.

It's no coincidence the Cleveland Avenue Smart Corridor links the city with the low socioeconomic-status neighborhood of Linden. "There will be a new bus rapid-transit line (BRT) equipped with DSRC which will give the vehicles prioritization at signalized intersections," says Dial. This means that passengers will enjoy faster journeys, a more reliable service and up-to-date information about running times. "It should make riding the bus more attractive and that should help give people access to jobs and reduce congestion," says Dial.

Wi-fi will be installed on the Cleveland Avenue BRT next year, for travelers' use. In addition, 3,000 other vehicles across the city will get the DSRC treatment, so there will be massive connectivity, which will help traffic to flow more smoothly.

One way of maintaining traffic flow is to reduce collisions. A new Smart Columbus initiative should do just that, thanks to a new application of vehicle connectivity. The transit buses are to be fitted with Mobileye Shield+ systems. Although the system's primary function is to warn a driver when there is a vulnerable road user in their blind spot, it will also help reveal points of danger not recognized before. Each unit uses telematics to send alerts to a central system, making it easy to identify hazard hot spots. Currently three intersections in Linden are known to be among the 25 most hazardous in the city.

The Cleveland Avenue Smart Corridor should go some way to reconnecting Linden to the city. It was cut off when I-71 was built, ostensibly to improve traffic flow. Today the district is deprived not only of decent physical access to the city but also to the digital world. "Not only is it physically disconnected but also technologically," says Dial, "The coaxial network is not in very good shape at all.

"So we're going to upgrade the streetlights," she says. "They'll have motion sensors to reduce electricity usage but also to make the city more walkable. Plus, we're going to include wi-fi internet access via the streetlights." This will be free for the community. Access to work, education and the city itself is what Smart Columbus is all about, both physically and via communications technology.

Above: **Autonomous shuttles will connect residential areas with retail and transportation hubs in Columbus**

3,000

The number of vehicles due to get DSRC connectivity for V2X functions in Columbus, Ohio

Last-mile solutions

Autonomous technology comes to the fore

To solve the infamous last-mile connection challenge and deliver commuters all the way to their final destinations, Smart Columbus will deploy on-demand, self-driving electric vehicles that communicate with a central hub and each other. The city hasn't had to look far for appropriate technology to test, thanks to the work of Ohio State University's SMOOTH project (Smart Mobile Operation: OSU Transportation Hub).

In trials on the university campus road network, a mobility scooter and a golf cart have been communicating with each other and the hub by using Rocket M900 radio modules from Ubiquiti Networks, each with an omnidirectional antenna configured to increase data throughput. The modules give broadband access of at least 150Mbps at 900MHz and they can also act as repeaters, receiving and forwarding signals from each other, allowing the range to grow as the vehicle fleet expands.

On the streets of Columbus, the vehicles will ply a fixed route from the Easton Transit Center through residential, commercial and retail facilities in the Easton and Port Columbus areas. The public roads will be upgraded with technology to ensure the vehicles stay in their lanes and respect traffic signals.

New antennas expand network options for V2X planners

A successful ITS deployment depends on consistent wireless coverage. Vehicle-to-everything (V2X) connections must seamlessly reach hard-to-cover corners of city intersections as well as vast expanses of highways. Optimum coverage can be achieved with a combination of omnidirectional, directional, and now bidirectional, infrastructure antennas.

Omnidirectional antennas

Omnidirectional antennas provide point-to-multipoint coverage and are particularly useful when signals are coming in from multiple or unknown directions. Locations where several roads lead into an intersection may benefit from such coverage.

Need to know

Optimum V2X connection coverage can be achieved with a combination of antennas

- Omnidirectional antennas are useful when signals are coming from multiple directions or from unknown directions
- Directional antennas relay data from point to point along a network, or capture data from a fixed location such as toll collection
- Bidirectional antennas radiate in two directions and provide optimum coverage along a highway or a narrow corridor in an urban setting

The antenna's uniform 360° coverage eliminates the need to line up the send and receive antenna nodes. Higher gain antennas will transmit and receive signals over a larger area, but the vertical beamwidth of the antenna narrows as the gain is increased.

Directional antennas

Directional antennas provide point-to-point coverage and are typically used to relay data along the network backbone. They can also be used to project the signal outward from a fixed location, such as a highway toll collection point.

Directional panel antennas are typically described by the width of the area they cover, such as 120° or 60°. As the sector size narrows, the signal extends to a longer distance and the antenna gain is higher.

Bidirectional antennas

Bidirectional antennas channel the radiation pattern in two directions and are ideal for providing optimum coverage along highways. They can also be used in tunnels to give consistent coverage with efficiently spaced wireless nodes. This same concept holds true for 'urban corridors' that occur when streets are flanked by large buildings.

When roadways that link to an intersection need to be isolated from each other, separate bidirectional antennas can be mounted to create two distinct coverage areas. The patterns can be optimized for each road.

New antenna choices

Mobile Mark has introduced two new bidirectional infrastructure antennas for ITS/V2X networks using DSRC at 5.9GHz.

Left: **Mobile Mark's bidirectional blade antenna**

Right: **Mobile Mark's bidirectional rod antenna**

The dielectric rod antenna features double radiators and a single feed. This narrow diameter antenna can be mounted in the middle of an intersection, along a highway or in any setting best served with narrow beamwidth coverage. Heavy-duty hose clamp mounting accommodates pipes or poles of vastly different diameters.

The dielectric rod antenna provides 14dBi gain from 5.0-6.0GHz with a 30° beamwidth. With a gain of 14dBi, the antenna has three times the effective radiating power (ERP) of a typical 9dBi omnidirectional antenna. While 9dBi gain is sufficient in many installations, areas that are narrow and hard to cover will benefit from the higher performance of the 14dBi gain antenna.

The bidirectional blade antenna is typically mounted on a street-side cabinet. This antenna contains two radiating elements in a single antenna housing. The two elements are combined into a single feed to be connected with the DSRC radio.

The bidirectional blade antenna offers 13dBi with a vertical and horizontal beamwidth of 30°. Its most distinct feature is its small footprint of 7.5 x 1.5in (191 x 38mm). This slim profile is ideal for the type of hardware often found in roadside settings.

Which style is best?

Omnidirectional or directional antennas are suitable for many V2X infrastructures, but the new bidirectional antennas provide more options to help network designers optimize the number of nodes in the network.

Operational traffic modeling for Sydney CBD

Construction is already underway on Sydney's CBD and South East Light Rail (CSELR) network, which will reshape Sydney's transportation system and reduce the city's reliance on buses.

Operational modeling

In the early stages of the project, which started four years ago, the pre-existing Roads and Maritime Services (RMS) microsimulation model represented best practice at a microsimulation level, but did not take into account traffic effects outside the CBD (central business district). As a consequence, the model was likely to overestimate congestion when traffic capacity was reduced in the CBD and, conversely, to underestimate congestion when capacity was increased.

The operational assessment approach included the development of an area-wide mesoscopic Aimsun model that enables the dynamic simulation of an area large enough to account for regional route diversion, as well as microsimulation modelling of smaller pockets that require the representation of dynamic individual vehicles in the detailed road network. The hybrid platform is proving to be an efficient method for data exchange or model transformation from the macroscopic level (Sydney Strategic Travel Model) (SSTM) and the Public Transport Project Model (PTPM)) to the mesoscopic/microscopic levels in Aimsun.

Model behavior

The Sydney Coordinated Adaptive Traffic System (SCATS) controls all signalized intersections in the modeled study area and allows adaptive phase times, cycle times and offsets to respond to fluctuating traffic conditions and public transport demands, and improve the efficiency of individual intersections. However, the introduction of light rail within the complex road network environment will require an overhaul of the existing SCATS signal control strategies to cover various new light rail traffic signal priorities. The implementation of SCATSIM into the Aimsun mesoscopic model has provided an estimate of the magnitude of traffic issues, enabling the development of more appropriate congestion management plans and the evaluation of signal priority levels, as well as their impact on travel time reliability.

There are some distinctive differences in vehicle detection emulation between the microscopic and mesoscopic models: the mesoscopic car-following model is simplified when the acceleration and deceleration constraints are removed. The model estimates the earliest time that a vehicle can enter and exit the section, and uses this information to calculate the arrival time of a vehicle at a particular detector. The first-of-its-kind SCATSIM interface between SCATS and the mesoscopic model enables the exchange of information between SCATS and the simulator. In addition, a recently added microsimulation pocket along the length of the light rail corridor can accurately replicate detailed light rail vehicle characteristics and ultimately increase confidence levels in forecast travel times.

City of Sydney, George Street at the Town Hall: an artist's impression

Operational assessment

In October 2015, during the implementation of the new CBD Bus Plan and the first closures of George Street, the assessment of actual traffic volumes within the CBD cordon after the first closures showed a reduction in trip numbers and peak spreading away from the busiest time periods. This demonstrated the successes of the on-going travel management campaign by the New South Wales (NSW) transport authorities, which aims at reducing vehicle numbers in the Sydney CBD.

The model results showed a 2% overestimation of inbound and a 16% underestimation of outbound vehicle trips in the morning peak period. This relatively high underestimation of outbound volumes was due to the changeable nature of those trips. In morning peak traffic, diversions resulting from the proposed road closures and the new bus plan were likely to occur on alternative north-south routes, which correlated closely with the survey data.

Simulation success

The use of the Aimsun modeling platform, in combination with SCATS, has provided Sydney with a cutting-edge tool that was able to successfully support the development of several demand management and operational transport strategies.

Need to know

The Aimsun Sydney CBD model platform is the first of its kind to communicate with SCATS

- SCATS is an ITS developed in Sydney, Australia in the 1970s
- It manages the dynamic timing of signal phases at traffic signals
- The implementation of SCATSIM in the Aimsun mesoscopic model has enabled estimates of the magnitude of traffic issues, inside and around Sydney CBD, to be made

Using smart sensors for informed traffic decision making

Smart city road sensors and software systems can help authorities to better manage certain elements of a city, including its hospitals, transportation, power plants, law enforcement, and more.

By integrating smart technologies into a city's infrastructure, real-time traffic data can be collected, providing a basis for smarter decisions to be made for elements of the city, including traffic management, parking management, urban planning and energy management.

Smart city sensors

Flir Systems has been supplying smart sensors to traffic authorities for many years, enabling them to collect real-time data at intersections and arterial roads, which are typical areas for bottleneck traffic to occur. Smart sensors from Flir are based on visual CCTV and thermal imaging technology, and can be used to measure a variety of parameters to provide valuable insights into traffic flows.

Pedestrian presence detectors can give pedestrians increased visibility and green time to enhance their mobility and safety, as well as that of motorists and other vulnerable road users.

Real-time traffic data

The city of Hamburg, Germany, partnered with Flir Systems to use smart sensors and intelligent wi-fi tracking technology in order to collect high-resolution, high-quality intersection data from within the city.

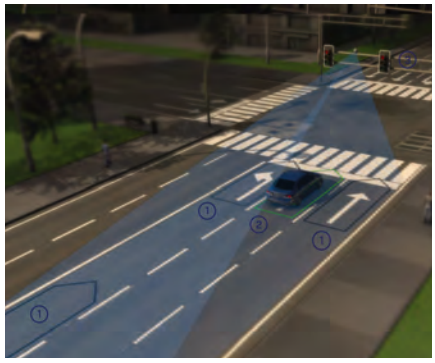
Visual and thermal sensors were used to detect vehicles' presence and flow volume, and vehicle presence sensors were supplemented with advanced wi-fi tracking technology. By monitoring wi-fi media access control (MAC) addresses of wi-fi enabled devices (such as smartphones), it was possible to determine travel and route times along road segments. The wi-fi signal strength information allowed the relative proximity to be determined and could measure queue delay times at intersections.

While the vehicle presence sensors provided data from one specific point at an intersection, the wi-fi tracking technology provided data about what was happening between different installation points. With wi-fi detection, vehicle movement was fully characterized as a vehicle approached, stopped and left an intersection.

Information from different sensors could be collected, combined and accessed for further traffic analysis with Flir's cloud-based analysis platform. Smart analytics transformed the data into useful traffic insights, which were critical for understanding the road network's performance. The user-friendly dashboard helped traffic engineers to run reports and take measures where they were required.

TrafiOne

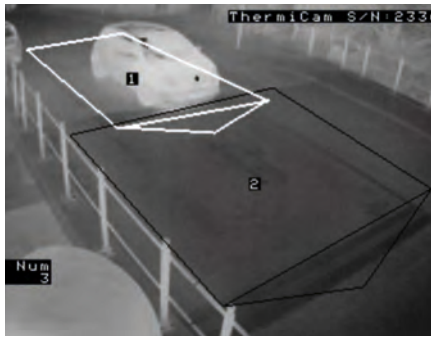
Flir's TrafiOne is an all-round detection sensor for traffic monitoring and dynamic traffic



Far left: **Flir's visual sensors detect vehicles approaching or waiting at an intersection**

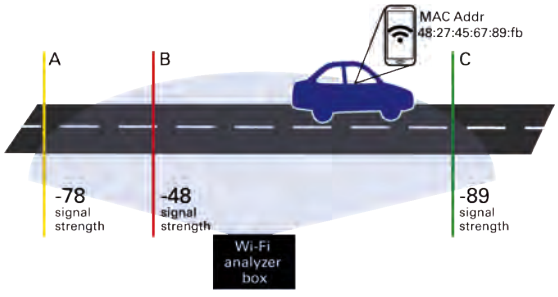
Left: **Pedestrian presence detectors provide pedestrians with the appropriate green time and visibility**

Right and far right: **A dedicated bicycle traffic signal scheme based on Flir thermal imaging sensors in Utrecht, Netherlands**



Above: **Flir TrafiOne traffic detection sensor**

Below: **By monitoring wi-fi MAC addresses, Flir could determine travel and route times**



by **Neil Hoose**

In-vehicle signage, though technically possible, still has many regulatory barriers to deployment

"Most signs have a safety benefit, just as a medical treatment has a health benefit"

One of the debates that is gaining some traction at the moment is whether a substantial business case for connected systems can be based on replacing physical infrastructures such as signs, signals and road markings. The cost of maintaining, replacing and keeping up-to-date fixed-plate signs, dynamic electronic signs and signals – and even painted road markings – is a considerable drain on highway authority and road operator budgets. Using a mix of ubiquitous communication and onboard or personal mobile devices, it is possible to present the same information to the driver, or linked to an onboard system controlling all or part of the driving function.

Demonstrations of this sort of direct, virtual signage have been made by various projects over the past 20 years and more; anyone remember projects such as Road Traffic Advisor and Cartalk2000?

So are we any nearer the large-scale deployment of in-vehicle signage and to reaping the benefits of reduced infrastructure costs?

In order for a successful deployment that results in a worthwhile reduction in infrastructure, the system will need to function in as wide a range of roads as possible, and be available and used by all road users. On highways where access is restricted to motorized traffic, the onboard system will have to be available on all types of vehicles, including motorcycles. Furthermore, all vehicles must have a working onboard device and communications system.

At the moment it is the responsibility of road authorities to maintain the signing and signaling but, assuming they do so, they can be confident that all users passing the sign are able to receive the same information irrespective of whether they choose to act on it. If all the signing is within the vehicle, then it is the owner's responsibility to maintain the onboard device – and the communications system provider's role to ensure the accurate and timely transfer of information. The onboard sign system will have to be included in the build regulation and, more importantly, in the statutory maintenance check, rather in the same way a working and accurate speedometer is required in all vehicles. The obligations of the communications provider will also have to be determined, whether or not this is the road operator, a telecoms company, or a dedicated service provider.

The situation on roads where there are non-motorized users is more complex. Which signs and signals do they make use of, even if the signal is not intended for them? And will they need to have a hand-held device in order to use the streets?

These are complex, system-wide issues. A key point to remember is that most signs and signals have a safety benefit, just as each medical treatment has a health benefit. Medical treatments are changed, but only after careful, evidence-based studying and monitored, structured trials.

I think we understand the issues involved in deploying connected systems much better than we did 20 years ago, but the realization of the benefits of replacing, rather than augmenting, the current fixed infrastructure is still some way off because we have yet to address the broader issues.

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Illustration: Ian Parratt, the-caricatureartist.co.uk

Need to know

The right data enables authorities to give informed answers to a wide variety of traffic management questions

- **Intersection traffic control:** traffic data can help road authorities to better manage traffic lights and provide dedicated signal schemes based on traffic volume
- **Priority for public transportation or emergency vehicles:** smart technology can give these vehicles priority over less important traffic
- **Energy management:** with the use of smart sensors, public streetlighting can be configured to suit the movements of cars, pedestrians and cyclists – ultimately saving energy

signal control. Offered in a compact and easy-to-install package, the Flir TrafiOne uses a combination of advanced thermal imaging and wi-fi tracking technology in order to provide traffic engineers with high-quality, high-resolution data from vehicles, bicycles and pedestrians on streets. It can be used both at intersections and in other complex urban environments.

Free reader inquiry service

Connecting highways and improving traffic flow with big data

Cross Zlín has developed various traffic monitoring systems which, if their outputs are combined, can support the concept of 'big data' in road infrastructure – whether it's monitoring different categories of vehicles, analyzing weather conditions on roads, or simply quantifying the traffic environment in inner cities.

Data-driven behavior

The age of computation has been relatively short, yet unbelievably rapid. What started as manual data recording by educated personnel has advanced considerably. Human behavior is now being recorded, stored and analyzed by various firms operating in the mass of digital networks, but although it is humans who create the data, that very same data obtained by automated devices with high resolution and precision can show patterns in, and help to predict our behavior.

Over the years, Cross Zlín has built its own perspective on the phenomenon. Its vision is not to use the term big data as an empty buzzword; it aims to apply all of its acquired experiences from its long-lasting practices and combine the systems which, despite being developed as individual monitoring networks, can serve as sources for a unified data output. The vision for the future is to use multiple sources of data in a cooperating sphere, which can be reflected in other dimensions of life – not necessarily solely in the area of transportation.

A smooth system

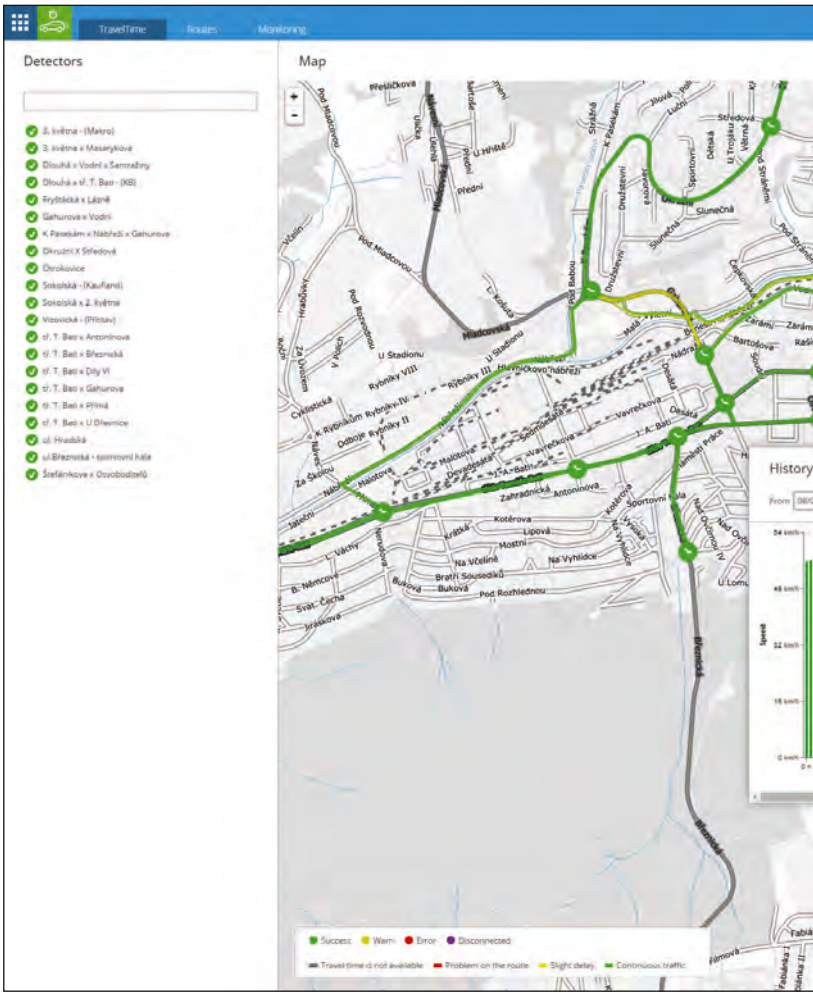
Cross Zlín is applying big data to traffic detection with its traffic flow monitoring and classification system, CrossCount. The technology, which is based on inductive loops installed on a road's surface and a Bluetooth BTTT module (a reliable and flexible Bluetooth traffic detector for travel time measurement and directional transport surveys of roads), was used in a case study that aimed to inform the public in the Czech Republic about possible delays caused by upgrades to the largest arterial road in the country, the D1 highway. Although it could be argued that having to install the technology directly into the road is disruptive, the system is able to obtain accurate data.

CrossCount allows data to be obtained for monitoring and quantifying purposes, as well as categorizing road traffic. Data is gathered in two basic sets: counter and classifier.

Monitoring enables the operators to observe how many vehicles pass through a certain road section within a given time period. It also categorizes the vehicles into predefined classes, such as car, truck or van, and calculates their average speed according to the traffic density. This first set of data can be used as a basis for statistical background knowledge for infrastructure planning and development.

The second set of data concentrates on how each vehicle operates in a given space-time context. In order to create a database of a current traffic environment, different technologies are needed to collect the information: ALPR cameras are required to obtain license plate video footage, and roadside detectors are required to anonymously obtain media access control (MAC) addresses from Bluetooth devices carried by the observed vehicles. By tracking the license plates or Bluetooth signals from observed vehicles, the system can build a general image of the density and flow of road traffic in certain areas. The analyses of such data can then be used in different ways.

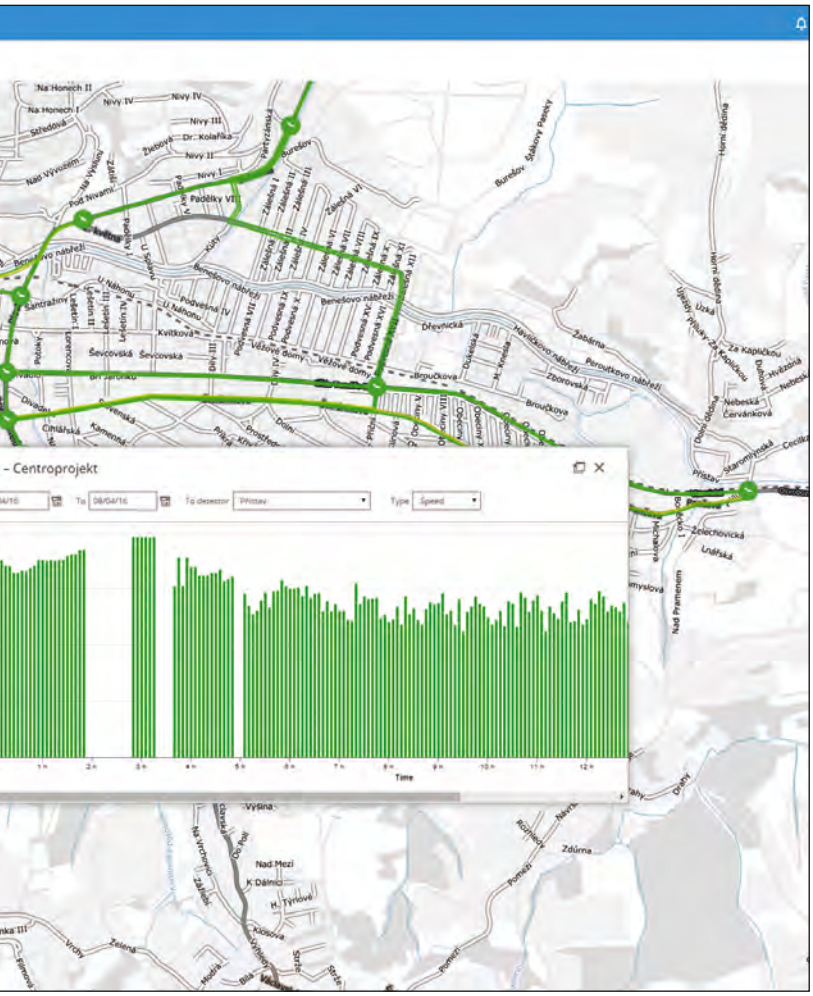
Traffic signal settings can affect the time a vehicle has



Need to know

InVipo by Cross Zlín is a platform for collecting, processing and analysing big data

- It collects and aggregates data from various traffic and city technologies
- The platform validates data according to predefined rules and conditions, and it notifies the user if data is inconsistent
- It can show hidden context between various data sources, thus simplifying the decision making process



Above: **A screen view of travel times in the city of Zlín, Czech Republic**

spent on certain sections of a road. The settings of inner cities' crossroads also enable data collection from a system that calculates the number of pedestrians waiting for a green light at crossings. This kind of data processing can be beneficial to drivers on the road. If there is a traffic jam or a road incident, for example, the system can offer them an alternative route.

Real-time weather data

There are many factors that can affect traffic flow and one of the least predictable, yet most impacting, is the weather. In order to react to weather conditions in real time, Cross Zlín relies on a network of meteorological stations across the entire D1 road infrastructure, which generate complex data sets about current weather conditions. These weather data sets include the state and the temperature of the road, the dew point, the speed and direction of the wind, and the range of vision.

Data produced by the CrossCount system is linked to weather forecast data, and is then calculated and stored.

GPS locators for road maintenance are another useful data source during winter months. Their purpose is to gather information about the state of the snow and the level of road maintenance required, in real time.

The road weather system serves to inform drivers about the accessibility of roads and of traffic control measures that may be in place, such as speed reductions or other tools that affect the direction of the traffic.

Smart traffic in Izmir

The potential uses of big data depend on the way it's sourced, measured and analyzed. Traffic data can be gathered from a variety of different detectors, such as inductive loops; video detectors, which are able to recognize a vehicle while streaming; radar, which records the movement of vehicles; magnetic detectors inside roads; and thermal detectors, evaluating not only cars, but living individuals as well.

The complex data set outputs can be used as a centralized tool for the control of traffic in an inner city. An example of this is a case study of the Turkish city of Izmir. Cross Zlín's Pavis parking violation system, which is in operation there, records the status of parking spaces, identifies parking offences, and issues fines for violating drivers. There are also more than 400 intelligent crossroads in Izmir, which are able to carry out dynamic and adaptive traffic control.

The network data structure in Izmir records more than 1,000 events per second from 1,000 connected systems with real-time data storage, or document-based storage in place. Izmir's complex data system has its own infrastructure, including a data center and an optical network.

The vision

Traffic data is only a small part of the vast and complex data systems that have major influences on our daily lives. In smart cities, traffic data is combined with data from other sources, such as from smart buildings and smart infrastructure. We are now experiencing an information revolution – where data and software are omnipresent in our lives. Learning how to evaluate data in a useful way, analyze it and explore its context will be the key to success in the future.

Data processing is, and will continue to be, a powerful tool, whether we like it or not. Cross Zlín, therefore, believes that these new and influential data techniques will be used in a positive and enriching way.

A smooth, efficient upgrade for Oslo's automatic tolling stations

Automatic toll stations, or 'charging points', were installed in Oslo, Norway, in 2008. Today, there are 29 in operation on highways and municipal and secondary roads in and around the city.

Revenue loss and the desire to reduce operational costs pushed Fjellinjen, the toll scheme's operator, to look at replacing the original roadside equipment. A program with strict criteria was then put in place, including the possibility for financial penalties to be imposed on the new system's supplier if individual gantries were out of operation beyond a specified period.

Q-Free gained the project's replacement contract and installed a new solution in 2015.

Q-Free developed a portable gantry solution to minimize revenue loss during the replacement of permanent gantries

Charging in Oslo

Oslo's tolling system is unmanned, free-flowing and has full redundancy. The onboard unit (OBU) usage stands at around 80-90%. No manual or direct payment takes place at the tolling point and vehicles are also only charged when traveling in one direction – when passing the Oslo Ring, heading into the city.

Q-Free's portable roadside tolling solution is CEN DSRC TS278-compatible and consists of: an electronic identification system antenna that reads OBUs; a vehicle detection system that uses a SICK laser; automatic license plate recognition (ALPR); a roadside controller combiner to collate information into a single transaction; and a central security system server to provide secure communication between the roadside and central systems.

Guaranteeing service

For the Oslo project, Q-Free created a number of innovative solutions for the charging points' installation and the ongoing operational phases, both of which were intended to keep disruption to a minimum.

The mobile gantry unit (pictured above) was developed for use when equipment was being replaced, to keep tolling station downtimes as brief as possible. Prior to the replacement work, the mobile gantry was parked next to the appropriate tolling station. It was elevated to the correct height and then configured and tested, which would take around two hours.

By using the portable tolling system, Q-Free was able to reduce the total downtime of the primary tolling station to just a few minutes. Revenue loss was minimized and there were several instances where the portable solution stayed in operation for several weeks because some primary tolling stations needed considerably more civil works than was realized at first.

The portable tolling system is not a full replica of the permanent roadside solution; its equipment enables only front image captures and dedicated short-range communications (DSRC) readings. The portable tolling system can be used as a stand-in during charging point maintenance or other traffic-monitoring applications.

Where tolled routes experience high daily traffic levels, closure for preventive and corrective maintenance can be costly and disrupt traffic flows.

For the Oslo project, Q-Free collaborated with a Norwegian

Need to know

Some of the most important features of Q-Free's portable roadside tolling solution...

- CEN DSRC TS278-compatible
- Consists of an electronic identification system antenna that reads OBUs
- Has a roadside controller combiner that collates information into a single transaction
- Uses ALPR , which captures images of vehicles' front license plates

The need to reduce operating costs and revenue leakage led to the operator of Oslo's tolling scheme carrying out an *in situ* replacement of its older roadside systems

Tolling in Oslo

The E18 toll road originally ran across Rådhusplassen, or the City Hall Square, in Norway's capital, Oslo. In 1990, Rådhusplassen became vehicle-free and all traffic was diverted into what is now known as the Festning Tunnel. In the same year, a tolled ring-road was established around the city to part-finance the Festning Tunnel project. The operator of the Oslo Ring subsequently became responsible for financing a joint plan of action for infrastructure in Oslo and the adjoining county of Akershus, in 2002-2011. A third package of infrastructure improvements, including its financing, was adopted by the Norwegian Parliament in 2008 and then revised in 2012. This is worth €8bn (US$8.81bn) over the 2013-2032 timeframe.

Annually, Fjellinjen is scheduled to contribute €210m (US$230m) to this third package, collecting tolls in the counties of Oslo and Akershus, and the municipality of Oslo and Bærum. In 2014, it contributed €250m (US$270m). It has approximately 620,000 account holders and registers 113 million toll crossings per year.

gantry unit manufacturer to create a gantry pole with a rotatable base. When necessary, systems can be swung out of action and over a service area that is a safe distance from the live lanes. There are currently 18 rotatable gantries in operation in Oslo.

Replacement process

All of the replacement work was done at night and on-road work finished before 6:00am the following day.

With the existing power installation found to be undocumented and in poor condition, Q-Free had to completely renew the earthing and power supply to every tolling station. Although this was a major task, it was essential for ensuring the system met relevant standards and requirements.

All equipment was pre-deployed and checked before being shipped to sites; the portable tolling system was installed; existing roadside equipment and cabinets were removed; all cables were removed and replaced with new ones; and new, fully redundant roadside equipment was installed and fine-tuned. In several cases, foundations and gantries were upgraded.

During the nights when the replacement work was taking place, Q-Free's network operations center in Stockholm monitored the installation of the tolling stations and confirmed the connection to the equipment. When traffic increased the morning after installations, the network operations center had access to all equipment and the charging point was fine-tuned and tested. The portable gantry unit solution, if used, was removed and a full systems test could be carried out with the customer on the afternoon of the following day.

At the start of the installation process, only one or two tolling stations were replaced per week. A few weeks later, the installation process was optimized and the number of installations rose to three or four stations per week.

Acceptance testing with the customer had to be done within 48 hours of taking down the old charging point, otherwise the project was subject to financial penalties for every hour that the acceptance testing was delayed by. In this case, no fines or penalties were incurred.

Observations and outcomes

The success of the Oslo tolling station replacement project shows how exchanging an existing toll system with a new one can be swift and painless, with minimal loss of revenue.

This was achieved with proper planning at each site, teams of engineers who were well-trained and fully aware of each other's tasks, adequate spares provision, planning to cater for any eventuality, pre-testing and deployment of equipment in advance, and good cooperation with the customer and road authorities. Another key element of the team's success was the development of the trailer-mounted mobile gantry solution.

In operation, the new tolling system is performing well. Fjellinjen is enjoying a 10% higher tag read rate and this, combined with wider detection zones that prevent drivers from avoiding detection (by switching lanes or mounting curbs, for example), has reduced revenue leakage.

Traffic management system incorporates connected technologies

Autonomous vehicles are expected to improve both road safety and traffic efficiency, as well as returning time and comfort to drivers with busy lives.

But with few global testing regulations and restrictions in place, autonomous vehicles can also pose a risk to traffic efficiency and safety.

Imagine an instance where, for argument's sake, a number of autonomous vehicles have ended up in a tricky situation (pictured). How should the vehicles resolve the scenario? Should each one come up with an individual solution and behave autonomously, without coordinating with the other vehicles? Should one of the cars take the lead and try to control the others? Should the vehicles follow a set of simple rules in the hope that the 'wisdom of crowds' phenomena will surface, allowing an 'invisible hand' to guide them through? Or should a central intelligence system located in a cloud sort out the mess?

Indeed, vehicle autonomy alone would not be able to resolve such a solution. Somebody would have to take control and to coordinate, to lead each individual car out of the situation – which is not too dissimilar to traffic management.

Above: **Despite an increasing level of autonomy on our roads, traffic management will still be necessary to manage situations like this, if they occur**

The needs of traffic management

Traffic management cannot be avoided in the wake of vehicle automation. In fact, it is likely to become even more important in order to leverage the advantages of vehicle automation, even if it ends up looking different to the traffic management measures in place today. Instead of stopping, starting and directing vehicles, traffic management of the future may also include advising each individual vehicle on how to approach and pass an intersection in a safe, energy-efficient manner that is respective of surrounding traffic. Traffic management will become much more complex than it is today and traditional methods could lose their purpose.

In the future, traffic management will need to become automated, to be compatible with autonomous vehicles on the roads – a need that ANDATA is able to serve. The company has designed VERONET, a new traffic management system, which considers how road networks with autonomous vehicles, vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) in place need to be managed.

Autonomous traffic management

VERONET consists of a decentralized, subsidiary, hierarchical control scheme. It allows vehicles to drive autonomously only when traffic volumes are low enough. If a certain traffic volume is reached and traffic flow reserves are exceeded, the risk of conflicts and collisions between vehicles increases. A superordinate hierarchy of traffic nodes and/or traffic lines then becomes active and improves traffic flow volumes by coordinating the vehicles involved. The system is optimized by the use of artificial intelligence and mathematical algorithms. Traffic nodes for the control of intersections are allowed to work autonomously at their level until they exceed their individual flow reserves – in which case a superordinate line or network control will take the lead. The system's control elements only operate autonomously when they have enough reserves.

by **J J Eden**

Failures of semi-autonomous vehicle technology should not put the brakes on future development

"When you activate these systems, you are told that you need to stay in control"

The media and our society love controversy. It's easy to get wrapped up in, and shapes our opinions in a matter of minutes. We all seem to like sensationalism. If it's funny, it's really funny; if it's sad, it's really sad. However, we rarely see more than one side of the headline, at least when glancing at our Twitter feeds. We don't even take the time to read the entire story.

Technology has long been a target of the media. However, as recently as last month, some of the most futuristic technological advancements in transportation started coming together in the production of semi-autonomous vehicles. Car companies are scrambling to produce fully autonomous vehicles by 2020 with Google and Tesla in the forefront; the 2017 Mercedes 'E' class claims many breakthroughs; and even my wife's 2017 Acura has semi-autonomous features.

Safety is always a guiding light for a good news story. We've all seen YouTube videos of the self-driver stopping a vehicle inches from crashing, saving the occupants. Of course there's the occasional fender bender or post of someone sleeping while the vehicle is purring along autonomously, but that inattentive behavior has been generally overlooked as a humorous side story.

Then on a fateful day in May this year, a tragic accident occurred that took the life of a driver. The car involved was the reigning king of commercially available semi-autonomous vehicles, a Tesla S.

In our industry, we can understand how the Tesla sensors failed to see the high trailer of the 18-wheel truck that turned in front of the self-driving car. From the accident account, the car went under the heavily backlit trailer with the point of impact being the vehicle windshield.

We know that toll collection systems have struggled with repeatable and accurate vehicle separation. A tractor trailer (depending on the configuration) can appear as two separate vehicles splitting under the trailer, regardless of the type of sensors deployed. In this case, it appears that if the truck was moving a little faster or slower, the autopilot function most likely would have picked up the wheels of the cab or trailer, and then stopped or slowed down.

Now, some of the media is pouncing – this new technology should be regulated. Some are calling for all self-driving systems to be disabled until the new investigation by NHTSA has been completed. Several articles proclaim that robotics can never be 100% accurate and reliable. But what human is? Indeed, 94% of road accidents are human error-related.

Every currently deployed autonomous system gives constant warnings to drivers to stay alert and keep their hands on the wheel. When you activate these systems you are told that as an early adopter, you need to stay in control.

Will this incident slow the progress in autonomous vehicle development? Will this force politicians to stop or slow down the development of this technology?

We cannot ignore safety, but these advancements should fuel our future – not hinder it. We must continue to lead technological advancements that make autonomous vehicles and tolling a reality.

J J Eden is director of tolling at Aecom
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Illustration: Ian Parratt, the-caricatureartist.co.uk

Need to know

VERONET traffic control system considers how roads of the future will need to be managed

- VERONET allows a city's crucial traffic junctions to be individually managed by the traffic node control
- With the help of the traffic line control the main inflows and outflows of an inner city can be managed with prioritization and conscious throttling
- Congestion can be prevented with predictive control strategies such as combining incident detection with traffic updates

The controls at all hierarchy levels – vehicle, node, line and network control, and complete city and regional control – are underlaid with a uniform process scheme, allowing automation. With this, it is possible to introduce and enforce higher ordered cooperative behavior, when – and only when – necessary. If there are enough reserves, vehicles and indeed drivers can continue to drive autonomously, which will ultimately lead to the technology being more accepted.

Converting vehicles into smart, secure payment devices

The introduction of near-field communication (NFC) enabled smartphones has allowed people to start using their phones as a tool for payment – and now you can use your car in a similar way, with technology by NXP.

Placing a special radio-frequency identification (RFID) tag, equipped with secure, long-range ultra-high-frequency (UHF), on a vehicle's windshield or license plate turns the vehicle into a secure authentic credential that can serve the same purpose as a loyalty, access or payment card. This enables drivers to pay for parking, enter a toll road, redeem loyalty points, or even buy their lunch at a drive-through, all without reaching for their wallet (or phone).

Charge it to my car

The RFID tag can be read at high speeds – up to 93mph (150km/h) and over a distance of 39ft (12m). This means that the driver does not have to stop or even slow down to make a payment. Furthermore, transactions are made securely with cryptographic authentication, which is a similar technology to the kind used in bank cards, credit cards and passports.

The tags can be applied to any car, in any country – not just the newest models. The driver simply has to mount the electronic sticker onto their vehicle, and their car instantly becomes a secure payment device.

Trusted operation

Secure, long-range UHF RFID tags combine cryptographic algorithms with high-speed reading performance, so they're ideally suited for use with automotive applications. The tags show if they have been tampered with, which can deter thieves and counterfeiters. When added to a license plate, the long-range RFID transponder is securely embedded into the plate itself, and it can communicate to the vehicle if it has been copied or stolen.

The tags use cryptographic authentication technology as their foundation for security. Cryptographic authentication is a proven and accepted technology throughout the world of payments, because the cryptographic algorithms and other security mechanisms used with it can keep private information safe, protect against attacks, and deter fraud and counterfeiting.

Even though a vehicle identification tag can be read from several meters away, transactions remain secure. This was tested on more than 100 military vehicles by the military in the Netherlands in cooperation with Tönnjes and Kirpenstein, where it was confirmed and proven that the cutting-edge technology is robust, secure, effective and reliable.

Tags can be configured to respond with a secure random response, to ensure that they do not get tracked or followed. Only an authorized reader with access to secure cryptographic keys can derive the tag's unique identity. End-user data remains private because all of the sensitive information that is linked to the tag – name, address and payment credentials – can be stored in

Need to know

Vehicles can instantly be turned into payment devices when a UHF RFID tag is affixed to a wind-screen or license plate

- Long-range UHF RFID tags combine cryptographic algorithms with high-speed reading performance, so they're ideally suited for use with automotive payments
- The RFID tags can be read at up to 93mph (150km/h) and over a distance of 39ft (12m)
- The tags can be applied to any car, in any country – not just the newest or most technologically advanced models
- Cryptographic authentication technology provides a foundation for the tags' security

Above: **An NXP RFID tag affixed to a license plate**

Left: **The tags can be read at high speeds, so drivers do not have to stop or even slow down to make payment**

a secure back-end system, rather than on the tag itself.

Loyalty and personalization

The tag can become part of loyalty schemes and other marketing initiatives, in a similar way to payment cards. You can collect points and redeem them for free products and services, get faster service as a returning customer, or enjoy preferential treatment as a member or frequent buyer. The tag can also present your preferences at the time of the transaction, so the attendant at a drive-through, for example, can call you by name and ask if you'd like to place your regular order – with no gherkins.

Success stories

There are a number of success stories for the application of RFID technologies in cars. For example, in some countries, governments are already using secure, long-range UHF RFID as the basis for electronic vehicle registration (EVR) to reduce fraudulent activities, while ensuring privacy and boosting revenue income.

The successful results of the military field trial in the Netherlands led to a large-scale implementation of applying chips to electronic license plates in South America.

In Mexico, millions of vehicle owners use a system called UrbanPass, by Neology. A single RFID tag allows cashless payments to be made on toll roads and in parking lots. Furthermore, the RFID tag enables the electronic management of individual accounts and payments. The UrbanPass is equipped with short-range RFID for cell phone interactivity, and long-range RFID for use with fixed infrastructures. There's only one transponder and it is easy to manage transportation accounts with a smartphone application.

NXP: the starting point

NXP's reputation for providing security is strengthened by its expertise in automotive electronics, including secure car networks that connect vehicles and their drivers to the outside world in a safe, intuitive and convenient way. ○

The sustainable war against traffic congestion

United we stand, divided we… sit in gridlocked traffic? As part of the ongoing movement to address increasing levels of traffic congestion worldwide, TomTom is championing collaborative crowd-sourced data streams and free-to-use traffic information platforms, with the goal of optimizing traffic flows to benefit all road stakeholders.

Cities now face severe mobility challenges, and with many across the globe increasing in size, traffic challenges are also becoming greater. Drivers in London, for example, can expect to spend 38% of their travel time stuck in traffic at any time of the day, and up to 45% in evening peak periods. These delays can add up to 149 hours – more than 18 eight-hour working days – of extra travel time per year.

Traffic jams can also have serious effects on economies and societies, costing industries billions of dollars a year in lost productivity. The environmental impacts of additional CO_2 emissions and increased fuel consumption from slow-moving traffic are also huge.

TomTom believes that governments, automotive companies, service providers and drivers can reduce congestion dramatically by cooperating more closely, and is actively working toward solutions that will enable this goal to be achieved.

"Traffic is like water: it will always try to fill the available space," explains Bob Randsdorp, a senior product manager at TomTom. "Left alone it ends up in the same place, creating the congestion we know. But, like water, traffic can be managed."

It could be argued that traffic control is only necessary in extreme situations, such as emergencies and where there are road closures, to minimize road users' exposure to hazards and danger.

In most other cases, road users and stakeholders making better informed decisions may be more efficient than active traffic control, but such informed decisions can only be made when the right information is made available to them. TomTom, in support of road authorities, aims to provide all road users with the best information possible.

A ground-up view

Traffic congestion occurs when road infrastructure cannot meet the immediate demands of the traffic using it. Therefore, congestion is linked to drivers' choices to use particular roads at particular times. If drivers' choices are the cause of congestion, then they may also lie at the heart of the solution.

TomTom believes that one of the most effective means of sustainably addressing traffic congestion is for agencies to make better use of available data to help drivers proactively optimize their journeys.

When this data is fused with traffic information, shared and then used by drivers for better decision making, the road network can be employed more efficiently. Ultimately data can help drivers become part of the traffic management solution, rather than part of the problem.

When the data that is available to authorities is merged with open traffic information, the next challenge is to gain the support of road users so that they can use it to their advantage and work toward optimizing traffic flow.

Left: **TomTom City aims to help reduce traffic congestion in cities like London**
Above: **Journey times for drivers using TomTom's personal navigation devices can be reduced by up to 15%**

Need to know

TomTom City optimizes traffic flow by linking road users, connected vehicles and traffic management

- TomTom City is a free-to-access web portal that provides live and historical traffic and travel information services to help transport and mobility stakeholders
- The platform uses an extensive range of traffic information to monitor live traffic situations, identify problem areas, analyze the cause of bottlenecks and influence drivers' behavior to ease areas of congestion

Left: **Congestion is a challenge in many metropolitan areas**

Below: **From traffic incidents to delay hotspots, TomTom City users are provided with real-time views of cities' changing traffic conditions**

Right: **TomTom City provides drivers with insights into traffic behavior in cities, enabling them to make better decisions when planning their route**

Traffic authorities have historically used roadside communication platforms to achieve this – from simple steel traffic signs indicating that a road is closed, to modern variable message signs that offer more flexibility, to broadcast radio messages.

The effectiveness of these platforms is limited for two main reasons. First, their information is not tailored to individual drivers' needs, so it is not relevant for everyone on the road; and second, by the time drivers see the shared information it may be too late to change their travel plans, take a different route or depart at a different time.

The future is collaborative

One way to overcome the data sharing hurdle is by disseminating enriched traffic information via service providers who have access to in-car communication systems.

As the number of connected vehicles on the road increases, along with the emergence of semi- and highly automated driving, the preferred means to keep drivers informed is via in-car platforms, which help to optimize drivers' journeys by making the best route-planning decisions for them. The journey times for drivers using TomTom's personal navigation devices can be reduced by up to 15%, and with in-car systems becoming more widely used, a 'collective effect' will further contribute to lessening congestion on busy road networks.

To this end, TomTom introduced a global innovative traffic platform, TomTom City (city.tomtom.com), earlier this year. TomTom City is accessible online, and was created as a starting point to encourage closer cooperation between stakeholders to optimize traffic and travel information – which can be incorporated at an individual level into cars or traffic management centers.

TomTom City provides city authorities, transport planners, business owners and private motorists with insight into transportation behavior city-wide, bringing together an ecosystem of TomTom partners who share a common vision. TomTom City aims to reduce traffic congestion for everyone by offering new ways to manage city mobility – through unparalleled trend analysis, traffic visualization and real-time congestion monitoring – and simultaneously help both drivers and traffic operators to make smarter decisions to avoid delays on the road.

"TomTom and its partner network are on a mission to reduce road traffic congestion for all," says Anders Truelsen, managing director of TomTom Maps. "With unique views into traffic information, governments and traffic planning agencies can reduce costs by eliminating the need for fixed measurement systems.

"At the same time, fleet companies can save money by ensuring their vehicles spend less time in traffic and get to their destinations faster. Individual drivers can also save time and money, enjoy a more relaxed navigation experience and minimize their environmental impact."

Enforcing truck speeds and safety with sensor technologies

Applied Concepts' traffic technologies, the Stalker Speed Sensor II and CCTV Speed Sensor, were recently used in the building of an application-specific solution to monitor and report the speeds of heavy trucks in Brookby, New Zealand, in accordance with a ruling by the Environment Court of New Zealand.

Initially, a mining company had requested the approval of the court to increase its traffic on a narrow public road from 200 to 450 truckloads per day. The trucks were traveling at 62mph (100km/h) on the 1.2-mile (2km) road.

Need to know

Applied Concepts' Stalker technologies monitor and regulate trucks' speed along a narrow 1.2-mile (2km) road

- The Stalker Stationary Speed Sensor II's directional digital signal processing enables the sensor to track vehicles either moving toward it, vehicles moving away, or in both directions simultaneously
- The Stalker Stationary Speed Sensor II is used to output RS232 speed data on a 2 x 1.5ft (660 x 450mm) LED pane
- Truck speeds can be monitored with the Stalker Speed CCTV Sensor
- A transmission microwave link connects the CCTV to a video recorder at the monitoring location

Local residents living nearby objected to the traffic increase and raised road safety concerns. The court sided with the residents and requested that the company submit a traffic management plan to reduce and monitor the speeds of the trucks.

A safe speed system

A system was proposed to advise heavy truck drivers of their speed, so that they could ensure their vehicles traveled at a prescribed speed limit.

Applied Concepts' Asian sister company, Khmer New Zealand Trading Company (KNZTC), attained the project and completed the installation.

Following the court procedures, a traffic management study requested that trucks of at least 26ft (8m) in length should travel at 31mph (50km/h); an LED sign should be installed to advise truck drivers of their speed when approaching and leaving the narrow 1.2 mile (2km) road; and if trucks exceed the recommended speed, a video signal with speed overlay could be sent to the central monitoring location.

When the project was advertised, three companies expressed interest. However, after nine months, the companies were not able to submit a working solution that complied with the court's final ruling.

Sensor technology

The traffic management consultants overseeing the project then contacted KNZTC, which proposed a plan that included the Stalker Stationary Speed Sensor II and Stalker Speed CCTV Sensor. After receiving the approval, the system was installed within a month and is currently operating in accordance with the court's requirements.

The Stalker Stationary Speed Sensor II is used to output RS232 speed data on a 2 x 1.5ft (660 x 450mm) LED panel. Truck speeds can be monitored by an operator using Stalker Speed CCTV Sensor and viewed on a TV monitor off-site. A transmission microwave link is installed to send the CCTV video signal to a video recorder at the monitoring location. A 433MHz datalink signal is sent to activate the alarm switch output on the CCTV sensor for the trucks traveling over the

Left: **Truck speed data from the Stalker Stationary Speed Sensor II is output onto the LED sign**

speed limit. All of the truck violation data is recorded and stored on a USB memory stick for playback.

The Stalker Stationary Speed Sensor II's directional digital signal processing enables the sensor to track vehicles either moving toward it, vehicles moving away, or in both directions simultaneously. The Stalker Speed CCTV Sensor embeds speed measurements into the video signal, which is compatible with most video surveillance systems.

An initial reading is used to advise the driver via the LED sign of his current speed and warn the driver if his speed exceeds by 6.2mph (10km/h). A second reading is taken approximately 328ft (100m) further along the road, and if the truck is exceeding the speed limit, a video signal is transmitted to the monitoring location for the action to be taken. The video signal includes date, time and vehicles' recorded speeds.

All of the equipment used in this project is powered by solar panels.

by **Larry Yermack**

Development of integrated traveler information systems has been going on for many years... and will continue into the future

I was recently at ITS America's annual meeting in San Jose, California, the heart of Silicon Valley. While ITS America has been to Detroit, the automotive capital, it was the first time that it was – appropriately – hosted in the technology capital.

We are at a time of convergence between government, automotive and consumer products that we could barely have imagined even a few years ago. As is my wont, I was musing about what we got right and what we got wrong as we grew the ITS business over the past several decades.

What first came to my mind was an experience I had at the first ITS America meeting in Reston, Virginia. It was a small gathering of a few hundred prescient souls at a shopping mall hotel in an edge city. One afternoon I was sitting on a couch with the late Tony Barber, who was responsible for tolling at the New York/New Jersey Port Authority. At the time, we were creating E-ZPass and making plans to promulgate a uniform toll collection scheme throughout the New York metropolitan area, but were struck by the lack of interest in this by the broader ITS community. Toll roads just got no respect then and were not seen as worthy of attention; the focus was almost entirely on the state Departments of Transportation (DOTs).

In retrospect, ITS missed the significance of payment systems, perhaps because the gas tax was still a viable funding source and perhaps because toll roads were not a part of federal funding. It has taken decades for USDOT to truly integrate tolling into its thinking, but at least with mobility on demand, has started to get there.

But we did get one really important thing right. We understood that the goal was to integrate traveler information from all sources into one easily digestible service. We could not have imagined the iPhone, which came along in 2007, but we did conceive of fax, pager and email push services. The key then and the key now is a fully integrated database that allows for journey planning and provides real-time conditions updates. Inherent in that was our faith that the customer would make the right choices to balance the system and the market does prove that.

> "ITS missed the significance of payment systems… gas tax was still viable"

The other thing that we got right was that government, automotive companies and consumer product companies would need to collaborate to make the system work. At first we had the automotive companies of the US. Then they declined and have since returned, as connected and automated vehicle advancements bring car technology to the forefront. Similarly, initially, consumer product companies were niche companies such as Garmin, and now they are Apple and Google.

We have indeed come a long way and it's quite clear that the best is yet to come.

Larry Yermack is strategic advisor to Cubic Transportation Systems, USA. ***lyermack@gmail.com***

Illustration: Ian Parratt, the-caricatureartist.co.uk

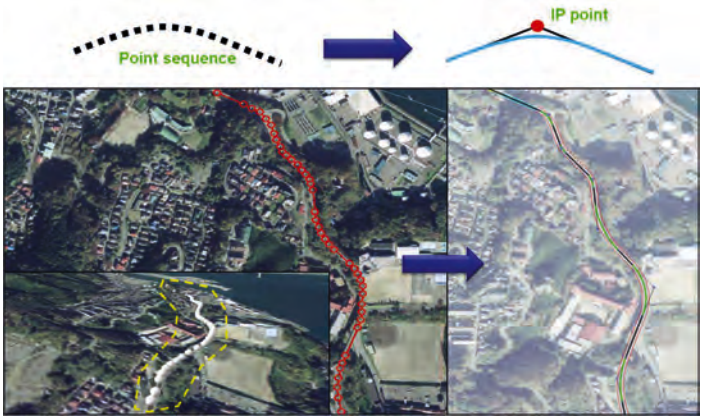
Constructing 'real' road networks in 3D VR

Forum8's premier software product VR-Design Studio (formerly known as UC-win/Road) was initially developed to enable transport engineers to produce interactive road networks in a 3D virtual reality (VR) space.

Although it is extremely quick and easy to produce a hypothetical highway system, a more complex approach is required to develop a real road network. However, this problem has now been solved in the latest version of the software.

Version 11 of VR-Design Studio includes a road alignment calculation feature, which enables users to automatically create a road by generating the horizontal or vertical curve that best fits all the available turning points.

These turning points can either be imported via a CSV file containing GPS trajectory information, or they can be manually inserted by following an aerial photograph of the road in question and adding mouse clicks as and when necessary.



Above: **Structure from motion (SFM) is a technique for generating point-cloud data from digital camera images**

Right: **A simulation from Version 11 of Forum8's VR-Design Studio**

Curve calculation

In previous versions of VR-Design Studio, roads were usually defined by first pasting orthophoto aerial images over the appropriate digital terrain model, then drawing the curves manually by entering turning points. In Version 11, however, road curves can be defined far more quickly and easily with the new curve calculation function. When the user imports information via GPS tracking, or simply clicks the mouse a few times, the road centre-line, horizontal and vertical curves are automatically generated, rather than the user having to input them manually when using software pre-Version 11.

Horizontal curves mostly consist of straight lines, arcs and transition curves, and are calculated using these elements. To calculate horizontal curves, the new curve calculation software function first searches for the straight lines and arcs before progressing any further. Once found, the software will calculate the transition curves that link the straight lines and circles together, or circles and circles (also known as clothoid) curves together, and connect to combine everything.

Vertical curve calculation is executed with similar logic to the horizontal equivalent. First the software searches for straight lines and arcs, then it calculates the turning points, and finally it adjusts the vertical curve line, so that it matches the point sets according to the road.

In addition to the new curve calculation function, VR-Design Studio Version 11 also offers users a number of additional features to assist in the rapid production of interactive 3D VR environments.

Open street map support

The new open street map (OSM) plug-in is a worldwide collaborative project that enables users to create free world maps. Anyone can join and edit the data to further refine its precision via the OSM website. OSM is an alternative to more expensive options such as Google Earth. This open and flexible data format is characterized by its composition consisting mostly of nodes and roads. Elements such as roads, tunnels, bridges and buildings can all be displayed correctly.

The OSM plug-in allows OSM data to be imported, which shortens the time it takes to create interactive 3D VR environments. Version 11 users can now import OSM files, which can be converted into VR-Design Studio data. Roads, lanes, tunnels and bridges are currently supported by the plug-in and the roads are complete with information such as their names, types and lane widths. Each of these elements is capable of being converted for further customization if and when required.

Need to know

Version 11 of VR-Design Studio includes additional features such as...

- Structure from motion (SFM): this enables the user to generate point-cloud data from photographs taken with a regular digital camera
- Improved rendering engine: the visualization of shadows has been improved, enabling higher speed rendering while maintaining quality. The visualization of ripples in lake water has also been improved along with a new sky-dome model
- Extended 3DS export: the coordinates of objects and many landscape settings can now be added into the exported XML files

Automated moveable crash barriers used for Singapore traffic control

Left: **Traffic Tech's VEVA3 automated moveable crash barrier**

Far left and left: **The old barrier system, which could be moved manually with a pickup truck, required staff to be on-site in hazardous conditions**

Need to know

The VEVA3 is an automated moveable crash barrier, designed to control traffic flow in either direction on busy highways

- Remote control of the VEVA3 is via a secure link, for reliable communication between the highway operator and the VEVA3
- An on-site video link enables the operator to control the VEVA3 while considering the traffic flow at the location
- Integrated LED lighting alerts drivers when the VEVA3 is moving

The use of contraflow lane reversal (CLR) in traffic management is increasing worldwide due to urban sprawl and increased traffic volumes on existing highways. In most road networks, there is not enough room for new highways to be built, or even to increase the number of lanes. Instead, engineers are turning their attention to CLR systems to better employ available traffic lanes.

CLR in action

Jurong Township Commission (JTC) and the Land Transport Authority (LTA) in Singapore have operated a CLR system on the Jurong Island Road Bridge for eight years, with great success. The normal lane configuration of four lanes in both directions can be changed to six lanes (toward Jurong Island) and two lanes in the opposite direction for five of the busiest hours in the morning peak. That's a 50% increase of usable traffic lanes for the morning peak period. The system can then be returned to its normal configuration in time for the afternoon flow.

There are many hazards associated with manually operating the barriers, including the number of personnel required on the highway to push the metal barrier with a pickup truck (pictured above).

Automated barrier solution

JTC wanted to find a method of moving the CLR barriers on the road bridge without putting work crews at risk.

Traffic Tech and Jansen Venneboer offered JTC a safer, smarter solution: the VEVA3 automated moveable crash barrier. The VEVA3 is a fully automated, remote controlled, crash rated barrier system that meets both European and Australian standards. It has been successfully introduced throughout Europe, with this installation in Singapore being the first such installation in the Australasia region.

Distributed throughout Asia, the USA and Australia by Traffic Tech, the VEVA3 is an ideal moveable barrier solution because it acts as a moveable traffic channelizer as well as a crash barrier.

This partnership is set to innovate and contribute to the ITS industry for years to come.

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Dramatic increase in the UK's use of SPECS enforcement cameras

Whether it was the recommendations of the UK government's Transport Select Committee, the findings of the RAC Foundation's recent research or the countless press articles, SPECS cameras (average-speed camera systems, originally manufactured by Speed Check Services Limited) have certainly made a strong impression on road users across the UK in 2016.

The first average-speed (or point to point) cameras were installed in Nottingham, UK, in 2000, and the growth in their use was relatively slow for the next decade. This was largely due to the high cost of the system and a general lack of understanding or appreciation of the benefits that average-speed control could deliver to monitored roads. However, over the past three years, the use of average-speed enforcement has increased dramatically. At the time of writing, Jenoptik has been contracted to deliver 100 permanent UK SPECS sites, mostly on routes where a significant casualty history hasn't been reduced by other interventions.

Why the increase?

Politically, there is now a greater understanding of the benefits of average-speed enforcement. These benefits are highlighted in a Transport Select Committee report, *Road Traffic Law Enforcement*, which was published in March 2016. The report suggests that, "Further deployment of average-speed cameras, which are generally better received by motorists than traditional fixed-speed cameras, should be considered."

Economically, the cost of a SPECS solution has steadily fallen, allowing a wider range of road types to be addressed more cost effectively. For example, the first generation of equipment required fiber-optic cable to run between each connected camera, which would often result in the greatest cost in the whole project. The latest generation of SPECS Vector cameras can now be delivered at a fraction of the cost of earlier systems, by using easier-to-install modules and public communications networks. As a result of the experience from delivering dozens of SPECS sites, the SPECS3 Vector – the newest average-speed camera available on the market – was developed around high-volume components that achieved UK Home Office Type Approval much more rapidly (in 2014).

Socially, there is now a greater acceptance of average-speed enforcement from the public. This was referred to in the Transport Select Committee's report, and has been backed up by a number of independent studies, such as that published by Transport Scotland, relating to the A9 route enforcement scheme – which uses SPECS cameras along 136 miles (220km) of road. Drivers also feel that there is a degree of discretion toward them; a speeding offense will not occur due to a momentary lapse of concentration because an average-speed violation requires a vehicle to speed consistently over a length of road, rather than at one isolated point in the view of a spot speed camera.

Advances in technology and design have contributed to the increase in average-speed

Need to know

Key reasons for the increase in use of average-speed cameras in the UK are as follows...

- Advances in average-speed enforcement technology
- A greater understanding of the benefits of average-speed enforcement
- SPECS systems being cheaper to install and maintain than ever before
- Greater public acceptance, which is backed up by research reports

Overcoming poor lighting conditions

Improvements to the technologies used in average-speed enforcement can make a big difference to how and where the system can be applied. For example, a unique feature of the SPECS3 Vector system is the synchronized Vector infrared (IR) scene illumination. Most ALPR cameras use dedicated IR illumination to read the license plate, but this alone is not sufficient to make a car visible on a dark road; additional illumination is needed. To capture good-quality images in poor lighting conditions, some average-speed camera systems require intense white lighting to be directed at the vehicle capture point. This may result in images that capture the vehicle make and model, but they can distract and dazzle drivers, cause light pollution on an otherwise dark road, and draw attention to the camera's location, which can reduce some of the benefit of average-speed control. In contrast, the Vector IR lighting uses invisible IR LEDs, which are synchronized with the camera to be extremely energy efficient, producing crisp and clear overview images that don't distract the driver. Dozens of UK sites currently benefit from this approach, including national parks, urban streets and unlit rural routes.

Above: **The Vector IR lighting feature uses invisible IR LEDs to provide enough lighting for a clear image of a vehicle to be captured, even when it is dark**

enforcement sites, with the number of new routes monitored by average-speed camera systems rising whenever a new type of SPECS camera is introduced. An example of this is the introduction of the SPECS3 Vector camera, which is the most recent average-speed system to come onto the market (in 2014) and also to receive UK Type Approval (2014).

Since then, more than 50 permanent sites have been contracted, which makes SPECS3 Vector the most widely used average-speed camera in the UK.

Another key element that has led to the uptake of SPECS cameras is the range of configuration and installation options available to users. A six-lane motorway, for example, differs from a city center urban street, or an inter-urban rural road. Not only are the speed limits likely to be different, but so too are the types of infrastructure present. To address these differences, SPECS3 Vector is available with a number of options, including: standard steel cantilever columns, suitable for high speed roads where there is a barrier; passively safe columns, in a range of configurations including tilt down; gantry mount brackets, operational at heights of up to 32ft (10m) for highway applications; and streetlighting brackets to affix to existing columns, using a highly distinctive SPECS design.

Remove and replace

As well as being added to new routes, SPECS enforcement cameras have also been used to replace obsolete enforcement technologies, both through the upgrade of the early SPECS systems and the replacement of spot speed cameras. More than 20 SPECS sites have involved the replacement of 'wet film' (as opposed to digital) spot speed cameras, many of which had been in place for almost 20 years.

In cases where spot speed cameras are replaced with a SPEC system, traffic flows are seen to be smoother, without the sudden braking or the 'halo effect' associated with spot speed cameras.

The future looks bright for average-speed enforcement, with no lessening in the number of planned and proposed sites. Thanks to SPECS technology advances, operational experience and intelligent application, more and more roads are now safer and flowing better.

Transport modes in Melbourne to be optimized with NCMT initiative

The National Connected Multi-modal Transport (NCMT) initiative is a collaboration that aims to demonstrate how different modes of transport can be optimized by using real-time data from vehicles and infrastructure, so that transport infrastructure can be used more efficiently and can react to incidents in real time.

NCMT is a collaboration between a number of organizations including the Australian state of Victoria's road agency, VicRoads, telecommunications company Telstra, the University of Melbourne, and software and solutions company PTV Group.

Melbourne is becoming a better connected city

Building the testbed

The NCMT testbed consists of the university's installation of state-of-the-art sensors around the Hoddle Street area, on the eastern fringe of Melbourne's central business district (CBD), and onto high-mileage vehicles such as trucks and buses.

The data is collected and analyzed using PTV Group software: PTV Visum and PTV Vissim. The software constantly models road users and their interactions, and is now a recognized standard tool in transport planning to model networks and travel demands, predicting traffic flows and public transit demands, and developing advanced strategies and solutions.

"There is a wide range of uses for the data produced," explains David Ng, managing director of the Australian subsidiary of PTV Group. "Public transit operators can optimize routes and timings, and logistics companies can ensure their deliveries use the most efficient route and schedule. "This will help organizations to optimize their fleets, and that will improve traffic flow throughout the city. Also, through lower fuel consumption and less idling in traffic jams, city center emissions will be reduced", he adds.

Real-time benefits

Because the system works in real time, transport planners, including operators in traffic control centers, will be able to react quickly and intelligently to unplanned incidents on the roads. In mitigating the effect of an incident, they can model a number of scenarios and choose the most efficient response.

There is a lot of potential in this NCMT testbed, which can bring benefits to stakeholders involved in the network, including pedestrians, cyclists, drivers, and organizations who transport goods.

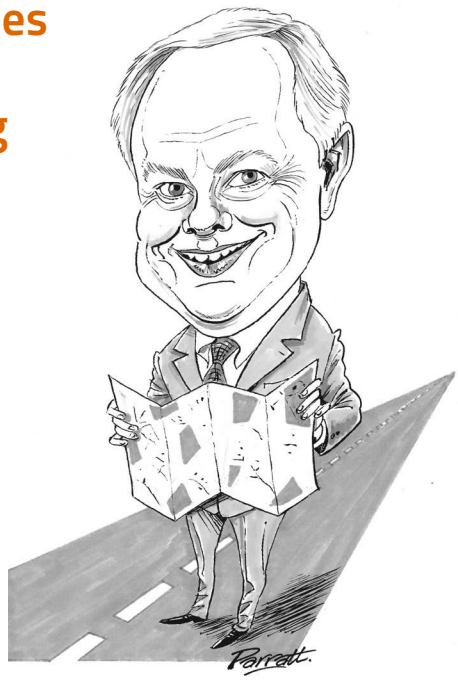
"This testbed is Australia's first project of this nature," continues Ng. "It is innovative because so many collaborators are working together on it.

Another key factor of the pilot is testing how quickly the solution can be implemented. So far, signs are pointing toward the initiative having a relatively short timescale, which suggests that this is not another of many projects that promise much but take so many years to deliver results that by the time they go from theory to practice, technology and the city's transport needs have moved on.

"With industry experts from across the world arriving in Melbourne, it's the right time to get engaged and have a significant impact on future technology," adds Miller Crockart, PTV's vice president of traffic global sales and marketing. "The City of Melbourne and the University of Melbourne are currently involved in different projects to show the world that Melbourne is prepared for the future of transport."

by **Don Hunt**

Transportation authorities need to move quickly to take advantage of big data opportunities



"The industry leads the way, with public transit authorities challenged to keep up"

As we approach the ITS World Congress in Melbourne, it's interesting to think about some of the issues that need strong transportation authority leadership to keep the promise of tech-enabled mobility moving forward.

Firstly, connected cars and big data analytics already offer great benefits with existing technology, and transportation authorities need to move more quickly to take advantage of these opportunities. Melbourne is the home of one of the most advanced managed highways, VicRoads' 62 mile (100km) system centered around the M1 Freeway. While active traffic management has been applied elsewhere in the world, no agency is more committed than VicRoads to using analytics and operational intervention to improve system throughput and safety. Especially interesting is VicRoads' coordinated ramp signals system that balances highway access and mainline flow. Owners and operators of highway systems throughout the world would be well served to see first-hand the operations of the VicRoads-managed highway system. In the USA, at least two state transportation authorities are working with VicRoads to transfer the technology – Colorado DOT on I-25 and Utah DOT on I-15.

Secondly, the world of automated and connected mobility is moving at a pace that is difficult to comprehend. Industry continues to lead the way, with public transit authorities challenged to keep up. With auto makers (as well as tech and ride-share companies) in the USA, Europe, Japan and China making advances at a rapid pace, it continues to be difficult for transportation authorities to deal with this inevitable mobility earthquake.

From a vehicle automation perspective, how can governments maintain safety during product roll-outs, while still allowing the industry elbow room for innovation? Is it reasonable to continue to accept Level 2 and Level 3 systems (where the driver must be ready to resume control) in all roadway situations? Recent events have shown that Level 2 and 3 systems with self-steering can be misused in a surface street environment. Perhaps it's time for countries to agree about the gray area of intermediate vehicle automation, especially levels of automation that lead drivers to be alternately attentive and inattentive. Limiting Level 2 and 3 vehicles to controlled access freeways might be a positive government decision right now.

Another question that would benefit from frank discussion: What is the future of DSRC connectivity, especially V2I? Auto makers continue to address connectivity with cellular technology, and few have shown great interest in DSRC. And on the transportation authority side, the implementation and operation of a DSRC backhaul system has always been a cost barrier. Meanwhile, cellular technology continues to advance, and data transmission security for critical, real-time vehicle response remains unsolved. While some policy agencies continue to promote DSRC connectivity, especially the USDOT, perhaps the time has come to better sort out what can be accomplished with cellular connectivity and what remains the role of DSRC. Transportation authorities can ill afford to begin the build-out of an expensive connected vehicle data communication system if cellular will do most of the job.

Don Hunt is a transportation consultant and former director of Colorado DOT ***dhunt@anteronet.com***

Illustration: Ian Parratt, the-caricatureartist.co.uk

Need to know

PTV Group provides software and consulting for traffic, transportation logistics and geomarketing

- The testbed area will see state-of-the-art sensors installed around the Hoddle Street area, on the eastern fringe of Melbourne's CBD, and on high-mileage vehicles such as trucks and buses
- PTV's Visum and Vissim modeling software supports analysis of the collected data
- The analyses will be used to plan and predict transport, traffic flows and public transit demands, and to develop advanced strategies and solutions, which will ultimately lead to transportation and infrastructure being utilized more efficiently

NCMT: future vision

Although this NCMT trial begins in one defined area of Melbourne, ultimately, the vision is to integrate it across Australia to best manage the transportation requirements of a country with diverse transport challenges, from very busy, congested city centers to long-distance logistics operations.

Best practices for effective traffic enforcement

With automotive technologies advancing so quickly, it can be difficult for authorities to find an effective traffic enforcement system – and issues surrounding the protection of road users' privacy add to the challenge.

What makes a traffic enforcement system an effective one, and what tools should you be looking for when choosing one to suit your authority's needs? How can you implement a good system that respects others' privacy, and what can you do to ensure that it can keep up with the pace of developing automotive technologies?

Bruce Gurfein, vice president of marketing at RoadMetric, shares his insights and answers these questions…

Collect all data

No single source of data is adequate in today's world of traffic enforcement. For example, fixed spot speed cameras, which started off as the go-to tool for enforcement, have gradually become a less effective option, because motorists are now able to locate them using their GPS systems, and slow down – at risk of causing harm to themselves or other road users – as they approach the device, to avoid being caught driving at speeds exceeding the limit. Additionally, drivers continue to argue that citations from this type of enforcement device are unfair and ineffective.

Instead of limiting enforcement technology to a single data-collection tool, traffic authorities can use an open platform that will allow them to expand their data-collection capabilities. An open platform can support a variety of tools – from in-car mobile video with ALPR capabilities, to Doppler radar – and can help the user to develop a more complete picture of what's really happening on your streets. This kind of enhanced technology also has the advantage of being able to monitor traffic anywhere, at any time.

Additionally, rather than settling for data collection alone, traffic authorities should invest in smart data-processing systems to help them get the most out of their collection tools and efficiently use data from a number of sources.

Interoperability

Just as it's not enough to collect data from one source, it's also not enough to jury-rig a system by tying different data-collection programs and platforms together. Interoperability is the key to effective enforcement. Blending data from multiple sources can be done effectively using an open platform, which can link a number of systems and is flexible enough to expand, grow and integrate data according to the user's needs, while avoiding redundancy.

Traffic experts are calling on enforcement agencies to take a closer look at their systems to see what serves them best. They also recommend an approach that relies both on driver engagement and effective interactions between technologies.

Accessing and blending data from different sources through an integrated system enables the user to create a more effective traffic enforcement system that is greater as a whole than the sum of its parts.

Choose the right metric

The right metrics are important and choosing the correct ones is a matter of budget, manpower and safety priorities.

The right metrics will help traffic authorities to understand which areas need more monitoring and what kind of data-gathering tools will be most effective. For instance, if some neighborhoods are more prone to crime, then authorities could invest in streaming technology that keeps patrol vehicles in constant contact with the central command; if some intersections are more prone to accidents and/or speeding violations than others, the authorities could consider a

Far left: **A screen view of RoadMetric's back office solution**

Left: **RoadMetric's Enforcement Deputy mobile ALPR system**

mobile average-speed detector as well.

Understanding these metrics and how to measure them can help authorities to operate and improve the safety of their roads more efficiently and in a more cost-effective way.

Keep it dynamic

Authorities should aim to choose technology that refreshes itself. The most effective enforcement systems use real-time data to refresh themselves and grow with authorities' needs for them.

For example, mobile analytics can integrate gathered data, which can improve traffic enforcement in the field. Processing is the key, and authorities should be sure to have a system that can collect, process and transmit data on the go.

Regular updates will improve the system's ability to track, respond to and improve the user's traffic enforcement capabilities.

Look to the future

A US National Highway Traffic Safety Administration official recently said that although there's not enough data in vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) transmissions to link speeding to individual motorists today, it is indeed possible – and it is likely to happen soon. After all, even self-driving vehicles are not yet immune from accidents caused by human error.

Traffic enforcement agencies need to stay vigilant and take notice of new innovations that could help them adapt their systems to overcome the challenges faced by older technologies.

Have the driver in mind

It may not be possible to guarantee the complete privacy of drivers when gathering traffic data. But if authorities do fall short of the ideal, it should be remembered that even those who advocate the use of vehicular transponders to protect driver privacy and see cameras as a threat, still acknowledge that drivers will have to compromise their privacy to some extent (as shown in a study by *Proceedings. 2005 IEEE Intelligent Transportation Systems*). Additionally, other studies have shown that while drivers cherish their privacy, on the whole, they are grateful that measures are taken to keep their roads safe. The use of mobile cameras and mobile ALPR can go a long way in assuring drivers that traffic enforcement officers are working in their best interests.

Need to know

RoadMetric develops smart in-car video and communications systems for real-time collection of traffic enforcement data

- The Public Lane Enforcement System (PLES) offers an efficient alternative to fixed camera installations that provide limited enforcement for public transportation lanes
- The Enforcement Deputy mobile ALPR event recording tool enables authorities to gather video data that can be used as evidence in court
- RoadMetric also offers event processing and violation detection back-end solutions

Turning VMS gantries into traffic measurement points

A key part of traffic management includes maximizing throughput during peak hours when traffic volumes are highest.

The maximum throughput of a single lane is between 1,500 and 2,500 vehicles per hour. The speeds at which this throughput can be achieved are between 49mph (80km/h) and 62mph (100km/h). Achieving optimal throughput is a fine balancing act – a single car slowing down, for example, to allow a motorist in front of it to enter the lane, can cause a phantom traffic jam.

For most highways, the speed limit is between 68mph (110km/h) and 80mph (130km/h). Others do not have a speed limit at all. When traffic is moving at a high speed, the maximum volume is substantially lower.

The most common way for traffic management systems to maximize throughput is to measure the volume and speed of traffic at frequent locations along a highway. When the volume reaches a certain threshold at a given site, the maximum speed at preceding sections can be lowered to 62mph (100km/h) or less to avoid the onset of a phantom queue. Motorists can be informed about the speed limit via variable message signs on gantries above the highway.

Some highways around city centers have numerous gantries with variable messaging signs (VMS) to relay feedback to motorists, allowing authorities to inform them about speed limits, lane closures and other vital traffic information. These gantries also serve as perfect mounting locations for overhead traffic detectors to obtain accurate traffic data from individual lanes.

ADEC Technologies offers overhead detectors, such as the triple-technology detector (TDC3), which features multiple sensing technologies to acquire highly accurate traffic data.

Image: QSG Verkehrstechnik

Overhead detectors can be neatly mounted right above the lane for maximum accuracy

Need to know

The triple-technology detector (TDC3) uses three sensing technologies to ensure accurate data is acquired

- The detectors use radar to identify each vehicle's exact speed
- A proven ultrasonic sensor scans the vehicle's height profile and determines each vehicle's class
- A passive infrared sensor (PIR sensor) assesses the exact position of vehicles in lanes
- Specifically designed to be fitted onto overhead gantries

Accurate data acquisition

The benefits of mounting detectors on overhead gantries include not having to damage the pavement to insert alternative detectors such as inductive loops; easily accommodating shifted lanes due to construction; accurate traffic data acquisition, even when mounted inside tunnels and immediate detection of queues and vehicles traveling in the wrong direction.

One version of ADEC's overhead detector provides configurable trigger output to tie into third-party equipment, such as ALPR cameras, while another version integrates a quarter video graphics array (QVGA) snapshot camera to automatically capture images of irregular traffic conditions (such as cars moving in the wrong direction), to visually verify and reduce response times for law enforcement teams.

Like most VMS, all of ADEC Technologies's TDC detectors are compatible with the protocols defined by the German TLS (Technische Lieferbedingungen für Streckenstationen) standard.

The detectors are available in several versions, depending on the mounting location (in front of or behind the gantry) and the number of distinct vehicle classes they can differentiate.

Vehicle classification data is welcome information for road operators and can be used, for example, to obtain statistical information about the composition of vehicle classes or to adjust speed limits, not only for the overall traffic volume but for specific vehicles to minimize the environmental impact.

TDC3 detectors for classifying vehicles into the common TLS 8+1 classification scheme deliver accuracy of 85-99.9%, which has been independently verified. Special versions of TDC3 detectors are also available to retrofit older installations from previous generations of overhead double- and triple-technology detectors from other manufacturers.

Every day thousands of TDC3 overhead detectors help to maximize traffic throughput and minimize delays from phantom traffic jams and other disturbances by delivering up-to-date, reliable and accurate traffic data at all times.

WIM sensors for low- and high-speed applications

Forty years of weigh-in-motion (WIM) history has seen growth in a variety of different applications, and in turn, the development of the devices needed to serve them.

With these developments in WIM technology, the specialization of sensors and scales for particular applications has become more prevalent. Low-speed WIM (LS-WIM), medium-speed WIM (MS-WIM) and high-speed WIM (HS-WIM) are commonly accepted categories, with equipment achieving ever-increasing accuracy for each respective speed group. LS-WIM and static scales serve their purpose in enforcement, and MS-WIM and HS-WIM scales are used in pre-selection for enforcement, bridge protection, tolling and data collection.

Advances in strain gauge WIM technology have shifted the requirement for changing scales or sensors for different applications, enabling various applications, and indeed speeds, to be served by a single technology.

Intercomp's strain gauge strip sensor is employed for applications that involve a wide range of speeds. Installed in 3in-wide (75mm) channels cut into the pavement, the WIM sensor operates at vehicle speeds ranging from 2-80mph (3-130km/h).

High-speed WIM

Data collection for pavement design and maintenance was one of the first uses of WIM technology, and continues to be an important tool for today's roadway planners. Typically done at high speeds, axle weights, gross vehicle weights (GVW) and vehicle classifications are gathered by a single pair of strip sensors. As technology has progressed, COST 323 B(10) and ASTM E1318 Type I accuracies are easily achieved, to supply quality data to authorities. A loop for vehicle detection, the central processing unit (CPU), and electronics for storage or transfer of the information complete a simple data collection system.

An Intercomp strip sensor installed in the pavement

Need to know

The latest strip sensor technology makes strips suitable for use in a wide range of WIM applications

- Intercomp's versatile strip sensor operates at vehicle speeds from 2-80mph (3-130km/h)
- They can perform with less than 5% error when operating in low- and high-speed applications
- When operating at higher speeds, the strip sensors are able to obtain axle weights, gross vehicle weights and vehicle classification information, as well as detecting both left and right wheels from each axle

As WIM technology continues to progress to greater accuracy at higher speeds, users have become less reliant on MS-WIM applications to achieve required accuracy levels. Pre-selection for weight enforcement and bridge protection is now done largely at highway speeds. Even in locations where sensors experience lower speeds due to the WIM site location, or changes in vehicle traffic, the same strip sensor platform is capable of being used for variable speed ranges.

Intercomp regularly supplies four strip sensor configurations for these applications. Achieving COST 323 B(7) or better, the sensors are deployed in two rows of two sensors each. With sensors detecting both left and right wheels from each axle, wheel loads are tabulated in addition to the axle load and GVW, providing even more information for the operator.

More recently, it has been possible for direct enforcement to be explored due to the steady improvement of WIM systems' accuracy. At highway speeds, a six-sensor configuration in three rows yields better than COST A(5) or ASTM E1318 Type III performance. Either four- or six-sensor configurations are coupled with ALPR and scene view cameras to add WIM capabilities to systems conducting real-time registration, permit and weight-based enforcement of commercial vehicles.

Low-speed WIM

Although strain gauge load cell axle scales for LS-WIM continue to provide high accuracies at low speeds, Intercomp strip sensors are deployed for low-speed applications as well. Electronic toll collection (ETC) and other low-speed applications demand a high degree of accuracy, and when deployed in configurations ranging from four sensors (two pairs) to eight sensors (four pairs), performance with less than 5% error is achieved.

Building on the proven performance of strain gauge sensor technology, WIM strip sensors offer a straightforward sensor platform for a range of uses. Access to a single sensor that has the capability to operate over a range of conditions such as speed, temperature and applications gives site planners a valuable option for integrating it into WIM systems.

Express lanes

Your shortcuts to some of the big stories in this issue – and beyond!

"Hydro-demolition is an innovative technique that uses water at high pressure to remove the top 2-3in of concrete. It saves time and money"

Oanh Le Spradlin, project manager, Utah DOT

Efficient workzones improve safety and traffic flow. Watch the video here: trafficTechnologyToday.com/hydro

"Through constant monitoring, and preventative and responsive maintenance, we have reduced costs and maintained availability for 3,000 ITS devices"

Mark Demidovich, assistant state traffic engineer, Georgia DOT

Page 13

"We have several districts that are using a 3D laser scanner… the technology is a viable solution for construction and surveying projects"

Ryan Culton, research implementation manager, Illinois DOT

Find out more about how IDOT is using 3D laser scanners in the field by watching our video report here: trafficTechnologyToday.com/idotscan

Page 16

"Average-speed camera systems have proved very effective at achieving compliance and generating a low number of tickets"

Stewart Leggett, head of network operations, Transport Scotland

Index to Advertisers

Weight monitoring on bridges and motorways

Weigh-In-Motion with WIM-DSP 32

WIM-DSP 32 is a Weigh-In-Motion system for up to 8 lanes. It accurately determines the distance between axles to ±1 cm and speeds in the range from 10 km/h to 120 km/h to ±1 %. It is capable of weighing vehicles with up to 18 axles while on the move. The results can be saved locally and the weight displayed lane-by-lane on Variable Message Signs (VMS). The data can also be signed and transmitted to a central control room.

A certificate of conformity in compliance with OIML R 134 is in progress. This will enable WIM-DSP 32 to be calibrated and used independently to provide photographic documentation for prosecuting instances of overloading.

Traffic Data Systems
Innovative Technologies

www.traffic-data-systems.com

Traffic Law Enforcement | Police & Security ANPR | Traffic Data Management | Traffic Safety Services

Improving roads, journeys and communities with Traffic Law Enforcement.

SHARING EXCELLENCE

The international solution provider for global traffic safety, Jenoptik, handles thousands of traffic enforcement cameras in operation. Deterring drivers from illegal behaviors and capturing evidence that allows road authorities and the Police to secure prosecutions.

Jenoptik is a world leading supplier of enforcement technology, with solutions to address every conceivable traffic enforcement requirement.

Offering a complete range of enforcement technologies that can be used to identify and process traffic offences, including; spot speed, average speed (P2P or section control), red light, speed on green and many more. Key to our capabilities is the wide range of sensor technologies available to us, including radar, laser, in-road loops and video triggering. This unique range allows us to configure standard, proven modules to create a customer specific, 'fit for purpose' solution.

Facts & Figures

- 30,000 systems delivered
- Operating in over 80 countries
- 480 staff working on traffic solutions
- 130 governmental approvals

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