February/March 2017

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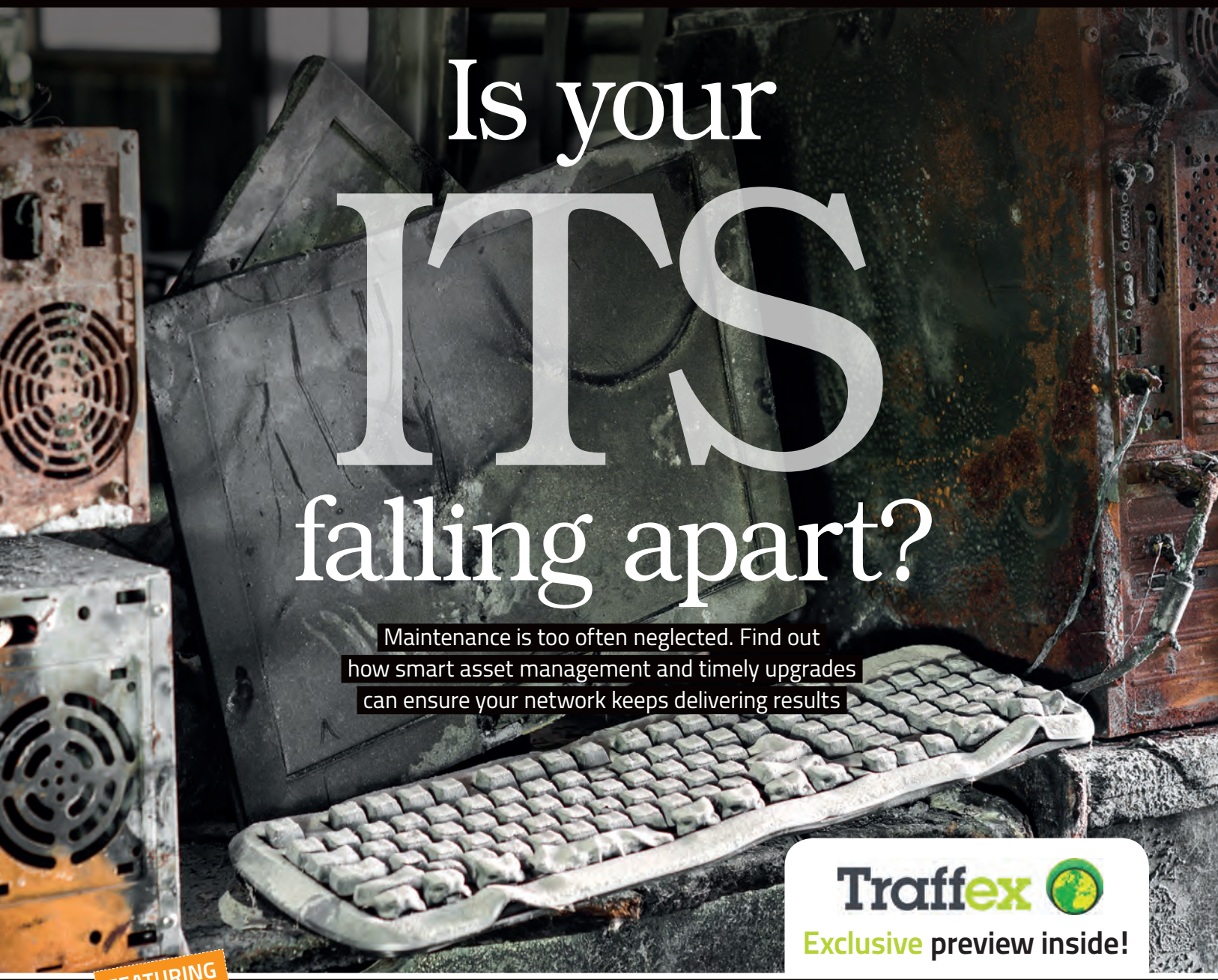

Is your ITS falling apart?

Maintenance is too often neglected. Find out how smart asset management and timely upgrades can ensure your network keeps delivering results

Traffex
Exclusive preview inside!

FEATURING

comtrans
Your essential guide to the future of transportation communications

Reversible express lanes
How connected vehicle technology is being trialled in Florida to make an unusual stretch of road safer

New V2X standards
As real-world deployment of V2X gathers pace, a new collaboration is focused on setting standards

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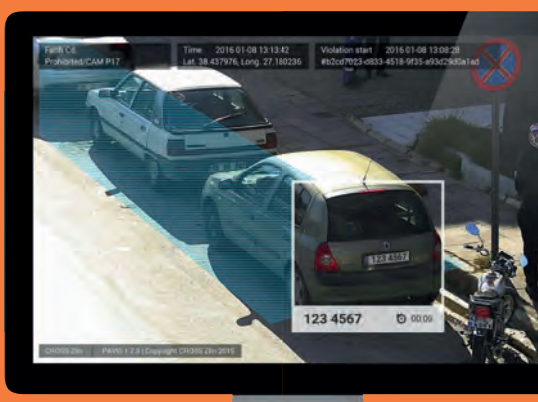

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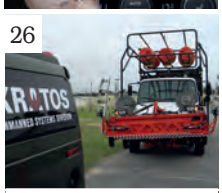
Cover story

40 Is your ITS falling apart?

Network maintenance can be done without breaking your budget

Smart asset management by road authorities is maximizing product life. Max Glaskin reports



Technology Profiles

Editor's letter

These days it seems everyone is talking about the future of transportation, and now *Traffic Technology International* is one of the brands behind a conference dedicated to this very subject. It's taking place in Cologne, Germany, July 5-6, and you can find out more and how to book your place on page 10.

Such conferences attract the best engineers and academics in the world, but they no longer feel like niche events: the subject has become so talked about online, on television and in newspapers, that gatherings of this type are almost mainstream. But why has transportation captured the public imagination so successfully of late?

A large part of the answer lies in the subject of driverless cars. It's a concept so easy to understand that even my four-year-old daughter was able to see potential benefits. "One day cars might be able to drive themselves," I told her one afternoon as we drove home. She thought for a moment before replying, "That's good. Then you'll be able to play more games with me." Or perhaps in the future busy parents might prefer to pretend they're driving in order to get a bit of a break!

But the disruption is likely to go much deeper than a few extra rounds of Scrabble Junior. Road safety, car ownership, traffic management, communications and even the future of roads themselves are up for grabs. It feels as if a revolution is underway, and if it's anything like the last revolution in transportation, which began with the invention of the car, the world will look very different once it's done.

In this issue we look in detail at some very specific parts of this ongoing and accelerating era of change. On page 18 we investigate the challenges of keeping up with the growing number of smart parking technologies. On page 50 there's our third and final installment of our in-depth report into USDOT Connected Vehicle Pilot Deployment, which takes a look at how V2X technology is being used to make reversible express lanes safer in Florida. And of course, don't miss our cover story. Turn to page 40 to find out why embracing change isn't all about rushing to buy the latest technology – adequate maintenance is essential.

But quite apart from new technology, or even maintenance contracts, one of the most important ways to head off unintended consequences of rapid change is industry debate. Closer at hand than this summer's Cologne gathering is Traffex, one of Europe's largest transportation expos, taking place in Birmingham, UK, April 4-6. The *Traffic Technology International* team will be there to meet our readers, find out about the latest products and hear from expert speakers, including Richard Hayes, CEO of the Institute of Highway Engineers, who I spoke to as he prepared for the event. Read my interview with him in our Traffex preview starting on page 12. See you in Birmingham!

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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. 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$104/£80
USPS Periodicals Registered Number **012-893**

ISSN 1356-9252 (Print)
ISSN 2397-5970 (Online)
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Printed by William Gibbons, Willenhall, West Midlands, WV13 3XT, UK

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Fish inspire jam-beating technology

Honda is using V2V technology that emulates the movements of a shoal of fish to limit phantom traffic jams and reduce accidents, as **Graham Heeps** discovers

We've all seen how drivers rarely work together to reduce unnecessary highway congestion, leaving insufficient space for vehicles to merge smoothly, or creating concertina effects by reacting later than they should to a hazard further ahead.

Now Honda believes the answer to the problem could lie in nature, and is seeking to emulate the seamless, collision-free movement patterns of fish in order to create smoother flows of traffic and to eliminate accidents.

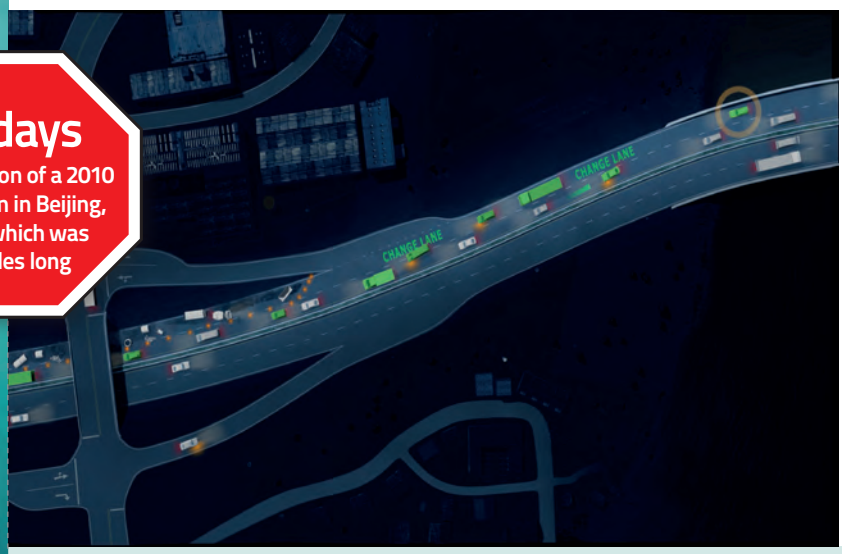
At the 2017 Consumer Electronics Show (CES) in Las Vegas, Nevada, the company presented the Safe Swarm concept to the public for the first time, and used video demonstrations to show how it might improve traffic flow as vehicles merge or change lanes, and inform the driver of hazards ahead to prevent phantom traffic jams.

"The basic concept is to make traffic flow like a shoal of fish," says principal engineer Shige Saigusa, who has spent five years developing the system since moving to Honda R&D Americas' Detroit office, which is leading the company's V2X work. "The question is how to achieve that. Safe Swarm uses DSRC [dedicated short-range communication] for wireless car-to-car communication and we have developed some unique algorithms.

"It's not just a question of understanding the current traffic conditions, it's about predicting the traffic ahead based on the movement of other vehicles," Saigusa continues. "For example, if three cars ahead make a lane change at the same time and location, it can be predicted that there may be a hazard on the road. The

Right: **Vehicles further along the road can inform following vehicles of the need to slow down in advance**

12 days
The duration of a 2010 traffic jam in Beijing, China, which was 62 miles long



> As humans we can look further ahead and gauge what's going to happen, whereas with autonomous vehicles the decisions are more limited – if something happens, slow down, if not, continue. But it's rarely that simple
>
> *Shige Saigusa, principal engineer, Honda R&D Americas*

Above: **Inspiration for Safe Swarm came from how a shoal of fish is able to move in sync**

Top right: **Safe Swarm can also advise lane changes far in advance of an incident in order to keep traffic flowing**

driver can be informed and can react early, for example by braking sooner or making a lane change. That kind of behavior can avoid unnecessary congestion."

The driver in this case could be human or semi-autonomous: Honda envisages Safe Swarm operating in scenarios up to Level 4 automation, with Saigusa believing it would help blend early autonomous vehicles into conventional traffic. "If you put a prototype autonomous car into an expressway today, it would create some problems," he assesses.

"The embedded sensors are looking only in the immediate vicinity. As humans we can look further ahead and gauge what's going to happen, whereas with autonomous vehicles the decisions are more limited – if something happens, slow down, if not, continue. But it's rarely that simple."

Safe Swarm is at an early development stage. Honda has tested a fleet of prototype cars on the proving ground and the next step will involve field testing on public roads, although no date or location has been published.

"Honda is part of the Columbus Smart City initiative," notes Saigusa. "Testing this application in a Smart City would be ideal because the DSRC infrastructure will be installed. But we're open to everyone. If other auto makers or suppliers want to join us for large-scale testing then let's do it together. I hope our presence at CES will trigger some collaboration."

Needless to say, Safe Swarm would only have meaningful benefit in a production context if DSRC became a universal standard for V2V communications. As Saigusa acknowledges, that's a big 'if', with the first DSRC-equipped vehicles only now trickling onto the market. However, he believes that unless latency issues with cellular communications in safety-critical V2X applications are solved, DSRC could retain an efficiency advantage.

"It makes sense for there to be a combination of both in the future," he sums up.

"DSRC has a range limitation and if you want to see beyond that, maybe cellular can help. If you have both, you can provide smoother driver assistance."

Midland mobility

Birmingham, UK, home to April's Traffex 2017 expo, is served by advanced transportation infrastructure

Infographics: Andrew Locke

Birmingham links five motorways (M1, M5, M6, M40 and M42)

7% of the population are home workers 8% have no fixed workplace

Birmingham had 37.2 million visitors in 2016

SOURCES
Office of National Statistics
Department for Transport
British Gas
Birmingham.gov.uk
Birminghamtoolkit.com

Aston University was involved in the UK's largest electric vehicle trial

Birmingham is the youngest city in Europe, with under 25s accounting for nearly 40% of its population

84% of the public transport journeys in the West Midlands are by bus

The city's transport connections put more than 90% of the UK market within a four-hour journey

New Street is the busiest interchange station in the UK, with a train leaving every 37 seconds

There are 25,000 car parking spaces in the city center alone

Commuters into Birmingham 166,272
Commuters out of Birmingham 101,467
Net 64,805

Birmingham was the first place in the UK to have a hydrogen filling point for cars

Birmingham has the highest number of uninsured drivers in the UK

The city has **2,000** miles of road

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Road gems

A new type of intelligent road marking actively guides drivers around complex junctions, improving safety. **Rachelle Harry** reports on a world-first test deployment of the technology and finds out why it is now winning awards

Above: **The A720 Sheriffhall roundabout in Edinburgh, Scotland**

> “Benefits are strong and ‘after’ casualty rates are less than half those previously recorded. There is good scope for the studs to be applied in other locations where similar problems occur
>
> *Judges of the Chartered Institution of Highways & Transportation’s John Smart Road Safety Award*

In 2014, intelligent road studs, a new type of intelligent road marking, were installed to safely guide drivers on the complex, busy, six-arm A720 Sheriffhall roundabout in Edinburgh, Scotland, which handles up to 42,000 vehicles per day.

The project improved the roundabout’s safety, and in 2016 the scheme won four awards, including the Chartered Institution of Highways & Transportation (CIHT) John Smart Road Safety Award, and the Excellence in Technology and Innovation Award at the 14th annual Scottish Transport Awards.

Prior to the studs’ installation, navigating the roundabout, which had spiral road markings and was controlled by traffic signals, was challenging and confusing for drivers. Between 1993 and 2013, some 65 injuries were recorded. The aim of the scheme was to reduce the number of lane changes and lane transgressions at the roundabout, thereby reducing conflicts and collision risk, particularly during the busiest periods in daylight hours.

Right: **IRS2 hardwired intelligent road studs minimize hazard risks when embedded in a road surface**

Road maintenance service provider Bear Scotland and ITS provider Clearview Intelligence collaborated to produce IRS2 hardwired intelligent road studs as an active road marking solution for Sheriffhall – the first of its kind to be installed in the world.

The studs work in a simple way: when a traffic signal at the roundabout turns green, the road studs illuminate to guide drivers into the appropriate lane. The stud lights turn off when the traffic signal turns red and studs for other arms of the roundabout remain off until the traffic signal for their lanes turns green.

The studs are available with red, amber, green or white LEDs, and can be programmed to display solid or flashing lights.

Since their installation at Sheriffhall, the road studs have had a notable impact on the roundabout’s safety. Research conducted by the Transport Research Institute at Edinburgh Napier University in 2015 showed a reduction in lane transgressions of up to 60% and driver behavior is now more consistent and predictable.

IRS2 studs are now used in other UK applications, including in an award-winning project on the A41 north of the town of Telford in the West Midlands, in combination with VMS and solar-powered studs. The studs are also used to delineate lane divisions in normal or in contraflow mode in the Hindhead Tunnel on the UK’s A3 London-Portsmouth road.

Judges of the 2016 CIHT John Smart Road Safety Award commented: “The panel was impressed by this solution to poor lane discipline on a large six-arm roundabout. Benefits are strong and ‘after’ casualty rates are less than half those previously recorded. There is good scope for the studs to be applied in other locations where similar problems occur.”

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Traffex
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Traffex 2017 **Preview**

As chief executive of the Institute of Highway Engineers, **Richard Hayes** is a man with his finger on the pulse of road transportation. Here he sets out his vision for the future, as he prepares for Traffex 2017

Interviewed by Tom Stone

> If you're going to have autonomous vehicles relying on road markings and traffic signs, they have to be kept at a reasonably good specification

Every two years, for three days in April, Birmingham, UK, becomes the main focus for Europe's transportation professionals. That's because Traffex, Europe's largest dedicated road, traffic, parking and transportation event, comes to town. One of the main halls at the National Exhibition Centre will be packed with more than 350 exhibitors showing off some of the latest technological innovations in the field. And, though the exhibition hall is still the main focus for most visitors, technical and policy sessions, hosted by leading lights from the industry, are a growing major attraction. With that in mind, this year organizers have added an additional area for these sessions to take place – the Highways and Transport Theatre, which, alongside the Traffex Theatre, will keep delegates busy and informed throughout the event.

Key speaker

Richard Hayes, chief executive of the UK's Institute of Highway Engineers (IHE) will be appearing on both stages. On Thursday, April 6 he will begin proceedings in the Highways and Transport Theatre with a 10:30am presentation looking at the implications of new codes of practice on asset management. For more details on this, turn to *Is Your ITS Falling Apart?* on page 40.

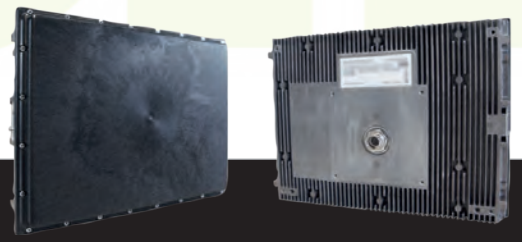
Before that, on Tuesday, April 4 at 4:00pm, Hayes will be part of the presentation team

for Making The Network Work in the Traffex Theatre. This session will examine a year's worth of work by the Road Safety Markings Association (RSMA) into the many important aspects that join together to help make the network function correctly. "We'll focus on the development of operatives and supervisors to professionalize their work," says Hayes.

TTI caught up with Hayes as he was making plans for Traffex, to discuss the event and also to chat about the role the IHE plays in the industry.

"Our members include traffic signal professionals, sign designers, management and those who repair and maintain the network structures," explains Hayes.

EXHIBITION HIGHLIGHT



Advanced radar technology

Smart Microwave Systems is an expert radar technology company based in Germany. Its traffic sensors, which will be showcased at Traffex 2017, feature the most advanced 3D, HD object-tracking radar technology on the market.

The product portfolio covers intersection applications (stop bar and advance detection), road-traffic management applications (counting and classification) and enforcement applications (speed and red light).

Many partners, municipalities and customers worldwide put their faith in its unique front-firing technology.

In 2016 SMS sold more than 5,000 radars just for traffic management purposes.

Traffex | SMS Stand No. **H50**

EXHIBITION HIGHLIGHT

Laser guided

Truvelo has all the angles covered with its UK Home Office type-approved speed measurement devices.

Among the hardware on display will be the user-friendly ProLaser 4 handheld laser, with features such as low power consumption (from AA batteries), bright OLED display and a countdown timer.

The LASERwitness Lite digital video mobile speed enforcement camera with TRIMMS infrared floodlamps will also be showcased. It has a range of preset exposure modes for day and night-time operation and three speed settings.

Visitors should also look out for Truvelo's D-CAM digital speed and red light camera, offering front and rear photography and simultaneous live enforcement in both directions with one camera.

New at Traffex from Truvelo is its VIA-Cam (pictured), a spot-speed radar camera for industrial sites. VIA-Cam operates 24/7, and like the D-Cam can provide dual-direction enforcement.

Traffex | TRUVELO Stand No. **F31**

Virtual reality

EXHIBITION HIGHLIGHT

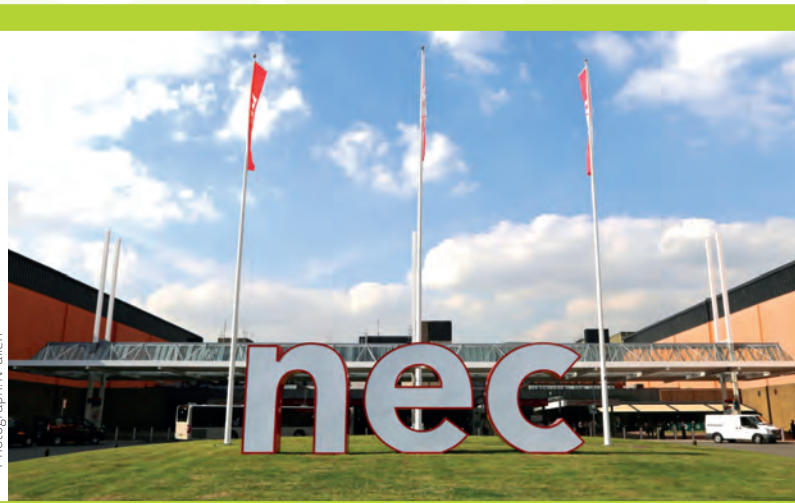
Forum8 is a Japanese producer of state-of-the-art 3D engineering software. Its premier product, which will be showcased at Traffex 2017, is the VR-Design Studio (formerly known as UC-win/Road). It is at the forefront of interactive 3D virtual-reality simulation and modeling technology.

VR-Design Studio is the ideal solution for urban and transport planning/design projects, as well as driving simulation, interactive visualization of rail, road and pedestrian-based events, and the development of emergency planning/training scenarios.

Forum8 is a member of the Institute of Transportation Engineers and an associate of the Transportation Research Board's visualization group, with offices and partners on every continent.

Traffex | FORUM 8 Stand No. JZ1

Left: **VR-Design Studio can support transport planning projects**



Photograph: N-allen

Above: **Every two years for the last 28 years the NEC in Birmingham has hosted the Traffex event**

> How do we manage the demand? Do we allow it to grow, as we are at the moment? Or do we have to put in measures that will restrict use?

"One of our key aims is to raise academic and professional standards. We are looking to increase the qualification level of membership through registration with the engineering council so that they become chartered or incorporated at technician level.

"The requirement for demonstrating competence was failing to keep pace with technology, but it has caught up in the past five to six years – not so much academically, but through vocational experience. So we deliver technical training on lots of subjects and then assess the performance of individuals."

Indeed, attendance to Traffex will be recognized as vocational experience by the IHE. "We give the event continuous professional development status," says Hayes.

New technologies

Whereas in the past a highway engineer might only be required to lay asphalt or repair lights, today a whole host of new technologies are being added to our roadsides, which must be understood by the engineers employed to install and fix them. "We are looking at how we can put together a competency framework for the new technologies, such as smart motorways," says Hayes. "Because when you see this new technology being used, do the people installing it fully understand what they are trying to achieve? Or are they simply copying someone else's example?"

Looking further into the future, Hayes muses about the challenges that will be posed by autonomous vehicles. Such technology could have significant implications for those in charge of road infrastructure. "If you're going to have autonomous vehicles that rely on street furniture, road markings and traffic signs, they have to be kept at a reasonably good specification," says Hayes. "So they have to be maintained well."

But that's not where it will end. In Hayes's view, road signage and markings will soon have to deliver a lot more than just clean, retroreflective surfaces. "You can move into more intelligent scenarios, like intelligent road studs, technology that improves roads for people with disabilities, and other technology for pedestrians in general. And then you get into the big concepts, such as the interaction between the autonomous vehicles and the other road users."

Fighting congestion

Smarter traffic lights and intelligent road studs are tools available to traffic engineers in the battle against growing vehicle volumes. But Hayes points out that these tools could soon prove to be inadequate unless more fundamental issues are addressed, particularly in the UK. "The basic problem is that we're trying to maximize vehicle movement in what is an increasingly

Pedestrian detection system

AGD Systems makes easy-to-integrate, globally compatible intelligent transportation systems designed to help create safer, greener, more efficient traffic and transport environments. At Traffex, AGD will launch its wi-fi-enabled, IP-capable 645 optical pedestrian wait area detector, headlining its traffic and pedestrian control showcase.

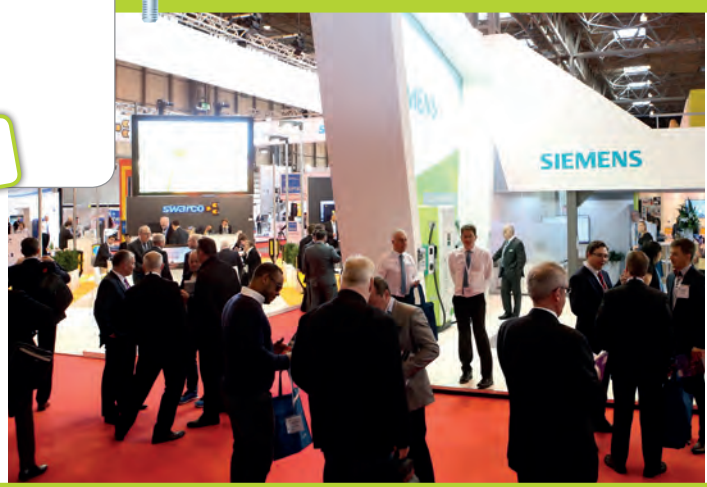
As part of its MOVA portfolio, the company will also demonstrate its 318 traffic control radar, and preview the highly complementary 350tc traffic control radar, which launches later in 2017.

AGD says these products all deliver ease of deployment, integration and setup to allow maximum flexibility for evolving traffic models.

Traffex | AGD SYSTEMS Stand No. **C24**

EXHIBITION HIGHLIGHT

Left: **The new AGD 645 pedestrian wait area detector is wi-fi-enabled**



Right: **More than 350 exhibitors will be at the Traffex show this year**

> At some point in the future you'll have to book space on the network. If you want to go at peak hour there'll need to be some road charging

congested road situation, and in a sense the big issue is how we manage the demand. Do we allow it to grow, as we are doing at the moment? Or do we have to put in measures that will restrict use? All signals are doing is trying to manage the congestion to a minimum level of disruption.

"I work in the center of London and know that even in the Congestion Zone there's no way you can keep traffic flowing. It just doesn't work. You have to manage demand in a completely different way by restricting access into the city from the outskirts, by slowing traffic down or by increasing the red time as you approach, to try to allow the center to decongest. We can keep trying to come up with smarter systems, but at the end of the day capacity is finite."

Hayes believes that some sort of wider road user charging scheme will have to be implemented in the UK. "I think at some point in the future you'll have to book space on the network," he says.

"If you want to go at peak hour there'll need to be some sort of road charging. So if you travel now your journey might cost £5, in an hour it would be £3 and later it would cost you nothing. Politicians aren't interested in addressing this problem, but time is ticking away.

"From a practitioner's point of view the other problem is how you actually repair the network with so much traffic on it. You can't even get access. The standard practice of working on a Saturday or Sunday doesn't work anymore because the space is so heavily used – you can't actually get to the site effectively to get the work done.

"For repairs on the M25 London Orbital, you have to work in a window between 2:00am and 4:30am, so by the time you've set things up and taken things down you've only got an hour-and-a-half to do physical work. If you did it during the normal working day you would get gridlock very quickly. Demand is still on an upward curve and there don't seem to be many processes to try to reduce that."

Working together

Of course, events like Traffex are a time when the industry can come together and communicate, and hopefully begin to address some of these pressing issues. Hayes is very much looking forward to the event. "There are two sides to Traffex," he says. "Obviously you meet new people and introduce your product. We'll have a stand there and we're trying to get members to join up. It's also a great opportunity for us to meet suppliers. It's just as important for us to meet the people on the stands as it is to meet visitors. We aren't often all able to get together and have a discussion. That helps all of us."

The IHE is offering free membership to all Traffex attendees. Visit stand J61 for more details

For more details about Traffex 2017 and to register for FREE entry, just visit www.traffex.com

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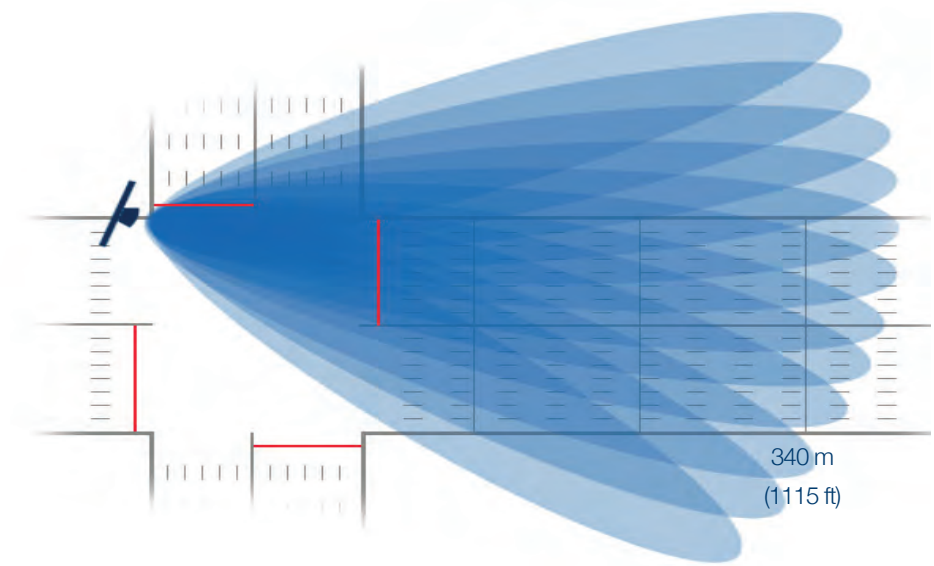

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Is smart parking a waste of public money?

Informing motorists where available parking spaces are can undoubtedly have a big impact on reducing city congestion. However, with so many private companies, from app developers to vehicle OEMs, now becoming involved in the field, is it still worth road authorities investing? **Michael Donlevy** investigates

The parking industry is developing at a pace that rivals the speed at which empty spaces fill up in a busy garage, and those developments are being fueled by technology. One of the most common solutions is offered by app developers working in partnership with road authorities, who are embedding smart parking sensor hardware into road surfaces. But with predictive algorithms, video solutions and automotive sensing technology offering alternative ways to generate real-time parking availability data, are public bodies wasting their money on the sensors?

London's Westminster City Council is the highest-profile example of a local authority in the UK installing parking sensors – 3,500 of them – in roadside bays and parking garages.

The SmartPark RFID sensors used are virtually flat and anti-slip. They use infrared to detect when a vehicle has occupied a space. Real-time data is then used to update a cloud server with changes to parking space occupancy on a minute-by-minute basis. Motorists can use the council's ParkRight app to find spaces in real time, compare costs and store their favorites.

Councillor Heather Acton, Westminster City Council cabinet member for parking and sustainability, says, "Sensors make it easier to find a parking space, and reduce congestion in the process. They are a key investment in our commitment to provide fair, easy and safe parking."

Which is all well and good, but car manufacturers are working on their own systems that also deliver up-to-date parking information without the need for sensors.

Automotive innovation

Mercedes-Benz, for example, teamed up with Bosch to install sensors in its vehicles to constantly monitor curbside parking availability. The system searches for spaces when the car is traveling at any speed up to 55km/h (34mph), even when the driver isn't looking to park, and relays the information back to a cloud server for other Mercedes drivers to access when they want to park.

"Nearly all of our cars are connected by a smart network," says Sajjad Khan, head of digital vehicle and mobility at Mercedes-Benz. "When equipped with the right sensors, they generate data 'in passing'. We see using that data for rapidly identifying available parking spaces as the next logical step."

Above: **Local parking information can be relayed to the car or to a smartphone**

50 million

The number of parking spaces covered by parking service provider Parkopedia, across 6,000 cities in 75 countries

Using such a system alone, you'll never know what's going on inside parking garages and on lots. Mercedes, of course, has thought of this. "If you look at our E-Class you'll see our latest parking service: on the navigation screen we show our customers available parking spaces in public parking garages," Khan says, before confirming, "This information is based on smart parking sensors. In the future, parking spaces located with community-based parking will be added, so the database of available parking spaces will be expanded."

> For us, there are clear benefits for the data to be shared and made available to motorists through other channels
>
> **Simon Morgan, change officer for city management and communities, Westminster City Council, UK**

Westminster's own service is no closed shop. "We've set up a web portal for third-party developers to access real-time data via an API at

Driverless drop-offs

Driverless cars could take the stress out of parking. Or, they could remove the need for parking spaces altogether

Milton Keynes is one of several councils in the UK that is working with car manufacturers on parking trials for autonomous vehicles, and the results could revolutionize the way motorists travel in the future.

"We're working on trials in Milton Keynes with Jaguar Land Rover and Ford's autonomous cars," says Brian Matthews, the council's head of transport innovation. "The idea is to ensure that when a self-driving vehicle arrives in the town center, it's directed to a pre-booked parking space. Through the MK:Smart app, the car will be directed to an autonomous pod, which will cover the last mile, drop the passenger off wherever they want to stop, and then take the car to its parking space, or allow the car to leave on another journey."

It's that last point that's worth bearing in mind. It's no stretch of the imagination – and it's something that has the motoring industry concerned – to picture the day when we don't need to own a vehicle anymore. In the future, you could be able to book an autonomous vehicle to collect you from your location and drop you off at your destination.

"There will be a significant transition period to get to the end-state that's being predicted, so parking sensors will help manage this transition over the next 10-15 years," says Matthews.

After which point, parking sensors may be irrelevant...

30

Number of sensors recently installed in taxi ranks by London's Westminster City Council to provide taxi drivers with real-time information on where to 'rank up'

Left: **One of the 3,500 parking sensors that are embedded into parking spaces in Westminster, central London**

api.parkright.io," says Simon Morgan, change officer for city management and communities at Westminster City Council. "For us, there are clear benefits of the data being shared and made available to motorists through other channels, especially as cars become more connected."

This information is provided by companies such as Parkopedia, the world's largest parking information provider, with the likes of BMW, Apple, Ford, Garmin and Toyota among its partners.

"Parkopedia allows drivers to book and pay for parking online, through a mobile app and in-car," says head of marketing and operations Christina Onesirosan Martinez.

Westminster is far from the only council in the UK to have been tempted by parking sensors, but not

every council has the weight of traffic – and therefore parking revenues – to pay for a full implementation of this technology.

"We trialled the sensors a couple of years ago," says Brian Matthews, head of transport innovation for Milton Keynes. "We have 25,000 parking spaces, but found only 75% were occupied, so we wanted to help customers find the spaces. The technology worked, and we had some interesting results – for example we installed the sensors outside the railway station, where there is pressure for short-term parking and where we had a maximum loading time of 10 minutes. We found most motorists were staying for 15 minutes, so we realized we weren't giving them enough time and raised the limit."

Cost implications

There was a hitch, though. "Each sensor costs up to £30 [US$38], with installation and maintenance costs on top of that, so we're looking at other options," says Matthews. "We're currently testing a network of low-cost, low-res cameras that each cover a wide area and can send digital information rather than images – so they can't identify license plates – to a server to update parking data in real time."

The council requires no more than 400 cameras to cover the entire town and is currently seeking funding to roll out the program. "We want this to form part of our MK:Smart project, which will allow motorists to access that information via our app. We also plan to commercialize it, because when you look at apps such as RingGo it's clear people are willing to pay for this service."

> Each sensor costs up to £30, with installation and maintenance costs on top of that, so we're looking at other options
>
> **Brian Matthews, head of transport innovation, Milton Keynes, UK**

25,000

The total number of parking spaces in Milton Keynes, only 75% of which are occupied at peak times

Top right: **Apps are available that link to Westminster's parking data, generated from pavement-embedded sensors**

Sensors aren't out of the picture altogether, Matthews adds. "The cameras do have some blackspots, mainly on corners. Our EV parking bays tend to be closest to corners so we plan to install ground sensors in all of those bays."

One-click parking

There seems little doubt, then, that all of these technologies and the information they provide is converging rather than diversifying, so the next step is to enhance usability.

Westminster has been working with AppyParking and Vodafone to test a parking application that incorporates the sensor data to enable 'one-click parking' for customers. The AppyParking app connects to Vodafone's in-car sensor, which plugs in to the car's diagnostics port to detect when a vehicle's engine stops in a parking bay. The app uses GPS data to determine the location, and the customer automatically starts a parking session. When the customer drives away, the sensor automatically stops the session.

"The concept is being rolled out into full production now, with Appy having just released its one-click functionality," says Morgan. No longer should searching for and paying for parking be stressful.

Fighting pollution with parking

London's Westminster City Council has just announced that it is to trial emissions-based parking charges

A groundbreaking trial will begin on April 3, 2017, in the Marylebone area of central London, which will see diesel vehicles paying 50% more for parking.

Diesel car owners will now have to pay an extra £2.45 (US$3.05) per hour for a maximum stay of up to four hours – this is on top of the £4.90-per-hour basic charge. The system will be enforced using ALPR technology.

London's City Hall is also introducing a top-up to the Congestion Charge later this year, which will see the owners of older, more polluting cars face an extra £10 fee for entering the Congestion Zone.

Marylebone suffers some of the highest pollution levels in London. The 'polluter pays' principle aims to reduce harmful vehicle emissions. Any money raised will be spent on initiatives to promote sustainable transport.

"Residents and visitors tell us all the time that air quality is a key concern in central London and we have consulted with our partners and local stakeholders on this step in improving our health and wellbeing," says Westminster councillor David Harvey, who is cabinet member for environment, sports and the community.

However, the policy drew an angry response from the FairFuelUK campaign. "This is greedy, unscrupulous money-grabbing, using dubious emissions evidence as the reason to fleece hard-working motorists," said Howard Cox, founder of the campaign. "FairFuelUK has been calling for a debate on incentivizing older diesel vehicles to change to cleaner fuels for the past seven years. Instead we are seeing more short-sighted, local authorities penalizing diesel drivers with punitive taxation."

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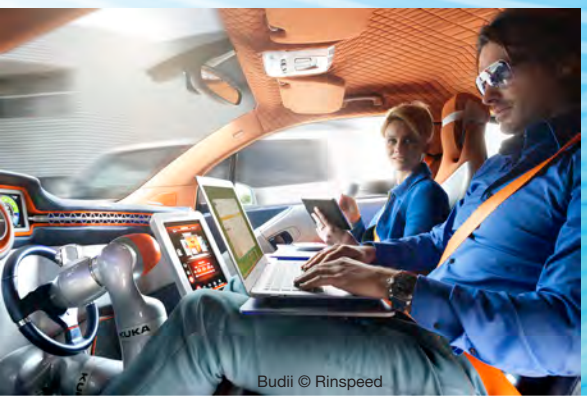

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Model workzones

Creating the most efficient workzones possible requires careful planning and deployment using the latest technology. **Max Glaskin** discovers how new breakthroughs can help road authorities use smarter setups to save money

It's simple logic. Workzones cost highways agencies and road users alike, but efficient workzones cost less. That said, it's not easy improving their efficiency. Although good planning is key to reducing the resources and time needed to do the job properly while lessening impact on traffic, innovative technologies can accelerate operation and eliminate delays.

These advances are bringing sophisticated technologies into arenas where brute force has, conventionally, held sway. Manpower and heavy machinery are being enhanced by subtle systems to optimize the way workzones function.

The autonomous truck-mounted attenuator (ATMA), soon to be tested in the real world by a commercial operator is, in effect, a driverless, mobile crash barrier to protect workers. It follows them as the workzone moves forward, absorbing the impacts of any vehicles that don't change lane as directed.

Reduced risk

Manned impact protection vehicles like these are vital. In a five-year period there were 149 impacts on them in the UK alone. All of them, along with the hundreds of others around the world, put the vehicle's driver at risk of injury. So, the development over three years of the ATMA, by Micro Systems (a Kratos Defense & Security Solutions company) with Royal Truck & Equipment, not only eliminates risk, but also releases the driver to be available for other tasks.

The UK highways construction company Colas has bought the first ATMA system and trials will indicate the most efficient way to deploy the technology. Colas is providing the trucks and Micro Systems fitting the autonomy kits, says Maynard Factor, Micro Systems' engineer and business development manager. "There is hardware and software for two vehicles – the manned leading vehicle at the head of the rolling workzone, and the following, unmanned attenuator truck at the back," says Factor.

> There is hardware and software for two vehicles – the manned leading vehicle at the head of the rolling workzone, and the following, unmanned attenuator truck at the back
>
> **Maynard Factor, engineer, Micro Systems**

The main component in the leading vehicle is a module with a computer processor, navigational components such as a GPS receiver, a digital compass, and a transceiver radio. "It records velocity, heading and position information; the computer packages and transmits it in data packets called eCrumbs, 10 times every second," says Factor. They are received by the driverless ATMA, which has similar equipment plus a steering actuator, and actuators for controlling the brake and accelerator. "It receives the eCrumbs, processes the information, and interfaces to the different actuators to control speed and heading. There is also a radar-based

"I'm over here!"

Smart personal protective equipment (PPE) being developed by Virginia Tech could alert workzone operatives to danger via V2X technologies

If each worker, machine and passing driver has timely information about the whereabouts of all the others in and around a workzone, the job will be finished more quickly and safely. That's the theory behind connected workzones and there are many US projects to get such information to the smartphones and GPS units of vehicle drivers. Virginia Tech Transportation Institute (VTTI), however, has been looking at novel ways to alert workers to potential incidents.

"The idea is that workers get a warning through their hi-viz vest, helmet or other hardware that they may shortly be in conflict with a vehicle," says Andy Alden, executive director at VTTI. With funding from Virginia Transportation Research Council, they have assessed technology to attract attention via different senses, including lights, sounds and vibration. A smart vest and helmet have been trialled.

Getting the technology to prompt a reaction from the wearer is not so difficult, but making sure it's the right reaction isn't so straightforward. "We have to be careful that the alert doesn't start people running into harm's way, so there has to be some contextual element to the information they get," says Alden. "We've had a lot of interest and some offers of funding to continue the research. We need to do more to develop an integrated solution."

Above left, center and right: **The autonomous attenuator truck improves road and workzone safety**

obstacle detection system, an active safety system with emergency independent braking, and manual E-Stop switches inside and outside of the vehicle that can be used to shut down the truck at any time," he says. The same systems have been applied for several years to military vehicles.

For safety reasons, it makes sense to remove a worker from a collision-prone vehicle and so could help contractors because highways operators often stipulate strict safety measures. It also makes better use of human and financial resources as the worker no longer has to sit in the cab. "The price tag depends on what technology options are added, but it is affordable," says Factor.

It's still early days for the ATMA, and Factor believes enhancements will soon be identified. "We're working with academia and with a construction company on a bunch of different scenarios and that's going to map which technologies could be added," he says.

Eyes in the sky

Keeping workers out of harm's way is a priority for efficient workzones, so monitoring project progress from a safe and remote location is an attractive option for Illinois DOT (IDOT). To this end, it has recently begun assessing the potential of drones to improve many aspects of its work, including the planning and implementation of workzones.

"We acquired our first drones in August and started using them right away to assess their potential," says Bill Viste, aeronautics project coordinator at IDOT. "They've been flown specifically for workzones half a dozen times, and when the winter's over, we will be gearing up for a busy spring and summer with them so we can see how best to integrate them into our operations."

The use of drones for workzone efficiency could start long before the first barrel is placed on the highway, Viste believes. "We're exploring mapping, survey, 3D design, bridge and infrastructure inspection," he says. "We're even looking at the opportunities for identifying environmental and cultural resources, along with geological and geotechnical studies for sub-surface water." This kind of drone-acquired information can help to design a more effective workzone that avoids or minimizes any impact on environmental or cultural resources, as required by the National Environmental Policy Act. If there

The future is 3D

Using 3D scanners to survey intersections prior to road works can improve efficiency; however, dealing with large amounts of data poses problems

The ultimate efficiency of a workzone depends on preparation that has to be completed long before it is deployed. Of course, acquiring all the information that's needed to plan the whole project in detail will often include putting workers on-site while the roads are still fully open to vehicles. New surveying technologies are helping to speed up part of this process while reducing the number of people required for the task and also distancing them from potentially hazardous vehicles.

"We're into the second phase of a three-year research implementation project studying the benefits of using 3D laser scanning to survey intersections," says Ryan Culton, an engineer with Illinois DOT's bureau of research. "With our laser scanners there is a reduced amount of time for our field crew to be out in intersections or dangerous workzone areas." They can safely capture data without interruption even when there is fast and heavy traffic flow in the areas being surveyed.

There is, however, a trade-off. So far, the project is finding that, while the crew spends less time gathering the information, there can be more time spent at the office processing the data, because the large file sizes test the available computing power when the images are being stitched together.

"For the near future I would say 3D laser surveys will definitely supplement but not supersede conventional methods, which may still be more appropriate for the smaller jobs," says Culton.

has to be any detrimental impact, drones will also help to plan efficient subsequent remediation.

Perhaps the most useful application of the two battery-powered quadcopter drones from DJI, a dual operator Inspire 1 Pro and a single operator Phantom 4, will be the ability to monitor workzone progress. "Drones can give you a unique and comprehensive view not previously possible," says Viste. "There is also the potential for a live assessment of the site if there are issues, like a problem with the traffic flow, and they need to figure out why. Those kind of on-demand tasks are less likely than using the unmanned aerial systems as a tool for documenting the job in a way that simply was not possible or too expensive." Pictures of workzones can be stitched together to produce ortho-mosaics or 3D models that help current or planned projects.

The use of drones is strictly regulated by the Federal Aviation Administration (FAA), and IDOT, as a public agency, has been granted a Certificate of Waiver or Authorization, and abides by the blanket Part 107 rules for aircraft below 55 lb (25kg). For its ongoing research, though, it will seek changes. "We will petition the FAA to get some exemptions so we can expand our operating environment, like flying after dark, over non-participants and in controlled airspace, to enable us to do the work we do," says Viste. "We definitely believe these unmanned aerial systems will play an important role throughout the entire development process of projects."

Above and right: **Driveway assistance devices makes it safer for traffic to merge into one-way workzone flows that change direction**

Driving ahead

Back on the ground, the efficiency of workzones in Michigan is being enhanced through trials of another new technology – driveway assistance devices (DAD). They are set up along workzones where the road has been reduced to alternating one-way flows, controlled by signals at both ends. DADs can show drivers, entering the road from a driveway or low-volume side road, which way the traffic is flowing at that moment, so they don't create a wrong-way incident.

> Drones have been flown specifically for workzones half a dozen times, and when the winter's over, we will be gearing up for a busy spring and summer with them
>
> **Bill Viste, aeronautics project coordinator at IDOT**

"We've been assessing them since 2015 at a number of workzones and they work very well. They improve efficiency in several ways," says Chris Brookes, workzone delivery

engineer for MDOT. It's common for one-way-flow workzones to be dismantled each day to give residents two-way flow overnight, before restrictions are imposed again next working day. "That takes time and manpower. DADs at each driveway or access road mean the alternating one-way flow can stay safely in place and we don't lose time and resources taking down and reassembling each day," says Brookes.

The devices plug in to the same system that controls the signals positioned at each end of the traffic zone. MDOT is continuing with trials, assessing the volumes of driveway and side-road traffic relative to the length of workzone that DADs can manage before queues build up. The Federal Highway Administration is also to be consulted on what an acceptable level of driver compliance would be before DADs are deployed more widely.

Virtual traffic

Saul Wordsworth finds out how traffic modeling software has evolved, what makes a good model and how they are best used, plus we showcase some of the best new traffic modeling software on the market

Traffic modeling is key to ensuring that our vehicles keep moving forward. A bad model, or one implemented badly, may mean the road system grinds to a halt. Development over the past few decades has enabled detailed traffic models to be flexible enough to be applied to almost any design that traffic planners and engineers foresee. When used well, such models can greatly increase our understanding of comparative capacity, traffic flow and safety at intersections.

"The greatest challenge with modeling traffic at such a detailed level is that it is the interactions between all the objects within the model that are the dominant factor, rather than the characteristics of the individual objects," says Dr Ben Waterson, head of the Transportation Research Group at the University of Southampton in the UK. "While we may be able to accurately calibrate technological aspects such as acceleration rates of individual vehicle types and set precise traffic-signal timing plans, the realism of any traffic model results is still reliant on how representatively the behavioral relationships of the drivers, cyclists and pedestrians are included."

Serving a purpose

The demands placed on modeling and simulation – and therefore modelers and simulators – are growing exponentially. The available information on which to base models is increasing in both volume and detail, with data from satnav systems and transit fare collections now part of the calculation. The types of

> A challenge with modeling traffic is that the interactions between the objects within the model are the dominant factor, rather than the individual objects
>
> **Dr Ben Waterson, head of the Transportation Research Group, University of Southampton, UK**

The big picture

Inro's Dynameq 4 software is a traffic simulation solution for large scale planning applications

BEST TRAFFIC MODELING SOFTWARE
DYNAMEQ BY INRO
BEST FOR: Large-scale urban planning

Dynameq, developed by Inro, provides an advanced vehicle-based traffic simulation and simulation-based dynamic traffic assignment (DTA) that allows even large, congested situations to be modeled reliably and at a consistent level of detail throughout an entire network.

Dynameq is specifically designed to overcome the challenges of applying traffic simulation to large-scale urban planning applications. Without sufficient model stability in response to forecast future-year demand or demand estimates from a regional transportation model (RTM), modelers may be unable to produce MOEs (measures of effectiveness) for highly congested scenarios. Dynameq uses novel algorithms to overcome these challenges, virtually guaranteeing DTA convergence even in extremely congested conditions.

In the latest software release, Dynameq provides high-performance animations of vehicle-level detail

across an entire model area. These outputs illustrate the simulation of individual vehicles in lanes, using car following, lane changing and gap acceptance models. The traffic simulation captures the true causes and effects of congestion – traffic signals, freeway merging and weaving, turn pockets that overflow, late merging and queue jumping – all of which have a major impact on actual traffic conditions and travel costs.

Dynameq applications can scale with a single traffic model and can produce consistent and continuous vehicle trajectories over an entire network and simulation period. They are now available in a 3D visualization and analysis framework to enable users to understand network-wide routing, diversion and traffic patterns.

Planners are taking advantage of these features to develop and maintain reusable simulation-based DTA model platforms, instead of having to rebuild isolated simulation studies multiple times.

Dynameq also provides parallel performance, manageable random-access memory (RAM) requirements and large-scale visualizations for metropolitan-scale traffic simulation projects and beyond.

questions planners and policy makers ask are changing fast: what are the short-term and the long-term impacts of road congestion pricing? What are the implications of autonomous vehicles for traffic congestion reduction? Models need to be able to help answer them. In addition, model users have expectations related to levels of certainty and increased accuracy resulting from the use of more data at a very personalized level, such as individual decisions on trip destinations, mode choice and route taken. The increased level of accuracy may sometimes be impossible to achieve in practice. Last but not least, the results need to be easily understood by decision makers, the increased complexity of modeling approaches requiring a distillation into easily digestible data.

"The need to present to lay individuals grows and this has resulted in many modeling products offering better ways to present results, without blinding them with jargon," says Christopher Kettell, head of traffic software for TRL, Britain's center of excellence for future transportation. "The products themselves, as they have become increasingly feature-rich, need to be user-friendly at the same time. Data-entry needs to become smarter, offering intuitive ways of operating and providing feedback when the data appears to contain errors. Blaming bad results on the adage 'rubbish in – rubbish out' is no longer acceptable, especially when the products themselves encourage the use of reliable data."

> There is often trade-off between model complexity and the level of uncertainty. The more variables we include in a model, the more likely it is to perform well in simulating real-world behavior
>
> **Luis Ferreira, professor of civil engineering, University of Queensland, Australia**

"The questions that models must address are changing fast," observes Prof. Luis Ferreira, a member of the civil engineering department at the University of Queensland, in Brisbane, Australia. "One question is how to make models relevant in a changing technology world. We have more and more historical data available on which to base models. This allows increased levels of complexity, hence the rising model cost. There is often trade-off between complexity and the level of uncertainty. The more variables we include in a model, the more likely it is going to perform in simulating real-world behavior. However, each additional variable needs to be forecast if the model is to be useful to predict the future."

What makes a good model?

Commonly, much effort is placed in ensuring models are able to reflect some observed pattern of behavior in

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Version 8.2 of the integrated Aimsun traffic modeling software builds on its reputation for flexibility and superior scenario management

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BEST FOR: User-friendly interface

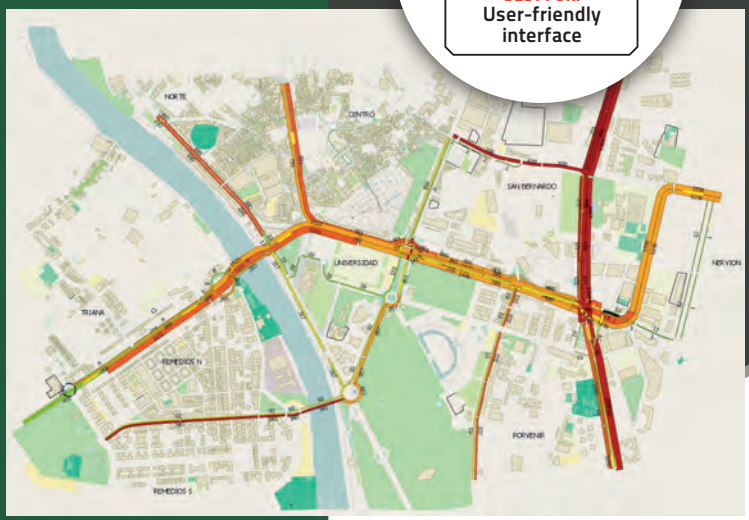
In February 2017, TSS-Transport Simulation Systems released the public beta of version 8.2 of its Aimsun traffic modeling software. Over the course of 20 years, Aimsun has matured from a microsimulator into a fully integrated traffic modeling application that now fuses travel-demand modeling, macroscopic functionalities and the mesoscopic-microscopic hybrid simulator.

Aimsun's all-in-one approach not only enables the operator to build models quickly and with great accuracy, but also brings many associated benefits such as lower software costs, faster training and greater user-friendliness. With over 4,200 users in 75 countries, Aimsun is rapidly gaining ground and is currently being used in high-profile projects in major cities around the world including Toronto, Sydney, New York, London, Lyon and San Diego.

As in previous versions of Aimsun software, the latest version continues to emphasize user-friendliness, with significant improvements at both the modeling and platform level. Highlights include dynamic origin-destination matrix adjustment – a procedure that fits a multiclass, time-sliced demand to a real data set of traffic counts for multiple time intervals within the simulation period, be it a microscopic, mesoscopic or hybrid simulation. Other improvements are richer public transit assignment and more dynamic user equilibrium assignment options than ever.

Aimsun 8.2 also features an improved path analysis and dynamic user equilibrium (DUE) convergence analysis, and also has a recorder and player function so that users can record the animation of a microscopic or mesoscopic simulation and then replay it for easier analysis of events that occurred during the simulation.

Another highlight is the car-following model extension for congested highways, which can achieve more accurate simulated speeds in heavy traffic.



Above: **Aimsun software displays clearly where congestion may occur**

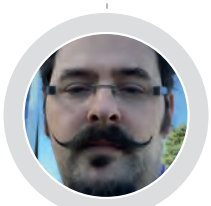
the recent past. Given enough time and effort, simulation professionals will often prove that models can pretty much mirror what actually happens in real life. This is done by changing model parameters until model output traffic volumes are close to actual volumes.

"Validation is important, but verification is key," says Kettell. "The latter provides a feedback loop into your future modeling methods. If you can verify that the model predictions have been reasonably accurate, then you know that your modeling process might not be too bad after all. It is crucial not to use a model beyond its scope. Always accept and understand its limitations and do not use it beyond that which it is designed to do."

The signs that a model is underperforming include poor data relative to what is being required of it, and assumptions made but not checked or accounted for. Models that are built blindly for the client's wishes are all too common. Clear communication is essential to ensure deliverables are genuinely useful and to specific requirements.

"You need to ask the question of your model: Is it fit for purpose?" says Ferreira. "And will it give the sort of answers you are after? Does it include all your variables of interest? Is it sensitive to those variables in a reasonably sensible way? For instance, if we introduce road pricing for congestion, what does the model predict will happen? Routes change and transit ridership changes in the shorter term. What are the long-term impacts on employment and residential location? In summary, can we believe the model outputs? Do they make sense intuitively?"

> It is crucial not to use a model beyond its scope. Always accept and understand its limitations and do not use it beyond that which it is designed to do
>
> **Christopher Kettell, head of traffic software, TRL**



Going autonomous

Automated vehicles offer much promise, but are also one of the great imponderables of the future driving experience, and their true impact on traffic flows is yet to be fully established. This is why the UK's Department for Transport (DfT) recently conducted a study using modeling on the effects driverless cars will have on Britain's roads. The project was commissioned in October 2015, ran for six months and consisted of two phases: an evidence review of the impacts of autonomous vehicles on traffic flow and road capacity; and an analysis using microsimulation modeling. The results were fascinating and a perfect showcase for the potential that traffic modeling can bring.

"Traffic microsimulation is a commonly used tool for testing new designs for road layouts and traffic control," says a DfT spokesman, department officials being unable to

BEST TRAFFIC MODELING SOFTWARE

TRANSYT BY TRL

BEST FOR: Signalized intersections

Advanced intersection planning

Research center TRL helps organizations create affordable and efficient global transportation systems with tools such as TRANSYT 15.5

TRANSYT 15.5 traffic modeling software offers users worldwide the ability to design, model, evaluate and optimize timings on their networks, whether that is a single signalled junction, or a large mixed network of junctions (signals and unsignaled).

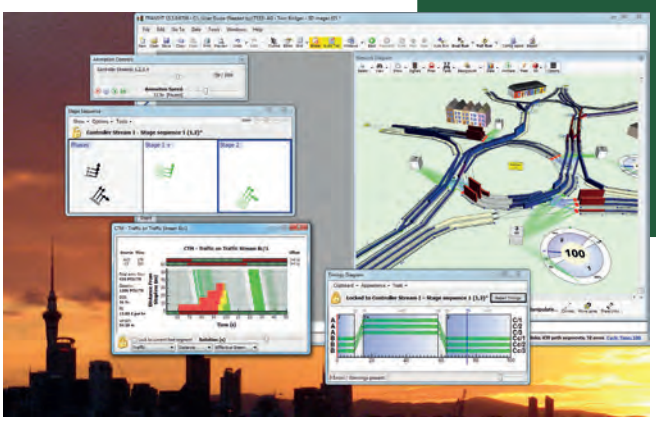
To avoid the mistake of 'trying to be all things to all people', the software has stuck to its strengths, while branching out into targeted new areas to provide further benefits to its users. This software has evolved over many years, and it is now much easier to use than many imagine it might need to be.

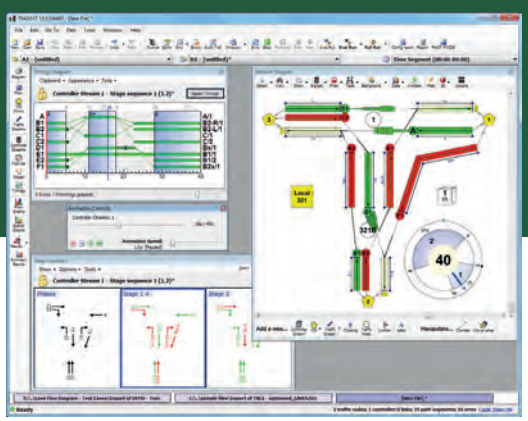
An example of one of the enhanced features of TRANSYT is its network diagram flow overlays. These are TRANSYT's equivalent of the lane flow diagrams deemed 'essential' by the UK Department for Transport Local Transport Note 1/09 when assessing signaled controlled roundabouts. Unbalanced lane use, oversaturated (lost traffic through the junction) and poor lane designations can all be spotted and rectified, using this facility. The function enables individual junctions to be designed with ease.

In recent years, TRANSYT has been developed to ensure that users get fast 'pin-through-the-problem' solutions via its intuitive user interface (UI). Having an intuitive UI is vital, because Transyt users have consistently increased demands on their time and don't necessarily use the software every day.

TRANSYT does not have a bank of obscure icons, and all buttons are clearly labeled. The fully integrated UI was designed to ensure it's as easy to use as possible, enhancing the products' ever-growing capabilities. A lot of effort has gone into speeding up TRANSYT 15.5's network creation, meaning that the operator can spend more time making good modeling decisions. This was achieved partly by reducing required clicks, as well as expanding on the use of automated calculations: the automatic calculation of UK intergreens and conflicts from TRANSYT's scaled diagram, the automatic setting of lane designations, and the automatic calculation of link lengths. The building in of the Arcady and Picady models has also helped to ensure that data used by TRANSYT is retained (an important BIM principle).

Looking to the future, TRL continuously seeks to develop TRANSYT, and better integrate it into users' own processes by offering a product that assists and encourages, rather than hinders – a product that is accepted as a comprehensive single junction design tool, as well as one for larger networks. A product that continues to evolve to the industry's needs.





Left: **From 'traditional' T-junctions to signal-controlled roundabouts, TRANSYT has it covered**

comment due to the Civil Service Code. "Our study showed that autonomous vehicles can be a game-changer for road travel."

The motorway model consisted of a 12.5-mile (20km) expanse of road connecting three junctions and including common types of merge and diverge arrangements, lane gains and lane drops, along with a section of dual carriageway and reduced-speed dual carriageway approaches. The study sought to determine the difference autonomous vehicles made when they constitute the greater proportion of vehicles on the road. On major roads journey times in rush hour were found to be up to 11% faster with journey time reliability improved by 54%. On smaller urban roads the benefits were even bigger. Journey times were reduced by 21% and journey time reliability improved by nearly 80%.

Surprisingly enough, the results on urban roads still applied even when there was only a minority of automated vehicles in the model, showing there was still a 12% improvement in delays.

> You need to ask the question of your model: Is it fit for purpose? And does it give the sort of answers your are after? Does it include all your variables of interest?
>
> **Luis Ferreira, professor of civil engineering, University of Queensland, Australia**

Clearly traffic modeling is an increasingly sophisticated tool for predicting the future and can even be used, as the DfT study demonstrates, to attempt to establish the benefits of future technologies such as autonomous vehicles. If we want to plan better roads, traffic models are one of today's essential tools.

THE FUTURE OF TRANSPORT

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Extends TRANSYT's functionality and allows optimised signal plans to be sent directly to on-street controllers to enable adaptive optimisation of signal timings

TRANSYT

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Is your ITS falling apart?

Intelligent transportation systems are a worthwhile investment, but if maintenance is neglected, that investment could be wasted. **Max Glaskin** looks at the ways in which road authorities are maximizing product life through smart asset management

Illustration: Justin Metz

It's all very well having a network bristling with expensive roadside technology, but if that technology is not properly maintained, the money initially invested isn't working as hard as it should. What's more, if you don't regularly assess the functioning of intelligent transportation systems, how will you know when you might be better off cutting your maintenance losses and upgrading?

"People have still not completely bought in to the principle of good asset management," says Richard Hayes, chief executive at the UK's Institute of Highways Engineers. This is a major concern because doing it well will always benefit the bottom line. After all, ITS assets represent a substantial investment. For example, the surface ITS contract that Transport for London awarded in February was valued at more than US$125m (£100m).

While few ITS programs are as extensive as TfL's, they all face potential disruption and decay due to elements inherent in the technology and from environmental and human sources, all of which can create faults and downtime. The answer is not to let them happen.

Georgia DOT's award-winning NaviGAtor Comprehensive ITS Maintenance system is so effective at keeping the gremlins at bay that it always has at least 99% of its 3,000 CCTV, VMS, traffic camera, radar systems, ramp meter, video detection and thermal cameras available. As digital techniques advance, looking after what you've got should only get easier and a key point is to bear maintenance in mind when specifying a new system or renewing an established one.

Focus on maintenance

"In the first instance, when you're investing in ITS you need to make sure you're designing for its maintenance throughout its whole life," says Lee Street, director and head of technology at Aecom in the UK. That includes looking at whole-life costs – a perspective that can lead to perhaps surprising conclusions.

"If highway operators keep specifying the highest standards for certain ITS devices, such as message signs, they're not going to create enough competition among suppliers," says Street. "If lower standards are accepted, less

> Cost is obviously a huge factor but it's not the only one. We have to have a [maintenance] team in there that knows what they're doing
>
> **Matt Smith, ITS program manager, Michigan DOT**

US$125m
Total value of Transport for London's most recent surface ITS contract

Above: **Smart Motorway infrastructure in the UK**

Left: **London has one of the most extensive ITS networks in the world**

> The network has a value and it's decreasing year by year because you're doing nothing with it. At some point you're going to have to spend some money
>
> **Richard Hayes, CEO, Institute of Highways Engineers, UK**

expensive equipment may be available. Over the medium term it may be just as reliable and, while it might not last as long, for the whole life of the ITS the maintenance and replacement costs might be less."

Street has found that highway operators are changing tack with regard to making sure ITS is working well enough to aid the safe and efficient movement of data, goods and people. "In the old days you used to get a specification from a client that would say things like 'Three times a year we want you to go to all the telephones and all the cameras and do a, b, c, d and e,' regardless of whether you needed to or not," says Street. "Nowadays its much more about 'These are the availability figures you need to achieve.'"

Monitoring and achieving such figures is getting easier with digital connectivity. "We're finding more intelligent ways. There's a lot of equipment now that will self-report its problems," says Street. "The next step is to do remote fixes, rather than having to visit the device. Remote diagnostics and remote fixes are now part and parcel of maintenance."

A new code to follow

While maintenance at a distance is increasingly common, there are changes afoot in the way that on-the-spot assessment and testing is being

600
The number of traffic cameras operated by Michigan DOT

Advanced guards

Michigan DOT knows the value of quality maintenance for effective ITS

Michigan DOT has built up a state-wide ITS portfolio of 600 cameras, 140 dynamic message signs and several hundred vehicle detectors. They're maintained under a three-year contract worth US$4m annually.

"Maintenance is a really specialized field, without doubt, mainly because of the communications and network management and IT components," says Matt Smith, ITS program manager at MDOT. "Typically we have had three or four proposal teams over the past couple of contract cycles."

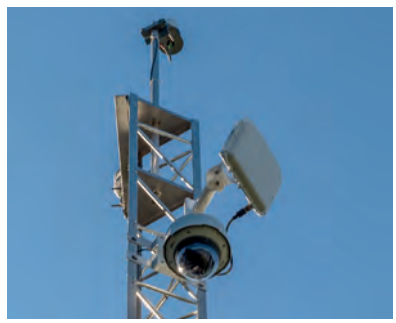
The decision as to who gets the contract is not made just on price. "Cost is obviously a huge factor but its not the only one. We have to have a team in there that knows what they're doing. So we go through the Michigan Best Value process, which has a quality component," says Smith.

On a practical level, the speed of progress in technology has been impacting maintenance decisions at MDOT. "It can be easier and more cost-effective just to swap out a traffic camera than to repair it," says Smith. "One of the challenges we have as the technology advances is the obsolescence of the devices themselves. It can be a big issue.

"Technology can advance to the point where we cannot get parts or components for a certain system," he explains. "To buffer against that we try to maintain a healthy spare parts inventory that our contractor can use, but when those are depleted and something is obsolete we have to go for a capital replacement. That's the downside of rapid changes in technology."

Above left: **A specialist maintenance crew assesses ITS assets in Michigan, USA**

Below: **Pole-mounted cameras and sensors in Michigan**



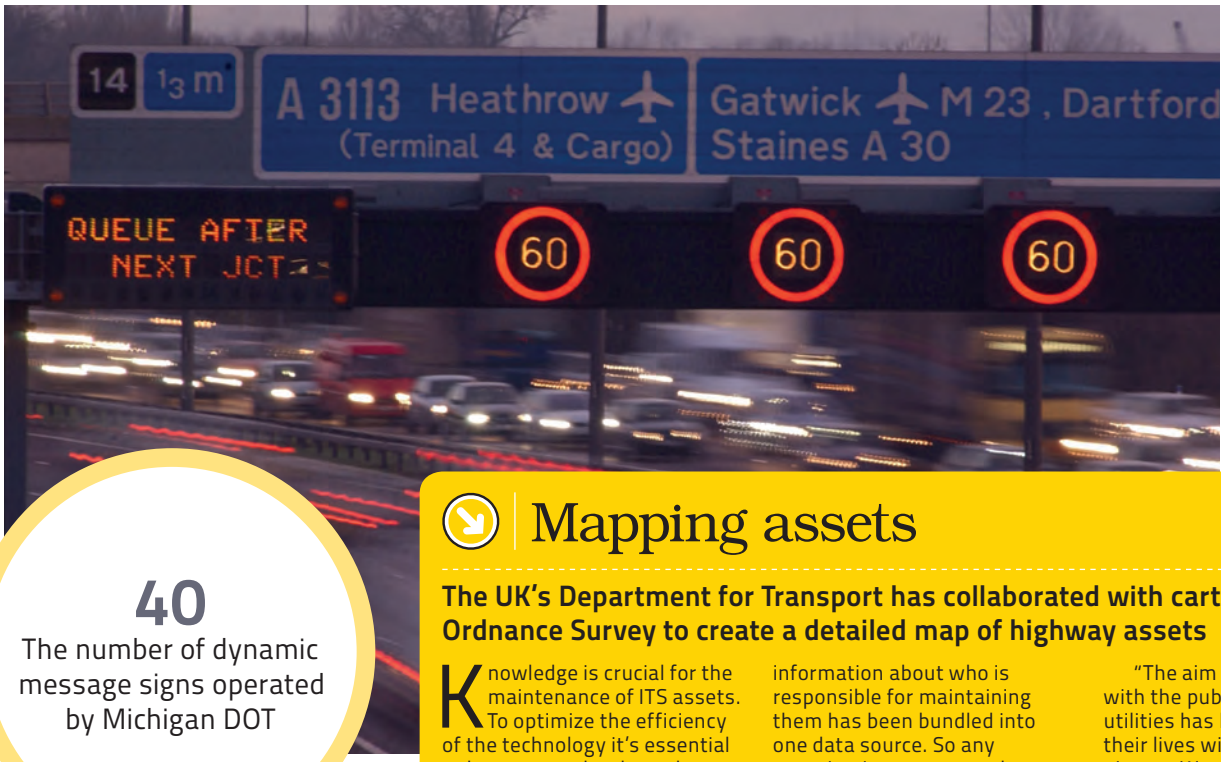
scheduled. The UK Roads Liaison Group – an association of government administrators and private contractors – issued a new code of practice entitled Well Managed Highway Infrastructure late last year. "We are moving from prescriptive best practice to evidence-based service delivery," explains Hayes. "It's for anyone who has to consider why they do what they do and when they do it. In the past they could rely on a code of practice that said, 'You do this X times a week or 10 times a year or whatever it happens to be.' In the future you'll have to decide why you do what you do."

> Maintenance is a really specialized field, without doubt, mainly because of the communications and network management and IT components
>
> **Matt Smith, ITS program manager, Michigan DOT**

"We're moving from routine, standards-based maintenance to a more predictive maintenance model," agrees Street. "When something reports itself as not working three times in one week, for example, software systems with certain algorithms can predict when it's going to fail based on previous experiences. That's where the clever development of diagnostics comes into it."

Codifying this new way to deliver the ITS asset management service is a challenge in itself. "You need a strong asset management principle for your network on how you're going to look after it. In other words, you've created the standards you want through evidence," says Hayes. "That will actually assist you in getting better funding because it's saying that the installation or the network has a value and it's decreasing year by year because you're doing nothing with it. At some point you're going to have to spend some money on that. If you do regular maintenance you can reduce the overall effect of the deterioration to the lowest level. But you have to produce the evidence to say why you do what you do."

The new evidence-incorporating code means that those responsible for managing ITS assets will have to look



Left: **The M25 London Orbital is a focus for ITS installations**

40
The number of dynamic message signs operated by Michigan DOT

at every element and consider how it is affected by all the others. "Then you're building up a picture for everywhere, which is covering what you need to maintain your network at the appropriate level," says Hayes. This can help road operators keep a close eye on maintenance costs. "Ultimately it's a risk-based approach so, if your funding is reduced in the future, you are able to reduce spending on elements with the least risk of deterioration and continue with the high-risk ones."

Improved networks

To some extent, the latest ITS deployments are already applying this approach automatically through the way elements talk to each other. "Those protocols, and the way they speak to each other, use the bandwidth and communicate certain messages, is moving on," says Street. "Clients are looking at protocols and architectures that differ from the traditional ways, to allow better, more efficient communications for assets to self-report and enable remote fixes. With that, you're going to get more efficient maintenance, with less time in the field and fewer road closures," says Street.

With evidence like that feeding through to the balance sheet, managing ITS assets should be a sweeter experience.

> The aim of our collaboration with the public sector and utilities has been to simplify their lives with a complete picture
>
> **Mark Le Page, product manager, Ordnance Survey**

Mapping assets

The UK's Department for Transport has collaborated with cartographers at Ordnance Survey to create a detailed map of highway assets

Knowledge is crucial for the maintenance of ITS assets. To optimize the efficiency of the technology it's essential to know not only where the devices and networks are located but also how to get access. A new geographical database should help speed this process in the UK.

The national mapping agency Ordnance Survey (OS) has created what it describes as "the ultimate and authoritative road and transport management product", OS MasterMap Highways Network. It hopes it will help professionals make informed decisions about asset management.

The physical dimensions, accessibility and ownership of roads and paths and information about who is responsible for maintaining them has been bundled into one data source. So any organization or agency that needs to implement or maintain ITS networks and devices will be able to make contact with all the relevant authorities.

Collating all such data for a country as diverse as the UK is no mean feat. The OS has refined its own high-quality road mapping and supplemented it with quality-assured data provided by 174 local highway authorities and utility companies. It cost the government's Department for Transport US$3.7m (£3m) and the investment was seen as necessary to improve planning, maintenance and keep traffic moving efficiently and safely.

"The aim of our collaboration with the public sector and utilities has been to simplify their lives with a complete picture. We are helping them increase their productivity and profitability, and driving efficiency by enabling better decision making. This is because they now have a single source for current and accurate data that is relevant to their needs. Having this information in one package should also reduce their costs associated with maintaining multiple data sets," says Mark Le Page, product manager at OS.

The physical road information, maintenance responsibility, official name, type and number, access points, motorway junctions will be updated every four weeks.

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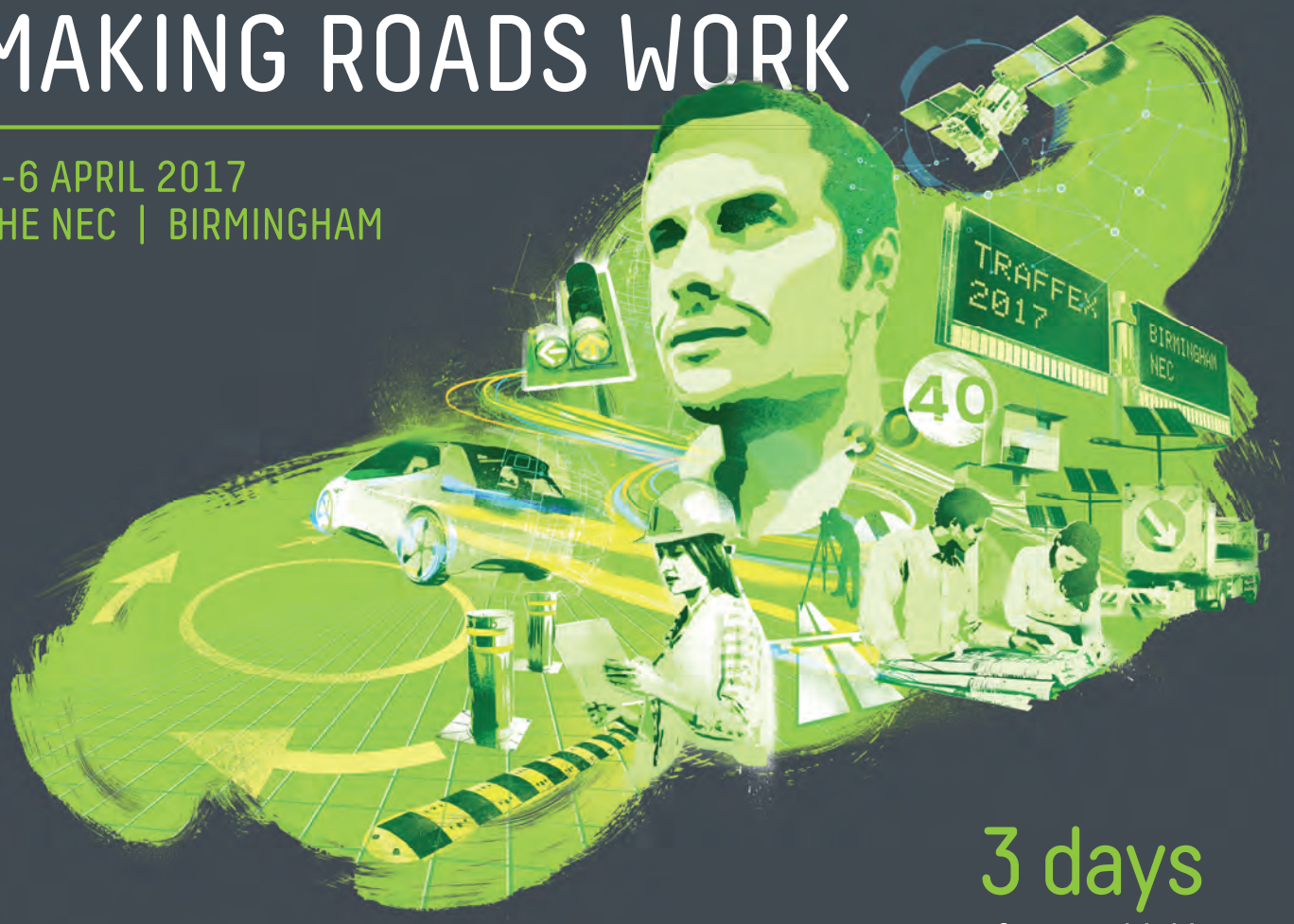

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Your essential guide to the future of transportation communications

Joining forces

The Genivi Alliance and OCF are to work together to produce open standards for V2X technology in a bid to speed up deployment

The Open Connectivity Foundation (OCF) and the Genivi Alliance have announced a collaboration on open standards for V2X, which aims to create a unified approach for connected cars to communicate in smart cities globally.

Under the agreement, the two connectivity organizations will collaborate with the W3C Automotive Working Group, which develops an Open Web Platform API specification, to expose vehicle data to web application developers.

This year Genivi plans to field test Remote Vehicle Interaction (RVI) in a smart city context. RVI is open source software that enables connected vehicles to communicate in real time with municipal infrastructures, data centers, public transit and other connected vehicles.

Joonho Park, executive director of OCF, said, "We are excited about today's announcement, which helps us build on our momentum to deliver specifications and open source components that will benefit the entire IoT ecosystem."

50 – Reverse psychology
Tampa, Florida, transport officials are testing V2X technology in an attempt to solve the increasing congestion problems in the city

58 – Russian connections
Russia is embracing transportation communication with an extensive national program of modernization underway

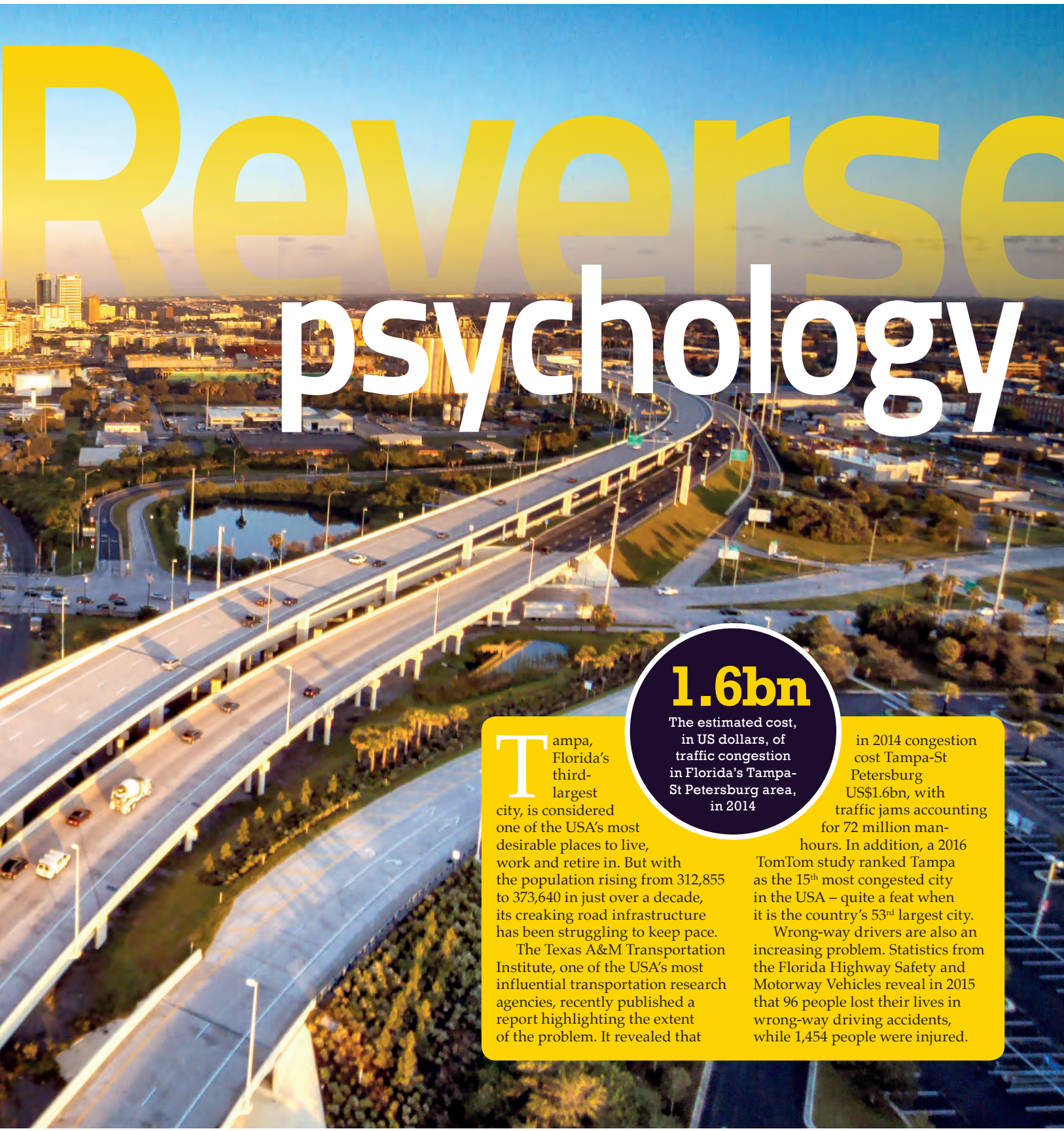
USDOT Connected Vehicle Pilot Program (Phase 2) Update

Part Three

Tampa, FL

Reversible Express Lanes in Tampa, Florida, help maximize traffic flow in a limited space. After several years of successful operation, they are now the focus for the USDOT's Connected Vehicle Pilot Program, which aims to use CV technology to reduce congestion and improve safety in the area, as James Gordon reports

Reverse psychology



1.6bn

The estimated cost, in US dollars, of traffic congestion in Florida's Tampa-St Petersburg area, in 2014

Tampa, Florida's third-largest city, is considered one of the USA's most desirable places to live, work and retire in. But with the population rising from 312,855 to 373,640 in just over a decade, its creaking road infrastructure has been struggling to keep pace.

The Texas A&M Transportation Institute, one of the USA's most influential transportation research agencies, recently published a report highlighting the extent of the problem. It revealed that in 2014 congestion cost Tampa-St Petersburg US$1.6bn, with traffic jams accounting for 72 million man-hours. In addition, a 2016 TomTom study ranked Tampa as the 15th most congested city in the USA – quite a feat when it is the country's 53rd largest city.

Wrong-way drivers are also an increasing problem. Statistics from the Florida Highway Safety and Motorway Vehicles reveal in 2015 that 96 people lost their lives in wrong-way driving accidents, while 1,454 people were injured.

1,500
The total number of private vehicles being equipped with new hardware as part of the CV Pilot in Tampa

Above: **Tampa is only the USA's 53rd largest city but is the 15th most congested**

In March 2016 a policeman was killed in a head-on collision on the Lee Roy Selmon Reversible Express Lanes (REL), a stretch of road owned and operated by the Tampa Hillsborough Expressway Authority (THEA).

Although the first fatality on the REL (where traffic flows are reversed depending on the time of day) since it opened in 2007, Bob Frey, THEA's planning director and project manager for the Connected Vehicle Pilot Deployment Program, says, "Wrong-way drivers are a growing cause for concern and we are hoping this next-generation technology can play a role in providing motorists with the information they need to make safer decisions. This ground-breaking USDOT Joint Program Office initiative to develop and test CV technology will also have a profound effect in helping to reduce gridlock and solve key real-world traffic issues that Tampa commuters experience daily."

The project will enable 1,500 private vehicles, 10 commuter buses and a Tampa Electric Company (TECO) streetcar to communicate with each other and the surrounding traffic infrastructure.

Team building

THEA assembled a team of 14 key stakeholders to work on the US$17m CV program, a three-phase initiative, which began in September 2015, will deploy by April 2018, and is due for completion by October 2020. The team includes the City of Tampa, the Florida DOT, the Center for Urban Transportation Research at the University of South Florida, and the Hillsborough Area Regional Transit Authority.

> Wrong-way drivers are a growing cause for concern and we are hoping this next-generation technology can play a role in providing motorists with the information they need
>
> **Bob Frey, project manager, Connected Vehicle Pilot Program**

For technological insight, THEA brought in Siemens, Europe's largest electronics firm, to oversee the systems engineering and roadside infrastructure deployment; HNTB Corporation, one of America's most established civil engineering consultancies for program management; and aftermarket vehicle technology supplier Brandmotion.

With design, deployment and testing currently underway, HNTB's senior project manager Steve Novosad says, "Our aim in the next 20 months is to develop, equip and test a complex system of wireless in-vehicle mobile devices and roadside technology. We plan to install 40 roadside units (RSU), in a test area spanning one square mile."

Onboard units (OBU) will be retrofitted on buses, streetcars and private vehicles. As well as hardware, a software app is being developed for pedestrians. The RSUs will be connected to Tampa's Traffic Management Center via satellite.

Novosad, who confirmed the OBUs and RSUs will be deployed by April

Street (car) smart

A further aim of the Connected Vehicle Pilot deployment in Tampa is easing congestion for the city's public transport network. THEA has identified Marion Street, which is a key corridor for the city's buses, and Tampa's Channel District and historic Ybor City, which is a vital artery for the city's iconic yellow street cars, as its key areas of focus.

"As well as utilizing the two pedestrian applications, in certain cases buses will be allowed to request and will receive priority at traffic signals," says Steve Novosad. "With bus stops very close to traffic lights near the bus terminus, buses that have stopped to drop off or pick up passengers can easily fall behind schedule. If instrumented buses are delayed, the OBU will transmit the vehicle's position in real time to the traffic signal, which will give the bus a green light. However, priority will not be granted if the bus is on schedule. In this case the driver will receive no alert and the RSU will simply wait for the next request.

"In regard to the TECO Line Streetcar, by traveling on it ourselves we identified a serious safety issue. Each trolley bus reaches speeds of only 10mph, making it very tempting for drivers and pedestrians to overtake or cut it in front of it. So, we developed the vehicle turning right in front of a transit vehicle application, which sends an audible alert to the trolley driver."

2018, says testing will focus on six user cases, including wrong-way entry, improving pedestrian safety, minimizing peak rush hour congestion, and better regulating traffic signals for pedestrian and vehicular commuters.

The workings

So what will this infrastructure look like and, more importantly, how will it exchange and make use of information?

Who better to ask than Siemens ITS's principal systems engineer, David Miller? Having spent the last decade working on CV projects in the USA and Europe, there is very little Miller, who has been working on the project since March 2015, doesn't know about CV technology.

"There are three main servers: traffic management, RSU master and transit management," he explains. "The traffic mainframe is manned by the City of Tampa and the other two systems are used by the various agencies."

Data from the traffic server, which conforms to NTCIP 1202 regulations, is transmitted to a wi-fi-enabled advanced transportation controller (ATC), that meets the NEMA TS 2-2003 signal controller standard before it is pushed out to one of the traffic signals in the test area.

40
The total number of roadside units being deployed in Tampa's one square mile test area

"The ATC is a cornerstone of the technology," says Miller. "Not only does it relay real-time data to the RSU master and transit servers, but also feeds information to the 40 RSUs, which is then distributed to the OBUs on cars, streetcars and buses through seven dedicated short-range communication (DSRC) channels and to pedestrians via a bespoke wi-fi connection."

The V2I and V2V technology will enable motorists, pedestrians and cyclists to receive and send real-time warnings, as the DSRC technology, which leverages both IPv4 and IPv6 tunnels, broadcasts a car's position, direction, elevation and speed of travel 10 times a second securely and without identification of the driver or vehicle to maintain privacy.

Miller explains, "The RSUs, each the size of a video camera with two antennas and mounted on traffic

Above: **The direction of flow on the reversible express lanes is changed depending on the time of day**

signal gantries, allow traffic lights to communicate with equipped vehicles in real time, providing motorists with audible warnings through the OBU in regard to color sequencing and also issue a countdown as to when the signal will turn green."

How does the technology aid pedestrians who might be crossing a busy junction in the study area? Take the George E Edgecomb Courthouse on Twiggs Street, for example, which is busiest on Mondays for jury selection. Then, as many as 400 people, have to negotiate a busy junction to enter.

"The PED-X and PED-Sig apps, which are being trialled on roads parallel to the courthouse, work in much the same way as the OBU in a car," says Miller. "The only challenge we encountered is that drivers and pedestrians cannot use the same frequency band. Therefore each RSU has been specially programmed to translate the personal safety message issued by the phone into a basic safety message (BSM), which gives the walker warnings of approaching vehicles at a crossing and also gives drivers warnings of pedestrians and cyclists ahead."

11

The total number of connected vehicle applications being tested across 1,500 vehicles in Tampa

> Drivers and pedestrians cannot use the same frequency band. Therefore, each RSU has been specially programmed to translate the message issued by a phone into a basic safety message
>
> **David Miller, ITS principal systems engineer, Siemens**

Saving lives

Miller believes this cutting-edge CV technology could help reduce the 34,000 fatalities recorded on US highways last year. It is a view shared by Novosad: "The deployment team has created 11 CV applications, which issue curve speed, forward collision and red light violation warnings. We have also created an intelligent traffic signal system and equipped 1,500 vehicles with probe-enabled data-monitoring software, which means they can now feed back traffic accidents to us in real time."

With safety and mobility being the central aims of the project, a key element is eliminating wrong-way drivers on the area's unusual REL and reducing rush-hour traffic. "At the peak of the rush hour it is not unusual for commuters to experience a queue of over a mile at the end of the REL," says Novosad. "To alleviate gridlock and reduce safety issues we will deploy the curve speed warning, forward collision warning and emergency electronic brake light (EEBL) apps, as well as better regulating our traffic signal systems. To combat the problem of wrong-way entry we've also developed several other apps, including intersection-assist technology."

How do the apps alleviate congestion and protect the public from those who accidentally drive against the flow of traffic?

"The westbound REL ends on a gentle curve," says Miller. "But the issue is that drivers cannot see the build-up of traffic until they are almost on top of it. By relaying BSMs to the instrumented cars around it, the curve speed warning app can calculate and notify the driver of the safe curve speed, thus minimizing rear-end collisions.

"If a driver ignores the warnings or misjudges the safe stopping distance, the EEBL will notify all

Top: **OBUs can transmit a delayed bus's location so the traffic lights will change in its favor**

Right: **The technology is also helping pedestrians to cross roads safely**

vehicles in the area of an incident of heavy braking.

"The intersection movement assist and forward collision warning apps works in exactly the same way," says Miller. "When an equipped vehicle identifies a wrong-way vehicle, the OBU broadcasts an audible warning to the driver and to all the other instrumented vehicles in the area, as well as the TMC. The forward collision warning app triggers a warning when a car senses an imminent head-on collision."

Crossing the Meridian

Meridian Avenue, also owned by THEA, is the entrance and exit to the REL, making it one of Tampa's busiest rush hour streets. To help, the CV pilot team will deploy up to 40 RSUs to improve traffic flow for commuters.

Novosad explains how V2I and V2V technology will contribute. "We'll use PED-X and PED-Sig apps as well as the intelligent traffic signal system (I-Sig). With RSUs able to feed back data to the TMC 10 times a second, if there is a sudden surge in commuters, we can better regulate the signals on Meridian Avenue and also notify other CVs."

20

The maximum percentage increase in traffic mobility predicted in Tampa by 2020 as a result of the CV Pilot

Above: **Tampa's reversible express lanes are built on an elevated section of freeway**

There is a long way to go before this vision can be realized, but with the CV deployment program not set to be completed until October 2020, there is still plenty of time. So what are the ultimate ambitions?

"We are hoping to see a marked improvement in safety and a 15-20% improvement in mobility of city traffic," says Frey. "We forecast savings in fuel of 7% and 5-6% in CO_2 emissions. It would be nice to realize that level of benefit. Overall the CV pilot deployment will provide the Tampa Bay area with another set of tools to enhance safety and operational capabilities of the region's mobility options. And finally, it's hugely satisfying for the multi-agency project team to be part of the USDOT CV pilot program in deploying this trailblazing technology in Tampa."

> The CV Pilot Deployment will provide the Tampa Bay area with another set of tools to enhance safety and operational capabilities of the region's mobility options
>
> **Steve Novosad, senior project manager, HNTB**

Wyoming

Last issue (January 2017) *Comtrans* focused on the second location in the USDOT's Pilot, Wyoming, where CV technology is being used to make I-80 safer in extreme weather conditions. Read it at tinyurl.com/wyomingi80

New York

In our October/November 2016 issue, we brought you our first report on the USDOT's Connected Vehicle Pilot, in New York City. You can access the feature online for free at tinyurl.com/nycpilot

CV Pilot phases

All three locations in the Pilot Program are organized in four phases

Phase 1
Concept development
Duration: 12 months
Status: Completed September 2016

Phase 2
Design, deploy, test
Duration: Minimum of 20 months
Status: September 2016 – April 2018

Phase 3
Maintain/operate
Duration: Minimum of 18 months
Status: Has not begun

Phase 4
Ongoing post-pilot operations
Duration: Ongoing
Status: Has not begun

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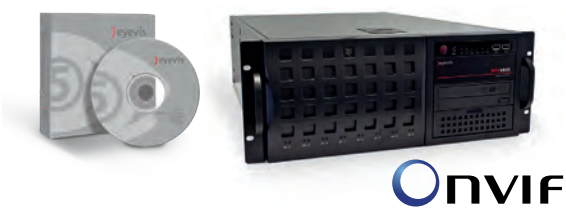

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Russian connections

Moscow cannot ignore the huge benefits of transportation communications any longer, and is consequently moving ahead with an extensive national program of traffic technology modernization, as **Eugene Gerden** reports

As of January 1, 2017, it is mandatory in Russia for new cars to be equipped with the nation's ERA-GLONASS in-car emergency system. This communication technology is based on the European standard eCall/E112, which issues an emergency call from a vehicle in the event of an accident. It is hoped the introduction of ERA-GLONASS will help to significantly reduce deaths from traffic accidents. It is just one of a growing number of ways in which the Russian government is moving to facilitate the rapid introduction of connected vehicle technology.

Analysts at J'son & Partners Consulting found the popularity of ERA-GLONASS managed to propel the Lada Vesta car, which is pre-installed with the system, into fourth place in overall sales rankings in Russia, clocking up 42,500 units from January to October 2016.

Other areas of growth in the Russian transportation communications market include automated toll collection (Platon), connected infotainment systems, connected video surveillance systems and smart insurance via telematics.

To date, rapid development of the industry has been prevented by the lack of legislation in this field. However, this situation is now changing as the Russian government, and in particular the Ministry of Transport, has started developing laws that will regulate the domestic sphere of transport communications.

New legal framework

At the heart of the planned legislative base is the existing federal law. In addition, the government is designing a series of national standards and industry guidance documents that will be focused on the creation of conditions for the introduction of connected car, V2X and other similar technologies.

Above: **New Russian cars must be equipped with ERA-GLONASS communications technology**

Left: **At the heart of Russia's ITS revolution is Moscow's new state-of-the-art traffic management center**

According to Alexander Gurko, president of the GLONASS Union, a federal network operator in the field of navigation, planned legislative acts will regulate the establishment of the necessary infrastructure for the deployment of the new technologies and will set new requirements for onboard equipment.

"It is believed that up to 80% of road accidents could be prevented by using V2X technology," says Gurko. "The introduction of such technologies is currently being tested by Kamaz, Russia's leading truck maker. Similar plans have also recently been announced by Gaz Group, another leading Russian auto producer. In general, the development of these technologies in Russia has been slower than in Europe, the USA and China, where hundreds of standards in this field have been approved with a number of pilot projects."

> It is believed that up to 80% of road accidents could be prevented by using V2X technology
>
> **Alexander Gurko, president, GLONASS Union, Russia**

New navigation

The Russian navigation industry is still dominated by imported modules, which remains a major obstacle for further development of the industry domestically. In response to this situation, the Russian government is now allocating up to US$100m to fund domestic navigation startups.

US$100m

The amount the Russian government is allocating to fund domestic navigation startups

According to Igor Levitin, an adviser to the Russian president and responsible for the introduction of communications technologies in the field of transportation, this will also help to protect Russia's state security by reducing its dependence on western technologies.

New space race

In addition to GLONASS, new standards will be developed by the experts at Russian Space Systems, the country's leading enterprise in the field of space device engineering.

Vladimir Puchkov, a senior project manager in the Space Technologies and Telecommunications Cluster at the Skolkovo Foundation, expresses confidence that successful implementation of these state plans will help to form a precision navigation network.

A final piece of the connected vehicles jigsaw for the Russian government is the building of smart roads. The first road in Russia specially designed for autonomous vehicles, as well as cars equipped with V2X, will be built on a section of road between the cities of St Petersburg and Novorossiysk by the end of this year.

The volume of investment in the project is currently not disclosed, but according to an official spokesman for Maxim Sokolov, Russia's Minister of Transport, every mile of the new road will be equipped with sensors, which will help to optimize traffic and minimize congestion and traffic jams.

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From the publisher of
Traffic Technology International

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Next-generation speed enforcement technology

There are a number of requirements clients expect from their traffic technology supplier, including accuracy, versatility, innovation and value for money. Truvelo is a company that provides all the above. Formed in September 1993, it now offers UK Home Office type-approved products for handheld use (ProLaser 4), mobile operation (Laserwitness) and fixed-site operation (D-Cam P speed and red light camera).

The ProLaser 4 speed meter offers a fast target acquisition time and a high-contrast low-power OLED (organic light-emitting diode) display. A count-up timer and speed lock are just two of the features favored by operators. Coming soon, and on show at Traffex, is the LaserCam4 device with built-in camera.

In recent years, UK police have tended toward a policy of night-time as well as daytime mobile speed enforcement. This is in part due to improvements in the technology available. One example of this is the development and introduction of the Trimms infrared (IR) lighting technology for use with Laserwitness.

Truvelo's LaserCam (below) **and Via-Cam** (right)

The Truvelo make and model solution is essentially a Trimms floodlight that can be mounted alongside the mobile enforcement vehicle on a tripod or fixed to the rear door. The Laserwitness operator tracks an oncoming vehicle from 200-300m away, recording a short video-clip tracking history until the vehicle enters the wide-angle beam of the Trimms lamps. This provides high-quality make and model defined images, even in the darkest of rural locations.

Supporting cast

As IR technology improves, so do the results and the distance at which they can be achieved. To supplement the success of Trimms, the company has introduced a new generation of power packs specifically for powering Trimms through and beyond a full shift, while still being hand-portable.

The Laserwitness offering is further enhanced with the introduction of Frame-Sender, a short-range video transmission system, used solely within the enforcement vehicle to present images on a large screen.

Calvin Hutt, Truvelo's sales manager, comments, "Laserwitness is now an even more compelling proposition for safety camera partnerships with all the enhancements we have introduced. New customers continue to come on board as we do more and more demonstrations of the night-time capability. We have almost 60 systems in use in the UK now."

Truvelo's D-CAM speed and red light camera system is perhaps the most impressive example of the company's innovation and versatility. The D-Cam provides front or rear photography, speed enforcement and speed on green enforcement all in one package. The system is also compatible with any type of

Need to know

Mobile speed enforcement checks are now possible at night as well as during daytime

- The handheld ProLaser 4 has a high-contrast low-power OLED display
- The Laserwitness incorporates Trimms infrared technology and offers a variety of mounting positions on an enforcement vehicle
- The Frame-Sender video transmission system supports the Laserwitness
- Via-Cam is aimed at speed control on industrial sites

signal head. It is the combination of front and rear photography that allows the introduction of simultaneous bidirectional sites. This means one camera can provide live enforcement, on demand, on opposing lanes of traffic.

A more recent innovation is the move into speed camera technology for the industrial sector client. Large sites like steel works, car manufacturing plants, quarries, ports, etc have a potentially risky mix of employees and vehicles exceeding the site speed limit.

Where Tru-Sign vehicle-activated signs or speed humps don't cure the problem, there is Via-Cam. The radar-activated camera can be deployed front- or rear-facing and captures a single day or night image per offense. Launching for the first time at Traffex, the camera has already gained some notable orders from blue-chip customers.

Among the many features is the ability to capture approaching or receding vehicle images with one camera, and to set different speed limits for each direction. The image capture point can also be set at a defined distance from the camera to optimize zoom and focus settings, and, of course, IR lighting means it can be deployed at night or daytime.

All these products and innovations can be seen at Stand F31 at Traffex 2017.

by **Neil Hoose**

Pinpointing the 'smart' in transportation networks and applications

Over the past couple of months I have taken part in several workshops on the future of smart highways and smart cities. As you might expect, the discussions ranged far and wide but one common theme struck a chord with my early academic training in transportation. The workshop debates often led to a key feature of transportation networks that has been known for a long time, stemming from seminal work by John Wardrop in the mid-twentieth century: network optimum and traveler optimum are not the always the same.

If 'smart' means optimizing the use of resources and minimizing the external effects of travel, congestion and environmental effects, then which optimum will the system seek? This depends on whether we consider smart travelers or smart transportation networks.

A smart traveler gathers all the information available and uses it to find the best trip characteristics. For example, the time of travel, the modes used, the routes followed and the costs incurred according to the personal preferences that their smart technology has acquired – either directly or through learning from previous trips. These aims may not be entirely selfish, as travelers may seek to minimize their carbon footprint or the amount of exhaust pollution they emit. They may show further altruism by sharing information about the state of the network that they have observed, for example by using social media to give warnings of queues, or allowing data gathered during their journey to be used by a third party. However, they expect their smart mobility service to meet their personal requirements and not compromise any of them to meet someone else's.

A smart transportation network gathers all available information and uses it to advise or control the trip characteristics in order to apportion scarce resources, create the best overall travel patterns for the network, and minimize negative travel experiences for both travelers and non-travelers. It may use information provided through the altruism of smart travelers but, if that is insufficient, it could be a result of an obligation that is part of the conditions that allow access to the network in question. In other words, if you want to use a smart network you must be prepared to share data about your movement across that network. The transportation network operator may seek to satisfy the needs of travelers but it will not do this to the detriment of optimizing the network as a whole.

"Smart networks and applications need to recognize the existence of each other"

Clearly smart travel applications and smart transportation network management need to recognize the existence of each other and find a way of working together. At some point individual travel options will start to impede each other to the point where the individual can no longer obtain any benefit and the overall situation for the transportation network will be less than optimal. Ideally, before this situation arises the smart transportation network will be able to take over and work toward a transportation network optimum, even though individual travelers may still not be able to get the best possible routing. The mechanism by which this collaboration may be brought about is not yet clear, but without it, will either be smart enough to make a significant difference to the efficiency of travel in crowded urban areas?

Neil Hoose is an independent ITS consultant and owner/director of Bittern Consulting Limited ***info@bittern-its.com***

Transforming urban areas into smart cities

Founded by Cross Zlín, software developer Incinity has created Invipo – a software solution for traffic, ITS and smart cities.

Cross Zlín, which has more than 20 years of experience in developing products, components and turnkey solutions for road traffic, has split its smart city initiative into two complementary procedures.

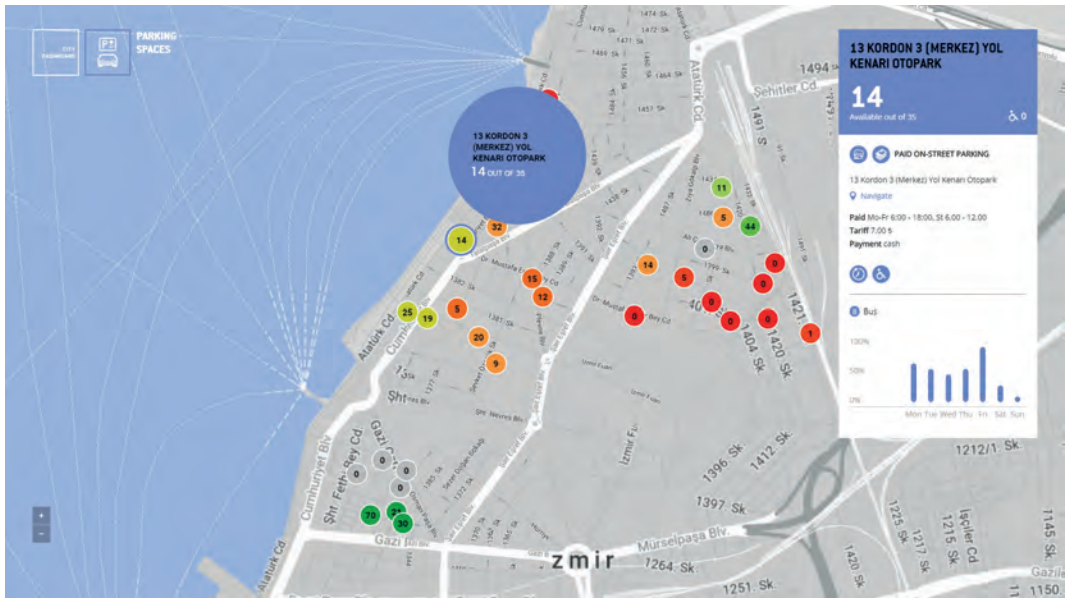
The first process is monitoring traffic technology, such as road traffic stations, traffic light controllers, weigh-in-motion systems, parking systems and traffic counters. The second process – which is also Incinity's main goal – is the development of the software platform that integrates these technologies and makes them interoperable for end users. The success of this technological cooperation was proved in a smart city case study in Izmir, Turkey.

The new buzzword

As there is no official definition for the term 'smart city', it has become something of a buzzword. Incinity attempts to define smart city in the simplest and most comprehensive way: A smart city is one that uses modern technologies and data from these technologies for information acquisition to create services that make its operation and control more efficient. It is a city that transforms data into information that can help to improve the quality of life for citizens living in urban areas.

Size doesn't matter

For every municipality, the implementation of smart city technology remains similar regardless of the size of the area. The approach is comparable and differs only in the complexity of each given case.



Above: **Online parking occupancy is displayed on Invipo's public web application**

Need to know

A smart city is one that uses data to improve the lives of citizens

- Izmir is currently the largest city in the world to incorporate Cross Zlín Smart City technologies
- Road journeys across the city take 30-50% less time since it became a smart city
- Cross Zlín has over 20 years' experience in traffic device development

First, it needs to deliver new in-field technology to the city. The technology must be integrated into existing local data sources and other data providers. Then, a network capable of interconnecting information throughout the city has to be established, server housing and hardware environment allocated, and adequate data storage created – or expanded if such storage already exists.

Once this basic data infrastructure is in place, the implementation process is completed with the installation of an integration platform for monitoring, maintenance, control and analysis. This infrastructure provides city intelligence in the form of smart scenarios, rules and validation. In the final step, Incinity delivers information to the city's public web portal and mobile application, both of which are accessible by citizens.

Smart city: Izmir

With four million inhabitants in the metropolitan area, Izmir, Turkey's third-largest city, served as an ideal area to implement smart city technologies and observe the improvements that the local population experienced as a result. The project began in 2014 and has not only become the largest smart city project in the region, but has also developed into the largest project of its kind in the world.

The project was launched with the aim of improving traffic congestion, improving public transit services, gathering information from the city in order to inform citizens via the mobile app, and establishing new city services to become the first 'smart city lab' in the region.

Putting the plan into action

To turn such a complex project into a reality, more than 4,000 traffic technology devices and other services were implemented. Cross Zlín installed more than 400 traffic signal controllers, hundreds of red light and other enforcement systems, more than 200 traffic counters, 130 pedestrian zone

Left: **Invipo's city dashboard shows traffic, weather and parking information**

Below: **Parking spaces are monitored according to location and occupancy**

bollard entries, 1,500 GPS-tracked buses, 2,000 on-street parking spaces, more than 30 monitored parking lots, 110 CCTV cameras, and 100 variable message signs.

The system's functionality was made possible by establishing an adaptive traffic control system, public transportation prioritization, and the use of violation registers, management of parking places and pedestrian zones access, statistics and reporting tools, a public 'city dashboard' portal and an application for handheld devices.

The results

Noticeable benefits soon became apparent. Traffic flow improved greatly, saving drivers 30-50% of time on long and short routes. This was demonstrated by comparable measurements of test drives with and without adaptive traffic signal control on selected roads with heavy traffic congestion.

The project also provided new data and statistics that could be used for reporting, not only for traffic but also in wider contexts. Combined with a complete set of historical data, this enabled before and after comparisons.

The city's new intelligence is based on a complex rule engine that makes use of the interoperability between the systems and devices that are installed throughout Izmir.

Steps to a smart city

Planners preparing for the huge challenge of creating a smart city should address several key points.

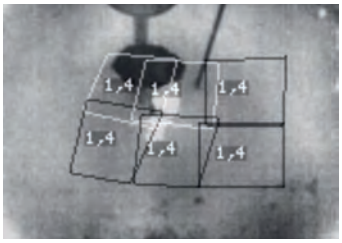
Expect the volume of data being collected to double or even triple. This increase in volume requires detailed groundwork and preparation. Remain flexible and open-minded, and expect changes throughout the project. City planners must also acknowledge the unlikelihood of the first version of the project's schedule surviving, regardless of how precisely it was created. Planners should be aware of the need for 'reinventing' city systems with smart technology. Even though the city may not know what it is required for it to become smarter, the implementer must help it to discover this. Common sense must be applied, taking the bigger picture of the project into consideration. City planners should remember the importance of simplicity in such a large-scale project. They should also consider using project prototypes. Lastly, it should be remembered that everything is measurable; it is essential for making before and after comparisons. ○

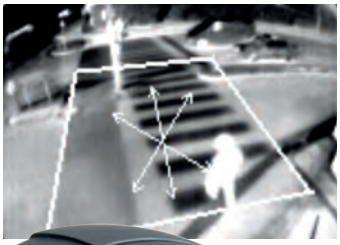
Smarter road crossings for improved traffic flow

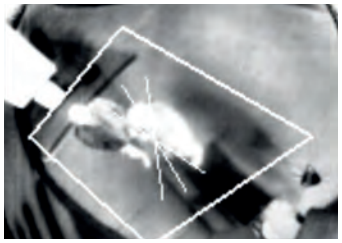
Cities are making efforts to promote pedestrian traffic and encourage people to leave their cars at home. However, pedestrians are not always taken into account in traffic circulation planning.

Most signalized intersections have constant interaction between motorized and slower-moving traffic (pedestrians and cyclists). The challenge is to optimize signal timings so delays are minimized.

Intersections with no detection mechanism in place make use of fixed signal cycles. Obviously, these timings are not adapted to the real-time traffic situation so do not optimize traffic flows.







Above: **The TrafiOne system uses thermal imaging to identify and adjust the crossing times for pedestrians if necessary**

Pushing buttons

The classic way to adapt traffic to the presence of pedestrians is the push button for green calls. Although this is a good way to improve the safety of pedestrians, many issues remain when it comes to traffic flow. The biggest issue probably is non-compliance. A typical situation is when a pedestrian pushes the button and starts crossing the road without waiting for the green phase. As a result, the green phase will start after the pedestrian is long gone, leaving the idling vehicles behind in needless frustration.

However, there are ways to tackle this. The Dutch city of Haarlemmermeer offers one example. Traffic officials have installed smart sensors to verify the green call of any pedestrian pushing the button. In other words, if a pedestrian pushing the button walks away, the call for green is canceled, so there is no direct influence on the vehicle traffic flow.

This may seem a minor change, but the number of people who don't wait after pushing the button is actually very high: statistics point at 30% of pedestrians during rush hour, and up to 70% at other times.

Haarlemmermeer chose the TrafiOne smart sensor from Flir Systems. It is an all-around detection sensor for traffic monitoring and dynamic traffic signal control, using thermal imaging to detect the presence of pedestrians approaching or waiting to cross the road.

Night and day vision

The benefit of thermal imaging sensors is they can see in total darkness, through shadows and sun glare, providing reliable traffic detection 24/7. The Flir TrafiOne sensors are connected to the traffic signal controller via dry contact outputs or via TCP/IP network communication to allow for a more dynamic control of traffic signals based on presence or volume information.

Multiple possibilities

Haarlemmermeer is just one example of what smart pedestrian detectors can do. But the technology makes the implementation of many other smart mechanisms possible.

Typically, a certain amount of clearance time is provided for pedestrians to cross the road. During this time, all traffic signals are in red phase to keep vehicles waiting, preventing possible collisions. Pedestrian detectors can be used to extend the crossing time for elderly and less mobile people. They can also be cut when no pedestrians are present, so as to avoid unnecessary delays.

A countdown timer is often used to indicate the time left for pedestrians to cross the road. By measuring how crowded the curbside is, the countdown timers can start at a more optimal value.

Intersections near schools, business centers, shopping malls and sports stadia struggle to cope with the changing pedestrian traffic flows during the day, as fixed signal schemes do not match the actual situation at different times of the day. Pedestrian sensors can give extended green times for larger groups of people so they can cross the street all at once.

The ultimate step in making the intersection pedestrian-friendly is making the push button redundant and replacing

Need to know

New technology can help ease traffic congestion

- The ratio of peak travel time compared to free-flow increases by 5-10% every year
- In rush hour, 30% of pedestrian crossings are unused when signals turn green; 70% at other times
- Flir TrafiOne is connected to the traffic signal controller and detects if the crossing request is no longer required by a pedestrian

Above: **Pedestrians can be detected regardless of lighting and weather conditions**

it with detection-based control. But then, the effectiveness of pedestrian detection totally depends on the performance of the detector. That's why it is very important for traffic engineers and technicians to have a field-proven detection product, because false or missed detections can have a negative impact on the safety and efficiency of the intersection.

For Flir Systems, a global leader in thermal imaging, thermal imaging is without a doubt the way forward, if only because of the robustness of the technology. Thermal cameras and sensors can see a pedestrian day and night, and in very difficult weather conditions, including rain or light fog. Add to this the ease of integration from a product like the Flir TrafiOne, and you realize push buttons could soon become a thing of the past.

Tolling relies heavily on the performance of back-office systems

by **J J Eden**

One consistent component in all tolling environments, no matter what type of system is used to capture the transactions, is the back office. Whether a tolling organization uses all-electronic tolling, open-road tolling, invoicing or violation noticing, the back office receives these transactions and must appropriately process each using the applicable business rules.

It serves as the customer interface for the entire tolling program. Both back-office systems and the operations business rules and staff must work effectively to assure the highest levels of accuracy and customer service.

The one area paramount to attaining the required standard is quality management (QM). Unfortunately, some toll agencies choose not to implement QM programs. Some implementing these systems cut back on QM as demands rise and staffing levels become challenging. This causes QM to become a box to be checked rather than the integral cog in the operational wheel. A complete QM program needs to include more than just monitoring phone calls and spot-checking processed work. A thorough QM program needs to assure compliance in all areas including: contract management, customer contact reviews, image process auditing, transaction processing validations, continuous report validation and key indicator trending. Other areas such as ITOLS, transaction rejects, image automation levels and accuracy, invoicing accuracy, and department of motor vehicle statistics, are also often overlooked by a conventional quality assurance (QA) system.

A solid program needs to include both the control and assurance of quality. Quality control provides the monitoring, auditing and validations necessary to assure benchmarks are being met. QA provides a way to assure they maintain consistency as program rules and systems evolve over time. Many people assume the two are interchangeable when in fact are distinct parts of a good QM program.

The other critical element necessary in any QM program is timely and valuable reporting. As with any back-office system, the ability to manage that system is only as good as the reports used to control the program. Quality controls and assurance can only achieve the essential consistency if they produce the information needed to allow management to make the necessary adjustments. Quality reporting needs to show compliance levels during operational periods, as well as quality trends over time. Management needs to be able to see the performance against key benchmarks and whether it is heading in the right direction.

> "One area paramount to accuracy and customer service is quality management"

Having a consistent QM program with a centralized quality reporting system also allows for timely and accurate responses to outside inquiries about program accuracy and levels of customer service. When a tolling agency must respond to a legislator calling on behalf of a concerned customer, a timely, accurate and thorough response leads to greater program credibility. When implementing a system, ask yourself could your agency produce real-time reports showing the quality and accuracy levels of your program over extended periods of time? Or, will you be sorting through numerous Excel spreadsheets trying to figure out what your quality levels actually are?

J J Eden is director of tolling at Aecom
james.eden@aecom.com

Finding common communications in sensor technology

In recent years, Q-Free has worked to bring innovation to the parking sector by drawing on its tolling experience. It has created barrier- and cash-free parking solutions that enable travelers to enjoy the benefits of mobility at ever-greater levels of convenience.

Q-Free has created a new, low-power, radar-based sensor which, when combined with a new cellular-based narrowband communications technology called NB-IoT, will significantly reduce the cost of installing and operating smart parking systems. The new sensor is currently being tested in a pilot project in the Norwegian city of Trondheim.

Q-Free's efforts are in line with several broad trends. These include: a move toward open-standards solutions, as procurement agencies look to be freed from suppliers' proprietary offerings; the removal of institutional barriers between once-discrete technology applications such as parking and traffic management; and the increasing focus on the road user as a customer, and efforts to improve the 'journey experience'.

Thanks to Q-Free's parking sensor (middle)**; NB-IoT is provided via a cellular network and can help to reduce the cost of deploying parking solutions**

Standards and technologies

Smart objects and devices are the building blocks of smart cities and communities and are forming the so-called Internet of Things (IoT).

Increasing levels of system awareness are enabling good-quality information services and applications to be created – many of them operating in real or near-real time. Allied to good-quality apps is the need for good-quality – and preferably unbroken – wireless connectivity. Often regarded as inexpensive compared with traditional hard-wired solutions, these can in fact still require considerable planning, infrastructure and financial outlay. It is also often assumed that technological progress will allow us to do more with less. This is true to a degree, however there is no avoiding the fact that very few new or improved capabilities can be had without some form of additional cost.

Within the wider ITS sector, communications protocols are also evolving. For example, the necessarily protracted development of 5.9GHz-based technology, with its zero-latency characteristics, has led to discussions about whether custom-made solutions are the answer for safety-related Cooperative ITS (C-ITS) applications, or whether mass-market communications solutions (such as 5G cellular) might be the way forward.

As far as C-ITS is concerned, the answer, at least in the near- to mid-term, will probably be a combination of the two, with others. However, there is merit in looking at how to use mass-market communications technologies for non-safety ITS and smart city-type applications.

Some ITS/smart city sensory tasks (such as the collection of traffic volume and flow data) have already been divested to apps in travelers' self-bought smart devices. By going down this route, service providers significantly reduce or even eliminate their hardware development, production, installation/distribution and maintenance costs. The potential to do the same with communications infrastructure is obvious; the sticking points are power and bandwidth requirements. However if these issues can be resolved, then the realization of communications

Need to know

Q-Free is a supplier of intelligent transport system (ITS) solutions and services

- The smart parking sensor pilot was launched by Q-Free alongside Telenor and the Norwegian Public Roads Authority (NPRA)
- The Trondheim, Norway, pilot involves the Narrow Band Internet of Things (NB-IoT) being tested with the sensors
- The sensors could help to reduce congestion and pollution in urban areas because they provide information on available parking spaces, saving drivers search times

infrastructure able to support smart city-type applications will become less expensive.

Mass market for the niche

In collaboration with Norwegian-headquartered mobile telecommunications company Telenor, this is precisely what Q-Free has been exploring in the Trondheim pilot. In recent months, NB-IoT has been standardized under the 3G Partnership Project (3GPP). It is based on LTE/4G wireless telecommunications and, in most cases, all that is required for it to be provided is for telecommunications companies to upgrade the software in their base stations. The base stations then provide a number of narrowband channels that feature a relatively low data rate and much better link margin (range). Compared with LTE, the new protocol is simplified and the power consumption is lower. This enables sensors and other devices to be employed with no external power connections – something that has so far not been achieved with LTE. NB-IoT also solves a current machine-to-machine (M2M) dilemma: the near-term shutdown of 2G and 3G networks.

Smart city potential

Huawei, Telenor's infrastructure developer, has manufactured a small number of first-generation NB-IoT chipsets and some of these have been released for use in the Trondheim project. This represents something of a coup for both Q-Free and Telenor; in the coming year, NB-IoT chipset manufacture is set to increase dramatically and early involvement in application development allows the two companies to achieve a lead in the market in terms of deployment strategy development.

A three-month development project started at the beginning of 2017, involving a series of the new radar-based in-ground sensors at a park-and-ride scheme in Trondheim, as well as a nearby Telenor base station that has been upgraded to support NB-IoT.

In specific terms, the application of NB-IoT to Q-Free's smart parking sensor solutions enables the features of its currently narrowband communications solutions to be replicated, but via a cellular telephony network. This replication includes the availability of adequate bandwidth and also extends to power consumption: the much-reduced power needs of NB-IoT enable a battery life of up to a decade.

The use of a more commonly used 'language' will enable the deployment at a reduced cost compared with many ITS that do not require zero latency.

The same communications research and technology currently being applied to Q-Free's parking technology has a direct impact on many of its other products. For example, Q-City, its smart city solution, uses a range of embedded and roadside sensors, and this initial parking-related application paves the way to incorporation of NB-IoT into the company's wider range of traffic, air quality and environmental sensors.

Versatile and efficient license plate recognition technology

Seeking to improve on the performance of earlier designs, Lector Vision has recently introduced a new automatic license plate recognition (ALPR, also known as ANPR) system dubbed Traffic Eye. Combining the best of off-the-shelf hardware with custom hardware designed and developed by Lector Vision, plus its own OCR engine, the system can be rapidly tailored to identify license plates from any country.

Traffic Eye captures monochrome images of vehicles as well as color overviews of the scene using two cameras. Software running on an advanced processor detects where the vehicle plates lie in the monochrome images, identifying the individual characters using an artificial neural network. Both the license plate number and the color overview are then identified before being transmitted to a control center.

Gonzalo Garcia Palacios, manager of R&D at Lector Vision, says: "In the past, specialized cameras were required for ALPR applications, but thanks to the performance of Flir's (formerly Point Grey) camera range, the new system can make use of off-the-shelf products."

Above: **The Traffic Eye ALPR system**

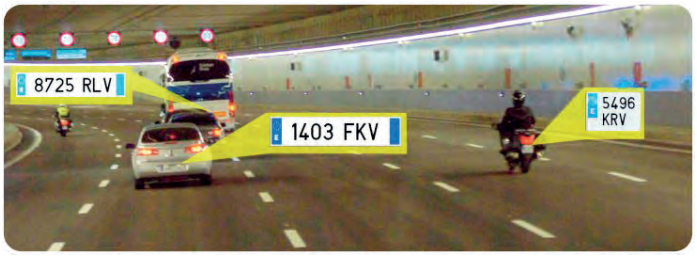
Camera equipment

The first of the cameras in the Traffic Eye system – a Blackfly 1920x1200 pixel GigE monochrome camera with a Sony Pregius IMX249 CMOS global shutter sensor and an IR filter – captures images that are analyzed by the system software to determine vehicles' license plates. The color camera has the same pixels and sensor speed to capture scene overviews.

While GigE cameras have been extensively used in the Traffic Eye system since its introduction in 2013, the modular nature of the processor and control hardware means the company is not restricted to one camera interface.

In the past, many ALPR systems illuminated license plates using infrared light in the 880nm wavelength range. At 940nm, however, the intensity of sunlight is about 60% of its intensity at 880nm. Hence Lector Vision chose to reduce the level of sunlight interference by illuminating traffic scenes with a custom-built array of pulsed LEDs operating at the higher wavelength.

"The trade-off when using higher-wavelength LEDs is that the sensitivity of the sensor in the camera to light at 940nm is somewhat reduced," says Palacios. "To compensate for this, a control system in the Traffic Eye pulses the IR LEDs for microsecond intervals, producing an intense strobed IR light that can easily be detected by the monochrome camera when reflected off the license plate. As the scene is illuminated by the pulsed IR light, the controller triggers both cameras simultaneously to capture both a monochrome and a color image of the traffic scene."



Need to know

Lector Vision's Traffic Eye system

- Includes a Blackfly 1920x1200 pixel GigE monochrome camera and a Blackfly 1920x1200 pixel GigE color camera
- Both cameras have a Sony Pregius IMX249 CMOS global shutter sensor
- The system is not restricted to one camera interface
- Over 500 systems have been installed since its 2013 launch

Character reading

The images are then transferred over the GigE interface to an embedded quad-core processor in the Traffic Eye system. Here, the monochrome image is analyzed by custom software running on the processor to determine the characters on the license plates in the image. To do so, the software first searches for rectangular regions of interest in the image where a license plate is likely to be present. An edge-detection operation is then performed on the region of interest to find the boundaries of the characters on the license plate by detecting discontinuities in brightness in the images.

Having determined the location of the characters on the plates in the images, the system then identifies the individual characters themselves. To do so, Lector Vision chose to deploy a software-based artificial neural network that was first trained to identify characters on license plates by being presented with many thousands of separate examples from a single country. The neural network then uses the examples to automatically infer rules from which it can identify new unknown

characters from the images captured by the monochrome camera once the Traffic Eye system is deployed in the field.

"Once the license plate has been identified," says Palacios, "the license plate number and the image of the traffic scene captured by the color camera, as well as an optional GPS time stamp, can be sent to a control center over cable, optical fiber, GPRS or 3G, depending on the nature of the application. Users such as highways agencies who monitor traffic flow and enforce red light violations can view the two images to identify the vehicle in question through its license plate and examine an image of the car and its occupants at the precise location where the license plate of the vehicle was captured."

According to Palacios, over 500 Traffic Eye systems have been installed since the system was launched in 2013, and have proved capable of reading license plates of vehicles traveling at speeds in excess of 200km/h. Systems have been deployed in eight countries and the OCR software has also been sold as a standalone product.

In addition, the system will be upgraded so that it can detect traffic from more than three lanes on a highway at one time. Lastly the system will be improved so that it will not only read license plates, but also detect many other types of events on the road, such as traffic moving in the wrong direction down a highway and car accidents. ○

by **Larry Yermack**

The Transportation Research Board has many strengths but can improve

Early in the new year is always Transportation Research Board (TRB) time in Washington DC. I've been attending the annual event off and on for more than 30 years. I have fond memories of a more intimate gathering when the tracks were divided among three hotels. If you hung out in the lobby bar of one of them you would see all your friends over the course of several hours. But those days are gone and this last version had 13,000 registrants and is now firmly ensconced in the Washington Convention Center. What we lost in intimacy we more than made up for in depth and diversity.

I'm also grateful for when I came up in this industry when I go to the poster sessions and listen to the earnest graduate students explaining their work. I'm lucky if I can catch some of the math, but I'm always learning. I'm learning as well in the sessions, even the ones where I don't expect to hear anything new.

TRB had a pitch meeting, like *Shark Tank* (*Dragon's Den* in the UK), for start-up companies, so they are following the entrepreneurship trend, but there is another important trend they missed: how the big new ideas in transportation don't fit neatly into the committee and track structure on which the conference is built. TRB is built on a wide-ranging committee structure with thousands of volunteers and it is these committees that create the TRB program.

TRB, its committees and in fact our entire industry, depends upon our conceptual silos. Whether the subject is bridge design, pavement conditions, traffic management systems or signal systems, we talk among ourselves. It's a great way to focus on problems and we've been very successful with this approach, but over the past few years we've come to recognize its shortcomings. Simply stated, the big picture of multiple interactions is neither seen nor analyzed.

Let's take a look at what the big issues are in transportation today. They are connected and automated vehicles, road user charging, mobility as a service and, with the new administration, probably transportation finance. The problem is that none of these issues fit neatly into an established category or track.

"The TRB is still the most magnificent global intellectual gathering in transportation"

It's for this reason that this year's TRB program seemed disconnected from today's reality. There were sessions on these topics but they were hard to find amid the 'regular' subjects. And when you did find them, they were not crosscutting with the conventional ideas.

I don't mean to be negative about TRB. It's still the most magnificent global intellectual gathering in transportation every year. I'll be back again in 2018 but I do have one wish for that gathering, and that is that each committee takes a hard look at the emerging big issues and talks about how its work relates. Beyond that, TRB should establish a few multidisciplinary groups to seed the big issues throughout the conference. That way 2018 will be even better.

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

How urban planning is supporting the uptake of electric vehicles

The latest figures show that in September 2016 there were 90,000 plug-in electric vehicles (PEVs) registered in the UK, with motorists buying more than ever before. Can this momentum be sustained? Can the electricity needed for an increasing number of PEVs on the UK's roads really be met by a national power grid that is already showing signs of buckling under the pressure of today's demand?

For the EV market to continue its growth, the UK needs to take a fresh approach – and a far-sighted one – to the development of a charging network fit for the future.

Justin Meyer, general manager of eVolt, the Swarco Group's eMobility brand and supplier of electric vehicle charge points, talks about what the charging infrastructure of tomorrow will look like.

Left: **Load distribution is essential for multiple charging stations with dual sockets**

The UK government has responded to the need to cut carbon emissions, partly through Go Ultra Low, a joint campaign with industry promoting the uptake of low-emission vehicles. The expectation is that by 2027 PEVs could dominate the new car market. The long-term economic plan is to invest £600m (US$749m) by 2020, with pioneering cities – called Go Ultra Low Cities – recently awarded £40m (US$50m) of that funding to deliver innovative ideas that will encourage PEV uptake. The first few tenders from these cities show they are embracing the new technical capabilities we are developing in the charging market.

For the UK to have a future-proof charging network – worth investing in today and fit for purpose tomorrow – it is imperative local sections are built with the consideration of their impact on the national power grid.

Drivers want a quick charge – they want to get on their way without delay. Battery developments are making driving a PEV so much more accessible to so many people. Charging technology in turn has come a long way to meet this demand, with the result that we now have the charging capability to draw down power very quickly. The challenge comes when larger numbers of PEVs are demanding a fast charge simultaneously, especially at peak time, when the power grid is already under immense pressure.

Load distribution technology is key for any site with dual sockets for multiple charging docks to ensure that the total power to all points is consistently available. Not only that, but it prevents overloading and ensures power is evenly distributed, as well as redistributing power when each PEV reaches full charge so that all the connected PEVs achieve full charge in the fastest possible time. Load distribution is fundamental and necessary, but this is only concerned with managing the total available power in the most effective way.

There are currently 4,100 public PEV charging locations in the UK – a substantial rise from only a few hundred in 2011. The expectation is that by August 2020 the number of electric car charging locations will overtake

Need to know

The UK has pledged to invest £600m (US$749m) in various electric car schemes

- In 2011 there were a few hundred public PEV charging locations; today there are 4,100
- It is expected that by 2020 there will be more PEV charge points than gas stations
- One-third of the UK's local electricity networks would need upgrading if PEVs reach mass acceptance

Far left: **The UK government recently awarded US$50m to Go Ultra Low Cities to encourage PEV uptake**
Left and inset: **By 2020, there will be more charging points than gas stations**

petrol stations. Put another way, in three-and-a-half years you will find a PEV charge point before you find a petrol station. The Go Ultra Low Cities will invariably shape this growing network of public chargers. So when we look at the ambitions of these cities we can get a glimpse of the future.

Encouraging use

Dundee, Scotland, for example, is embarking on the first phase of its initiative to deliver cutting-edge technology that will encourage the use of PEVs. One of its major ideas is the opening of new charging hubs in the city that will provide links across the region for plug-in vehicle drivers. These hubs will be dedicated areas for PEV charging, equipped with rapid and fast charging units that can charge two PEVs simultaneously to 80% battery life within 30 minutes and an hour respectively.

But crucially, each hub will see a mix of green energy and energy storage to store solar and off-peak energy. To reduce the heavy demand placed on the power grid when PEVs are charging simultaneously.

It is this type of PEV charging hub that will no doubt be central to the UK's infrastructure. They will be in cities and on major highways, but what impact will this concentrated consumption have on our national grid?

With electricity consumption charged on a time-of-use basis and retrospective charges applied when consumption outstrips capacity, we can expect spiraling costs. However, this is just the tip of the iceberg. Ofgem, the government regulator for gas and electricity markets, has already reported that almost one-third of Britain's local electricity networks could need upgrading if PEVs reach the point of mass acceptance. Whether the necessary level of investment is made in time is anyone's guess and not something those connected with future developments on a local or national level should be leaving to chance. It won't be spiraling costs we need to worry about, but a prevailing darkness that falls when the local substations on susceptible networks are overloaded.

This is where peak shaving comes into play. This is the process of reducing the amount of energy drawn from the utility company during peak hours when the network is under the most pressure. An effective storage solution is imperative, especially at a PEV charging hub, but in the near future, this will be true for any site with multiple charge points offering fast charging.

Closing the loop

Some storage solutions are already demonstrating how innovators in the PEV charging sector are proactively addressing the future concerns around consumption, as we will see in Dundee, and the sector is also closing the loop between renewable energy and PEVs to improve sustainability credentials.

Lessons can doubtless be learned by seeing what other countries are doing. In the Netherlands, one charging operator with 57 locations has a real focus on sustainable consumption. It uses 100% green energy from solar panels on the roofs of its own stations, supplemented by wind energy from a Dutch wind farm.

There is a weight of responsibility for the Go Ultra Low Cities to ensure these major sections are set up correctly. With access to crucial funding, the decisions made now will inevitably make these cities the cornerstones to shape the UK's future charging network. However, even where there isn't necessarily access to funding on this scale, we are still seeing encouraging trends from some quarters, with a notable demand from private businesses, as well as colleges and universities, who are taking a responsible and forward-looking approach to new charging technology. Many are recognizing the benefits of storage solutions, and storage systems that also factor in renewable energy.

We aren't at mass acceptance of PEVs yet but that time is fast approaching. In the history of PEVs and the charging infrastructure that supports them, we are about to witness a genuine step-change.

Cutting-edge technology to reduce traffic fatalities in Jordan

In the spring of 2016, Sharihan Abu-Haswah of the Ministry of Transport in Jordan presented his findings to the Road Safety Forum in Geneva, Switzerland: "Traffic accidents cause serious threat to human life worldwide.

"Jordan has one of the highest global rates for traffic accidents involving fatalities and injuries. In 2014 there were 688 fatalities and 2,063 serious injuries. The estimated cost of traffic accidents was about JD238m [US$336m] in 2014."

Camera-based enforcement systems first came into use in Jordan in the capital city of Amman in 2003 and this first project was for only two red light camera systems.

Jordan has one of the highest rates of traffic accidents globally

Four digital radar camera enforcement systems were then introduced in 2005 in Amman.

Between 2007 and 2014, a total of 40 built-in car radar systems and red light and fixed radar were installed in Amman.

Historic tender

After experiencing the safety benefits of these automated law enforcement systems, the government decided in late 2015 to expand nationally in its largest tender ever. Instead of only the city of Amman, the tender included other northern and southern municipalities – almost all of Jordan. These 100 new systems will be deployed in major municipalities for the first time and include fixed speed and red light camera systems.

Nabil Haddad, general manager, and Ahmed Al-Otaibi, chief financial officer, of Traffic Tech Middle East/Jordan, say, "With our partner, the manufacturer Jenoptik, we have engineering professionals by our side to ensure our infrastructure investments provide intended benefits. Our relationship is based on the right combination of prices, quality and services, as well as a mutual sharing of knowledge."

Wholesale agreement

There were many bidders for this contract. However, Jenoptik won this project due to its long-standing history in the region; its global reputation; and its local partner, Traffic Tech, which provides strong local support and excellent aftersales services.

Powerful back office

One of the main selling points for Jenoptik's systems is the powerful back-office software solution, TraffiDeskPro MultiVentor, which has huge processing capabilities including the ability to deal with multiple systems from different vendors.

The project is now in the delivery stage and expected to be up and running in the first quarter of 2017. Local installation will be accompanied by a large data center with a huge storage area network system. The local software solution will include full integration between the Oracle national enforcement system and the unique Jenoptik TraffiDeskPro platform. The system is expected to handle more than 30,000 violations per day in its initial stage.

"We have been privileged to utilize the experience from Jenoptik's broad international background in large-scale traffic safety projects for a smooth roll-

Need to know

Jenoptik's systems will make Jordan's roads safer

- Consists of 100 fixed speed and red light camera systems
- The TraffiDeskPro expected to initially handle more than 30,000 violations per day
- Client will increase project scale, thanks to the professionalism of TrafficTech and Jenoptik

out," says Samer Amarin, project manager of Traffic Tech Middle East/Jordan.

Project growth

Last but not least, the professionalism and fast response that the client experienced with both Jenoptik and Traffic Tech, encouraged them to increase the project scale significantly.

by **Don Hunt**

It's not a problem if states have different autonomous car regulations

With the issuance of the USDOT Federal Automated Vehicles (AV) policy in September 2016, it became acceptable for states to begin stepping up with implementation strategies for AVs. And in the last quarter of 2016, indeed they did. Much can be learned from looking at the reports, regulations and laws recently implemented in three states.

In October, the California Department of Motor Vehicles revised its draft AV regulations. Most important, the revised rules provide a path for the testing and deployment of fully driverless vehicles (no 'safety driver'). However, the revised draft met with immediate criticism from industry on numerous fronts, including issues related to annual reporting, data sharing, and vehicle safety certification with NHTSA's 15-point checklist.

Moreover, requiring the approval for driverless testing from each local government almost ensures a lengthy and fragmented implementation process.

In November, PennDOT issued its draft report and, as has been widely reported, Uber is now testing its self-driving vehicles with fare-paying passengers in Pittsburgh. The testing has been arranged through informal cooperation with the city, and no permits were required.

A month after the draft report, PennDOT issued its proposed AV testing policy and immediately received industry criticism. Just as in California, the AV industry raised issues about testing proposals and data sharing. PennDOT also proposed a testing contract that assures the vehicles would meet all federal and state safety standards. Meanwhile, a Pennsylvania Senate bill separately introduced differs from the PennDOT approach. The AV industry is urging PennDOT to hold back its new requirements and allow legislation to establish a framework.

Finally, in December, Michigan took the big step of allowing highly automated, self-driving vehicles through legislation. The Michigan laws move past AV testing to also allow deployment of on-demand networks of self-driving vehicles on public roads. The Michigan laws have been praised, primarily because the home of the US auto industry is strongly supporting testing and deployment of AVs with minimum regulation. However, the laws have been criticized as using inconsistent and unclear language, and should not serve as a model for other states. The tech companies also worry the language favors existing auto makers in the roll-out of on-demand AV networks.

> "The USA is likely headed toward a 50-state AV experiment"

As a state DOT or DMV, what's the right approach? One clear conclusion from last year's actions is to establish a strong partnership with your legislature and the AV industry before moving forward with any laws. Looking at California, another conclusion would be to avoid general legislation requiring a state DOT or DMV to write extensive regulations. Regulators are trained to remove public risk, even if it means slowing innovation that would better protect long-term public safety.

Absent stronger direction from the federal government, the USA is likely headed toward a 50-state experiment in regulating AVs, especially as we move from testing to deployment. Does this result in the dreaded national patchwork, or the beauty of a federal system of strong states experimenting with different approaches as technology advances? I tend to side with the latter – we are in a decade-long transition of mobility, and differing approaches will get us a better result in the longer run.

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

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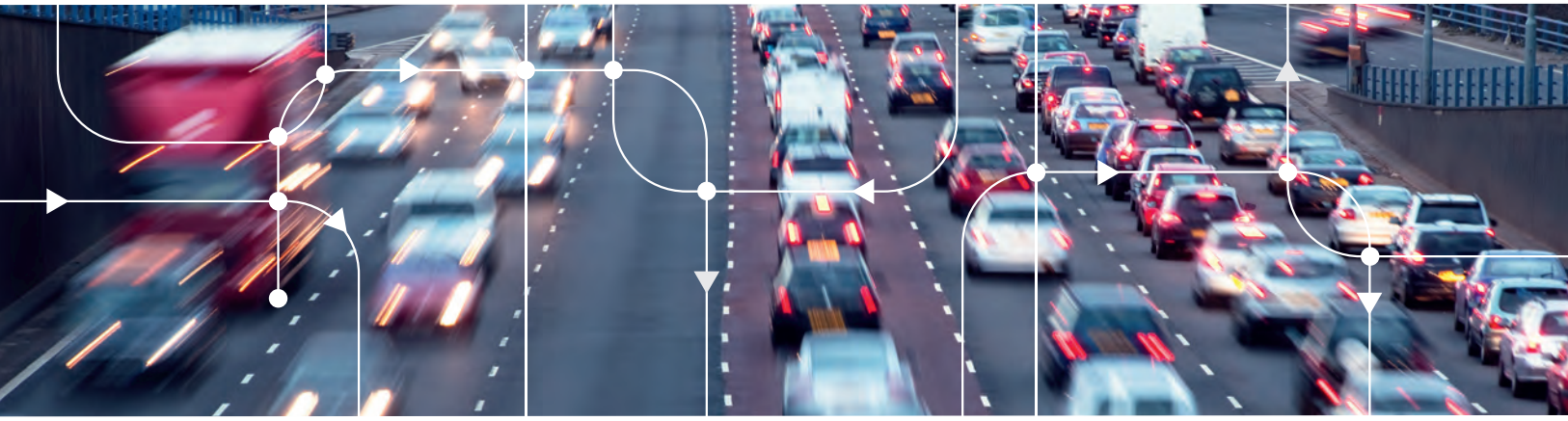

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Expanding the area covered by pedestrian detection systems

As smart cities work to manage congestion and necessarily become less vehicle friendly, the need to move more pedestrians safely across higher traffic densities with even more efficiency has grown. As pedestrian numbers grow, so too will the waiting areas before they cross the road, which will require ever-larger detection zones.

Building on the success of its 640 pedestrian detector, which has delivered reliable detection over a 3 x 2m zone in 15,000 installations worldwide, AGD has developed a product to detect within a larger 5 x 3m wait area. This pedestrian detector would improve detection over a larger zone, and can connect straight into smart city IP (internet protocol) networks for real-time intelligence.

The result is the first of AGD's IP-capable traffic and pedestrian control detection solutions, the AGD 645 pedestrian detector, which features a unique wi-fi 'Touch-setup'. The new 645 is an optical platform that will make crossings safer by delivering robust detection within a larger zone than was previously possible, with multiple units comfortably covering the new-style 'super-crossings'.

The new 645 pedestrian detector by AGD Systems

Larger detection areas need to reliably detect people and bicycles, while masking out background clutter such as bollards and fences. They must also cope with diverse lighting changes such as sunlight, clouds, rain, shadows and headlights, and ignore unwanted distractions such as birds, litter and puddles.

The 645 uses powerful 3D HD imaging technology for accurate, well-defined detection and is quick to configure with AGD's secure no-software wi-fi Touch-setup. It is a high-performance product that processes information on board with new chip-set and sophisticated algorithms for automated decision making for ultra-reliable detection. Being IP-capable means the 645 can feed information and video down the wire straight into ITS control rooms to empower truly informed decision making.

Additionally, the IP capability offers extra functionality, which enables control-room operators to see what is happening on the crossing in real time while the 645 continues to operate. This capability will probably become a requirement of all future detection solutions.

Installation savings

With improved safety addressed as a first priority, thanks to a larger enhanced detection zone and its IP communications capability, the new 645 will meet current and future demands. It is both easy and quick to deploy – bringing substantial savings on installation costs.

The AGD 645 has undergone rigorous trials. Testing at pedestrian crossings across the UK has shown that the 645 can detect people while rejecting shadows and small objects, such as birds entering the zone.

A trial to demonstrate the capability of the low-light sensitivity sensors has also been undertaken at a poorly illuminated crossing (<18 lux). It demonstrated that even in these near-dark conditions, people were still detected and crucially, when vehicles did pass, headlights were safely ignored.

The robustness of the AGD 645 has been proven by successfully working in snow and pitch-black conditions, with the aid of a near-infrared illuminator.

By design, the 645 also delivers on the total cost of ownership. Designers, integrators and stakeholders are used to the low-maintenance, long-life and cost-effectiveness of AGD products, but the new wi-fi Touch-setup of the 645 is a game-changer. It makes the complex simple. The three-step Touch-setup enables installers to: name the device, select the zone, and click to calibrate – using a wi-fi-enabled smartphone or tablet to securely 'talk' directly to the device. It can be adjusted for zone changes just as quickly in the same way.

The future of the 645 is clear, with many interesting developments designed into the product's internationally focused road map – for example, the ability to radically improve efficiency by integrating with the smart radars AGD is investing in heavily. Combining smart pedestrian-detection devices with non-intrusive traffic management radar reduces intersection infrastructure costs, installation time, and road space occupancy.

Production units will be available from July 2017.

Need to know

Smart cities require larger waiting areas for pedestrian crossings

- The new 645 pedestrian detector covers a 5 x 3m area – expanding on the 3 x 2m covered by its 640 predecessor
- The 645 uses 3D HD imaging and can quickly be configured with AGD's secure wi-fi Touch-setup
- Outstanding shadow and clutter rejection enables detection of pedestrians in poor light conditions

Pushing the boundaries of virtual-reality driving simulators

The Japanese interactive virtual reality (VR) specialist Forum8 is experiencing a considerable growth in the demand for driving simulation (DS) systems that can replicate the real driving experience. Apart from the multimillion-dollar hexapod-based units, there is a growing demand for lower-cost systems using the same interactive 3D VR driving simulation and modeling software, VR-Design Studio.

DS applications range from researching human factors in universities such as Morgan State in Baltimore, Maryland, or the University of Engineering and Technology, Taxila in Pakistan, to road safety studies by Kentucky's Department of Transportation and stakeholder consultation in Wisconsin. In addition, an emerging use is in the research and development of autonomous vehicles and advanced driver assistance systems by major car companies.

There are many reasons for choosing DS over real, on-road driving, including: convenience, efficiency, ease of reproducing required conditions and, of course, cost. Another major factor is the ability to test, monitor and record the driver and the vehicle under an almost infinite number of driving scenarios and environmental conditions, all within the safe confines of a laboratory or driving school.

VR-Design Studio is an interactive 3D VR simulation software from Forum8

When the above benefits are coupled with the ability to cluster a number of individual driving simulators together, all driving within the same 3D space, you have a virtual system that would be very difficult to replicate in real life.

A primary objective of any interactive VR driving environment is to simulate the real world as accurately as is possible. This includes being able to reproduce and control every conceivable environmental effect including the time of day, geographic location, shadows, streetlighting, car headlights, puddles, rain and snow.

DS software such as VR-Design Studio also needs to be able to set and control all aspects of road traffic, including number of lanes, vehicle speed, volume and direction, as well as traffic signals and intelligent transportation system signage. The DS system's scenario editor should also enable any number of 'what if' events to be produced, easily and quickly, and allow them to be triggered either automatically through 'way points' within the road network, or remotely by the instructor/researcher.

Systems such as Forum8's VR-Drive also enable the vehicle's physical dynamics to be controlled and simulated, as well as the sound of the engine, horn and tires (on different road surfaces). In addition, crash sounds can be reproduced, as well as the noises of rain, wind, thunder and lightning.

A range of software interfaces (plug-ins) means that data from specialist software such as CarSim and CarMaker can be integrated within the overall VR-Drive system – as well as allowing many other data sources to be entered such as lidar and micro-simulation traffic and pedestrian data.

The result is that by using VR-Drive, an instructor or researcher can monitor all the virtual drivers within the road network simultaneously, on a remote tablet or PC, and can interact with, or change, the driving conditions dynamically.

In addition, they can confront the drivers with any number of distractions and 'real-life' driving situations and can monitor their reactions either in real time or later, by means of the datalogger and driver diagnosis module.

Additional VR-Drive developments allow Forum8 simulators to take advantage of the motion systems produced when D-BOX actuators are employed, or head-mounted displays such as Oculus Rift to provide the driver with a more immersive option to normal DS display screens.

One of the more esoteric developments is the use of the Kinect depth sensor as an 'air driving' device that enables the movement of the driver's hands and feet to control the steering wheel, accelerator and brakes.

Need to know

Driving simulators are for more than just video games

- Universities, US state DOTs and major car companies benefit from driving simulators
- VR-Design Studio can simulate the sounds of engines, tyres, traffic, weather and pedestrians
- Specialist software and other data sources can be added to the simulation

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A senior technical officer at Transport Department, Hong Kong
A principle ITS engineer at New Zealand Transport Agency
A director at Korea Road Association
A senior engineer at Denso, Japan
An IoT solutions executive at IBM, Singapore
Plus senior transportation officials from seven national transport agencies

Next issue...

- Automatic license plate recognition
- Communication networks, Ethernet and cabling infrastructure
- ITS and the cloud
- Cooperative systems and V2X communications
- Surveillance and national security
- Vulnerable road users

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Express lanes

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"We acquired our first drones in August and started using them right away to assess their potential. They've been flown specifically for workzones, and we'll be seeing how best to integrate them"

***Bill Viste**, aeronautics project coordinator at IDOT*

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"The basic concept is to make traffic flow like fish. The question is how to achieve that. Safe Swarm uses DSRC for wireless car-to-car communication and we have developed some unique algorithms"

***Shige Saigusa**, principal engineer at Honda R&D USA*

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"There's been a lot of research on controlling congestion on major highways, but relatively little looking at controlling traffic on urban arterials"

***Ted Morris**, research engineer, department of computer science, University of Minnesota*

Find out more about the latest research on the effectiveness of roundabouts for traffic flow traffictechnologytoday.com/roundabouts

"Our aim in the next 20 months is to develop, equip and test a complex system of wireless in-vehicle mobile devices and roadside technology. We plan to install 40 roadside units, in a test area spanning one square mile"

***Steve Novosad**, senior project manager at HNTB*

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"America's highway network is woefully underperforming. It's outdated, overused, underfunded and in need of modernization"

***Dr Alison Premo Black**, chief economist at ARTBA*

Read more about ARTBA's report on 56,000 US bridges being structurally deficient traffictechnologytoday.com/usabridges

"It's staggering we live in a city where the air is so toxic that many of our children are growing up with lung problems. If we don't make drastic changes now, we won't be protecting the health of our families in the future"

***Sadiq Khan**, Mayor of London*

Find out more about London's plans to have the most stringent emissions standards in the world by October traffictechnologytoday.com/london

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Facts & Figures

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

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